Evolving Regions

The Evolution of Regional Industries in Indonesia

Khairul Rizal
13080013

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Bartlett School of Planning, University College London

I, Khairul Rizal, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

This research seeks to explain the unevenness in development across Indonesian provinces. Existing studies are mostly framed by mainstream growth theory in an attempt to explain the divergence and/or convergence of regional rates of economic growth. Those studies, however, pay insufficient attention to geographically specific socio-political relations in shaping the capacity of regions to grow toward different, and usually diverging, paths of development. In investigating why and how regions differ in their capacity to carry out development, an evolutionary approach is adopted to reveal the place-specific aspects influencing regional growth. This research particularly looks at an important aspect of regional development, i.e., its industry structure. Regional industry structures arguably mirror regions' capabilities in developing new industries, which, in turn, shape its future development paths. Regional change is understood as an industrial branching process, with regions diversifying into industries related to the existing industry structure. While new industries are important for regions seeking to diversify their economic bases, the direction of regional evolution is often assumed to be moving toward more sophisticated industries. In fact, industries that are highly motivated by lower domestic factor costs may cause regions to pursue low-end economic activities. Moreover, while the endogenous process of industrial branching is observed in regions of the countries in the Global North, work on regional development in the countries of the Global South highlights the role of exogenous relations, often in the form of foreign direct investment (FDI) in initiating development processes. This thesis thus improves evolutionary work on industrial branching by taking into account the direction of branching, the role of FDI, and the influence of factor costs in the evolution of regional industry in Indonesia. Most importantly, the interaction of those endogenous forces and other factors of production is shaped by specific regional institutions, which are part of the analysis as well.

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IMPACT STATEMENT

My research is strongly driven by the motivation to improve the formulation of regional policies in Indonesia. Here, I will elaborate the way in which I channel my research to realise its impacts on the making of regional policies at national level.

As a bureaucrat working for the Deputy Minister for Regional Development Affairs, under the Minister of National Development Planning, I have a unique 'spatial advantage' for being close to the centre of policy making process. One of the duties of my office is to provide the minister with regional policy analysis and proposals to be considered in the national development plan. The opportunity is widely opened as my office is preparing what is known as the background study for the next National Mid-Term Development Plan 2020-2024. Once I concluded my viva in March 2018, I have been officially appointed as technical team leader for the background study, responsible for conducting technical analysis as basic ingredients for policy formulation concerning nationwide regional development for 2020-2024 period.

The framework of the background study itself consists of three main components. It is started by macroeconomics analysis setting up some macro targets for national economic growth, poverty reduction, and unemployment level for 2024. These macro targets are then disaggregated by sub-national level (provinces). The second component identifies regional potential sectors and products in each province that can be promoted to achieved those sub-national targets. This component is substantially relevant to what my thesis does in Chapter 4. The last component discuses about what should government do to promote the development of those products. This includes providing sufficient infrastructures, supportive institutions, required skills and education as well as monetary and fiscal policies.

As of writing this statement, I am in the middle of advocating the method of product relatedness that my research adopted to identify potential products of each province. This method allows us to identify prospective – but not developed yet – products of which provinces are likely capable to promote, improving the chances of success for provinces to diversify their economic activities. This method, as argued in my thesis, is more relevant for the formulation of regional policies compared to the conventional methods that are primarily based on comparative advantages or export competitiveness analysis that focus too much on extant and already developed products.

This method has been also presented to the Centre for Policy Analysis under the Ministry Office.

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ABBREVIATIONS

AMS	Annual Manufacturing Survey
API	*Asosisasi Pertekstilan Indonesia* (Indonesian Textile Association)
Bappeda	*Badan Perencanaan Pembangunan Daerah* (Regional Development Planning Agency)
Bappenas	*Badan Perencanaan Pembangunan Nasional* (National Development Planning Agency)
BKPM	*Badan Koordinasi Penanaman Modal* (Investment Coordination Board)
BPS	*Badan Pusat Statistik* (Central Agency of Statistics / Indonesian Statistics)
CAS	complex adaptive system
CME	coordinated market economy
DEPANRI	*Dewan Penerbangan dan Antariksa Nasional Republik Indonesia* (National Council for Aeronautics and Space)
EEG	evolutionary economic geography
FDI	foreign direct investment
FE	fixed effects
GCI	Global competitiveness index
GD	generalised Darwinism
GDP	gross domestic product
GD-PP	generalised Darwinism-path dependence
GFC	global financial crisis
GOI	Government of Indonesia
GMM	generalized method of moments
GPE	geographical political economy
GPN	global production network
GVC	global value chain
HS	Harmonized System
IEG	institutional economic geography
I-O	input-output
IPTN	*Industri Pesawat Terbang Nasional* (National Aircraft Industry)
ISIC	International Standard Industrial Classification
ITB	*Institut Teknologi Bandung* (Bandung Institute of Technology)
KBLI	*Klasifikasi Baku Lapangan Usaha Indonesia* (Indonesian Standard Industrial Classification)
KLUI	*Klasifikasi Lapangan Usaha Indonesia* (Indonesian Industrial Classification)
KPPOD	*Komite Pemantauan Pelaksanaan Otonomi Daerah* (Regional Autonomy Watch)
LAPIP	*Lembaga Persiapan Industri Penerbangan* (Taskforce for the Preparation of the Aircraft Industries)
LIPNUR	*Lembagai Industri Penerbangan Nurtanio* (Nurtanio Aerospace Industry Agency)
LKB	*lembaga kerjasama bipartiet* (bipartite body)
LME	liberal market economy

LPM	linear probability model
MBB	*Messerschmitt-Bolkow-Blohm*
MME	mixed market economy
MNC	Multinational Corporation
NEG	new economic geography
NESOI	not elsewhere specified or included
NGO	non-governmental organization
OLS	ordinary least squares
PKB	*Perjanjian Kerja Bersama* (Working Agreements)
PD	path dependence
PTDI	*PT Dirgantara Indonesia* (Indonesian Aerospace Limited Enterprise)
R&D	research and development
RCA	revealed comparative advantage
RE	random effect
REG	relational economic geography
RGDP	regional GDP
RPJMN	*Rencana Pembangunan Jangka Menengah Nasional* (National Mid-term Development Plan)
RPJPN	*Rencana Pembangunan Jangka Panjang Nasional* (National Long-term Development Plan)
SMEs	small and medium-sized enterprises
UN	United Nations
UNCTAD	United Nations Conference for Trade and Development
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VoC	varieties of capitalism
WB	World Bank
WEF	World Economic Forum
WTO	World Trade Organization

Abbreviations for provinces

ACH: Aceh, NSM: North Sumatera, WSM: West Sumatera, RIA: Riau, JAM: Jambi, SSM: South Sumatera, BKL: Bengkulu, LAM: Lampung, BBL: Bangka Belitung, RIS: Riau Islands, JKT: Jakarta, WJV: West Java, CJV: Central Java, YOG: Yogyakarta, EJV: East Java, BAN: Banten, BAL: Bali, WKL: West Kalimantan, CKL: Central Kalimantan, SKL: South Kalimantan, EKL: East Kalimantan, NSW: North Sulawesi, CSW: Central Sulawesi, SSW: South Sulawesi, SESW: South East Sulawesi, GOR: Gorontalo, WSW: West Sulawesi, WNT: West Nusa Tenggara, ENT: East Nusa Tenggara, MAL: Maluku, NMA: North Maluku, WPA: West Papua, PAP: Papua.

ACKNOWLEDGMENTS

Any ideas presented in this thesis do not suddenly come out of nowhere, but from pre-existing ideas and information that influence my learning and understanding. These ideas and information emanate from people whom I met and talked to and embedded in the texts that I read through. What I have actually done is to merely craft all of those ideas and pieces of information to constitute a tiny piece of knowledge that I consider to be novel.

Writing a 240-page thesis was apparently not an easy work, and it took a small village of supporting people to complete what I started. I am certainly indebted to those who trained and assisted me since the very early stage of my research. In this opportunity I would like to express my deepest gratitude to:

My first supervisor, Jurgen Essletzbichler, who introduced me to evolutionary way of thinking in the field of economic geography and relentlessly encouraged me to apply quantitative method in my research.

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Last, but certainly not least of all, I would like to express my profound appreciation to my lovely wife Dea Supit who sacrificed much of her time to support my study and patiently went through all the tough moments during our journey in London.

CHAPTER I
INTRODUCTION

This research studies the unevenness in development across Indonesian provinces from the perspective of evolutionary economic geography (EEG). Specifically, this thesis focuses on regional industry structures, which, by themselves, reflect the industrial capability of regions seeking to diversify. Put simply, the existing industry structures shape the future development paths of regions. However, such endogenous evolutionary processes of industrial diversification also go hand in hand with other factors of production, such as capital, labour costs and even regional institutions. The analysis in this thesis covers those factors that are exogenous to industry structures as well by investigating their relative importance and exploring their dynamic interaction with evolutionary forces. The result is expected to lead to important policy conclusions on regional industrial development in Indonesia.

Differences in development, which have been puzzling scholars for quite some time (Barro and Sala-i-Martin, 2004; Helpman, 2004; Rodríguez-Pose and Gill, 2004; Ross-Larson et al., 2008; Sheppard, 2009), have been a central issue in development discourse (Gallup et al., 1999; Ozler et al., 2005; Engerman and Sokoloff, 2002; Easterly, 2007; Perkins and Perkins, 2006; Ross-Larson et al., 2008). A wide range of theoretical work has been put forward, seeking to explain the phenomenon. Neoclassical growth theory predicts long-term equilibrium for regional growth rates where regional inequalities will eventually be equalized through the mobilization of factors of production and the diffusion of technology. Endogenous growth theory improves the explanation by taking into account an increasing of returns element in its model. Yet, Marxist theory views regional development as a result of dynamic relations between capital and labour, which are unequal and exploitative. Others focus on what Rodrik (2002) calls deep determinants, such as institutions, trade and geography.

Recently, EEG has emerged as a major school of thought, which considers economic growth as the result of cumulative processes built up over time (Hodgson, 2009, p. 170). Within this view, a region evolves along its own development path which depends on, but is not determined by, its previous pathway. The role of geographically and historically specific contexts for regional growth is one of the central issues in the field of economic geography, which seeks to explain the transformation process of the economic landscape (Boschma and Martin, 2010). While much of the empirical works examine regional economic evolution in countries of the Global North, this thesis draws on evolutionary approaches in economic geography in order to understand regional evolution in Indonesia.

Focusing on regional evolution in a country of the Global South is expected to add a number of insights. First, there are a few empirical works on EEG that focus on countries of the Global South. This study thus hopes to explore the applicability of the EEG concept to the Global South context. Second, the evolutionary economic literature on industrial branching assumes relatively isolated regional containers in which development occurs (Boschma and Wenting, 2007; Frenken and Boschma, 2007; Neffke et al., 2011). Any change thus emerges from interaction between sectors within those regional containers. A focus on endogenous development processes as drivers of economic growth may work for regions with a developed set of capabilities, human capital, and absorptive capacity, but may stifle economic development in peripheral countries and regions without those developed capacities. Hence, endogenous processes of development need to be juxtaposed with processes of industrial development initiated through external economic links, such as FDI flows.

Before establishing the objectives and research questions, we first need to elaborate the main arguments and justifications for the choice of Indonesia as a country case study, the adoption of an evolutionary approach, and the focus on industry structure as follows.

1.1 Justification of the Indonesian case

1.1.1 Empirically unique and theoretically insightful

The choice of Indonesia as the locus of study mainly departs from the fact that Indonesia is part of the Global South, with EEG still lacking empirical evidence with regard to transition countries such as Indonesia. Besides, it highlights certain factors that may contribute to theoretical improvement. First, the size of FDI in Indonesia is rather dominant relative to domestic investment. According to Indonesian Statistics (BPS), on average, it constitutes around 60% of total capital invested every year in Indonesia, which could challenge the role of evolutionary forces in shaping industrial diversification. Given the inconclusive evidence on the effect of FDI (Iršová and Havránek, 2013; Iwasaki and Tokunaga, 2014), the overall outcomes of the interaction between evolutionary forces and FDI will hinge on the policies imposed by the government (Phelps, 2008).

Another challenge may relate to the fact that Indonesia is either blessed or cursed on account of its abundant natural resources. It is often theoretically assumed that the direction of regional evolution moves towards more advanced economic activities. In fact, the evolution of regions is open to any direction of travel, either toward high-end or low-end industries (Martin and Sunley, 2006, p. 418). Weak industrial capacity could be one of the plausible factors why regions choose 'low-road' of evolution. Another reason could be the strong temptation surrounding the exploitation of natural resources for quick and easy profits. The case of Indonesian provinces exhibits some variations in these possibilities. As we discuss in Chapter 4, some provinces grew into less sophisticated industries, while others improved in terms of their sophistication level. The theoretical implication of this phenomenon is that what is important in regional evolution is not merely the quantity but also the quality of the evolution itself.

Third, Indonesia is a diverse country in terms of its socio-economic institutions. The role of institutions has been considered pivotal in economic geography, both by EEG and IEG. Regional institutions guide the way in which the economy is managed by economic agents. At the same time, the manner in which economic agents interact incrementally reshapes the institutions where the interactions take place (Bathelt and Glückler, 2014; Gertler, 2010). Aligned to that, is the way the branching process must take place within a certain institutional setting, while different institutions will probably result in different branching trajectories. The Indonesian case could enrich analysis by offering the opportunity to explore a diverse set of regional institutions through which the branching processes is occurring.

1.1.2 Regional inequality in Indonesia: conclusive but inconsistent evidences?

Indonesian regions also exhibit a persistently diverse economic performance. Many studies on inequality in Indonesia were carried out between the 1980s and 2013 (Akita, 2002; Akita and Lukman, 1999; Aritenang, 2012; Garcia and Soelistianingsih, 1998; Hill et al., 2008; Resosudarmo and Vidyattama, 2006; Vidyattama, 2013). Most of these studies were conducted within the framework of mainstream economics. The results, however, seem inconclusive based on the specific measures adopted. Beta convergence[1] suggests a converging pattern[2], whereas sigma convergence reveals widening gap.

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[1] Beta convergence measures whether poor regions tend to grow faster than richer regions, while sigma convergence concerns the overall dispersion of regional growth rates.

[2] Vidyattama (2013) finds converging patterns among regions in Indonesia between 1999 and 2008. Hill et al. (2008) confirm regional convergence in Indonesia for the period 1975 to 2002. Using panel data of GDP per capita between 1993 and 2002, Resosudarmo and Vidyattama (2006) found a narrowing gap between regions after controlling for certain variables that influence growth, i.e., physical and human capital, population growth, and trade openness. Similarly, Aritenang's (2012) findings also show a converging trend after controlling for many variables, including decentralization and the openness index. An earlier study by Garcia and Soelistianingsih (1998) revealed similar results between 1975 and 1993.

The inconsistent empiricism on regional convergence in Indonesia and the lack of attention to a region-specific context motivate this research to look at regional inequality beyond the traditional perspective of mainstream economics. This is not necessarily meant to neglect the works that have been developed thus far. Instead, this research attempts to remedy some of the 'inherent weaknesses' that are sharply criticized in the literature by many social scientists – including the unrealistic assumptions of fully-rational maximizing individuals and equilibrium (see Boschma and Frenken, 2005; Granovetter, 1985; Nelson and Winter, 1982 for example). Responding to those critics, prominent economist Paul Krugman (1999, p. 26) argues that, while maximization and equilibrium are not found in reality, the concepts are useful metaphors 'to organize one's mind' in order to understand economic reality. Nevertheless, persistent regional inequality in Indonesia suggests a strong presence of path dependence that in turn leads this research to adopt an evolutionary approach when investigating the phenomenon.

1.2 Justification of an evolutionary approach

In order to understand how regions grow towards different paths, we need theory that can explain the process underlying regional growth. The previous section highlighted some shortcomings in the mainstream economic frameworks that dominate inequality analysis in Indonesia. This section proposes an evolutionary perspective that remedies some of those shortcomings. Hence, it is worthwhile discussing some merits to this approach.

First, modern growth theory commonly used to analyse economic disparities (at least in an Indonesian context) acknowledges that technological progress and knowledge play crucial roles for regions to grow in the long run. This theory, however, avoids engaging with the dynamics of how knowledge is actually created. This is understandable, as growth theory is built on the micro-foundation of rational choice. Hence, technological progress is viewed as a result of the rational choice of economic agents (usually in the form of investment in R&D and human capital), rather than a learning process that involves the distribution of prior knowledge and the capacity of economic agents[3]. Furthermore, instead of opening up the 'black box' of knowledge creation (Acemoglu, 1996), the rational choice approach tends to focus on the end results of the dynamics. The reason for ignoring the process is that it would make the analysis too complex to be modelled or theorized (see Krugman, 1999, pp. 25-27).

[3] Neffke (2009) discusses this particular issue in rather detail under the heading 'choice versus learning'.

However, if knowledge is important for long term economic growth, then learning as a social process, according to Teece et al. (1997), is a crucial process of acquiring knowledge. If so, ignoring learning processes by jumping to the end result when explaining regional growth could exclude valuable information for future improvement. In this particular context, the evolutionary approach is advantageous, as it offers some tools to analyse the incremental process of regional growth.

Second, mainstream growth theory puts too much attention on the relative abundance of factors of production, such as capital, land, and labour (and, to some extent, human capital). The idea is that the production of output is highly abstracted into a combination of different sets of factors[4]. Once regions manage to accumulate these factors, growth is likely to occur. The theory, however, neglects two important factors. The first is that regions are complex networks of economic and social relations embedded in historically and geographically specific institutions and cultural practices on which the capability of regions is accumulatively built. The second is that the development path of each region is based on its historically evolved structure, which constrains and enables future growth and development. As the structures of economic networks arguably reflect the capability of regions, the adoption of an evolutionary approach allows this research to look at the specific history of how this structure evolves and eventually shapes regional development paths.

Lastly, the choice of using an evolutionary approach is driven by the fact that this kind of research is still under-represented in the literature with regard to countries of the Global South in general and Indonesia in particular. Therefore, the adoption of an evolutionary analysis in this research should enrich the literature on inequality issues in Indonesia. *This can be considered as the novelty of this research*. In addition, much theoretical work on EEG is built at the firm level (Essletzbichler, 2009, p. 163). Even though it has changed over the last five years, empirical works on evolutionary processes at the macro level are still highly focused on countries of the Global North. This research, therefore, attempts to introduce a piece of empirical work to the EEG literature by analysing the evolution of industries at the regional level. *This is the main contribution made by this research*.

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[4] New Economic Geography (NEG) is one exception that takes into account some of the key factors of urban and regional production systems that explain why they would do well/poorly.

1.3 Justification for a focus on industry structures

Although there are important theoretical differences between mainstream growth theory and an evolutionary approach, the two also agree on some fundamental aspects. For example, both camps have emphasised the crucial role of knowledge underlying technological progress for long term growth. The difference is that mainstream economists focus on the end results of technological progress in the form of labour and capital augmenting (Acemoglu, 2003), while evolutionary theorists tend to pay more attention to how knowledge is generated (Lundvall and Johnson, 1994). If knowledge and technology are at the heart of growth, the capacity of regional agents, in this case their industries, in generating as well as absorbing new knowledge will be critical for regions to grow. From an evolutionary point of view, the capacity of regions to generate and absorb new knowledge is path-dependent, meaning that it is influenced by regions' capacity in the past. Schumpeter (1934) shows that the creation of new knowledge is the result of the combination of existing knowledge. Scholars such as Nooteboom (2000) elaborate this notion further by stressing that knowledge combinations and interactive learning processes should effectively take place within a certain cognitive distance. This means that new knowledge is not too far from the existing knowledge base; nor should it be too close to something it can learn from. By scaling up this reasoning to a regional level, the capacity of a region to generate new knowledge is dependent on the repertoire of existing knowledge within the region. Therefore, regions with larger existing knowledge repertoires, i.e., diverse knowledge bases, are likely to have a stronger capacity to create new knowledge through more options of combining the existing ones. If we consider that every production requires a certain type of knowledge, then the diversity of products in a region should mirror its repertoire of knowledge. In other words, regions that are currently capable of producing a wide range of products are likely to have a higher chance of creating new products in the future.

The diversity of products could reflect the existing capabilities of regions to develop new products in the future, but this is not the case if the products produced by regions are products with a low level of sophistication. For instance, a region that produces a wide range of textiles and agriculture products would be considered a capable region with a measure of diversity compared to regions that produce only a few sophisticated products, such as automobiles or electronic products. However, it is generally accepted that producing automobiles and electronic products requires more complex skills and advanced technologies than textiles and agricultural products. According to Hausmann and Hidalgo (2010), products that require a complex set of capabilities will only be produced by a limited number of countries or regions. This means that the ubiquity of such products will be low across regions. Hence, regions that produce uncommon products with limited ubiquity can be considered as having strong capabilities. The combination of the ubiquity characteristic and the diversity characteristic as discussed above will provide a more accurate description of regional capability. In short, the complexity of regional industry structures signals the knowledge capability of those regions.

Having diverse and sophisticated products/industries does not necessarily guarantee that regions can learn and take advantage of something new. If industries located in regions are too dissimilar (in terms of knowledge base, supplier and customer base, skill requirements, etc.), then the generation of new ideas through mixing and matching between industries is unlikely to occur. Simply put, ideas that are too different from one another are more difficult to synthesise. Similarly, having industries that are too similar will prevent a region from developing new products as nothing or little can be learnt from more or less the same thing. Therefore, learning capability is not only about the complexity (in terms of diversity and sophistication level), but also about the cohesiveness (in terms of relatedness between industries) of the regional industry structure. The bottom line is that the existing industry structure matters to the learning processes of regions.

1.4 Objectives and research questions

This research is built on the EEG framework in order to account for regional differences in economic development. The overall research goal is to ascertain the presence of evolutionary forces in a context of industrial development in Indonesian provinces. The hypothesis is that endogenous evolutionary forces shape industrial development in Indonesia, even in the strong presence of external links and seemingly defiant cases. More specifically, the following research questions are set as objectives:

1. Do existing regional industry structures shape industrial growth paths? This question is elaborated into two sub-questions:
    a. Does the cohesiveness of industry structures shape the paths of region's industrial developments?
    b. Does the complexity of existing industry structures constrain and enable regions to carry out industrial transformation?
2. How important are endogenous evolutionary forces relative to exogenous economic links and factor costs in explaining the industrial transformation of regions?
3. How do evolutionary forces really work across industries and to what extent do regional institutions influence the process?

The novelty of this research emerges from the application of an evolutionary framework to examine regional economic change in the context of the Global South. The research specifically contributes to capturing the influences of not only endogenous but also exogenous forces in the form of foreign investments, factor costs and institutions on industrial development paths. The research expects to shed light on the relative importance of these endogenous and exogenous forces in initiating, shaping and constraining economic development in a relatively peripheral country, as well as support or challenge policy conclusions based on evolutionary approaches to economic development.

By being built upon an evolutionary approach, this research is credible as numerous economic geographers have developed several analytical tools to quantify the concept of productive capability and the relatedness of industries. The research questions are answered by utilising data on industry outputs (products), which are acquired from trade dataset both at international and at regional levels, and plant dataset from Annual Manufacturing Survey (AMS), accessible from BPS.

This thesis is organized as follows. **Chapter 1 (Introduction)** establishes the justification of the research, sets the objectives and research questions, clarifies the novelty and significance of the research, and elaborates the thesis structure. Specifically, this chapter offers a justification, which emphasise the choice of Indonesia as the locus of study, an overview about disparity issues in the country in which this research is contextualized, a justification for adopting an evolutionary approach on which this research is built, and a brief outline of a conceptual framework concerning evolutionary forces that are embedded endogenously within industry structures from which the objectives and research questions are drawn.

Chapter 2 (An Evolutionary Approach in Explaining Differences of Economy Space) critically reviews evolutionary approaches in economic geography. The aims are twofold: to establish the theoretical position of the research and to craft a sound research framework. Specifically, this chapter provides an overview of some general theories related to regional economic development, followed by a rather detail theoretical discourse about diverse ontologies in economic geography, on which the adoption of an evolutionary approach is established. This chapter engages in detailed discussion about diverse and perhaps competing frameworks within EEG itself, namely Generalised Darwinism, Path Dependence, and Complex Adaptive Systems. Then, a hybrid theoretical framework is crafted by synthesising Generalised Darwinism and Path Dependence into a single framework. This chapter also elaborates four operational concepts by which the research is carried out, namely, industry relatedness, productive capability, variety of capitalism, and FDI spillover.

Chapter 3 (Methods and Data) explains in detail how the analysis is performed. First, an overview of Indonesian contents is offered, including the cases of two provinces and two industries under examination. Second, the two main measurements of productive capability and industry relatedness are discussed, particularly in terms of how they are constructed and used in network and statistical analysis. Next, this chapter develops the specifications for econometric estimation by including these two metrics and other variables of interest, followed by the elaboration of comparative institutional analysis design, which contextualises the quantitative analysis into a case study of two industries in two provinces. Lastly, we clarify the sources and types of data deployed in the analysis, together with an explanation of their validity and reliability.

Chapter 4 (Cohesiveness and Complexity of Regional Industry Structures in Indonesia) is the first of three empirical chapters in this thesis. The chapter's objectives are to quantify industry relatedness and productive capability in Indonesian provinces. The two metrics are then stylised to decipher patterns and relationships featuring each metric. Specifically, this chapter addresses the first research question about how existing regional industry structures constrain, enable and shape industrial growth paths. Here, regional industry structures are measured by their cohesiveness and complexity. Visual network and descriptive statistical analyses are deployed as tools to reveal the empirical aspects.

Chapter 5 (What Shapes Industrial Development in Indonesian Provinces?) performs a rigorous analysis in order to deliver empirical evidence for the presence of evolutionary forces in industrial development. Built on the foundations of the previous analysis, this chapter investigates the role of evolutionary forces, endogenously embedded within regional industry structures, in driving new industry development relative to other forces, which are exogenous to the structure. The relative importance of 'from within' forces of relatedness and capability will be contrasted to other factors of production such as foreign capital and minimum wage employment. This chapter estimates several econometric models at two levels of analysis, i.e., industry and province, in order to infer which force is more influential in the creative-destruction processes.

Chapter 6 (**Old and New Industries)** reveals the dynamics of evolutionary process by exploring two contrasting cases of textile and aircraft industries in West Java and Central Java provinces. Textile and aircraft industries offer excellent cases where the former exemplifies the rise and fall of related industry while the latter somewhat demonstrates a leap in product development. The differences in evolutionary process are then linked to the specific regional institution in which each process takes place. This chapter performs a qualitative institutional analysis, guided by varieties of capitalism frameworks comprising four elements of industrial institutions, namely, labour market, industrial relations, inter-firms relations and network of knowledge. The industries' response with regard to those institutional elements is thoroughly investigated. This is preceded by historical overview of industrial policies and the development of the textile and aircraft industries.

Chapter 7 (Conclusion and New Research Agendas) highlights the main findings of the research and its theoretical reflections, as well as derives its broad implications for the improvement of future industrial policies and acknowledges the limitations of the research, which should be addressed before pursuing more extensive research on the topics in question.

CHAPTER II
AN EVOLUTIONARY APPROACH IN EXPLAINING DIFFERENCES OF ECONOMY SPACE

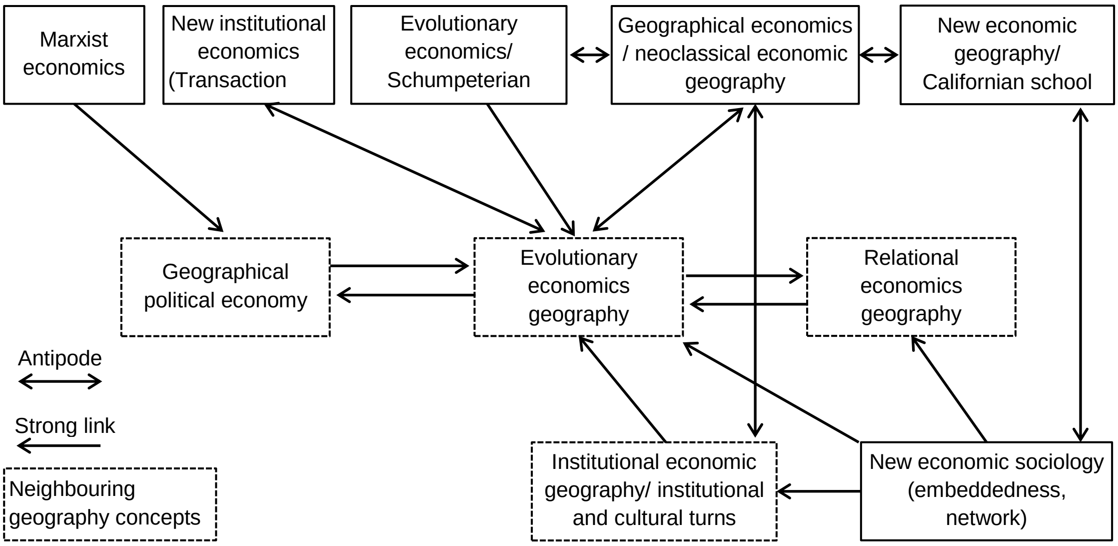
This chapter critically reviews evolutionary approaches in economic geography and discusses some concepts with which to operationalize them, i.e., the concepts of productive capability, industry relatedness and variety of capitalism. The aims are twofold: to establish the theoretical position of the research and to craft a sound research framework. Before constructing the research framework, a brief review of several theories related to economic geography is offered.

2.1 This research within a broader theoretical context

As a relatively young sub-field in economic geography, EEG has been struggling to secure its genuine domain amongst other approaches within the field. In my attempt to position this research within a broader theoretical context, I found in the literature that the struggle has not ended yet, although it has nearly concluded (see Hassink et al., 2014). Therefore, it is important to briefly review the theoretical constellation in which this research is situated. In doing so, I adopt the constellation constructed by Hassink et al. (2014) as presented in Figure II-1. Focus is directed on economic geography, while other theories will be discussed only briefly. We highlight crucial elements of those theories, such as the behavioural assumption underlying the construction of theory, its prediction over regional economic destiny and, most importantly, its relevance to this research.

A theory in social science can generally be classified by its fundamental differences in behavioural assumptions, i.e., into perfect and bounded rationality. As the terms suggests, perfect rationality views the human as a rational economic being who bases his/her economic actions on complete information, self-interest motivation and profit maximisation. Hence, ‘The collective behaviour of agents is assumed to lead to a state of equilibrium in which each agent's position is optimal (expected-utility-maximizing) for her given the positions of the other agents’ (Nau and McCardle, 1991, pp. 199–200). Neoclassical and modern endogenous growth theory (Barro and Sala-i-Martin, 2004; Lucas, 1988; Romer, 1986; Solow, 1956; Swan, 1956), geographical economics (Krugman, 1991) and new institutional economics (North, 1990; Williamson, 1989) are built on this methodological individualism. The strong assumption about equilibrium suggests that the prediction of mainstream economics over economic outcomes across regions is likely to be convergent. However, geographical economics, with its cumulative causation, new institutional economics with its transaction costs[5], and Marxist economics with its exploitative relationship explanation theoretically predict divergent economic outcomes.

Figure II-1 Related Disciplines in Economic Geography



Source: Hassink et al. (2014)

In contrast, bounded rationality (coined by Simon, 1957) assumes that economic agents have many constraints when making their economic decisions because of incomplete information, limited cognitive capacity, inadequate time and so on. Thus, in order to ease the complex situation that they are facing, economic agents partly lay their decision on social/economic/political institutions in which they perform their economic actions. Social sciences adopting this bounded rationality assumption in their theoretical constructions including old institutional economics (Hamilton, 1919; Hodgson, 2000), economic sociology (Granovetter, 1985; Zukin and DiMaggio, 1990), evolutionary economics (Nelson and Winter, 1982), and economic geography with its multiple branches (Amin, 2001; Bathelt and Glückler, 2003; Boggs and Rantisi, 2003; Essletzbichler and Rigby, 2007; Frenken and Boschma, 2007; Hodgson, 2009; MacKinnon et al., 2009; Martin, 2002 amongst others). As these theories are constructed to emphasise the importance of socio-cultural and spatial-specific contexts, all of them envisage divergent economic performance across regions.

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[5] As in the very long run only efficient institutions will survive, the prediction thus eventually shifts toward convergent outcomes.

With regard to economic geography, according to Boschma and Frenken (2011, p. 296), the discipline deals with 'the uneven distribution of economic activities across space'. Economic geography itself is an interdisciplinary field enriched with diverse approaches (Martin and Sunley, 2001). Grabher (2009, p. 119) and Hassink et al. (2014, p. 6) highlight that the diverse approaches in economic geography are highly influenced by theories developed in other social sciences (see Figure II-1). Our reading of the recent economic geography literature revealed four inter-related branches (some call it 'turns' or 'bents') in economic geography, namely, geographical political economy (GPE), institutional economic geography (IEG), relational economic geography (REG), and evolutionary economic geography (EEG). Each branch has its unique characteristics and offers specific approaches in explaining economic space performances.

Reading through the economic geography literature has brought us to an apprehension that, in general, the spatial scale seems still an unsettled issue in economic geography. At what level of space should the analysis be performed has been a contested arena in these aforementioned branches of economic geography. GPE and IEG, for instance, tend to occupy the macro and meso level of analysis (Bathelt and Glückler, 2014, p. 12; MacKinnon et al., 2009, pp. 136–7), while EEG and REG share preferences concerning micro or firms analysis (Boggs and Rantisi, 2003; Boschma and Martin, 2007; Boschma and Frenken, 2005; Essletzbichler and Rigby, 2007; Sunley, 2008). The position of firms in both branches (i.e., EEG and REG) is central to explaining the changes of economic landscape.

Despite sharp criticisms addressed to EEG over its dependence on the micro analysis of firms, thus relegating the role of institutions and power (MacKinnon et al., 2009; Pike et al., 2009), Hodgson (2009) and Essletzbichler (2009) contend that EEG is in fact developed on old institutionalism as its building blocks. While acknowledging the role of institutions in EEG, Boschma and Frenken (2009) argue that its role has not been as significant as envisaged by many institutionalists. They reject the deterministic view of institutions over agency and contend that institutions, particularly at the territorial level, only have weak influences. Evidences are put forward, for example, to demonstrate the ability of firms to set up new branches across regions with different institutions and their ability to grow within a very unfriendly national institutional environment like the customized software industry in Germany (see Strambach, 2010). Support for the indeterminate role of institutions also comes from Gertler (2010) who calls for more commentary on the roles of agencies whose economic behaviours are constrained and enabled by social institutions. Furthermore, Boschma and Frenken (2009) argue that IEG tends to depart from the 'real places' in which institutions are effectively established and shape the actions of economic agents. Meanwhile, EEG starts with a ‘neutral place’ from which specific institutions emerge through in situ evolutionary processes in order to fulfil growing institutional demands. In short, apart from disagreement about the extent of the role played by institutions, there seems to be agreement that there is a tight and close link between EEG and IEG. This research agrees with Boschma and Frenken’s claim that the effect of institutions on agents depends on the spatial level at which it is being analysed (see also Ostrom, 2005, pp. 58–62).

EEG and GPE, however, seem to disagree about the way in which power is incorporated into the analysis. In GPE, capital-labour conflict as a key driver of changes tends to be analysed at the macro level (see MacKinnon et al., 2009, pp. 136-137). The conflict that involves the struggle of and for power to shape political decisions occurs mainly at the territorial level. On the contrary, EEG tends to view routines as the outcome of capital-labour interaction at the firm level (see Boschma and Frenken, 2009, p. 154). Again, the unsettled issue is somehow related to the level of analysis. Nevertheless, the differences in the level of analysis can be considered as complementary, rather than contradictory. As Essletzbichler (2009, p. 164) put it, “A careful analysis of evolutionary and political economy explanations may reveal novel insights into the evolution of the evolving space economy”.

As mentioned above REG and EEG share preferences regarding micro analysis when explaining the dynamics of space economy. The major difference is that REG place a strong emphasis on the importance of power in its relational analysis (Yeung, 2005, p. 44), just as GPE does at the macro level. In its relation to IEG, however, Sunley (2008) disputes the ontology of REG and sees it as part of IEG, rather than a unique paradigm in economic geography by saying “economic geography's analysis of connections and relations would be better set within an evolutionary and historical institutionalism that understands economic relations as forms of institutional rules and practices and does not privilege ties and networks over nodes and agents” (2008, p. 1).

In bridging the complementariness between EEG, GPE, IEG and REG, Hassink et al. (2014) proposes engaging in the pluralism of economic geography, rather than for them to stand alone in their own shell. Addressing the level issue, Schamp (2010, p. 432) puts forward the notion of co-evolution, which interactively analyses the changing behaviour of agents at the micro and meso level with outcomes at the macro level. Indeed, this co-evolution notion has been one of the topics of increasing interest in the empirical research in EEG (Boschma and Frenken, 2011, pp. 302–3).

A summary of the overall review is displayed in Table II-1, which also highlights the relevance of each theory to this research.

Table II-1 Theoretical Review and the Relative Position of this Research

Behavioural Assumptions	Theories	Prediction	Explanations of regional convergence/divergence	Relevancy to this research
Perfect rationality	Neoclassical exogenous growth theory (Solow, 1956; Swan, 1956)	Convergence	Diminishing returns of capital; factors of productions (capital and labour) flow in opposite directions.	This research investigates the relative importance of evolutionary forces against the role of factor costs (labour and wage) and foreign capital (FDI).
	Modern endogenous growth theory (Barro and Sala-i-Martin, 2004; Lucas, 1988; 1986, 1990)	Convergence	Knowledge imitation is 'cheaper' than innovation (diffusion model); knowledge and technical progress in the form factors (capital and labour) augmenting.	Endogenous processes of development will be analysed within evolutionary framework by looking at the complexity and cohesiveness/relatedness of industrial structures rather than the combination of factors of production.
	New Economics Geography/Spatial economics (Glaeser et al., 1992; Krugman, 1991)	Divergence	Increasing returns from agglomeration economies (cumulative causation); efficiency gains from economies of scale.	This research studies diversity of industries that is one of the central concepts in agglomeration economies. This study adds the element of relatedness between industries that is neglected in NEG.
	Marxist economics (Harvey, 2006; Massey, 1984)	Divergence	Unequal struggle for power in global production system (capital vs. labour). Different functions of regions in spatial division of labour	The position of regions in the global production system requires a study of extra-region relations (e.g. FDI).
	New institutional economics (North, 1990; Williamson, 1989)	Divergence*	Some regional institutions are relatively efficient in terms of transaction costs than others.	This research lean its analysis much to the old rather than the new institutional economics.

Behavioural Assumptions	Theories	Prediction	Explanations of regional convergence/divergence	Relevancy to this research
Bounded rationality	Old institutional economics (Hamilton, 1919; Hodgson, 2000)	Divergence	Culture, social norms, political groups and other important factors varies across space, thus its outcome in coordinating economic interactions and reducing uncertainties differs.	Regional institutions play important roles in coordinating industrial development within regions. This research will analyse the influence of regional institutions on the evolution of industrial structures.
	Relational economic geography (Bathelt and Glückler, 2003; Boggs and Rantisi, 2003; Yeung, 2005)	Divergence	Refers to economic sociology theory within spatial landscape.	This research applies network analysis by looking at the relatedness between industries and how industries evolve by learning from related industries.
	Institutional economic geography (Amin, 2001; Hodgson, 2009; Martin, 2002)	Divergence	Refers to economic sociology theory within spatial landscape.	The influence of region-specific institutions will be analysed within the framework of Variety of Capitalism.
	Geographical political economy(MacKinnon et al., 2009; Pike et al., 2009)	Divergence	Refers to Marxist economics theory within spatial landscape.	This research will also analyse the influence of government industrial policies on regional industrial structures. This research however, does not analyse the political struggle in making those policies.
	Evolutionary economics (Nelson and Winter, 1982)	Divergence	Variety, inheritance, selection forces are different across space.	This research adopts evolutionary framework and applies it at regional industry level in which individual industries play the roles of routines in Nelson and Winter's framework.
	Economic sociology (Granovetter, 1985; Zukin and DiMaggio, 1990b)	Divergence	Embeddedness in local political-social-economical specific contexts.	The capacity of regions to diversify its industries is inherently embedded in the current structure of its industries.

Sources: Author's analysis
*) New institutional economics however predicts convergent outcomes as in the long run only efficient institutions will survive.

2.2 Evolutionary approaches in economic geography

According to Boschma and Martin (2010, p. 3), EEG gives appreciation to the importance of history within the economic landscape. The evolutionary approach in economic geography has two inter-related goals: first, ‘to interpret and explain how the economic landscape changes over historical time’; and second, ‘*to demonstrate how geography matters in determining the nature and trajectory of evolution of the economic system* (original emphasis, p. 6)’. Drawing mainly on evolutionary concepts from economics and biology (Essletzbichler and Rigby, 2007; Hodgson, 2002) and complex systems theory (Martin and Sunley, 2007), EEG analyses the process of change in the space economy by examining changes in its elements through repeated, cumulative effects of multiple responses over time (Hodgson, 2009, p. 170). Thus, notions such as path dependence and lock-in are central in EEG.

At this stage, at least three evolutionary frameworks have been put forward by economic geographers, broadly labelled as Generalized Darwinism, path dependence, and complex adaptive systems (Boschma and Martin, 2010). In addition to that, two evolutionary concepts proposed by Durham (1991) and Hull (1989), which are useful but less relevant to this research will be briefly reviewed as well. Each framework has its distinct explanatory power, although they share many common properties. While the presence of several frameworks in EEG can be attributed to different disciplinary origins, there may be a danger that works in EEG lose focus, reflecting the critique raised by Martin and Sunley (2001) when economic geographers took a cultural turn in 1990s. The problem involving a multitude of approaches has been highlighted by Essletzbichler and Rigby (2007) who argue that the absence of a common research paradigm, disagreement on basic principles and a lack of common framework may result in confusion about what an evolutionary approach stands for or what its main advantages and disadvantages are. Therefore, there is urgency here, not only to review the prevalent framework, but also to synthesise it, if possible, into a more comprehensive one.

2.2.1 Generalised Darwinism

One of the frameworks in EEG is Generalized Darwinism (Essletzbichler and Rigby, 2007; Hodgson, 2002). The notion suggests that the approach is drawn from theory developed in evolutionary biology. The basic idea of Generalized Darwinism is that the core principles of evolution i.e., variety, selection and retention are adopted as general framework to understand the evolutionary dynamics in other fields. The concept of variety, selection and retention should be applied within the context specific to the fields (Hodgson, 2002). In the context of economic geography, for instance, the concepts of variety, selection and retention can be employed by addressing questions concerning how different industry structures vary across regions, how some industries emerge and others decline, what the causes for selection are, and how stability, or inertia, is developed and maintained for selection to operate, among others. Within the view of evolutionary economics more specifically, variety is the result of innovation carried out by firms and driven by competition. New designs or products will increase variety in the market. As new products are introduced and become dominant in the market, firms will compete through cheaper product prices. Pressure for cheaper prices drives firms to standardise their production process in order to improve their efficiency and lower production costs. Everything else being equal, relatively more efficient firms will expand their market shares while relatively inefficient firms will decline and eventually bankrupt. The differential growth of firms is the process of selection. Another application of Generalized Darwinism principles, when analysing the evolution of network, comes from Glucker (2007), who argues that variety in the form of network variation is the result of bridging and brokering processes between unconnected or parts of networks. The selection mechanism in a network system occurs in the form of linkage formation. Some networks fail to create new linkages because linkages and interactions are costly to form and mutual in nature (both sides should benefit and agree to be linked), as well as limited capacity to maintain long-term relations once connected. Moreover, the forces that retain a network structure come from two main sources. The first is local externalities of communication, that is, a tendency to interact and link locally. The second is the inertia of a network due to actors favouring the prevailing distribution of resources and power in the network, suggesting a strong link between EEG, REG and GPE.

There are two other evolutionary frameworks that arguably share similar ideas to Generalized Darwinism, as proposed by Hull (1989) and Durham (1991). The first is Hull's notions of 'replicator' and 'interactor'. A replicator is defined as 'an entity that pass on its structure largely intact in successful replication', while an interactor is 'an entity that interacts as a cohesive whole with its environment in such a way that this interaction causes replication to be differential (Murmann, 2003, p. 11)'. In biology, for instance, the individual human acts as an interactor, while human genes act as the replicator. Individuals interact with their social and natural environment and, after a considerable time, adapt genetically[6]. As Hull defines interactor and replicator broadly,

[6] The discussion on replicator and interactor should be linked to genotype and phenotype distinctions (Hodgson and Knudsen, 2012). Within the Lamarckism evolutionary explanation, the changes in the phenotype bring out the change in the genotype (Vromen, 1995, pp. 92–95). Darwinism however, rejects the possibility of change in genotype, thus assuming stable individuals.

the distinction can be employed to understand evolution in social systems. For instance, firms could be considered as interactors, while firm routines could be considered as replicators. The second evolutionary framework concerns Durham's (1991) evolutionary requirements. He identified five requirements that have to be fulfilled by an evolutionary model. These are: (R1) units of transmission, such as genes, ideas and routines; (R2) sources of variation, such as gene mutation in biology, or innovating new products in an industry; (R3) mechanisms of variation such as sexual intercourse in biology, or spin-off or technological imitation; (R4) processes of transformation such as natural selection in biology, or market selection in the social sphere; and (R5) sources of isolation when analysing two distinct populations.

Despite the prospects it offers in understanding economic dynamics, Generalized Darwinism poses some challenges that need to be addressed. Amongst others is related to the selection mechanisms and the level at which selection operates. Essletzbichler and Rigby (2007) points out that 'within the evolutionary framework more squarely, it is still unclear whether firms are the most appropriate unit of selection within the economy' (p.554). This issue is also highlighted by Frenken and Boschma (2007), who query the spatial scales of selection mechanisms.

2.2.2 Path dependence

The notion of path dependence has been widely used in evolutionary economics and in other disciplines, ranging from anthropology and history to political science, sociology and management (Martin and Sunley, 2006). This concept attracted much attention after the influential works of Paul David (1985) and Brian Arthur (1994, 1989). According to Martin and Sunley (2006), path dependence is "one whose outcome evolves as a consequence of the process or system's own history" (p. 399). Drawing from the literature, they classify path dependence into three broad perspectives, i.e., path dependence as technological lock-in, as dynamically increasing returns, and as institutional hysteresis. The first perspective is associated with David's analysis of the emergence and lock-in of the QWERTY typewriter keyboard as the industry standard. The inventor, Christopher Latham Sholes, designed the QWERTY keyboard in 1868 to reduce the speed of typing by avoiding the problem of jammed keys. While this made sense at the time of conventional typewriters, it is inefficient in the era of digital computers. Despite the inefficient outcome, the decision to adopt the QWERTY keyboard arrangement in the past has led to lock-in effects, which are very unlikely to be reversed. The QWERTY keyboard case was used by David to describe the adoption of a new technology as a lock-in process. Three key features of David's theory of path dependence are worth highlighting. First, small events in the past could have a long-term effect and thus affect the future as well. Second, human decisions taken early on in a technology's or industry's history eliminate alternative paths and validate the chosen path. Third, technological lock-in is characterised by technical interrelatedness (difficult to shift as the use of existing technologies is compatible with other technologies), economies of scale (current technologies have reached economies of scale relative to alternative systems or technologies) and quasi-irreversibility (associated with sunk cost invested in current technologies). In sum, there is a strong tendency for lock-in to occur once we have decided to adopt a certain technology, instead of its alternatives.

What is interesting is that the concept of lock-in itself is not unproblematic. In David and Setterfield's (1993) views, lock-in is a sort of equilibrium or steady state from which it is difficult to escape. The difference, however, is reflected in David's belief that exogenous forces can release a technology or system from being locked-in, while Setterfield argues for endogenous forces. A different view of lock-in is offered by Arthur (1989), who defines lock-in as 'rigidification' or increasing inflexibility.

The discussion about lock-in is often perceived in negative terms. However, Martin and Sunley (2006) argue that lock-in can have both positive and negative effects. At the initial stage, lock-in may provide positive externalities in terms of increasing embeddedness, inter-relatedness and overall stability to a system. However, if inter-relatedness and embeddedness become too strong, they produce rigidity and negative externalities in the form of lower varieties, which can hamper the innovation process and economic performance. Furthermore, they identify several sources of negative lock-in: natural resources, sunk costs of local assets and infrastructure, local external economies of industrial specialisation, regional technological lock-in, economies of agglomeration, region-specific institutions, social forms and cultural traditions, and interregional linkages and interdependencies (p. 412). The crucial question, then, is how to avoid negative lock-in while, at the same time, maintaining its positive effects. This question urges us to understand the boundaries that distinguish positive and negative lock-in. Nevertheless, lock-in is not an inevitable phenomenon, as some authors have proposed several plausible ways for escaping negative lock-in and creating new paths (Lester, 2003). These include indigenous creation, heterogeneity and diversity, transplantation from elsewhere, upgrading of existing industries, and diversification into related industries (Martin and Sunley, 2006).

The second perspective of path dependence, proposed by Brian Arthur (1989), focuses on the process of increasing returns that reinforce the existing development paths through positive feedbacks from various externalities and learning processes. The positive externalities can be in the forms of falling unit cost to increased output, coordination effects, self-reinforcing expectations, and dynamic learning effects. In his models, Arthur (1989) demonstrates how increasing returns explain the location of new industries as a path-dependent process. He used spin-off, defined as a new entrant firm founded by a former employee of a firm in the same industry, and agglomeration effects to develop his model. His model revealed that the probability of each region to generate new spin-offs and agglomeration economies is proportional to the number of firms in the industry already located in a region. In other words, the greater number of firms established in the same industry in a region, the higher the probability that spin-off will occur and agglomeration economy effects will kick in. The spatial pattern of the industry, therefore, is dependent on the number of early spin-off dynamics and the concentration of firms found in a region. Once increasing return effects are set in motion, further concentration of the industry in that region occurs, relative to other regions.

The third perspective on path dependence is institutional hysteresis. This perspective, as argued by Setterfield (1993), emphasises the co-evolution between institutions and the economy. In the short-term, an institution is considered to be exogenous to the economy through which economic activities are framed; see the discussion on neutral place and real place by Boschma and Frenken (2005). Institutions provide some degree of certainty for economic agents to take decisions under uncertain market conditions and with imperfect information. In the long run, however, institutions adjust to and are shaped by economic activities in the economy. Thus, it is considered as endogenous to the economy, in the sense of displaying continuous interdependency with economic dynamics. This recursive relation between institutions and the economy makes gradual changes in institutions path-dependent. This perspective is similar to complex adaptive thinking, which will be discussed shortly.

Although path dependence is often understood synonymously with evolutionary economics, Witt (1992) challenges the path dependence approach for its lack of an endogenous mechanism to generate novelty. How one form of novelty is generated and how it is selected over other alternatives seems to receive little or no attention from the path dependence approach. Furthermore, Vromen (1995) argues that path dependence and lock-in are the results of deeper evolutionary mechanisms, such as selection and adaptive learning, while other authors, such as Garud and Karnoe (2001), argue that path destruction and path creation are inherently parts of path-dependent processes. Martin and Sunley (2006) seem to share the latter view, while arguing that path dependence also displays a variation and selection mechanism, given that "… place-specific histories and possibilities of capabilities and competence building, expectation formation, and organizational and institutional creation, produce variety and heterogeneity in the economic landscape, and hence constant pressure for path destruction and opportunities for new path creation" (p. 424).

Perhaps the biggest challenge faced by the path dependence approach, and probably evolutionary studies in general, is related to the objects of study. At what levels (firms, industries, clusters, technologies, institutions, cities, or regions) does path dependence occur? Addressing this issue, David (1994) proposes technological and institutional paths, as the main carriers of history, are appropriate units of analysis as well as building blocks for an evolutionary approach. According to Martin and Sunley (2006), it is possible to have multiple path-dependent trajectories within a region. These paths may be related (path interdependence, where two or more paths are co-evolving and mutually reinforcing) or different and unrelated. In contrast to David (1985), they propose a macro, system-wide level for path dependence analysis.

2.2.3 Complex adaptive systems

Another stream of evolutionary thinking is based on complexity system theory. If Generalized Darwinism is based on evolutionary biology principles of variety, selection and retention, complex-adaptive systems theory concerns the emergence of new system properties from interaction between their lower-level elements. Most importantly, these emerging properties at the system level are neither reducible to nor more than the sum of individual properties.

In Martin and Sunley's (2006) view, the spatial structure and organization of the economy, such as industrial districts, business clusters, cities, regional agglomerations, networks (p. 596), could be understood as complex systems, given the multi-scalar, open and emergent properties of those spatial economies. According to these authors, those spatial economic structures emerge as unintended[7] spatial outcomes from self-organization and adaptive processes of various micro actions of economic agents, such as households and firms. Moreover, the macro-spatial structure that emerges from this process in turn shapes the actions and behaviours of the micro-agents. Martin and Sunley (2006) suggest that understanding this upward and downward causation of a complex adaptive system should be the main focus of EEG.

One of the key issues in the application of complex-adaptive system approach in regional economic evolution is the strong emphasis on the interaction and connectivity among the components in a complex adaptive system. This suggests the important role

[7] This is as a consequence of non-deterministic features of complex systems.

of networks, which is similar to that of REG. Complexity theorists view self-organization as a balance between order and chaos, while considering the connectedness of the network in the economic sphere to be key to maintaining the balance. In a poorly connected system, a change in one or some parts of the system could have a small or no effect on the overall system. As a result, less connected systems tend to be stable and change only slowly. In contrast, a change in a highly connected system may have significant impacts on most elements of the system, leading to a change in the system as a whole. Thus, highly connected systems are often marked by instability and chaos. Complex adaptive systems are somewhere in between these two extremes.

The conceptual focus of complex adaptive system theories is on the emergence of variety, i.e., how new technologies or institutions emerge from interaction among firms, individuals, households etc. It is less clear why certain technologies and institutions survive, while others are eliminated. The complex adaptive system approach, in our view, lacks a selection mechanism that can explain the differences in relative growth and the decline of emerging properties. In this sense, we find that complex adaptive system echoes the familiar explanation of institutionalists who privilege upward and downward over forward and backward causation.

From the above review we can draw out some shared ideas among the three frameworks of EEG. First, it seems that path dependence and Generalized Darwinism share a much similar view on regional evolution. The concepts of path creation, path destruction and lock-in fit well onto the concepts of variety, selection and retention. Path creation refers to the creation of new paths of development, predicated on new technology, product or industry varieties. Lock-in describes the process of how those technological or industrial trajectories are maintained in the short or longer term, while path destruction refers to the selection of individual path ways at the expense of others. Instead of path destruction as the selection mechanism, Simmie (2012) argues that historical barriers to path dependence are, in fact, relate to the selection environment through which selection forces are at work. These barriers could be in the forms of institutional hysteresis or relevant existing technological paradigms, since they always favour prevalent technologies, routines and behaviours. In other words, not all new technological innovations can go through the rigidness of existing institutions and escape the barrier to entry of existing technology regimes. Most of them, in fact, fail to emerge. Once a new technology reaches a certain point of acceptance, a new path is then created and a new institution is likely to emerge. This does not necessarily mean that old institutions or technologies are replaced immediately. They usually persist for some period of time before being fully replaced by new technologies or institutions.

The concept of positive lock-in is basically similar to the concept of retention in Generalized Darwinism. The basic idea shared by the two concepts is that there is a strong tendency for economic agents to establish a certain level of stability to deal with uncertain environments and improve efficiency. At the level of firms, for example, establishing routines is one way to facilitate decision-making (Nelson and Winter, 1982). At the industry level, once a new industry emerges, more specialised firms enter the industry, leading to specialisation. The industry should gain increasing returns from this specialisation, thus improving overall efficiency, which, in turn, leads to further specialisation in the industry. The regional institution also makes adjustments in order to support dominant industries, which increase industries' competitiveness further. However, this accumulation of positive externalities and increasing returns, at a certain point, can become the source of rigidity and negative lock-in. When the established routines, networks and ideas no longer yield increasing returns and start to produce negative externalities, the existing industrial-institutional configurations become a barrier for future change, thus hindering the creation of new varieties (Engstrand and Stam, 2002).

Second, although the complex adaptive systems framework can be used to describe the evolution of the space economy, it shares less similarity with the other two evolutionary frameworks. As discussed above, the complex adaptive framework seems to neglect the role of selection in its evolutionary explanation. The strength of the complex adaptive framework is in its explanation of how new varieties/properties emerge at the system level from interacting and self-organizing micro agents, which cannot be disaggregated to the individual properties of those agents. Thus, it can arguably be seen as the creation process of novelty.

The main challenge when applying an evolutionary approach in the social sciences is in specifying each concept into operational categories. There is a prolonged debate about the most appropriate unit of analysis in an evolutionary approach, particularly in industrial evolution (Aldrich, 1999, pp. 35–41). With regard to this matter, Murmann (2003) reminds us that an evolutionary approach is inherently a multilevel approach (p. 12). It requires at least two levels, consisting of a (lower) individual level, which replicates at different speeds, and a (higher) population level on which evolutionary change works. Simply put, the differential rate or frequency of lower-level entities is related directly to change at the higher level. At the lower level, we can identify individuals, work groups or teams within a division, divisions within an organization, an entire organization (firm), entire industries, and groups of industries, regions and national economies[8]. If we aim to analyse evolutionary change of an industry, for example, we can analyse the selection process at work in individual firms in the course of their relative growth and decline. According to Murmann (2003, p. 13), theoretically, industries or even regional institutions can serve as units of analysis in which selection operates.

A synthesis of various frameworks in EEG is presented in the following matrix (Table II-2).

Table II-2 Variety of Frameworks in Evolutionary Economic Geography

Evolutionary model	Main concepts			Issues
General Darwinism (Hodgson, Essletzbichler)	Inheritance	Selection	Variety	Scale and level
Path dependence (David, Arthur, Martin)	Positive/negative lock-in	Path destruction	Path creation	
Complex system (Martin)	-	-	Self-organization, Emergence	Lack of selection mechanism

Source: Author's analysis.

2.3 Research framework

2.3.1 Theoretical framework and scope

This research is based on evolutionary theory to explain the changes in the economic landscape within Indonesian provinces by focusing on how the existing industry structures influence their future development paths, and how exogenous forces shape the process. In carrying out this research, we apply a dual evolutionary framework, comprising Generalised Darwinism and path dependence (we call it GD-PP framework). We have argued in the previous section that both EEG frameworks are principally equivalent. Nevertheless, in order to avoid confusion, we will simply consider that a path dependence framework comprises path creation, lock-in and path destruction.

The units of analysis are industry (used in Chapter 4-6), industry structure, i.e., the population of industries (used in the province-model in Chapter 5), and regional

[8] It is obvious that the highest level of population unit is the world economy. Thus, the world economy cannot be treated as an individual that is subject to selection processes.

institution (used in Chapter 6). The reason for using three layers of analysis is partly to address the level and scale issue, which we have encountered in the literature (see Table II-2), and partly for the purpose of a robustness check. Even though we use three levels of analysis we are far from claiming our work as being purely co-evolution analysis because we perform the analysis separately. In Chapter 6, we perform two levels of analysis simultaneously, which moves our work closer to co-evolution analysis. However, we are aware that the co-evolution of regional industries and institutions is likely to involve at least two perspectives in economic geography, i.e., EEG and IEG. Moreover, co-evolution analysis involves upward (emergence) and downward analysis within economic space, which, in our view, fits best with the complex adaptive systems framework. Despite those limitations, we attempt to qualitatively establish reciprocal causality of those two evolving units.

In order to scrutinize how evolutionary forces work on regional industries, we apply two operational concepts to quantify the relatedness of industries and the productive capacity of regions. There are two reasons why these two concepts are important to our analysis. Firstly, the concept of relatedness is to measures the cognitive distance between industries. Cognitive distance can be considered in terms of differences between industries with regard to the knowledge, technologies and skills used. Two industries that use similar knowledge, technologies and skills are considered to be highly related, and vice versa. Relatedness is an important element in our analysis because it offers us an instrument to investigate how new varieties of industry emerge and how existing industries are retained or selected out of regions. Secondly, the concept of productive capability is to measure the capacity of regions based on the diversification and sophistication level of their industry. Simply put, regions with complex capabilities are regions that are able to diversify into not only new, but also more advanced industries. While the relatedness concept helps us to explain how regions evolve, in which relatedness plays a kind of role as a selection mechanism, the productive capability concept helps us to investigate the direction of the evolution, into either a more or less sophisticated ones. In this section, we construct our research framework, based largely on these two concepts of relatedness and capability.

Moreover, the adoption of a regional institution as a unit of analysis has forced us to equip our research framework with an institutional element. In order to guide us in performing an institutional analysis, we refer to the institutional platform offered by the varieties of capitalism (VoC) literature. Lastly, we add FDI to the framework to facilitate contrast with factors external to industry structure.

In addition, a different framework to comprehend regional development is by analysing the position of regions within broader production system. This perspective has been developed under the literature on Global Value Chain (GVC). The GVC itself, or labelled as Global Production Networks (GPN 1.0), has been expanded toward a more dynamic theory of GPN 2.0 (Yeung and Coe, 2015). GPN obviously has some relevance, however this thesis primarily seeks to explain the internal processes of change in regional development. The reasons that we include some discussion about FDI in Chapter 5 and the role of external knowledge on the development of aircraft industry in Chapter 6 are to acknowledge the importance of external links in regional development and to add dynamism into our analysis. However, the GPN framework has been less attuned to understanding the evolution of industry structures, which is the primary focus of this thesis.

2.3.2 Relatedness concept

How regions develop new varieties of economic activities, particularly new products and industries, is a crucial area of investigation in EEG (Essletzbichler and Rigby, 2007; Hodgson, 2002; Schumpeter, 1942; Witt, 2002)[9]. It is argued that the capacity of regions to develop new industries heavily hinges on their existing industry structures (Hausmann and Hidalgo, 2010; Hausmann and Klinger, 2007; Hidalgo et al., 2007). In other words, current industry structures affect future structures. In the following, this research discusses why regions tend to develop new industries close to their current industry structures.

To start with, it is important to look at the behaviour of firms in searching for new solutions. Firms search for solutions in order to solve or avoid future economic problems by using their accumulated knowledge base. In contrast to the neoclassical firm evaluating all existing and conceivable solutions, limited cognitive abilities make individual firms look for solutions that are close to existing routines and within a spatial vicinity. Maskell and Malmberg (2007) refer to this tendency as a myopic search of economic agents. Borrowing the idea from the field of cognitive psychology concerning human judgement and decision-making under uncertainty, they argue that firms prefer to look for nearby solutions and use existing routines, even when the results may be suboptimal. Surrounded by high uncertainty, firms tend to avoid higher costs when searching for more sophisticated solutions, even though the potential benefits may outweigh the costs of searching. The propensity to look for nearby solutions drives firms and individuals to learn from others surrounding them. This behaviour highlights

[9] Most, if not all, manifestation of evolutionary thinking, including Darwinian or biological analogy (e.g., Hodgson, Essletzbichler) and self-organization evolutionary (e.g., Schumpeterian, Foster, Witt) thinking, share common ground about the importance of novelty in evolutionary processes.

the importance of proximity when searching for new solutions or products. But, what kinds of proximity are evolutionary theorists talking about? According to Boschma and Frenken (2010, pp. 122–3), there are five types of proximity that are relevant in economic geography studies: geographical, cognitive, institutional, social, and organizational proximities. We briefly discuss them here.

Much of the literatures in economic geography places great emphasis on the role of geographical proximity for learning and knowledge spillovers (Storper, 1997). According to this literature, geographical proximity plays a crucial role in facilitating knowledge spillovers among firms, particularly the tacit one that is embedded in local routines and networks. The physical closeness then facilitates interaction among economic actors, thereby improving the chance of learning from each other. This local learning process is believed to be the source of regional innovation systems (Edquist, 2011). Learning from other firms in close proximity could be the most rational strategy adopted by bounded rational firms, assuming a wide variety of local knowledge, which can easily be absorbed and embedded in production routines. The case would be different if the knowledge obtained from nearby firms was difficult to learn given the knowledge stock of the receiving firm. In this case, the learning process entails a rather steep learning curve, which makes it unlikely or more time-consuming to be absorbed by individual firms. On the other hand, if the available local knowledge is similar or already known by the receiving firm, then there will be no absorption. In the situation where knowledge variety is lacking, little or nothing can be learnt from knowledge exchange. Firms would still re-combine the knowledge that they probably already have and face greater difficulties to come out with new innovations. Regarding this line of reasoning, Nooteboom (2000) introduces the notion of optimal cognitive distance. Optimal distance means that some degree of cognitive distance is needed to ensure that effective and interactive learning processes occur effectively. However, it is also important to ensure that the distance is not too close in order to avoid a cognitive barrier (Dosi, 1982), as little can be learnt from similar ideas.

Drawing on the previously discussed theories, it is clear that both physical and cognitive proximities are important when generating innovation. This is one of the reasons why Porter (2003) proposes the cluster concept of related industries, not merely the spatial concentration of intra-industry clusters. The idea is to promote continuous learning processes and knowledge spillovers among firms in clusters, while avoiding a scenario where the clusters are dragged down into the lock-in situation. The question is whether innovation really does come from interaction among local actors. The innovation literature indeed shows the localised nature of innovation, but it also recognises the role of external actors, particularly foreign direct investors, in the diffusion of knowledge. The balance relation between local and external actors is emphasized by Bathelt et al. (2004) through the importance of both ‘local buzz’ and ‘global pipelines’[10] in promoting continuous knowledge creation. Markusen and Venables (1999), for example, develop a model and show how the demand for intermediate products by a multinational company can promote new industries, not only for intermediate products but also for final products. Evidence also comes from Boschma and Iammarino (2009), who found that related extra-regional knowledge helps inter-sectoral learning across regions in Italy. The two bodies of evidence suggest that imported knowledge, particularly knowledge that is cognitively related to the existing region’s portfolio, is beneficial for the learning and innovation processes of regions. In short, learning processes may occur at geographical distance, but they require cognitive proximity.

Institutional proximity refers to the closeness of social behaviour at the macro level, which stabilises the interaction and coordination among organisations and actors within it. Closer institutional proximity makes cooperation easier. A good example of how two institutional set-ups hamper organisational cooperation is provided by Gertler (1995; 2005), who shows how employees in Germany with high specialisation, resulting from lifelong employment and on-the-job training, have little difficulty in operating and maintaining complex machinery. In contrast, Canadian employees in an environment with high staff turnover and short on-the-job training struggle with using unfamiliar machineries. The point here is that two very different employment institutions may hamper inter-organisational cooperation operating within their respective institutional environments.

Another dimension of proximity is organisational proximity, which refers to shared relations, either within or between firms. This includes the degree of vertical integration, that is, the extent of links between customers, suppliers, and competitors in a particular sectors or related sectors. In the context of firm proximity, this comprises the degree of hierarchical or horizontal coordination and allocation of responsibilities, as well as the specialisation of tasks, within firms (Saxenian, 1994, p. 7). The last dimension of proximity, social proximity, refers to socially embedded relations between agents at the micro level (Boschma and Frenken, 2010, p. 122), or may be considered in terms of institutions at the lower level, such as community groups (Farole et al., 2011). According to the latter, social proximity is likely to influence economic growth through facilitating economic exchanges, creating/diffusing/absorbing knowledge and technical progress, and representing and governing individual preferences. Cohesive social

[10] Local buzz refers to knowledge flow within local cluster while global pipeline refers to knowledge flow resulting from interactions with external actors outside the cluster.

connection can promote economic growth through its capacity to counter external shocks and changes, resolving conflicts, and constraining unproductive behaviours, such as rent-seeking and free-rider behaviours. Too much social proximity, however, can hinder economic development, as well as by narrowing economic interaction only for the benefits of insiders, thus blocking positive spillovers into wider society.

The tendency to search for new products or industries close to existing products arguably also applies to regions. As proposed by Hidalgo (2009), products that are closely related to existing products are more likely to be developed by regions. Boschma and Wenting (2007) provide evidence of how the British automobile industry emerged in a region, which was well endowed with related industries, such as coach- and bicycle-making industries. They argue that these related industries supplied the capabilities required to develop the automobile industry in Birmingham. This evidence suggests two things: first, the more a region is endowed with related industries, the higher the chance for the region to develop new industries; second, the development of new industries based on relatedness demonstrates a path dependent evolutionary process.

The concept of relatedness is central in evolutionary studies for the following reasons. First, the concept of relatedness clearly highlights the crucial role of variety as one of the main evolutionary elements. The emergence of new varieties through branching processes in regions can be traced back to its relatedness to pre-existing products on which it is built (Boschma and Wenting, 2007). It can be used to demonstrate the evolutionary forces of path dependence at work and provides evidence of how varieties within regions are generated. Second, as argued by Boschma and Frenken (2011), the relatedness concept can show how the Schumpeterian process of creative destruction takes place. It not only demonstrates the possibilities for developing new products, but also shows how old products, which are less related to existing regional industry structures, may decline or be eliminated (path destruction). This can be interpreted as a selection mechanism through which some new industries are selected and some others are pushed out of the region.

The relatedness concept is crucial for this research particularly to address the first part of the first research question, i.e., ‘Does the cohesiveness of industry structures shape the paths of regions’ industrial development?’. Drawing from the conceptual discussion above, we put forward a hypothesis that Indonesian provinces are likely to develop new industries that are cognitively close to their existing industry structure. The conceptual argument for the hypothesis relies on the relatedness concept. However, the specific arguments that are relevant to the context of Indonesia as a developing country is that less developed industrial capabilities have limited the chances for provinces to initiate radical industrial development, leaving the provinces with no option except to diversify incrementally toward related industries. Likewise, we propose a hypothesis that related industries tend to stay in provinces they belong to as provinces have theoretically all the capabilities, in broad terms, such as regional institutions, knowledge, and physical assets, to sustain their competitiveness. Conversely, less related industries are likely to decline or exit provinces' industry portfolios probably driven by some incompatibility with institutional setting of provinces in which they reside.

2.3.3 Capability concept

The presence of persistent difference in welfare across regions implies two things. First, factors of production and knowledge, for some reason, do not travel as far as expected. Second, non-tradable factors must influence the development of regions. These, according to Hidalgo (2009), are specific inputs or capabilities, which are highly available at the local level. Capabilities include tangible factors, such as infrastructure, as well as intangible factors, such as institutions and social networks. In economic geography, these locally specific assets are well recognised as relational assets or untraded-interdependencies (Storper, 1997), which facilitate the creation and diffusion of knowledge, particularly the tacit form. If these local capabilities are crucial in explaining the differences within regional development, measuring these capabilities and analysing how it changes could reveal some insights.

Recently, Hausmann and Hidalgo (2010; 2009) developed an operational concept to quantify the productive capabilities of countries. Their concept is based on the assumption that countries or regions are linked to the products they produce. What connects regions and their products is the capability of regional agents to produce those products. Put simply, regions produce what they produce today because they are capable of doing so. If some regions produce a larger variety of products than others, this means that these regions have all the capabilities necessary to do so. Similarly, other regions may not be able to produce certain products because they simply do not have the required capabilities to make them. Following this line of reasoning, a high level of regional diversity implies that those regions are endowed with a wide range of capabilities. If that is the case, the level of diversification would be a good approximation by which to measure the capability of regions. However, producing various goods does not necessarily reflect the real capability of regions if the products require only a few basic skills and low technologies. In this case, diversification has a quantity bias with which to measure regional capability and needs to be corrected by adding quality elements. The level of product sophistication provides this information, as sophisticated products usually require more capabilities to be produced. Therefore, by combining these two characteristics of regional industry structure, i.e., the level of diversification and sophistication of products would capture the productive capability of regions. Analysing the variation in productive capability across time and spaces could provide plausible explanations of how capabilities are accumulated and evolve over time.

The creation of new knowledge as the result of the combination of existing knowledge has been widely discussed in the innovation literature (Fleming, 2001; Frenken et al., 2012; Henderson and Clark, 1990; Schumpeter, 1934). Following the arguments of bounded rationality and local search (Cohen and Levinthal, 1990; Maskell and Malmberg, 2007; Simon, 1957), innovation that emerges from combination of familiar components tends to occur locally[11]. Thus, regions endowed with more diverse capabilities have a higher possibility of combining them in order to create new products. As new products develop, new capabilities will be added to the portfolio of regional capabilities, increasing the chance of developing even more new products. On the contrary, regions endowed with too few capabilities are likely to face greater difficulties when developing new products. Lacking complementary capabilities expressed in low product variety means that there are few potential combinations from which new products can be made (Hidalgo and Hausmann, 2009; 2010; Hidalgo, 2009). This circular effect is similar to a negative lock-in situation within the path dependence framework.

Capability, that is reflected by the complexity of industry structure, is another important endogenous factor in answering the second part of the first research question, i.e., 'Does the complexity of existing industry structures constrain and enable regions to carry out industrial transformation?'. The capability concept has driven us to set a hypothesis that provinces with more complex industry structures are likely to be able to diversify further their industries and to escape from the peril of negative lock-in. Vice versa, having less diverse and less sophisticated industry structures makes provinces experiencing greater difficulties to diversify its industries, increasing its chances to get confined in a negative lock-in situation. Specific to Indonesia case, however, the outcome may not be as clear as the capability concept may suggest. Some provinces, as we suspect, may have relatively higher diversification level but, at the same time, lower sophistication level, and vice versa. This has led us to investigate further the composition of industry structure in some provinces with

[11] A distant search also offers the potential to invent completely new combinations or create a breakthrough. However, less familiarity with components increases uncertainty and the risk of failure.

upgraded/downgraded industrial complexity in Chapter 4. In addition, the level of sophistication that is part of complexity metrics can be used to estimate the direction of the evolution whether provinces evolve toward either more or less advance industry structure. Therefore, we put forward the hypothesis that province with more sophisticated industry structure are more able to diversify toward more sophisticated direction. Conversely, provinces with less sophisticated industry structure are less likely to diversify to more sophisticated industries. We address this issue of direction in Chapter 5.

2.3.4 Foreign direct investment spillovers

Within neoclassical growth theory, FDI is viewed as one of the input factors of capital (K). As capital is experiencing diminishing returns, the long term effect of FDI is neutral. Endogenous growth theory, however, views FDI both as capital input and as a source of productivity through knowledge and technological spillovers attached to it. Crespo and Fontoura (2007) suggest that FDI spillovers into domestic industries occur via five main channels: demonstration/imitation, labour mobility, exports, competition, and backward and forward linkages with domestic firms. Although the presence of spillovers accompanying FDI is well recognised, its overall effects on domestic economies are still questionable. Irsova and Havranek (2013) performed a meta-analysis of 52 empirical studies comprising 45 countries and found (on average) zero horizontal (within-sector) spillovers of FDI. Likewise, Iwasaki and Tokunaga (2014) concluded in their meta-analysis of 23 empirical studies from transition countries that the effects of FDI on economic growth 'fail to present non-zero FDI effects' (p. 53). Individual country analyses seem to support this finding as well. Based on the Colombian experience, Kugler (2006) confirms that knowledge spillovers from FDI occur vertically, or between sectors, whereas within-sector industries gain only limited productivity. Sjoholm (1999) also arrives at the same conclusion, that inter-industry FDI spillovers show positive effects on productivity growth whereas the opposite is true for intra-industry spillovers.

Several factors that determine FDI spillovers have been identified in the literature, including absorptive capacity and technological gaps, regional effects, domestic firms, FDI characteristics, trade policies, property rights regimes and labour policies (Crespo and Fontoura, 2007, p. 412). This thesis focuses on the first two factors. Evidence of absorptive capacity and the technological gap to explain spillovers from FDI into domestic firms is rather solid, both at micro (firms) and macro levels (Crespo and Fontoura, 2007). Two conclusions stand out. First, regions with a higher level of development have a better capacity to grab most of the benefits from foreign presences[12]. This seems to coincide with the productive capability concept discussed above, whereby regions with more complex industry structures (assuming complex structures are found in developed regions) are likely to have the required capacities to develop new industries. Second, a moderate technological gap between what is brought in by FDI and what is owned by domestic industries should facilitate FDI spillovers. We expect that too wide or too narrow a gap could impede spillovers. Again, this idea fits with that of cognitive distance (Nooteboom, 2000), in that learning and innovation are likely to occur within a certain cognitive distance, neither too far nor too close. Again, this echoes the importance of the relatedness concept, which is central to this thesis.

Another factor that determines FDI spillovers is so-called regional effects. This means that spillovers are confined within a spatial boundaries and fade away with distance (Audretsch and Feldman, 1996). The empirical evidence in the literature however, is inconclusive. Some studies found FDI to result in positive spillovers at the regional level (Girma and Wakelin, 2002 for the Russian case; Ponomareva, 2000 for the UK case), while others found negative spillovers (Aitken and Harrison, 1999 for the Venezuela case; Sjöholm, 1999 for the Indonesian case)[13]. In the case of FDI spillovers in Indonesia in particular, we need to be careful when reading the estimation results as the author distinguishes within- and between-sector spillovers. It is true that, at regional levels (provinces and districts), the coefficient estimates for spillover are negative. However, it is worth noting that the negative sign refers to within-sector spillovers. The signs of FDI spillovers are positive and significant for between-sector spillovers even though they occur at regional levels[14].

All in all, the effects of FDI seem to be vague at best, partly because of its contradictory between- and within-sector effects, and partly because of the regional policies in which it operates. In Section 5.2.2, we provide a comprehensive review of over 33 empirical works on FDI in Indonesia. Although we find some contradictions, the overall results seem to exhibit a rather positive effect. Therefore, the hypothesis for the

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[12] Phelps (2008) however, presented evidence, even for developed countries, such as the UK and the US the localised process of externalisation (spillovers) from FDI is far from what is expected. He persuasively argued that local institutions are partly captured by FDI interests because of minimum state intervention commonly featuring competitions state.

[13] The positive spillover means that the presence of FDIs improves the productivity of domestic firms in the region whereas negative spillover means the opposite. It is worth noting that 'regional effects' are measured by comparing the spillovers from one region into other regions (see the case of the UK) or by comparing them to spillovers at national levels (see the Indonesia case).

[14] One can find both positive and negative spillovers from FDI at the same time in the same region. The outcome depends on what type of spillovers we are measuring: within-sector (horizontal) or between-sector (vertical) spillovers. As much of the empirical evidences suggests (Iršová and Havránek, 2013; Kugler, 2006; Sjöholm, 1999), horizontal spillovers tend to be negative, whereas vertical spillovers tend to be positive.

second research question, i.e., ‘How important are endogenous evolutionary forces relative to exogenous economic links and factor costs in explaining the industrial transformation of regions?’, is that the role FDI, at province level (Section 5.4.1), is likely to be positive but weak. Our hypothesis of positive effects of FDI is based on the regional-effect argument as discussed above. At industry level (Section 5.4.2), however, the hypothesis is that FDI would likely bring negative effects on the emergence of new industries, echoing the within-sector argument.

2.3.5 Varieties of capitalism

In their seminal work, Hall and Soskice (2001) introduce the concept of varieties of capitalism, which is arguably influential in the context of national comparative advantage. They then develop an institutional framework in which economic institutions are divided into two broad dichotomies of an liberal market economy (LME), exemplified by the US, UK or Canada, and a strategic or coordinated market economy (CME), exemplified by Germany, Sweden or Japan. Any countries can thus be mapped onto this institutional framework of capitalism, whose range is in between these two categories. The institutional framework of capitalism itself consists of five key institutional configurations, namely, the industrial relations system, the education and training system, the labour market, inter-firm relations, and the financial system. The authors associate the institutional regime with the kind of innovation it is characterised by. LMEs tend to perform better at radical innovation, while CMEs prefer the incremental form. Boschma and Capone (2015) incorporate relatedness into the VoC framework in their analysis for 23 developed nations. Echoing Hall and Soskice, they found that the relatedness effect is stronger in CME than in LME countries, suggesting the former diversifies more incrementally than the latter.

Note that, although Hall and Soskice (2001) acknowledge the importance of capitalism at the sector and regional level, their VoC framework considers national countries as the primary unit of analysis. This invites many criticisms about neglecting the existence of different capitalism varieties both at subnational and at lower levels, which cannot be fitted onto the broad dual classifications of VoC. One effort to register a new variety that goes beyond the scope of the VoC framework comes from Zhang and Peck (2016). They argue for a different style of Chinese capitalism, which is not only beyond LME and CME classifications, but also, to some degree, a variant of what is found within China itself. In other words, the presence of variations of regional capitalism implicitly suggests that geography matters.

Another criticism comes from Goddin (2003), who questions the survival of institutions located between LMEs and CMEs. He argues that in globalising world eventually all economic institutions are likely to shift toward LMEs. In their response, Hall and Soskice (2003) argue that this is not always the case, as institutions are built as a result of a complex multifarious political process over a long period of time, while the outcomes are not necessarily biased toward LMEs. Rather, as they continue, the broad classification seeks to exemplify, rather than dichotomise. In the real world, many nations are actually a mix or hybrid and known as Mix Market Economies (MMEs), situated along the spectrum of the two institutional regimes.

Following Zhang and Peck (2016), this research analyses the changes in capitalism institutions at the regional level. Unlike them, the aim is neither to register a new variety of capitalism, nor to label regions with certain institutional regimes, such as an LME, CME or MME, and associate them with innovation performance. Rather, we use the VoC framework to help us investigate the evolution of regional institutions in a comparative way. What makes our work different to Boschma and Capone (2015) is that, first, we focus on the subnational level and use the VoC framework for a qualitative case study, instead of a quantitative cross-region analysis. Second, we neither attempt to classify regions into broad capitalist institutions nor link them to innovation performance, but choose to apply the VoC platform in order to scrutinise the institutional changes accompanying industrial changes within the regions being studied.

It should be noted that, for the Indonesia case, some regional institutional configurations may be comparatively similar among regions because the policies and practices of these institutions, such as financial institutions, are fully controlled by central government. Others vary, as they are set up by authorities at the provincial level, such as regional labour market, industrial relations, inter-firm relations, and research and training, particularly access to universities and a network of knowledge. This research focuses on these four elements of VoC.

Maskell and Malmberg (2007) offer a good explanation for the evolutionary process of institutional change. According to them, new industries will gradually get institutions that are most compatible with them. This is because the new industries, as they gradually become dominant, will try to create a favourable environment, which is supportive for their further development. This includes the establishment of some specific institutional requirements, such as R&D and training systems. This in turn creates demands on similar or complementary economic activities. As a result, institutions become more specialised and become anchored over time, leading to an overall performance improvement in the relevant industry. This process is similar to what Boschma and Frenken (2009) consider as evolving from a ‘neutral place’ to a ‘real place’. The process of transformation from neutral to real institutions somewhat fits with our case of the aircraft industry in Chapter 6. However, drastic institutional change could also happen because of external shocks, such as economic crisis or a rapid increase in competition. In this case, an evolutionary process starts from a ‘real place’. As a result, existing industries should quickly adapt to those sudden evolutionary changes, while the way it adapts could be different across regions, depending on the tightness of the industry attached to their host region. We attempt to explain this process by using the case of the textile industry in Chapter 6.

With regard to this research, the VoC institutional framework guides us to respond to the third research question, i.e., ‘How do evolutionary forces really work across industries and to what extent do regional institutions influence the process?’. Our hypothesis is that industries respond differently against the presence of evolutionary forces at work on them, and their responses are shaped by province-specific institutions within which they locate. That is, the effects of labour market, industrial relations, inter-firm relations, production technique on the evolution of industries (i.e., textile industry in our case) are distinct across regions. Moreover, evolutionary forces have put intense pressure on industries (i.e., aircraft industry in this case) to strengthen links to local knowledge to improve the industry’s competitiveness and resilience.

In this chapter, we have confirmed EEG as the theoretical foundation for this thesis and clarified its relative position within broader theoretical context. We have synthesized various frameworks found within EEG and adopted a hybrid framework of GD-PD. Despite their ontological genuineness, we found that EEG shares many common properties with IEG in the light that EEG is developed on old institutionalism as its building blocks (Essletzbichler, 2009; Hodgson, 2009). Therefore, by engaging in pluralism (Hassink et al., 2014), we complement the GD-PD framework with institutional framework of varieties of capitalism (VoC). We have also conceptually constructed the metrics to capture the endogenous evolutionary forces of regional industry structure, i.e., industry relatedness and productive capability (complexity). The two concepts are central to this work as they are directly related to the first question of this research: do existing regional industry structures, in terms of their relatedness and complexity, shape industrial growth paths? These endogenous evolutionary forces will empirically be challenged against exogenous forces, including foreign investments, which are widely viewed as a source of capital and knowledge spillovers. This empirical work serve the second question of this research: How important are endogenous evolutionary forces relative to exogenous economic links and factor costs in explaining industrial transformation of regions? The review also highlights the role of regional institutions on the evolution of regional industry. The upward and downward interactions between regional industries and the institution, in which they reside, shape the evolution of the both, as prescribed in the third question of this research: how do evolutionary forces really work over industries and to what extent do regional institutions influence the process?

To conclude, we condense the discussion about the theoretical and conceptual frameworks above by constructing a research framework as depicted in Table II-3. This framework guides the overall process of this research. How the research is implemented and what kinds of data are deployed will be elaborated in the next chapter.

Table II-3 Research Framework

Research Questions [Chapter 1]	Method [Chapter 3]	Labour market and industrial relations	Inter-firm relations and techniques of production	Network of knowledge	Unit of Analysis	Scope [Chapter 2]
		Institutional framework for varieties of capitalism [chapter 2]				
How do evolutionary forces really work over industries and to what extent do regional institutions influence the process?	Qualitative case study	Hypothesis: - Labour market effects are distinct across regions - Industrial relation effects are distinct across regions [Chapter 6]	Hypothesis: - Inter-firm relation effects are distinct across regions - Production technique effects are distinct across regions [Chapter 6]	Hypothesis: - Links to local knowledge determine industry's competitiveness and resilience [Chapter 6]	Regional institutions	
Do existing regional industry structures shape industrial growth paths? - Relatedness effects - Complexity effects	Statistics & visual networks	Hypothesis: - Related industries tend to emerge - More diverse and sophisticated industry structures are more able to diversify [Chapter 4]	Hypothesis: - Less related industries tend to decline or exit regional industry portfolios - Less diverse and sophisticated industry structures are less likely to diversify [Chapter 4]	Hypothesis: - Related industries tend to stay in - More diverse and sophisticated industry structures are less likely to be in lock-in situation [Chapter 4]	Industry/Regional Industry Structure	
How important are endogenous evolutionary forces relative to exogenous economic links and factor costs in explaining industrial transformation of regions?	Econometric models	Hypothesis: - FDIs has positive effects - Factor costs have negative effects - Sophistication level of industries/regions has positive effects [Chapter 5]	Hypothesis: - FDI has negative effects - Factor costs have positive effects - Sophistication level of industries/ regions has negative effects [Chapter 5]	Hypothesis: - FDI has positive effects - Factor costs have negative effects - Sophistication level of industries/ regions has positive effects [Chapter 5]	Industry/Regional Industry Structure	
	Method [Chapter 3]	Path Creation (Variety)	Path destruction (selection)	Positive/negative lock-in (inheritance)		Scope [Chapter 2]
		Evolutionary framework of GD-PD [Chapter 2]				

Source: Author's analysis

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CHAPTER III
METHODS AND DATA

The literature on industrial branching (Essletzbichler, 2013; Frenken and Boschma, 2007; Hausmann and Klinger, 2007; Hidalgo et al., 2007; Neffke et al., 2011) has revealed that the productive structure of regions matters for their future development. Thus, understanding the complexity of regional industry structures in terms of the level of diversification and sophistication is essential to industrial policymaking. In order to understand the complexity of regional industry structures, which reflect the productive capability of regions, one must be able to measure it first before analysing it further. Fortunately, the literature has provided some applicable measures that this thesis can start with. While understanding the complexity of regional productive structures is important, how this complexity changes over time offers key insights into understanding how regional economies evolve. One way to analyse this transformation is by constructing the product space, that is, a network depiction of a region's productive structure. The structure, as theoretically argued in Chapter 2, should inform us about the plausible future paths of regional development. In addition, endogenous change, based on the existing industry structure, is not the only force at play. External forces, such as foreign investments, are suspected to shape the productive structures of regions particularly in a developing country context, as the role of FDI in capital formation within such a country is noticeably large (Rodrik, 2004; Sawalha et al., 2013; UNCTAD, 2011).

This chapter elaborates the methods and data used to measure and analyse the evolutionary process of regional industry structures. In the method section, we first set up our case by offering a brief discussion of the Indonesia context, including the profile of the two provinces and two industries on which the investigation is focused. After that, we explain how we measure the two key concepts of industry relatedness and productive capability. We construct the specification for the econometric models to be estimated before proposing the design of our case study. In the data section, we describe the sources of data deployed in the analysis and clarify their validity and reliability.

3.1 Methods

In investigating the evolution of regional industries, this research will carry out three separate but inter-related analyses. Firstly, the current state of regional industry structures will be measured, mapped and simulated. This shall produce stylised facts on which the next analysis will be based. Secondly, the relative importance of endogenous evolutionary forces embedded in the structure of regional industry against other forces exogenous to the industry structure will be examined. We expect to decipher a general pattern, which may explain the weight of each force on the evolution process of regional industry. Thirdly, the applicability of the relatedness concept in explaining the evolution of regional industry will be challenged by two seemingly divergent cases. In doing so, we link the cases to the regional institutions in which those industries are embedded. In performing the analysis, we apply both quantitative and qualitative analyses. Quantitative analysis will be the primary tool for the first and second steps of the analysis. The first analysis uses mostly descriptive statistics to quantify and capture some facts about the evolutionary processes at work. In the second analysis, we use an econometric tool to infer the relationship between evolutionary processes with some variables of interest. Our final analysis will be qualitative in nature and attempts to zoom in on the dynamics of the evolutionary process by using two industries cases in two similar provinces.

Furthermore, we quantify two measures of relatedness and complexity. The two measures allow us to map not only the direction of the branching process towards related industries, but also the quality of the direction. The analysis will involve visual network analysis and descriptive statistics. Network analysis allows us to simulate the transition process of how the structures of regional industry evolve over time. These two analyses, which highlight the importance of the internal structure of regional industries, are then juxtaposed with other factors external to the structure. We carefully choose FDI and wages to represent the forces of capital and factor costs. Specifically, we are interested in the role played by these factors in maintaining, destroying and creating new industrial paths of regions.

The choice to adopt a single rather than a multiple, country analysis is based on the following reasons. First, by doing a within-country analysis, this research automatically controls other possible explanatory factors that might affect industrial structures, such as differences in national historical backgrounds and political systems. Even though these effects may still be present in within-country cross-regional analyses, the magnitude of this influence is arguably smaller than in cross-country analyses (Culpepper, 2005). For example, one can easily challenge Hidalgo et al. (2007) for comparing Chile and South Korea in terms of their industrial structure (product space), as these two countries are not really comparable given their very different histories, economic policies, political systems, etc. Second, in order to further control other possible explanatory factors, this research conducts two comparative case studies by carefully choosing two Indonesian provinces with similar socio-economic characteristics.

3.1.1 Case selection

3.1.1.1 Indonesia

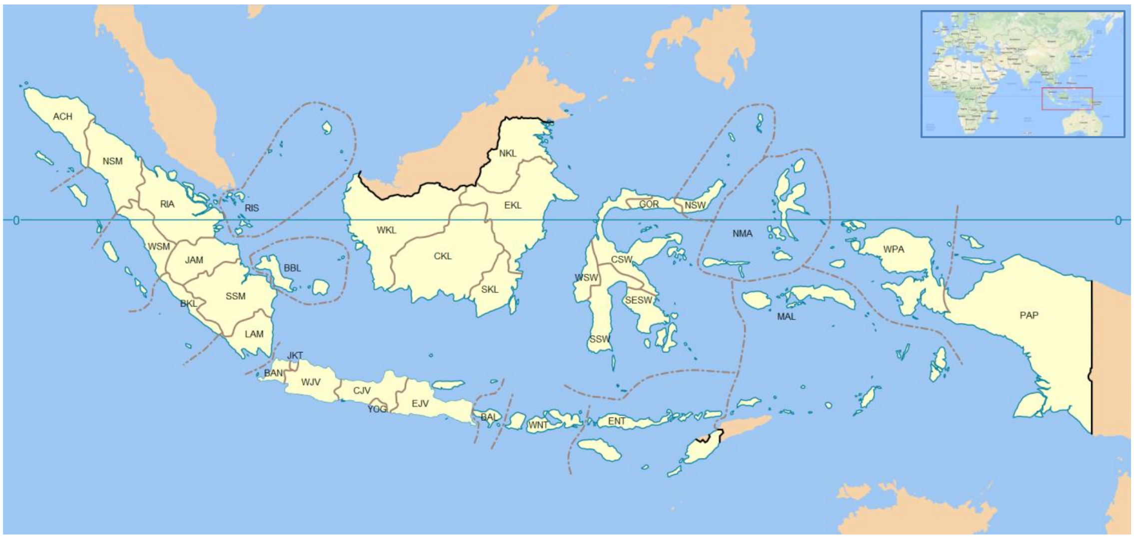
This thesis focuses on Indonesia as the object of study, since the country offers an interesting case for the following reasons. First, as discussed in Section 1.1, Indonesia provides a novel case for applying an evolutionary approach in order to investigate regional development, not only in the country but also in the Global South in general. Based on its level of development, the country is categorised as a developing country, which has been experiencing rapid industrialisation in the last three decades. In this case, Indonesia may offer new insight into the speed and dynamics of industrial evolution within a latecomer context. Moreover, in recent decades the country is considered as open in terms of its trade and investment regime (Aswicahyono and Anas, 2001), in which those external forces may play significant roles within its industrial development. Again, in this regard, Indonesia may be a perfect case with which to investigate the relative importance of endogenous evolutionary forces vis-à-vis the role of exogenous forces, such as FDI.

Second, the country exhibits a markedly persistent divide in its regional development, particularly between its main islands of Java-Bali and the rest of the country. These islands constitute only 7% of the country’s land size, but are hosts to almost 60% of the country’s economy. Manufacturing industry is largely concentrated on Java-Bali, whereas other major islands still rely much on agriculture and mining sectors. The rapid process of industrial transformation, albeit with an imbalanced distribution of industrial development, is not only crucial for establishing the setting of this thesis, but also offers cross-sectional and time-series variations at the sub-national and industry levels, which this thesis seeks to explore.

Third, the availability and accessibility of data are also important in the selection of Indonesia as the case. We have convenient access to the country’s manufacturing and trade dataset, which constitute the backbone of this research. Moreover, the personal and professional networks that we have in the country, as well as the familiarity with the social and cultural context of the society, are priceless assets for this research, particularly in carrying out the fieldwork. Alongside the reasons above, in the following, we provide an overview of the Indonesian context.

Indonesia is an archipelago in South East Asia with 17,504 islands (see Figure III-1). The country was inhabited by 237 million people in 2010 (see Figure III-2), and characterised by diverse ethnic divisions. The population concentrates largely in the main island of Java, accounting for 60% of total population, followed by the Sumatera Island with 21% of total population. According to the latest population census by BPS (2010), there are 1,340 ethnicities who speak 2,500 different languages[15]. Currently, Indonesia consists of 34 provinces of which the youngest, North Kalimantan, was established in 2012. The capital city of Jakarta is situated on the main island of Java.

Figure III-1 Map of Indonesia



Source:https://upload.wikimedia.org/wikipedia/commons/thumb/5/5a/Indonesia_provinces_blank_map.svg/800px-Indonesia_provinces_blank_map.svg.png.

Note: Without scale.

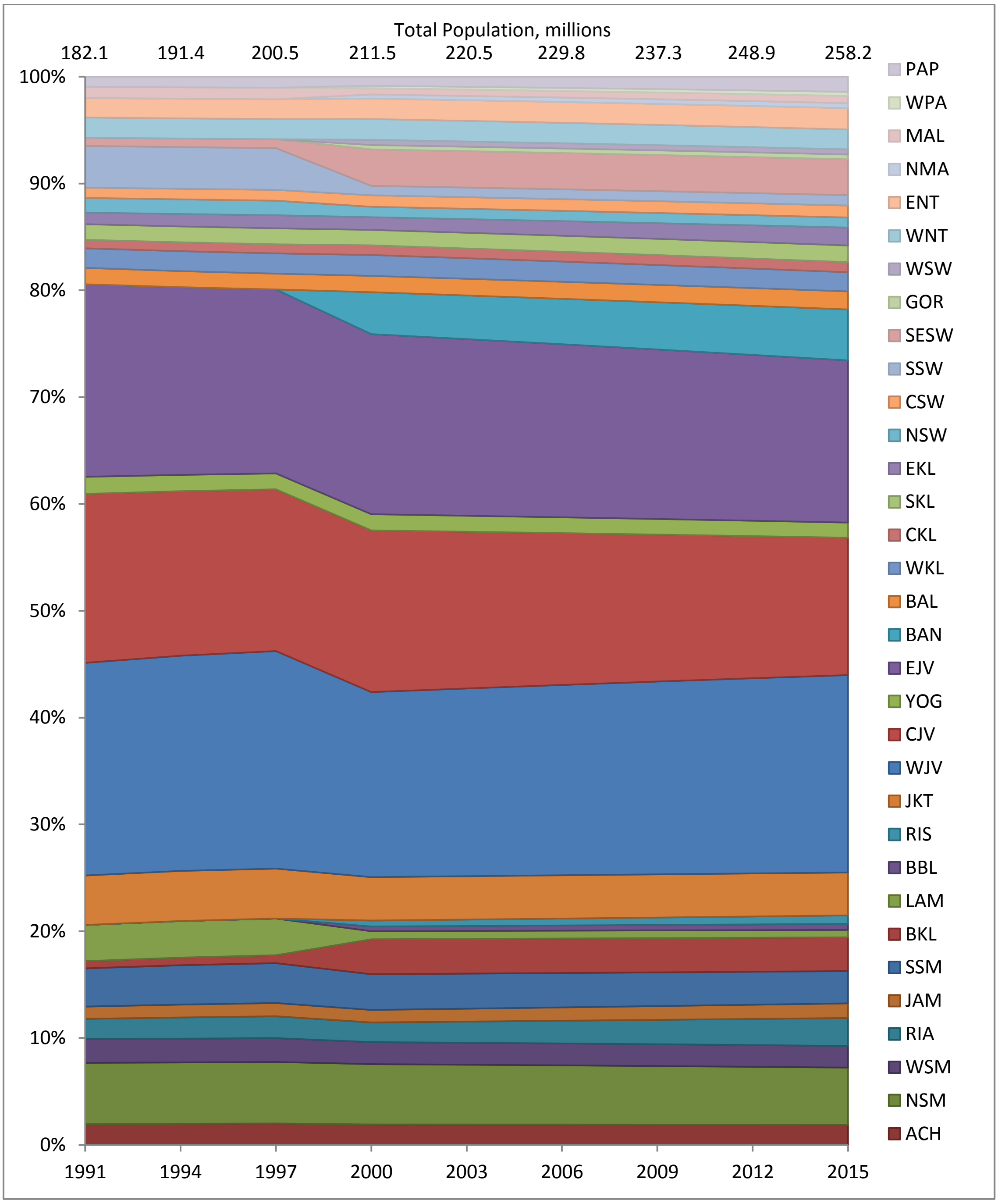
In terms of economic structure, the manufacturing industry makes a significant contribution to the country's economy, followed by the trade and agriculture sectors (see Figure III-3). This adds another justification of our focus on the manufacturing industry in order to analyse the evolution of Indonesian provinces. However, the share of the manufacturing industry has consistently decreased in the last decade from 29.1% in 2001 to 23.7% in 2014. A sharp decline in the manufacturing industry in 2010 fed concerns that Indonesia was undergoing premature negative deindustrialisation[16]. The good news is that, in terms of value, the manufacturing industry still showed positive growth by 4.79% on average in the 2000s. This growth rate, however, was

[15] See http://sp2010.bps.go.id/files/ebook/kewarganegaraan%20penduduk%20indonesia/index.html.

[16] Leading observers such as Basri (2009) and the Indonesian Institute of Science (LIPI, 2010) were among subscribers of this view (see http://ekonomi.kompas.com/read/2010/12/22/19523262/LIPI:.Indonesia.Menuju.Deindustrialisasi). This view of course denied by the Ministry of Industry at its press conference on 26 July 2010 (see http://www.kemenperin.go.id/artikel/58/Deindustrialisasi-Tidak-Terjadi-Di-Indonesia). However, the issue of deindustrialisation continues to be debated.

much weaker than in the 1990s. Although the real risk of deindustrialisation is still there, some prominent scholars, such Aswicahyono et al. (2010) and Narjoko (2014), argue that the slowdown in manufacturing growth after the 1998 Asian economic crisis 'may simply be a reflection of a long—but hard—consolidation process in manufacturing' (Narjoko, 2014, p. 373). These authors pointed out that better and more resilient firms entered the manufacturing industries, which is a good sign of a more solid manufacturing sector.

Figure III-2 The Population of Indonesian Provinces, 1991-2015

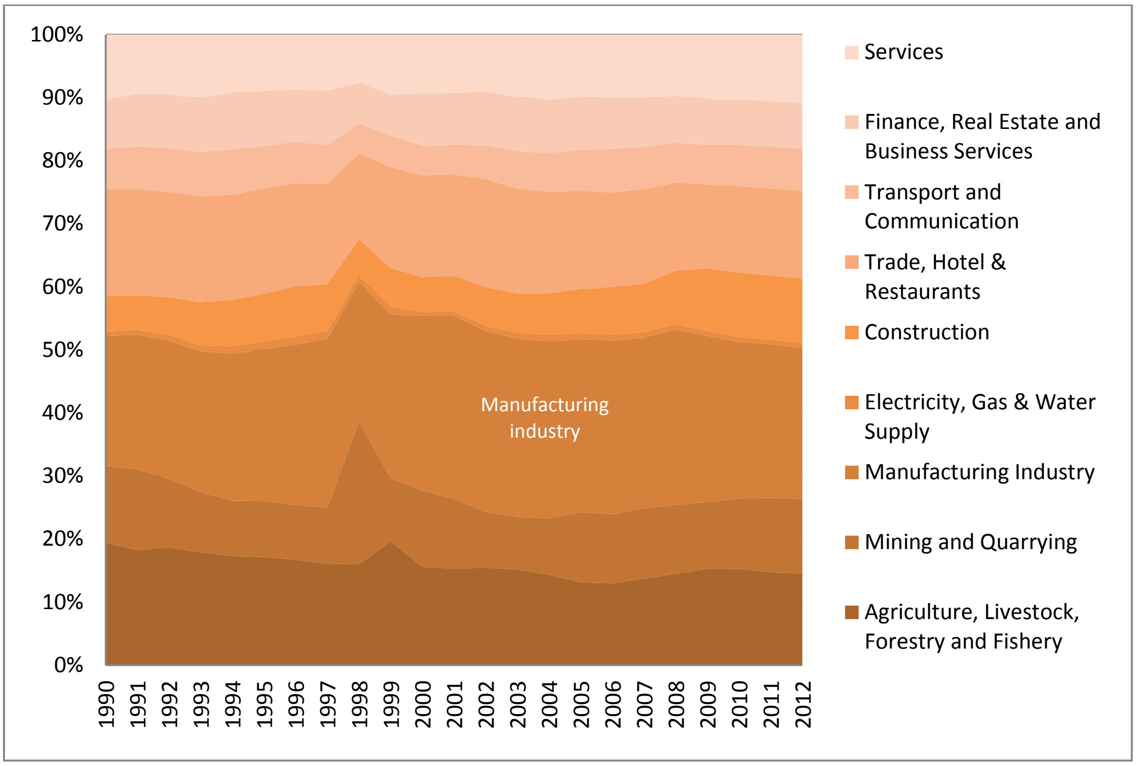


Yet, the deindustrialisation of developing countries is not a unique case of Indonesia; rather, it became a more common phenomenon, particularly after the Chinese joined the WTO in 2001. For instance, Edwards and Jenkins (2015) and Jenkins (2015) find fairly clear evidences of the impact of competition resulting from China's manufacturing on deindustrialisation in South Africa and Brazil, respectively. We check the claim made by the authors by exploring industry data of some industrialising economies in Figure III-4. To high extent, the data confirm the claim. We observe a decreasing pattern of industry sector starting in the mid-2000s. The trend, sad to say, has been continuing until the most recent data we have, i.e., 2016. The trajectory of declining industry implies two possible explanations. First, the share of industry in a country's GDP might be shrinking, but the real output could be still increasing. In other words, industry sector may be growing but it grows relatively slower than other sectors, squeezing its share in the GDP. Second, the industry outputs simply decline in real terms. The former is the case for Indonesia's manufacturing industry, suggesting that the country's manufacturing industry is still evolving.

In terms of political structure, since the turmoil in 1997-1998, Indonesia has been going through major political transformation from a centralist authoritarian to a democratic- and decentralised state. Decentralisation has transferred authorities and resources in most areas of development to around 500 autonomous local governments, including seven new provinces[17]. To high extent, this has resulted in institutional uncertainties by significantly increasing decision points, both vertically and horizontally. The situation is exacerbated as decentralisation has curtailed central government's capacity to craft an effective and harmonious policy design (ADB, 2014, p. 10). At the same time, it is also wrongly viewed by local governments as an opportunity to extract as much income as possible from local taxes and permit retributions, leading to tougher environments for private sectors to conduct business. Nevertheless, best practices have also emerged as an outcome of decentralisation. The World Bank and KPPOD have regularly reviewed subnational governments regarding their economic governance and produced promising results (KPPOD, 2016; WB and IFC, 2012).

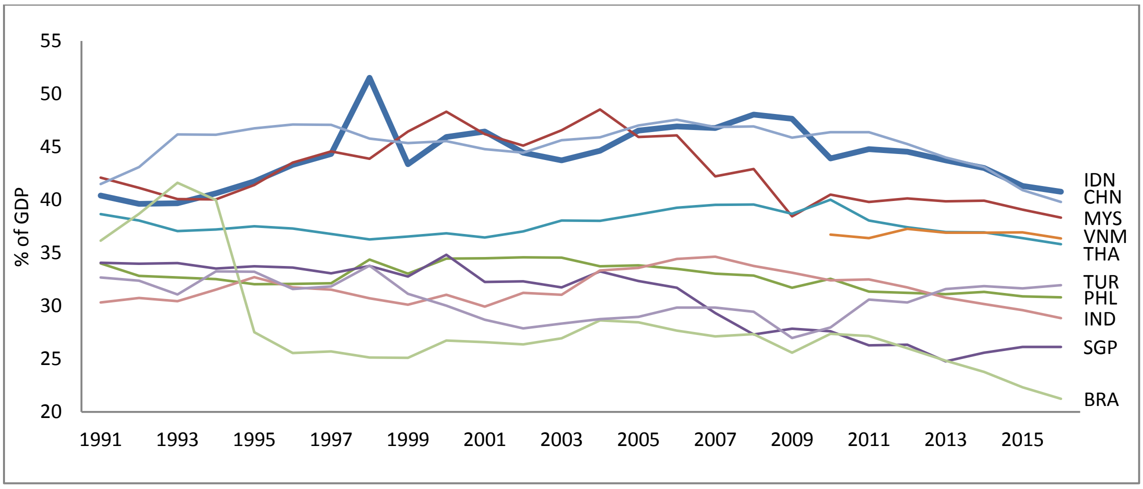
[17] These provinces are: Bangka Belitung separated from South Sumatera in 2000, Banten separated from West Java in 2000, Gorontalo separated from North Sulawesi in 2000, North Maluku separated from Maluku in 2000, Riau Islands separated from Riau in 2004, West Papua separated from Papua in 2004, and West Sulawesi separated from South Sulawesi in 2005.

Figure III-3 The Evolution of Indonesia's Economic Structure



Source: BPS.

Figure III-4 the Share of Industry Value Added to the GDP of Selected Countries



Source: World Bank, Development Indicators 2012

3.1.1.2 Indonesia in comparative perspective

Before further discussing the specific case of provinces, it is necessary to portrait Indonesia within the broader context of the Global South. We have argued in the Section 1.3 that a focus on Indonesia is justified by the under-representation of this kind of research in the literature with regard to countries of the Global South in general and Indonesia in particular. However, by focusing on a single country like Indonesia we have no intention to claim that Indonesia represents the typical country of the Global South. Certainly, countries in the Global South vary greatly, and each country is unique by itself. Thus, there is no point of making such claims.

Rather, by positioning Indonesia within a more general context of the Global South we might be able to highlight some differences and the similarities between Indonesia and other countries in the Global South. It may offer, at least, some rough ideas from comparative perspective on how Indonesia case may or may not apply in other countries of the Global South. Moreover, we expect that by highlighting the position of Indonesia within a broader context would add external validity of this research in a sense that Indonesia displays an interesting case of a country with weak institutional capacity but performs a rather progressive industrial development.

In positioning Indonesia within a comparative perspective, we have made some references to the five neighbouring South East Asian countries, which are Malaysia, Philippine, Thailand, Singapore, and Vietnam, and also to some comparable middle income countries like China, India, Brazil, and Turkey. The reasons of choosing those countries are as follow. First, neighbouring countries usually have, to certain extent, similarities in terms of culture and socio-economic context. Second, neighbouring countries, such as Malaysia, Philippine, Thailand, Singapore, and Vietnam, are less comparable to Indonesia in terms of the size of population and economy. Inspired by Ha-Yoon Chang's (2003) work on comparing countries across historical time[18], cross section comparison should also be made as equivalent as possible. That is why we include large emerging countries, such as China, India, Brazil, and Turkey, for comparison.

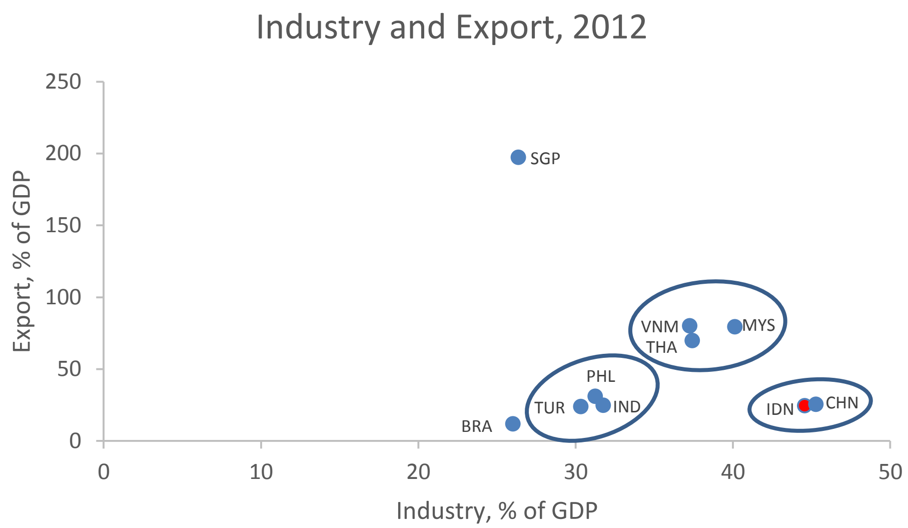
The analysis aims to comparatively explore the differences and similarities in terms of level of development, industrial capability, and institutional quality. One simple way to look at the relative position of each country is by depicting them into a graph by the mentioned criteria.

We approximate industrial capability by two development indicators provided by the World Bank[19], i.e., share of industry[20] and exports to GDP (see Figure III-5). The graph below tells us that the share of industry to Indonesia's economy (red dot) was relatively high compared to some major countries in the Global South. However, its export

[18] Ha-Yoon Chang (2003) systematically compares nowadays developing countries with developing countries in the past.
[19] https://data.worldbank.org/indicator
[20] Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing, construction, electricity, water, and gas.

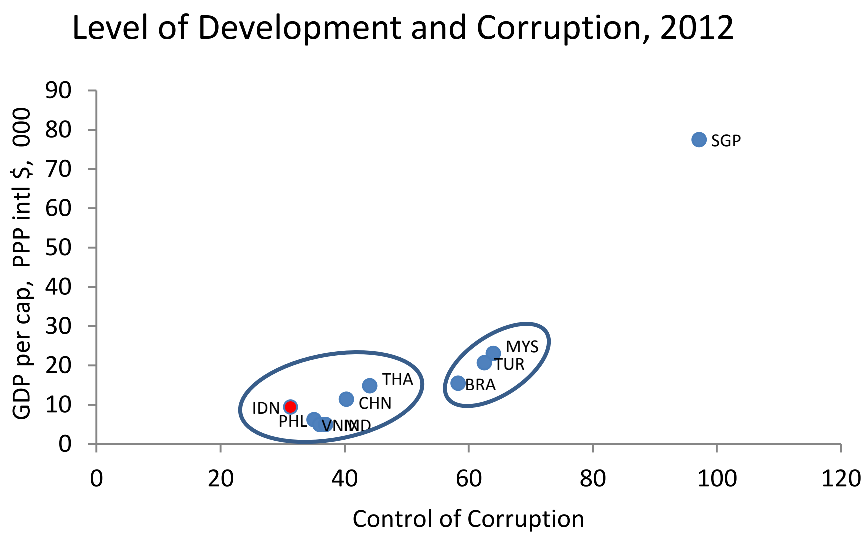
performance seems rather low relative to the size of its GDP. In terms of industry and export profile, Indonesia exhibits a high degree of similarity to China. Meanwhile, three neighbouring countries such as Malaysia, Vietnam, and Thailand still show a similarity with Indonesia, but they perform fairly better in their exports. In contrast, Philippine, Turkey, and India exhibit a rather different profile characterised with low share of industry and exports.

Figure III-5 Level of Industrialisation of Selected Countries in the Global South



Source: World Bank, Development Indicators, 2012

Figure III-6 Level of Development and Corruption of Selected Countries in the Global South

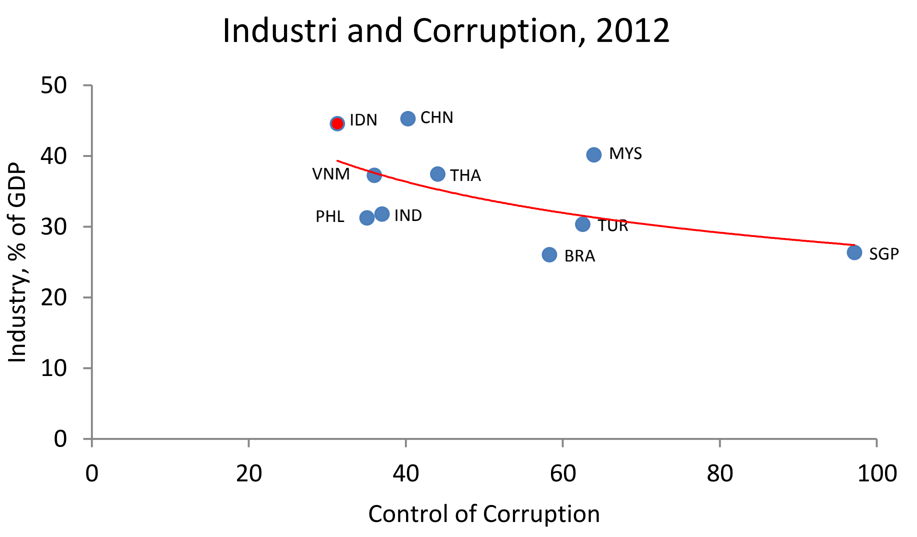


Source: World Bank, Governance and Development Indicators, 2012

Figure III-6 tells a different story. Although Indonesia demonstrates a rather progressive industrial development as indicated by the previous graph, it has a considerably weak control of corruption[21], even compared to countries with lower level of development such as Philippine, India, and Vietnam. Nevertheless, it is still reasonable to classify countries that are concentrated on the lower part of the graph, comprising Indonesia, India, Philippine, Vietnam, China and Thailand as countries with weak institutional control over corruption. Meanwhile, it is quite obvious that a group of countries, such as Brazil, Turkey, and Malaysia, have stronger control to tackle corruption.

The two graphs somehow seem to suggest a paradoxical comprehension. Countries with worse institutions appear to perform better in their industrial development. We clarify this issue by depicting the level of industrialisation and control of corruption of each country into a graph in Figure III-7. Although the relation seems to be weak and rather absurd, it still reveals a negative relation between level of industrialisation and control of corruption. That is, countries with weak control of corruption tend to have higher share of industry to their GDP. The graph also indicated four countries with similar profile in terms of their industrial development and ability to control corruption, i.e. Indonesia, Vietnam, Thailand, and China. In Chapter 4, we will explore the product space and the complexity of these four countries in a comparative fashion.

Figure III-7 Level of Industrialisation and Corruption of Selected Countries in the Global South

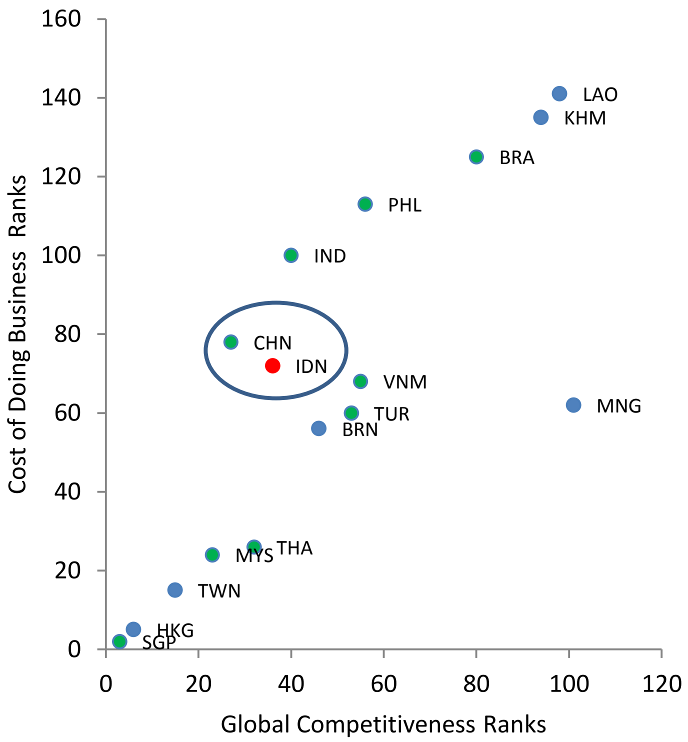


Source: World Bank, Governance and Development Indicators, 2012

[21] We have also looked at other governance indicators, such as government effectiveness, regulatory quality, and rule of law. All of those indicators suggest that Indonesia has weak institutional/governance capacity.

Another simpler way to compare the relative position of Indonesia within regional context is by utilising composite metrics regularly issued by international organisation, such as Global Competitiveness Index (GCI) by World Economic Forum and Cost of Doing Business (CoDB) by the World Bank. Both indexes use a different set of indicators but, we argue, serving a more or less similar purpose, i.e. reflecting the view of business communities. We add some more neighbouring countries (blue dots) into the picture to slightly extend the perspective, as depicted in Figure III-8.

Figure III-8 Ranks of Competitiveness and Easiness of Doing Business



Source: World Economic Forum and the World Bank 2017

The graph, once again, reveals the position of Indonesia that is not far from China in terms of competitiveness and the easiness of doing business. Regardless the indicators used in the comparison, all graphs seem to suggest that Indonesia has many similarities to China. However, the fact that economic performance of China, particularly over the last two decades or so, is much better than Indonesia warns us that something fundamental and structural is different between the two countries. We suspect that the cohesiveness and complexity of industry structure is responsible for the differences, which is the central theme of this thesis.

3.1.1.3 The developmental dynamics of Indonesian provinces

Table III-1 informs us about the dispersion of provinces' GDP per capita from national's GDP per capita (=100). The ranges between maximum and minimum suggest a decline variation of GDP per capita across provinces. In order to get a better idea of the relative positions of provinces, we also include the ranks of each province for the periods 1990-2010. Notice that there were 26 provinces in 1975, but 33 provinces in 2010. Seven provinces were split after decentralization took place in 1999. Few provinces persist to occupy the top ranks such as East Kalimantan (EKL), Jakarta (JKT), Riau (RIA) and Papua (PAP). EKL, PAP and RIA are resource rich provinces endowed with oil, gold and timber, while JKT is the national capital at where most strategic activities such as the financial sector and business headquarters are located (Hill et. al. 2008).

Even though provinces in Java Island are commonly viewed as developed provinces, in terms of GDP per capita those provinces do not have high GDP per capita. This is not surprising as they are populous provinces in which 60% of the country's population resides, pressing down their GDP per capita. We can also observe that some provinces, such as Jakarta and East Java (EJV), improved their ranks. Meanwhile, four provinces experienced sharp decline in their relative positions, including Aceh (ACH), Maluku (MAL), Banten (BAN), and Bengkulu (BKL). Severe conflict is one of many explanations for the relative decline of those provinces. The prolonged conflict between the government and the separatist movement in Aceh between 1976 and 2005 negatively affected Aceh's economy. This was exacerbated by the tsunami catastrophe at the end of 2004, causing more than 200.000 people losing their lives. Maluku also experienced a severe conflict in the period from 1998-2002, triggered by religious rather than political issues. Although this conflict might have a lasting impact on the economy afterwards, it could not explain the relative decline before that. One plausible explanation is the geographical location of Maluku (along with its adjacent neighbour North Maluku) that is relatively isolated from other major big islands (National Mid-Term Development Plan 2009-2014). Bengkulu's rank fell mainly because it has a very strong comparative advantage in agriculture (Hill et. al. 2008, p. 421). Thus far, there are no clear arguments found for why West Kalimantan and Banten experience a dive in their GDP per capita ranks. Nevertheless, this research finds a relatively high population growth in Banten (2.6% per annum) that might erode economic growth in per capita terms.

Table III-1 Dispersion of GDRP per Capita by Provinces to National GDP per Capita 1990-2010

Provinces	1990	1995	2000	2005	2010
ACH	200.7 (4)	146.1 (5)	119.8 (5)	111.4 (6)	64.1 (15)
NSM	99.6 (8)	94.9 (8)	94.6 (8)	88.5 (10)	78.4 (8)
WSM	78.3 (14)	82.0 (15)	86.0 (12)	77.2 (15)	66.4 (12)
RIA	352.0 (2)	234.6 (3)	181.7 (3)	239.5 (4)	230.4 (3)
JAM	65.5 (17)	62.8 (18)	63.4 (19)	67.3 (19)	64.3 (14)
SSM	118.5 (6)	86.6 (10)	92.6 (9)	94.8 (9)	78.1 (9)
BKL	64.6 (18)	60.9 (20)	47.2 (25)	50.6 (26)	40.1 (28)
LAM	50.8 (24)	52.3 (23)	56.1 (23)	45.4 (28)	52.6 (21)
BBL	-	-	96.5 (6)	107.1 (7)	80.2 (7)
RIS	-	-	-	253.6 (3)	157.5 (4)
DKI*	262.9 (3)	329.5 (2)	368.0 (2)	386.3 (2)	331.3 (2)
WJV*	84.9 (12)	83.4 (12)	79.7 (14)	78.8 (14)	66.2 (13)
CJV*	72.2 (16)	67.1 (16)	61.4 (21)	57.8 (23)	50.7 (24)
YOG*	62.0 (19)	82.0 (14)	68.3 (18)	59.8 (21)	48.7 (25)
EJV*	85.1 (11)	83.2 (13)	79.4 (15)	87.7 (11)	76.7 (10)
BAN*	-	-	86.8 (11)	73.9 (17)	59.6 (19)
BAL	103.2 (7)	109.3 (7)	85.3 (13)	79.2 (13)	63.3 (16)
WKL	80.3 (13)	84.3 (11)	72.8 (17)	65.9 (20)	50.8 (23)
CKL	93.9 (9)	115.0 (6)	95.2 (7)	86.4 (12)	71.1 (11)
SKL	85.3 (10)	92.2 (9)	88.2 (10)	76.4 (16)	60.9 (17)
EKL	538.2 (1)	403.7 (1)	497.9 (1)	499.3 (1)	334.5 (1)
NSW	57.7 (21)	61.3 (19)	76.0 (16)	69.5 (18)	60.0 (18)
CSW	53.2 (23)	55.7 (22)	61.6 (20)	58.8 (22)	52.3 (22)
SSW	60.9 (20)	58.8 (21)	56.1 (22)	54.4 (24)	54.2 (20)
SESW	57.6 (22)	49.4 (24)	51.2 (24)	52.2 (25)	46.9 (26)
GOR	-	-	31.7 (29)	29.8 (30)	28.6 (30)
WSW	-	-	-	36.0 (29)	35.0 (29)
WNT	37.5 (25)	40.7 (25)	47.0 (26)	48.4 (27)	40.7 (27)
ENT	34.7 (26)	34.5 (26)	27.1 (30)	27.4 (32)	21.9 (31)
MAL	76.6 (15)	65.3 (17)	38.2 (28)	28.8 (31)	19.5 (32)
NMA	-	-	41.4 (27)	23.0 (33)	19.2 (33)
WPA	-	-	-	97.1 (8)	130.5 (5)
PAP	126.8 (5)	155.5 (4)	153.6 (4)	183.5 (5)	114.4 (6)
INDONESIA	100.0	100.0	100.0	100.0	100.0
Max	538.2	403.7	497.9	499.3	334.5
Min	34.7	34.5	27.1	23.0	19.2

Note: In current price terms and including natural resources output. National's GDP per capita is 100. Scores in parentheses are the relative rank of provinces. Rank 1 means the province has the highest GDRP per capita. Provinces with star (*) are situated in Java island.

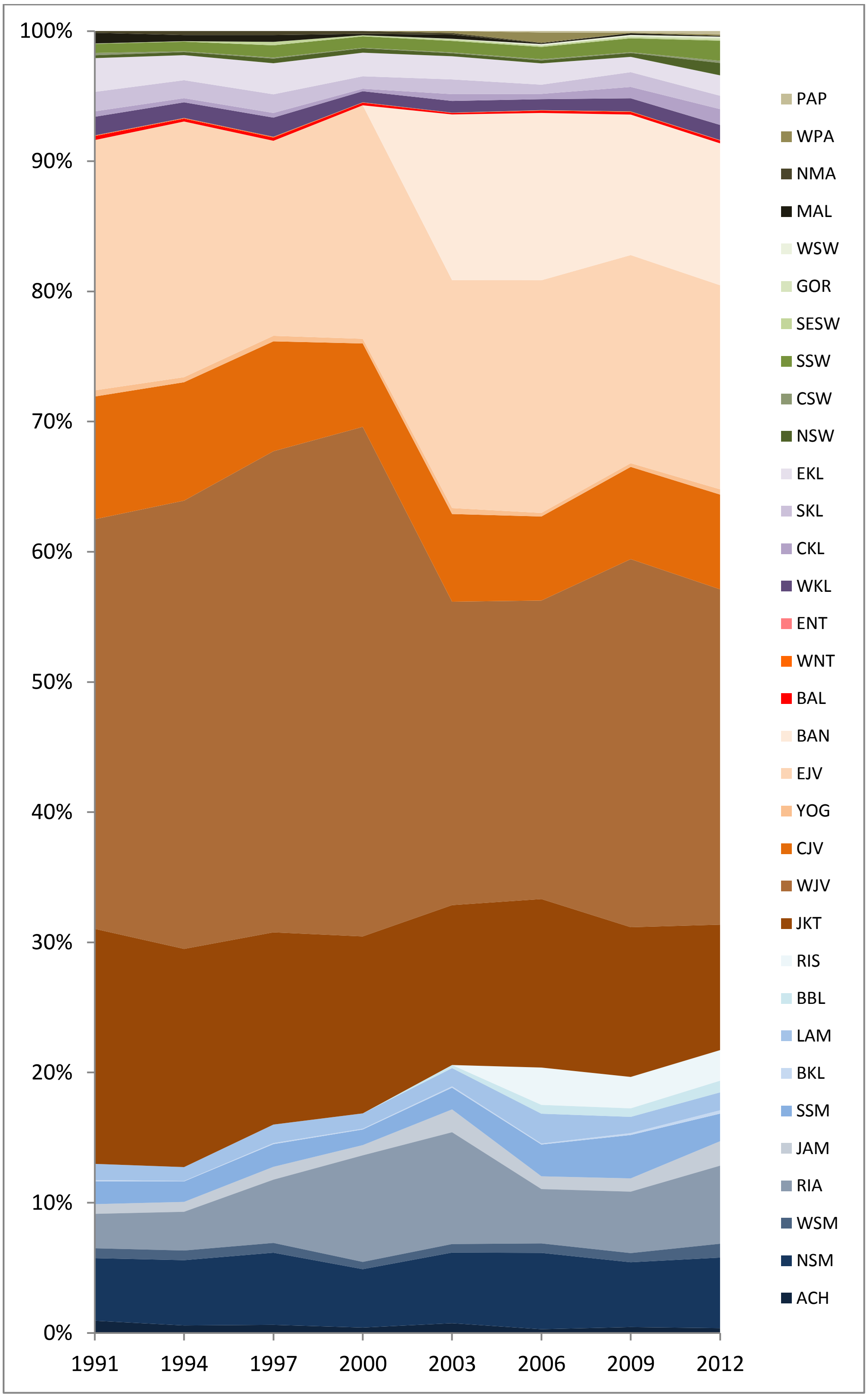
Sources: Various publications of Indonesian Statistics.

While the aggregate analysis offers an overview of regional economic change, it tells us little about the underlying structural changes. Consider two regions, EKL and WJV, for instance. The aggregate GDP per capita analysis of the two provinces would have suggested that EKL is richer, though not necessarily more developed, than WJV. If we look at the product of both provinces, EKL produces mostly extractive products, such as mining, while WJV produces high technology products such as automobiles. In order to get a better understanding of the underlying structural changes, we draw the share of provinces' manufacturing industries to national outputs.

Figure III-9 shows each province's manufacturing share over time. Apparently, most of manufacturing industries concentrated in Java Island, accounting up to 78% of national manufacturing outputs in 1991. This suggests an imbalanced development of manufacturing industries across the country. WJV, EJV, JKT, and BAN are the four largest manufacturing provinces dominating Indonesian manufacturing sector. The manufacturing landscape, however, has changed slightly in the later years as manufacturing industries has grown quite significantly in some Sumatera's provinces. The share of provinces in Sumatera Island increased from 12% in 1991 to 21% of national outputs in 2012, while the share of Java's provinces shrank by 9% in the same period. We will discuss this shift of manufacturing industries across provinces in Section 4.3.3.1.

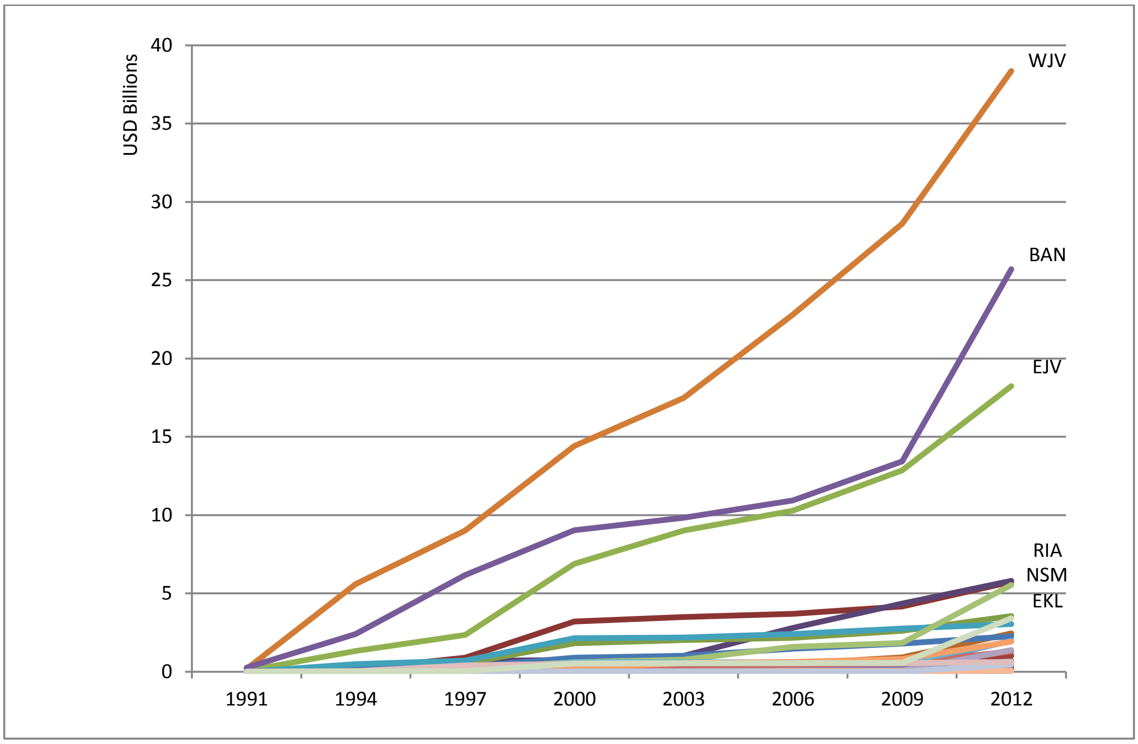
Lastly, we plot the foreign capital inflow into provinces in Figure III-10. We drop JKT from graph to enhance the readability of the graph. One would quickly notice that the three provinces receiving most FDI inflow are in Java, accounting for 40% of total FDI flowing into the country. The next three provinces with considerable amount of FDI inflow are RIA and NSM in Sumatera Island, and EKL in Kalimantan Island. The amount, however, is negligible to those in Java Island, accounting for only 5.2% of the total FDI. At glance, the amount of cumulative FDI inflow in Figure III-10 seems to be highly matching with the share of manufacturing industries in Figure III-9. That is, the concentration of manufacturing industries in Java Island seems to have a strong link with the massive presence of FDI in the island. We investigate if that is the case in Section 5.4.

Figure III-9 Provinces' Share to National's Manufacturing Sector



Sources: Annual Manufacturing Survey.

Figure III-10 FDI Inflow by Provinces 1991-2012 (cumulative)



Sources: BKPM's database.

3.1.1.4 West Java and Central Java Provinces

In the analysis, we deploy a comparative approach of two industries in two provinces. Two comparable provinces will be studied so that differences in response and behaviour can be accounted to the difference in their industrial institutions[22]. Here, we will provide an overview of the reasons behind our selection of West Java and Central Java Provinces in the case study.

West Java and Central Java Provinces are chosen because, to a high degree, they are comparable in the sense that both have similarities in many respects. In terms of the level of development, West Java and Central Java arguably have a comparable level of development[23] (see Table III-2). Both are considered as industrialised regions, where the share of the manufacturing sector was higher than the national share of 27.07% in 2000 (BPS). All these similarities somewhat 'eliminate' the macro-economic

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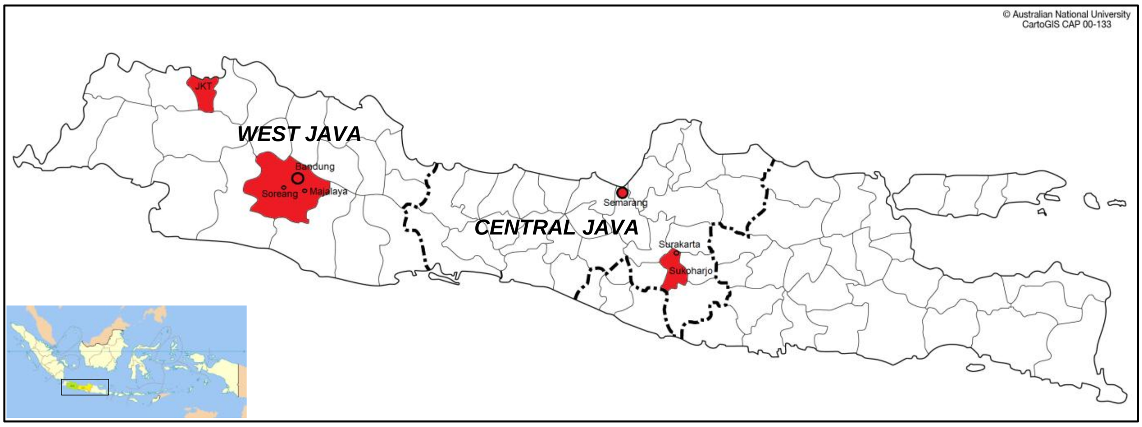
[22] This kind of study design is commonly used in comparative politics studies (Culpepper, 2005) and in historical studies (Murmann, 2003). Principally this approach is similar to a case-control study of which one province is used as a case and the other as a control, with both compared retrospectively.

[23] The GDP per capita of West Java seems higher than Central Java. However, both are the most comparable among all provinces. In terms of GDP per capita, Yogyakarta is actually closer to West Java. However, a much lower industrialisation level (16.1% in 2000) has made Yogyakarta less suitable for the purpose of study.

effects on their regional industrial paths[24]. Moreover, both provinces are well connected and share borders, controlling, to some extent, the differences in cultural and social factors.

Figure III-11 West Java and Central Java Provinces



Source: http://asiapacific.anu.edu.au/mapsonline/base-maps/java-districts-and-towns

Note: Red areas are the loci of the interviews. Bandung City and Bandung District are the centres of the textile industry in West Java, while Surakarta City (also known as Solo) and its neighbouring Sukoharjo District are the centres of the textile industry in Central Java. Interviews were also conducted in the capital city Jakarta with central government officials and Semarang Central Java government officials. Map without scale.

Despite those similarities, these two provinces are characterized by contrasting industrial characteristics. West Java, according to the Investment Coordination Board data, was the second biggest receiver of FDI in the last 20 years (after the capital city of Jakarta), accounting for 15.53% of total FDI inflow to Indonesia, compared to a merely 0.48% for Central Java within the same period. This may explain why the concentration of medium and large enterprises in West Java is much higher than in Central Java. Official figures for 2011 show that there were 5,861 large and medium enterprises in West Java compared to 3,850 in Central Java. In contrast, Central Java is highly populated by small and micro enterprises, with 547,050 enterprises compared to West Java's 252,808 enterprises in 2011 (BPS, 2012). Furthermore, West Java hosts a greater numbers of state-owned industries, some of which have been categorised as strategic industries by the government, such as aircraft, electronics, telecommunications, heavy equipment and military industries. Central Java also hosts a comparable number of state-owned enterprises, but most of them are viewed as less

[24] This does not necessarily mean that macro-economic conditions have no effect on the paths of industrial development. It does mean, however, that macro-economic conditions equally affect each province, thus, outcomes cannot be attributed to the difference in industrial specialization.

strategic. A comparable level of development and industrialisation, together with contrasting industry structures, is expected to reveal how the two adjacent provinces have different industrial development paths.

Table III-2 Two Comparable Provinces with Contrast Industrial Characteristics

Indicators	2000		2011	
	West Java	**Central Java**	**West Java**	**Central Java**
Development and industrialization				
Level of development+ (RGDP per capita, constant price 2000, without oil, IDR)	4,296,941	3,593,941	7,828,800	6,112,900
Level of industrialization+ (% of RGDP, current price)	40.84	29.15	37.16	33.25
Industrial characteristics				
Large and medium enterprises+ (total establishments)	7,253 (2006)	4,326 (2006)	5,861	3,850
Small and micro enterprises+ (total establishments)	227,501 (2006)	442,955 (2006)	252,808	547,050
FDI++ (% of total FDI cumulative inflow since 1990)	5.79	0.21	15.53	0.48
State-owned enterprises+++ (total establishments)*	61	57	61	57
Industrial estates (units) *	-	-	66	19

Sources: Various publications of the BPS (Medium and Large Industry Dataset, Village Potency Dataset), BKPM, Ministry of Industry and Ministry of State Owned Enterprises.

3.1.2 Measuring relatedness and analysing product space

3.1.2.1 Proximity and product space

In understanding the evolution of regional industries, we need to apply one of the evolutionary frameworks that have been elaborated above. First, we have to specify what is referred to as the population and what is referred to as the individual agent. This is an important step in conducting evolutionary analysis in order to avoid confusion when distinguishing which level is actually evolving and which is actually subject to the selection processes. In the case of regional industries, the population is ‘all industries’ within a region. Thus, it is the relative importance of individual industries within a region that evolves as the result of the selection process.

The next step is to determine the selection criteria explaining why some industries thrive while others decline or die. This is an important requirement in the context of evolutionary arguments. The selection mechanism that is commonly used today is market forces. Some industries survive market pressure and become dominant industries in a region for a certain period of time. Another way to think about selection criteria in this specific case is the concept of relatedness. Related products, defined as products that are cognitively close to a region's industry structure (portfolio), are likely to enter the region (path creation) and increase the variety of products in the region. Over time, the selection forces kick in. Some of the products in the region survive selection processes and even emerge as dominant products in the region, as they have the advantage of being close to pre-existing knowledge, infrastructure and institutions. Some products, however, fail the selection processes and leave the region, as they are less related to existing industry structures (path destruction). According to Sober (1984), and re-emphasized by Vromen (1995), this process is known as the selection 'of' industries 'for' its relatedness[25].

To perform this analysis, we need to measure the relatedness of products to other products in a region. When measuring product relatedness, this research adopts the proximity method introduced by Hidalgo et al. (2007), who developed a proximity measure based on the co-occurrence concept of two products being exported by a country at the same time. Formally, they defined the proximity between products i and j as 'the minimum of the pairwise conditional probability of a country exporting a good given that it exports another' (p. 484). Put simply, if many countries export computer monitors and televisions, it is likely that computer monitors and televisions are closely related in terms of their knowledge bases. It is important to note that the conditional probabilities between two products are not symmetrical. If the probability of countries exporting computer monitors, given that they also export televisions, is, say, 0.7, it could be the case that the probabilities of countries exporting television sets, given that they also export computer monitors, is, say, 0.6. In order to produce a symmetric relatedness matrix, Hidalgo et al. (2007) suggest adopting the smaller of the two values (in the case of monitors, this is 0.6) as the value of relatedness between the two products. The formal representation is:

$$\Phi_{i,j} = min\{P(RCAx_i|RCAx_j), P(RCAx_j|RCAx_i)\} \quad (1)$$

[25] Vromen (1995) discusses Sober's (1984) notions of 'selection of' and 'selection for', where the former refers to the *causes* and the latter refers to the *effects* of selection.

where $\Phi_{i,j}$ is the proximity between products 'i' and 'j'; $\mathrm{RCA}x_i$ is the revealed comparative advantage (RCA) of product 'i' in country *x*; and $\mathrm{RCA}x_j$ is the RCA of product 'j' in country *x*. The RCA is defined as follows:

$$RCA_{c,i} = \frac{x(c,i)}{\sum_i x(c,i)} / \frac{\sum_c x(c,i)}{\sum_{c,i} x(c,i)} \quad (2)$$

where $\frac{x(c,i)}{\sum_i x(c,i)}$ is the share of product '*i*' in a region; and $\frac{\sum_c x(c,i)}{\sum_{c,i} x(c,i)}$ is the share of product '*i*' at the macro level.

$\mathrm{P}(\mathrm{RCA}x_j|\mathrm{RCA}x_i)$ is the probability of country *x* exporting product 'j' under the conditions that country *x* also exports product 'i'. Similarly, $\mathrm{P}(\mathrm{RCA}x_i|\mathrm{RCA}x_j)$ is the probability of country x to export product 'i' under the conditions that country x also exports product 'j'. The lower value is assigned as the proximity between products 'i' and 'j'. To help with the calculation, a hypothetical example of how proximity is calculated in practice is provided in Appendix 2. Some empirical examples of product proximity between selected industry groups, based on the calculation using international export data for 2000, are shown in Table III-3.

Table III-3 Samples of Product Proximity

Code	Product names	Code	Product names	Proximity
8708	Parts and access for motor vehicles	4005	Compounded rubber, non-vulcanized, primary forms, etc.	0.7778
9401	Seats (except barbers', dental, etc.), and parts	4421	Articles of wood, NESOI	0.7000
6109	T-shirts, singlet, tank tops etc., knit or crochet	5205	Cotton yarn (not sewing thread), nu 85% cot, non-retail	0.5814
6405	Footwear, NESOI	6102	Women's or girls' overcoats etc., knit or crochet	0.5833

Source: Author's calculation.

Using the product proximity matrix, we can construct what is referred to as the product space. In constructing the product space, the proximity matrix is translated into a network where products and the values of proximity are referred to as nodes and links, respectively. The network representation should help us to visualise the changes in industry structure over time and to perform simulations in relation to it. Details of how to build the network will be discussed in Chapter 4.

The proximity value tells us only the cognitive distance between pairs of industries, or how close an industry to another is. The value however, does not tell us how close an industry is to a region. We have to have this information to evaluate whether regions really do develop new industries that are cognitively close to the regions. One way to summarise this information is by calculating the density of products for each region (Hidalgo et al., 2007). The idea of density is that if a potential product, i.e. product that has not been developed yet, is surrounded by a lot of dominant industries (i.e., industry with RCA > 1) within a region, then that product is considered having high density, and vice versa. They argue that regions endowed with a lot of dominant products will be denser and have a higher chance to develop new products. Formally, the density measure is given as follows:

$$\omega_j^k = \frac{\sum_i x_\mathrm{i} \Phi_{\mathrm{i,j}}}{\sum_i \Phi_{\mathrm{i,j}}} \qquad (3)$$

where ω_j^k is the density around product '*j*', given the export basket of region '*k*'; and x_i = 1 if $\mathrm{RCA}_{k,i}$>1, or 0 otherwise.

Another way is to calculate the closeness of a product to other products residing inside provinces. Adopting the approach taken by Neffke et al. (2011), closeness is measured by counting the number of links that a product has with other products hosted in provinces; this is known as the portfolio. The links should reach a certain proximity value if they are to be considered as 'close' to the portfolio. In our case, we arbitrarily chose the value of 0.143[26], as this is the median of proximity values. Formally, closeness (θ) is defined as:

$$\theta_{ip} = \sum\nolimits_{j \epsilon PFp} I(\,\Phi_{i,j} > 0.143) \qquad (4)$$

where '*I*' is an indicator that takes the value 1 if true, or 0 otherwise. We provide hypothetical examples to calculate density and closeness in Appendix 3.

[26] Neffke et al. (2011) choose 0.25 as the threshold, while and Essletzbichler (2013) adopt 0.237. Neffke et al. (2011) and the present author have experimented with different cutting values (0.02, 0.58, 0.125), although their results show similar patterns.

3.1.2.2 Simulation of transition

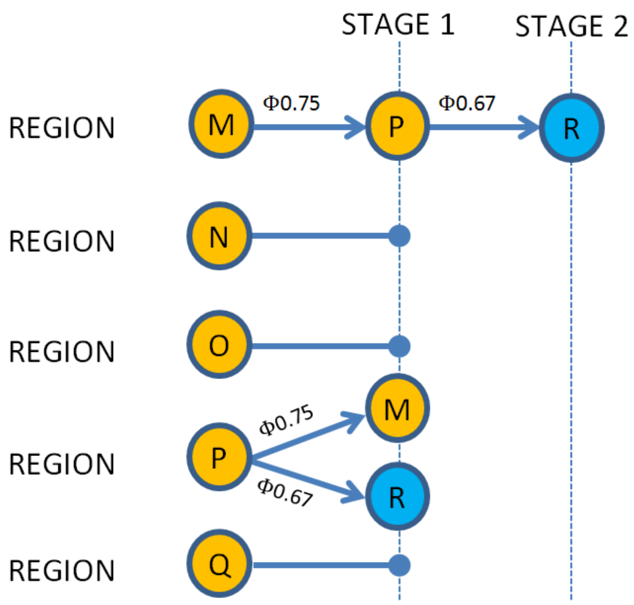
If all regions develop new products that are close to their current productive structure, logically, after a certain period of time, all regions will gradually be able to make all their products in the product space. If that is the case, in the end, regions will converge. However, Hidalgo et al. (2007) argue that regions may fail to reach the richest part of the product space, as it is simply too far to reach and the 'road' to get there is not well connected. This is similar to a situation in which we want to cross a river, but there is no bridge or canoe to get us to the other side. In short, the transformation of regions' productive structure into a more sophisticated one may not succeed if regions fail to develop the 'bridge' first. This highlights the need to investigate the plausible paths of regional development.

It is worth simulating the level of proximity at which all provinces in Indonesia will manage to obtain the ability to manufacture sophisticated products. Following Hidalgo et al. (2007), this thesis will conduct simulations in every province's product space in order to investigate the transition of regions' productive structure. We will experiment with several proximity values as thresholds. A threshold is defined as a minimum value of proximity, which should be reached by a region if it is to diversify to that product. In their cross-country analysis, Hidalgo et al. (2007) found the threshold value to be $\Phi 0.65$. This means that, if countries fail to find any product as close as $\Phi 0.65$ on their way to the rich part of the product space, it is less likely that they will manage to get there. We will begin the simulation with the lower value of $\Phi 0.40$ and then gradually increase it until we arrive at a certain value at which provinces can diversify no more. In turn, we will consider this value as the threshold value. It is important to note that the simulation only tells us that, given initial the industry structure and assumed critical proximity value, a region will probably go along this particular path of industrial development without explaining when exactly the region reaches that particular path.

A simple example of the transition mechanism is illustrated in Figure III-12. In this example, the critical value at which a region can develop new products is set at $\Phi 0.65$. A higher value of Φ means close products, and vice versa. We consider product R as the most sophisticated product, which all regions are eager to produce. Departing from the existing productive structure M, region 1 manages to develop nearby product P at the first stage of the transition. Region 1 develops its industries further and reaches product R in the second stage of the transition. Likewise, region 4 starts with more advanced product P, then manages to arrive at product R in the first transition. The rest (2, 3 & 5), however, fail to reach sophisticated product R because it is too far away from their productive structure at that time.

Statistically, these stages of transition can be summarised by looking at the number of products with which regions can manage to 'walk' on the way to the core of the product space. After N stages of simulation at a given proximity, say, Φ0.65, we can summarize, for instance, the distribution of provinces that still manage to have some products in their space. We can perform this statistical analysis for different numbers of stages (N) and for different proximity levels (Φ) in order to look for a range of possibilities of the regional industrial paths.

Figure III-12 Transition of Industrial Structure



Source: Author's illustration.

3.1.3 Measuring and analysing the complexity of regional industry structures

As discussed in the literature review, the wealth of regions is not solely determined by how many products a region can make but also by what kind of products it is capable to produce. The capability of regions is arguably reflected by their productive structure. Regions that produce diverse products are likely to have the necessary capabilities for making those diverse products. Thus, the diversification of products is a good approximation by which to measure the capability of regions.

Further, depending on the sophistication of products, some products may require complex capabilities that only a few regions are capable to produce. In contrast, many other products may require simpler skills, which are found in most regions. Therefore, the commonness of products may reflect the sophistication level of products, which strongly mirrors the capability of regions producing them. In short, less common products are likely to require more advanced capabilities, whereas more common products are likely to require low capabilities to produce. Hence, the commonness, or ubiquity, of products could be another good proximity by which to measure the capability of regions. By iteratively combining these two measures, we can construct a comprehensive measure for the industrial capability of regions.

Following Hausmann and Hidalgo (2010), industrial diversification of region *r*, denoted by k_r, is measured by the number of products with an RCA that a region makes.

$$k_r = \sum_p M_{rp} \tag{5}$$

where M_{rp} is product *p* with an RCA value equal to or greater than 1 in the region *r*. The RCA is defined as in Equation (2). For a simple example, if a region produces 20 products, of which 12 have comparative advantage greater than 1, then the diversification level of that region is 12. A higher value means more diversity, that is, a region with a diversification value of 12 is more diverse than a region with diversification value of 8.

Additionally, the sophistication, or ubiquity (k_p), of products is defined as the number of regions that produce such products. This is formulated as follows:

$$k_p = \sum_r M_{rp} \tag{6}$$

where M_{rp} represents the products with a comparative advantage, which are produced by regions. For example, if product A is exported by 10 out of 30 regions, then the ubiquity of that product is 10. Note that the lower the value of ubiquity for a product, the higher the level of regional capability for the region producing it. In other words, a product with a ubiquity value of 10 is more sophisticated than a product with a ubiquity value of 20.

By combining the two measures iteratively, we can estimate productive structures of regions that determine their industrial capabilities.

$$k_{r,n} = \frac{1}{k_{r,0}} \sum_{p=1}^{N_p} M_{rp} k_{p,n-1} \tag{7}$$

$$k_{p,n} = \frac{1}{k_{p,0}} \sum_{r=1}^{N_r} M_{rp} k_{r,n-1} \quad (8)$$

where $k_{r,0} = k_r$ and $k_{p,0} = k_p$.

For regions ($k_{r,n}$), an even value of n can be interpreted as a general diversification measure, whereas an odd value can be interpreted as general ubiquity measure. For products ($k_{p,n}$), an even value of n can be interpreted as a general ubiquity measure, whereas an odd value can be interpreted as a diversification measure of a region producing those products. It would be helpful to put this iterative formula into a hypothetical example, as given in Appendix 1.

With this measure in hand, we can examine how the complexity of regional industry structures changes over time. Furthermore, this complexity measure can be combined with the relatedness analysis to see whether a region is branching out into more sophisticated industries, thus increasing the complexity of its industry structure, or diversifying to similar or even less sophisticated industries.

3.1.4 Inferential analysis

After analysing the links the between existing structure and the evolution of regional industry, the analysis goes further beyond the industry structure. We take into account other factors external to the structure, which could influence the evolution of regional industry. We aim to compare the relative importance of endogenous evolutionary forces, which inherently reside within the structure of regional industry with exogenous forces external to the structure. In addition, we are also curious about whether or not regions evolve towards more sophisticated industries. This is important because economic impacts of the evolution towards low-tech industries may not be as significant those concerning the evolution towards high-tech industries. This thesis will perform an econometric analysis to infer the effects of industry structure on the evolution of regional industry, relative to other factors external to that structure. How the analysis will be performed will be discussed in detail in Chapter 5. Here we limit our discussion to the construction of two econometric specifications used to estimate the relative importance of relatedness, FDI and other potential explanatory variables.

3.1.4.1 The estimated equation

We start with the basic model as follows:

$$x_{i,r,t+3} = \alpha + \gamma Z_{i,r,t} + \beta Control_{i,r,t} + \varepsilon_{i,t} \quad (9)$$

where $x_{i,r,t+3}$ is defined as new industries *i* developed by region *r* in year *t*+3; α is a constant; $Z_{i,r,t}$ is a vector of the variables of interest (in this case, relatedness, $D_{i,r,t}$, foreign investment, $I_{i,r,t}$, sophistication level, $K_{i,r,t}$, and minimum wages, $W_{r,t}$); and $Control_{i,r,t}$ is a vector of control variables, which are suspected to affect the development of industries. In our model, control variables include the size of employment by industry and by province, and the lag value of the response variable; $\varepsilon_{i,r}$ is a random error term. The construction of the model's specification is discussed below.

The main variable of interest is relatedness, $D_{i,r,t}$. We presented a lengthy discussion about the theoretical foundation underlying the choice of this variable in Chapter 2. In our models, we use two measurements of relatedness, i.e., density and closeness, which are discussed in Chapter 4. We also include foreign investment, $I_{i,r,t}$, as a variable of concern. The main reason for including foreign investment in the specification is that it represents an exogenous force, which is viewed as both a capital input and a source of productivity, particularly for developing countries. We design our model's specifications to purposely compare its weight vis-à-vis the relatedness variable in driving industrial transformation both at the regional and the industrial level.

As theoretically discussed in Chapter 2, the complexity of industry structure is likely to affect the capabilities of regions to diversify their industries. The more complex its industry structure, the more capable a region is to develop new industries. For this reason, complexity will be added to the specification as one of the variables of interest ($K_{i,r,t}$). The inclusion of complexity also serves our purpose in terms of identifying whether provinces and industries diversify into more advanced industries. It is important to bear in mind that the sophistication level of this index is measured by the ubiquity of industries. This means that less prevalent industries are considered to be more sophisticated than ubiquitous industries (see Section 3.1.3). Therefore, a negative sign for the coefficients may suggest two things: first, less sophisticated provinces or industries tend to hinder industrial branching processes; and, second, provinces or industries tend to expand towards more advanced industries.

Apparently, the development of industries is influenced by other factors, which, in this study, need to be controlled. Following Essletzbichler (2013), Neffke and Henning (2013), and Neffke et al. (2011), we control the size effects of industries and regions using employment data. The underlying arguments are that large industries 'are likely to enter and less likely to exit a region' (Essletzbichler, 2013, p. 257). Similarly, 'large regions typically host a large number of different industries and are able to attract new and to retain old industries more easily' (2013, p. 257). Therefore, these two variables, i.e., the employment in region *r* ($Emp_{r,t}$) and in industries *i* ($Emp_{i,t}$), will be included in the equation as controls.

The model also follows Hausmann and Klinger (2007), Boschma et al. (2014, 2013), and Rigby (2012) in including the lagged value ($x_{i,r,t}$) of the dependent variable in the model to control the effect of the current specialisation of regions in certain industries. As revealed by Boschma et al. (2013), there is a strong positive relationship between the number of new dominant industries and the prevalence of dominant industries in previous years. Thus, controlling this variable is expected to improve the specification of the model. In addition, we also take into account the factor costs that may be influencing the locational decisions of firms and workers. Certainly, there are many factor costs incurred by firms, such as property rents, capital goods, raw or input materials, labour costs and taxes. However, Wood and Roberts (2010) argue that wages and labour constitute major domestic costs for most firms in the manufacturing industry. Thus, regional wages are included in the specification to capture and control the effect of domestic costs on the evolution of regional industry.

When using panel data, there are unobserved factors influencing the response variable, which are time-invariant in characteristics or change very slowly over time, such as culture, locations and laws. Econometric models that control this time-invariant characteristic are known as FE models[27]. These models are designed to analyse the cause of changes within an entity, such as people, industry and province, as a constant characteristic cannot explain those changes[28]. Technically, this is usually done by introducing dummy variables (δ) into the model, with a value of 0 for all entities except 1. Thus, dummy variables for both fixed province effects and fixed industry effects ($\delta_{i,r,t}$) will be added to the specification in order to capture all the variations between provinces and industries[29].

Putting all variables together, the basic specification to be estimated is presented in Equation (10). Departing from this specification, we can then construct two models with different units of analysis, namely, province model and province-industry model. Having two or more models allows us to compare the outputs for robustness.

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[27] Alternatively, Random Effects model may be more appropriate, subject to further testing.
[28] It is very unlikely that a change in one's income is engendered by how tall a person, given that one's height does not change over time. Factors such as education and experiences are more likely to cause it.
[29] Alternatively, a specific Stata command is available to estimate an FE equation.

Industries with CA in period t+3 | Relatedness effect | Complexity effects | Regional wage effects

$$x_{i,r,t+3} = \alpha_0 + \beta_0 x_{i,r,t} + \beta_1 D_{i,r,t} + \beta_2 I_{i,r,t} + \beta_3 K_{i,r,t} + \beta_4 Emp_{i,r,t} + \beta_5 W_{r,t} + \delta_{i,r,t} + \varepsilon_{i,t} \qquad (10)$$

Industries with CA in period t | FDI effects | Employment effects | Fixed effects

3.1.4.2 Province model

The unit of analysis for the province model is province. That is, all the variables are measured at the province level. We use the number of industries with comparative advantage in provinces as the response variable[30]. On the right-hand side of the equation, we measure the overall relatedness of provinces by averaging the density of industries hosted by provinces. The density of an industry itself is calculated by Equation (3). As theoretically discussed in the previous chapter, this research expects a positive sign for the estimated coefficient of $D_{i,r,t}$, confirming that new industries emerge in related industries. For measuring the capability of provinces, we choose Kc_7 to reflect the average sophistication level of provinces. A negative sign for the coefficients indirectly suggests that provinces or industries expand towards more advanced industries over time, and vice versa. Theoretically, provinces with a more sophisticated industry structure tend to develop more sophisticated industries as they have the capabilities to do so. This, in turn, should further improve the sophistication level of their industry structures. However, sophistication is a dynamic concept. What we consider sophisticated nowadays may be obsolete in a few years. Therefore, the expected direction of the relation is less predictable. The effect of FDI is estimated by the amount of FDI received by provinces. The coefficient should inform us of the extent to which FDI changes the comparative advantage of regional industries. The expected signs for $I_{i,r,t}$, however, cannot be predicted as yet, given that the empirical evidence seems to be inconclusive to date. We add lagged values of the dependent variable, provinces' employment and provinces' minimum wage as control variables. As discussed above, we expect a positive effect for the lagged value of the dependent

[30] We also experiment with the real value of comparative advantage for robustness checks, but this is not reproduced here.

variable and employment size. However, labour costs are likely to have a negative relationship with the probabilities of industries to emerge.

The specification of the province model to be estimated is as follows:

Σ industries with CA in period t+3

Relatedness effects

Complexity effects (K_{c7})

Domestic cost effects (min. wages)

$$x_{r,t+3} = \alpha_0 + \gamma_0 x_{r,t} + \gamma_1 D_{r,t} + \gamma_2 I_{r,t} + \gamma_3 K_{r,t} + \gamma_4 Emp_{r,t} + \gamma_5 W_{r,t} + \varepsilon_{r,t} \quad (11)$$

Σ industries with CA in period t

FDI effects

Size effects (manufacturing labour)

3.1.4.3 Province-industry model

The second model is a province-industry model. The name of the model is self-explanatory in that the unit of analysis is the combination of province and industry. Here, we treat the same industry in different provinces as a different entity. Thus, industry A in province Y and industry A in province Z are two different entities in this case. For the province-industry model, we use closeness as an alternative measure of relatedness (see Appendix 3). Nevertheless, we also use density to measure for robustness check purposes. The specification of this model is more or less similar to the province model, but different in its response variables. In this model, we separate out the effects of closeness on the membership, entry and exit of industry within provinces. Non-portfolio industries – industries not belonging to a province – tend to enter a province if they are relatively close to the province's portfolio. Likewise, portfolio industries (industries that belong to a province), which are relatively closer to non-portfolio industries are likely to exit from their host province. For this reason, we include 'closeness to non-portfolio industries' into the specification.

What differentiates membership, entry, and exit models are the samples used to estimate the coefficients. A membership model uses portfolio industries that pre-exist in provinces in period *t* and remain so in period *t+3*. An entry model uses non-portfolio industries in period *t*, becoming portfolio industries in period *t+3*. In contrast, an exit model uses portfolio industries in period *t*, becoming non-portfolio industries in *t+3*. It is important to note that we do not include the lag response variable in the equation, as the response variables themselves, i.e., entries, memberships, and exits, are constructed based on the information of their own lag values.

In this model, response variables are binary values of 1 and 0. For an entry model, for example, industries entering a province are given the value of 1, or 0 otherwise. Similarly, as in the exit model, exiting industries are given the value of one, or 0 otherwise. Other variables are adjusted according to the province-industry entity. So, for instance, FDIs are elaborated by their province-industry. For control variables, we include both employment sizes of industry and region separately. Thus, we control the size of industry and the size of a region in terms of employment. The expected signs of coefficients are the same as for the province model.

In this model, we also control the lagged value of each predictor variable. The reason is that, in evolutionary terms, the emergence of new industries cannot be simply assumed to take place within three years period, as initially assumed by the models. Some industries, particularly the young ones, may need longer time to emerge. Conversely, declining industries may struggle to survive, or to revitalise, in their host regions, making the exit process longer. We take this situation into account by including further lagged value of each estimator (t-3) as control variables into the model. The specification of the province-industry model to be estimated is as follows:

Binary: 1 or 0 for entry, remains and exit. | FDI effects | Industry size effects | Closeness to non-portfolio industries

$$x_{i,r,t+3} = \alpha_0 + \gamma_1 Cpf_{i,r,t} + \gamma_2 I_{i,r,t} + \gamma_3 K_{i,r,t} + \gamma_4 Emp_{i,t} + \gamma_5 Emp_{r,t} + \gamma_6 Cnpf_{i,r,t} + \varepsilon_{r,t} \quad (12)$$

Closeness to portfolio industries | Complexity effects | Regions size effects

Note: This is basic province-industry model that has three variances, i.e. membership/remain, entry, and exit model. Each variance has the same specification but with different sample of data.

3.1.5 Case study analysis

One plausible explanation for the different paths of regional development is the influence of institutions that shape the evolution of the regional industry structure. Many economic geographers have highlighted the role of institutions on shaping the behaviour of economic agents (Amin and Thrift, 1994; Bathelt and Glückler, 2014; Boschma and Capone, 2015; Gertler, 2010; Martin, 2002). On one hand, however, context specifics, such as regional institutions and all dynamics within it, are often neglected in a quantitative analysis because of its preference to look for generalization. On the other hand, exploring the influence of regional institutions is considered to be too broad and its influence is often too elusive to be clearly unveiled (Bathelt and

Glückler, 2014). Therefore, in order to avoid this vagueness in the analysis, we are guided by the institutional framework of VoC, which is widely discussed within the political economy literature (see Section 2.3.5). Specifically, regional institutions will be investigated in terms of the labour market, industrial relations, inter-firm relations, and network of knowledge.

We deploy a comparative approach of two industries in two regions (Silverman, 2013). Two comparable regions will be studied so that differences in response and behaviour can be attributed to the difference in their industrial institutions[31]. We have discussed the reasons for choosing West Java and Central Java Provinces in Section 3.1.1. Here, we discuss the justification and criteria of choosing the industries.

There are three considerations on which the selection of two industries is based as study cases. First, we seek to explore any significant divergent cases that seem to fit less well to the evolutionary narration. Thus, the chosen cases should, to some degree, exhibit a deviation from what is expected from the evolutionary patterns. Second, we search for a deeper understanding within a real-world context, as well as corroboration of a general pattern that has been inferred from the econometric analysis. Therefore, we expect to find two representative industries, which were found to be comparable at the beginning of the analysis but went through different paths of development. Specifically, those industries must be located in West Java and Central Java, and have similar relatedness values. However, the industry should have expanded in one province, but decline in the other. With this setting, we expect to attribute the presence of divergent-cases to differences in industrial institutions between the two provinces, while controlling other regional characteristics. Third, we also expect, if possible, that the two chosen industries are interesting cases to explore by themselves. The size of industry or the strategic position of industry in the national manufacturing sector may make the cases much more interesting to study.

Two industries are selected, representing divergent-case phenomena (Silverman, 2013), which call for an in-depth explanation (Schoenberger, 1991). Those industries are the textile (including spinning, weaving and garment manufacturing) and aircraft industries. In terms of its development, the textile industry has been experiencing several shocks, such as competition pressures, global crises and changing government policies. In this context, the textile industry in West Java and Central Java has more or less experienced similar situations. However, they could have responded differently.

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[31] This kind of study design is commonly used in comparative politics studies (Culpepper, 2005) and in historical studies (Murmann, 2003). Principally, this approach is similar to a case-control study, in which one province is used as the case and the other as the control, with both compared retrospectively.

Their responses have likely been shaped by the internal characteristics of the industry (e.g., upstream or downstream) and by the institutions specific to the regions which this study would like to unveil. To do so, a series of interviews were conducted to reveal the general responses of the textile industry in each province and, if possible, the reasons underlying them. Interviewing representatives of corporations is argued to be a more sensitive method in economic geography, particularly for uncovering evidence related to historic and institutional complexity. In the literature, this kind of methods is known as 'elite' interview (Schoenberger, 1991). Furthermore, by isolating as many, and as similar, factors as possible (e.g., macroeconomic conditions, socio-cultural factors and national policies) and comparing the evolution of the textile industries in West Java and Central Java should allow us to reveal the link between the different responses to specific institutional configurations within the VoC framework[32]. Determining which response is the primary cause is actually the essence of this analysis.

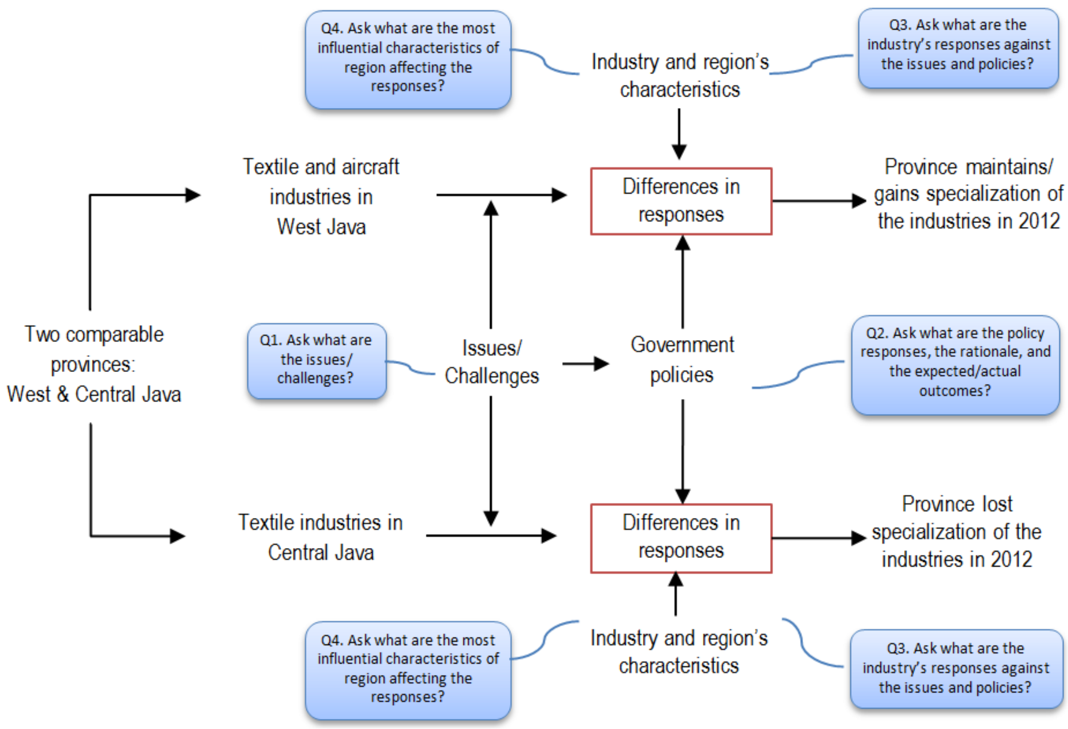
A similar procedure was applied to analyse aircraft industries. The reason for choosing the aircraft industry is that it had a similarly low relatedness in both provinces in 2000. In order to analyse how a less related industry gains comparative advantage, we need the same industry with a similarly low relatedness in the other province that fails to emerge in comparison. The aircraft industry fits this requirement, as it has had a similar relatedness level in both provinces, but has never gained any comparative advantage in Central Java. Alternatively, we could have chosen another transportation industry, such as the railway industry, as a case study due to gaining a comparative advantage in Central Java but not in West Java (just the opposite of the aircraft industry case). However, the railway industry, for example, had a different relatedness level in 2000, making it less comparable and, thus, ruling it out as a good case to study. We will return with more detail explanations on this matter in Chapter 6.

Both textile and aircraft industries are interesting by themselves. Textile is the largest manufacturing industry, in terms of employment and output, in Indonesia. In terms of geographical distribution, the industry mostly concentrates in West Java and Central Java province. Also, textile industry is considered Indonesia's 'traditional' manufacturing industry that has been exist for quite a while in the countries, representing a mature and labour-intensive industry. Meanwhile, aircraft industry is an interesting case to study because of its strategic position in the national manufacturing sector, as explicitly stated by the government itself. Aircraft industry also represents a

[32] Similar method is used by Saxenian (1994) in linking the performance of Silicon Valley and Boston Route 128 with industrial organization and culture. Flourishing Silicon Valley relies on flexible, network-based small companies while declining Route 128 based-on rigid, vertically coordinated big companies.

young and high-tech industry that offers a contrast case against the textile industry. The design of a comparative case study is graphically shown in Figure III-13.

Figure III-13 Case Study Design



Source: Author's analysis

3.2 Data

3.2.1 Sources of data

To perform the analysis, export data are required both at international and regional (provincial) levels. International export data are harvested from the UN and can be downloaded from http://data.un.org/. The available years are from 1992 to 2012. The provincial export data are provided by the Indonesian Ministry of Trade (for the period 2008-2013) and BPS (for the period 2000-2007). Another dataset deployed in this thesis is Indonesia's Medium and Large Industry Dataset. This plant-level dataset covers information on the number of plants, industry output according to the five-digit International Standard Industry Classification (ISIC), the source of investment (foreign, government or private), and employment. The dataset is derived from the Annual Manufacturing Survey (AMS), conducted by the BPS and available from 1991[33].

The trade data at the international and regional levels are based on the classification of the Harmonised System (HS) at the six-digit product level (HS6). As the classification has been revised three times (in 1996, 2002 and 2007, and the international trade data are available in the original classification of HS6 1992, all regional data have been converted to the HS6 1992 classification by using conversion tables[34]. The HS6 1992 classification yields 5,039 products, resulting in a large proximity matrix of 5,039 by 5,039 in size. In order to match FDI data, which use the ISIC system, and the availability of conversion tables from HS to ISIC at the four-digit level, the calculation of product proximity is performed by using a four-digit classification of HS4, resulting in a proximity matrix with a much smaller size of 1,241 by 1,241.

The two datasets, however, have some limitations. Regional export data, disaggregated by commodities, are only available from 2000. The use of these data could pose some challenges. First, the short coverage of the data may not capture the full picture of evolutionary changes at the regional level. Second, export data are collected at custom points, mostly at seaports and airports, thus they record where the products are exported, not produced. As some provinces do not have seaports, they export their products from the nearest seaport in other provinces. Thus, regional export data may be biased towards provinces with access to seaports. Alternatively, the AMS (plant dataset) will be used. The advantage of using this dataset is its long coverage back to 1991 and its accuracy in capturing regional manufacturing outputs by the way it records where the outputs are produced, not exported. That said, it only covers the manufacturing industry, which means that agricultural and mining sector are excluded. This dataset is also accessible for free under certain terms and conditions. Nevertheless, both data sets can actually complement each other. In fact, this is the reason why we use both data sets in the analysis: the trade data set in Chapter 4 and the plant data set in Chapter 5.

With regard to institutional analysis, the data will be retrieved from three different sources, i.e., in-depth interviews, content analysis of policy-related documents and tabulated secondary data. How data from those three sources are collected will be discussed in detail in Chapter 6.

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[33] Metadata from the AMS can be accessed via the following link: http://repository.bps.go.id/mikrodata/index.php/catalog/358.

[34] Conversion tables are available and can be downloaded freely via the following link: http://unstats.un.org/unsd/trade/conversions/HS%20Correlation%20and%20Conversion%20tables.htm.

3.2.2 Validity and reliability

It is highly important in social science to be cautious with the data used in research because they are often contested for their validity and reliability (Drost, 2011). In terms of validity, the use of export data to measure regional productive structures is arguably valid, although there are some inherent weaknesses in relation to the locations where the data are recorded. Alternatively, plant datasets are also used to complement export data. The plant dataset, however, is only valid for measuring manufacturing sectors, excluding agricultural and mining sectors. In terms of reliability, one of the ways to check the reliability of regional export data is by checking their consistency with international export data provided by UNStats. At the aggregate level, the export values provided by the Ministry of Trade and the BPS are consistent with those published by UNStats. With regard to qualitative data, the sources of data are official documents, which can be considered to be reliable sources of information. Information sourced from interviews can also be used as a mechanism to check the reliability of information provided in the documents, and vice versa. Alternatively, both document- and interview-based information can be triangulated with secondary data to ensure reliability.

To conclude this chapter, we highlight three important issues, i.e., the overall strengths and weaknesses of our approach, potential ethical issues and theorising the analysis. This research combines the quantitative and qualitative methods to take advantage of the broad and the depth of analytical perspectives offered by each method. The extensive method, referring to Sayer and Morgan's (2010) terminology for quantitative analysis, serves to provide empirical reality about certain phenomena that are directly observable. Meanwhile, the intensive method of qualitative analysis aims to reveal the critical reality that explains the causal mechanism behind those observed phenomena. The adoption of those two methods, to some extent, addresses the classic debates about quantitative versus qualitative methods. However, it might cost this research a greater effort to deploying both methods simultaneously. As consequence, the qualitative part of this research, we should admit, was not as comprehensive as they could have been. However, the qualitative analysis, as we demonstrate in Chapter 6, is sufficient to reveal the critical reality that is expected from this method.

Conducting an interview involves some ethical issues that must be taken into account. 'The ethical golden rule is to do no harm' (Höglund and Öberg, 2011, p. 141). Standard ethics of conducting interview, such as clarity about the procedures of interview (venue, expected duration, context and objectives of the interview) was submitted to the interviewees prior to the interviews. Confidentiality and permission has been kept intact. Any information documented in this thesis has been treated as the interviewees' wishes, including their preferences about anonymity. For instance, most interviewees prefer their positions, instead of their names, as identity, while a few of them prefer their institutions or the broader categories.

Moreover, this research is designed based on a specific theoretical framework, namely, EEG. The objective is to test the theory with empirical evidences. Therefore, the generalisation of the data drawn from both quantitative and qualitative analysis will not lead to totally new theoretical ideas, but rather to contextualise the dynamics of the aforementioned theory. What we mean by contextualisation is that to what extent the evolutionary idea applies in explaining changes of economic landscape within a Global South setting. Nevertheless, this research is open to broader theoretical implication for its findings, which may not fit well into the mentioned theory. We carry out this in the conclusion.

CHAPTER IV
COHESIVENESS AND COMPLEXITY OF REGIONAL INDUSTRY STRUCTURES IN INDONESIA

4.1 Introduction

How do new industries or products[35] emerge in particular regions and why do regions choose those particular sets of products instead of others are questions that have still been under investigation until now. At this point in time, the literatures addressing this particular issue can be divided into two lines of thinking. The first relies on the assumption of perfect rationality, while the other is built on the bounded rationality assumption (see Chapter 2 for this discussion). The perfect rationality side postulates that the production of outputs is a combination process of different factors of production, such as capital, land, labour and, to some extent, human capital, which occur within a region. Putting too much weight on factors of production implies that all regions can basically produce any product, say, from palm oil to aircraft, as long as they manage to gather together all the required factors. The fact that only a few regions can make aircraft, while not all regions choose to produce palm oil, is because the costs to acquire all the required factors of production are too prohibitive, not because those regions lack the capabilities to produce them, according to this line of thinking.

The bounded rationality side, on the other hands, places a strong emphasis on the capability of regions such as specific institutions, tacit knowledge, social networks and cultural practices, which are cumulatively built. Regions do not build aircraft, but produce oil palm instead, because they simply have no capabilities to produce aircraft. From this perspective, economic outputs cannot be reduced merely to a highly abstracted combination of different sets of factors of production, as they also rely on the capability of regions to make the output materialising. Here, 'capabilities' refers to a bundle of specific local inputs, which are required to produce a particular product, such as local tacit knowledge, skills, infrastructures, institutions and all other resources that are locally available. Capabilities are non-tradable factors endowed by regions, while products such as aircraft require a specific set of capabilities, which are different from capabilities required to produce other kinds of products. Given the importance of capabilities in explaining regional development, measuring productive capabilities of

[35] From now on we use the term 'products' to also refer to 'industries'.

regions is crucial to the understanding of how regions accumulate them. This is something that, to the author's knowledge, is surprisingly rare to find in the literature.

Capability is not something that simply comes from somewhere or is instantly gained; rather, it is something that is attained through a cumulative long run process. Learning as a social process is at the heart of the process of accumulating capabilities (Teece et al., 1997), which is determined by the existing capabilities. Therefore, in understanding how regions develop new products, it is important to study how regions actually learn and accumulate their learning over time. The literatures on innovation and cognitive behavioural science offers valuable insights by suggesting the importance of prior knowledge in the process of knowledge acquisitions (Cohen and Levinthal, 1990; Nooteboom, 2000). In a more explicit language, new knowledge is somewhat related to existing knowledge. Here the relatedness between knowledge becomes at least as important as the availability of the current stock of knowledge itself.

The notion of relatedness is central in evolutionary studies, particularly in evolutionary economic geography. Relatedness allows us to investigate whether regions develop new products near to existing products, as suggested by path dependence theorists. Conversely, less or unrelated products may experience declining shares of output and eventually be forced out of the regions. The emergence of new nearby products, the destruction of unfitted products and the inheritance of surviving products are somehow associated with the idea of relatedness. The closeness to the existing products makes potential products much easier to develop, as they tend to require similar or familiar capabilities.

Recently, two related measures of capabilities and relatedness have been constructed and used fairly frequent in the literature (Hidalgo et al., 2007; Hidalgo and Hausmann, 2009). This research takes advantage of this new development and uses it to uncover empirical evidences from a specific country at the province levels, which still leaves untouched by the literatures thus far. Principally, the two measures adopt output-based approach to quantify cognitive relatedness between products and to measure provinces' capabilities. What and how many kinds of products a province is capable of producing reflect the quantity, as well as the quality, of capabilities the province has. Provinces that make more products, which are technologically sophisticated, are considered to have more capabilities than provinces that produce otherwise. In terms of relatedness, if two products are often found to be produced together by many countries, it is likely that both products are somehow related to each other. In other words, relatedness is measured by the co-occurrence of pairs of products. Relatedness by co-occurrence has gained popularity in the literature and several studies have used it for analysis at sub-national levels (see Appendix 7). With regard to capability, however, to the best of my knowledge, the measure has only been deployed once for a within-country analysis by Balland and Rigby (2015).

The two measures used in this research are complementary to one other, as they are interrelated in many respects. First, relatedness may explain either how new products emerge or how existing varieties decline within provinces. In other words, relatedness may inform us about the plausible evolution trajectories of provinces. However, it tells us nothing about the quality of those emerging or declining products, as provinces may diversify into related but either less or more sophisticated products. Two provinces, for instance, may diversify into many products equally, but their outcomes in terms of economic performance may be different. Intuitively, a province that is capable of diversifying its products into more sophisticated products should display better performance than its counterpart, which is expanding toward less advanced products. Thus, merely measuring relatedness without knowing the quality of the evolution would not be enough to explain the economic development of provinces. Second, as discussed in Chapter 2, relatedness could be beneficial for provinces endowed with diverse products. Having more related products means that provinces have more options and flexibility to develop new products or to simply shift to producing alternative products. In contrast, provinces that are endowed with too few products are likely to face much greater difficulties when developing new products, as well as limited alternatives to diversify. This understanding has reminded us that product diversification is crucial to explaining the capability of provinces to grow to related products. This explanation brings us back to our capability measure comprising bipartite networks, which link the diversification level of provinces and the sophistication level of products.

Two main arguments are put forward in this chapter. First, the cognitive distance of industries to regions' industry portfolio affects the probability of those industries to enter or exit regions. Second, the capability of regions to diversify into more advanced industries depends on the existing level of diversification and sophistication of regions' industry structure. In order to defend those arguments, we calculate the two measures, i.e., relatedness between industries and the industrial capability of regions. We stylise the two measures in order to identify certain patterns and relationships featuring each measure. Specifically, we aim to address the following inquiries. With regard to relatedness, do regions really develop new industries for related products? Do less related industries tend to exit? How does the relatedness of products explain why regions evolve towards different development paths? With regard to industrial capability, our expectation is that we will be able to provide empirical answers to the following questions: Are provinces with more diverse products more capable of developing new products? Are provinces with more diverse products more capable of developing technologically better products? Are the improvements in the capabilities of provinces in Indonesia due to the increase in the diversification level of provinces and/or due to the upgrading in the sophistication level of products?

In the remainder of this chapter, we divide the discussion into two main parts. The first part discusses the relatedness of products. The flow of discussion in the first part is arranged as follows. We first discuss the literature on relatedness. Our objective is to provide further theoretical motivation and applicative concept on relatedness. Next, we seek to explain our methods on how we measure relatedness and data, which are deployed in the investigation. After that, we present our empirical results and discuss them thoroughly. The second part discusses the capability of provinces with a more or less similar structure to the discussion on relatedness. We end this chapter by summarising the main conclusions and discuss some limitations and potential for future research.

4.2 Relatedness of industries

How regions develop new varieties of economic activities, particularly new products and industries, has been conceptually discussed in Section 2.3.2. We have highlighted the theoretical foundation as to why regions have preferences towards developing new industries that they are familiar with. In the following, we proceed further by exploring the empirical evidence and existing measures of relatedness, elaborating the way in which we perform our analysis, and discussing the results of our analysis.

4.2.1 Emerging empirics of relatedness studies

In this section, we discuss 1) the evidence that supports the argument by reviewing empirical studies on relatedness accumulated thus far, and 2) different methods for measuring relatedness.

4.2.1.1 Empirical works on relatedness

Studies on branching out into related products have been reported in the literature for quite some time. However, the relatedness of products is measured by different methods, calculated with different data and applied at different spatial scales of analysis. In this section, we review all accessible publications about relatedness and branching processes. As most works of this kind are empirical by nature, we focus our efforts on the results of the econometric analysis. We diagnose eighteen empirical works that use different measures of relatedness, but specifically use the same response variable, i.e., new industries. The review is summarised in Appendix 7A. Some other works also embrace relatedness, but aim to study its broad impacts on the economy, such as employment growth, GDP per capita and productivity growth. Frenken and Content (2016) offer an excellent review of sixteen studies of this kind; we put the summary in Appendix 7 as well.

In their cross-country analysis, Hausmann and Klinger (2007) measured relatedness between products (known as proximity) by using the co-occurrence approach, that is, the joint probability of two products being produced in pairs by countries. Based on this proximity metric, they constructed the density index as the weighted relatedness of products to other products with a comparative advantage within a country. They found positive and statistically significant effects of density on structural transformation, that is, the tendency of countries to move to cognitively related products. They also found that density has a significant impact on retaining current products. Boschma and Capone (2015) added an institutional dimension to this approach by distinguishing capitalist institutions in which the branching process takes place. They found that institutions do matter in the branching processes. That is, relatedness has stronger impacts on promoting new products in coordinated market institutions, while liberal market economies have higher probabilities of introducing products that have a low relatedness to existing products.

Similar econometric results are demonstrated in a study of Spain by Boschma and Minondo (2013), who further elaborated their econometric analysis to compare the effect of density at two different spatial levels: country level and province level. They concluded that density plays relatively larger roles at the province level than at the country level in both sustaining existing products and creating new products. Lo Turco and Maggioni (2016) applied the density measure at the province and firm levels and controlled for firms' characteristics including size, labour productivity, export-import, foreign ownership status and multi-plant firms. The econometric analyses are designed to unveil the relative importance between a firm's characteristics (internal resources) and a province's diversification (local resources) in fostering new products in laggard and advanced provinces in Turkey. They found that density at the firm level plays a significant role in laggard provinces, while density at the province level is more influential in advanced provinces.

Neffke and Henning (2013) calculated diversification at the firm level by exploiting firms' expansion data in relation to other industries. Here, diversification was restricted to the internal development of firms in producing new products in different industries. Relatedness between industries was measured by the flow of labour between a pair of industries. The underlying idea was that a large flow of labour between two industries indicates that the industries are related in terms of required skills. As comparison, they also used relatedness based on I-O data and NACE classification. Their findings confirmed that employment relatedness is the most influential determinant of firms' diversification, followed by output relatedness. Borggren et al. (2016), instead of using industry outputs as response variable, utilised the information contained in firm registration database in order to estimate entries, exits and remainers within a Swedish context. Again, echoing Neffke and Henning's (2013) findings, they concluded that, in general, employment relatedness has a strong predictive power on the survival, acquisition and exit of firms, even though the effects vary between metropolitan and non-metropolitan areas and across groups of industries.

Other scholars use different response variables, such as the diversification index; for example, the study by Cainelli and Iacobucci (2016) on Italian manufacturing, which applied employment data in order to quantify the level of diversification and calculate the relatedness between varieties by applying an entropy index. The strategy adopted was based on industry classification codes. Industries operating and diversifying within/across the same group of classification were considered to be related/unrelated varieties and related/unrelated diversifications. After controlling for some determinants, including technology categories, geographic dummies and firm characteristics (i.e., size and productivity), they concluded that unrelated diversification tends to occur in less cohesive regions, while regions with related varieties of their industrial base are likely to experience related diversification.

Two studies from Neffke et al. (2011) and Essletzbichler (2013) adopted a different measure of relatedness, known as closeness. Basically, closeness is a cognitive distance between a product and a region's product structure, measured by the number of links that a product has to every other product hosted by a region (termed the portfolio), which exceeds a certain threshold value. Controlling for the size of industry and regions, both studies found similar results, such that membership and the entry of products to regions are directly proportional to the closeness of those products to the regions' portfolios, but inversely proportional to the closeness of those products to non-portfolio products. In contrast, the exits of products are directly/inversely proportional to the closeness to non-portfolio/portfolio products. The econometric outputs show significant coefficients, although both studies used different methods in measuring relatedness and were conducted in different countries. Neffke et al. (2011) used Swedish manufacturing data and applied co-occurrence at the firm level, while Essletzbichler (2013) used the input-output value-chain to measure the relatedness of products in the US.

Some other studies use patent data to estimate regional knowledge bases, such as those by Rigby (2012) and Tanner (2016). However, the way in which relatedness is measured is different. The former measured knowledge relatedness by tracing back the citations used in registered patents in the US, while the latter used the patent classification and Herfindahl index to estimate technological relatedness and related variety, respectively. Besides that, the two studies were distinct in their objectives. Rigby focused on the role of knowledge relatedness within the diversification of knowledge and resisting technological abandonment, while Tanner tested the role of relatedness in the emergence of radical technologies, such as fuel-cells. Both found similar outputs indicating that pre-existing knowledge spillover matters in retaining and fostering knowledge creation, even in the case of radical knowledge creation.

There are two studies on relatedness that perform their analysis with descriptive statistics. One of them is the seminal study from Hidalgo et al. (2007), who constructed a density measure based on the number and proximity of dominant products surrounding a product. With that measure, they revealed a tendency of ‘transition products’, i.e., products with an RCA<0.5 in 1990 and an RCA>1 in 1995, to have a higher density than undeveloped products, i.e., products with an RCA<0.5 in 1990 and 1995. The other study was conducted by Fortunato et al. (2015), who tried to link relatedness with the sophistication level of products, which was measured with the GDP-weighted comparative advantage of products (known as PRODY). The relations between related products and the sophistication level of products were evaluated by calculating the discrepancy between the actual and potential export baskets. In other words, they predicted the potential export basket based on the relatedness and sophistication level of product in the previous period. Then, they contrasted the predicted export basket with the actual export basket in order to assess the predictive power of relatedness and sophistication in explaining the diversification path of countries’ export basket.

Recently, we have come across a series of relatedness studies, which have emerged from China since 2016 (Guo and He, 2017; He et al., 2016, 2017; Zhou et al., 2016; Zhu et al., 2017). All these studies adopt the same co-occurrence-based metrics of relatedness and mostly utilise China’s manufacturing dataset. He et al. (2016), for instance, investigate the relationship between the relatedness of industries with their entries and exits. Their findings support the prediction of evolutionary economic geography theory that entries are positively related to relatedness, and vice versa. They also find that global links, more liberal regions, and sustained fiscal conditions encourage new industries to enter regions. A similar study by Guo and He (2017) also confirms the role of relatedness. However, lagging regions in the North West of China diversify into less related industries, which, according to their findings, is made possible because of high government interventions in that region. More support comes from He et al. (2017). By taking into account some regional factors (e.g. public spending) and industry-specific factors, such as ownership, exports, R&D and labour intensity, relatedness once again demonstrates a significant role in determining the entry and exit of industries. An interesting work from Zhou et al. (2016) draws on Schumpeter's idea of creative destruction. The exit of industries, according to them, releases some resources into the region, which invite new industries to come. In other words, exits positively influence entries. They also find that that is the case in China's manufacturing industry after taking into account some region-specific factors, as well as controlling for agglomeration effects.

Zhu et al. (2017) use different data to calculate inter-industry relatedness. They investigate whether regions can escape the relatedness tight of industrial diversification with the help of extra-regional linkages in the form of FDI, imports, and local capacity in the form of R&D, human and physical capital, etc. Their findings suggest that those two elements, i.e., extra-regional linkages and localised capacity, are the key to escape from the evolutionary force of path dependence.

4.2.1.2 Different measures of proximity

The capacity of a region to generate new knowledge is not only dependent on the repertoire of existing knowledge contained in the regions, but also relies on relatedness between that knowledge. Regions with larger existing knowledge repertoires, i.e., diverse knowledge bases, are likely to have better chances of generating new knowledge through more options for mixing and matching the existing ones. However, having a large pool of knowledge does not necessarily guarantee that regions can learn something new and take advantage of it. If the existing knowledge base is too dissimilar, then the learning curve will be too steep; thus, new ideas through knowledge spillovers are unlikely to occur. Similarly, having too similar a knowledge base will prevent a region from developing new products, as nothing or little can be learned from more or less the same things. This argument highlights the importance of relatedness in learning and creating regional knowledge.

Many studies use patent registration as a proximity for regional knowledge, such as those of Ponds et al. (2010), Rodriguez-Pose and Crescenzi (2008), Feldman and Audretsch (1999), Feldman and Florida (1994), and Rigby (2012). Following Hidalgo *et al.* (2007), this paper measures regional knowledge by using an output-based approach. Regions that produce a certain product must have all the knowledge and abilities necessary to do so. Therefore, a region's product structure arguably reflects the knowledge structure owned by regions.

Neffke et al. (2011) identify three approaches, which are commonly used to measure the proximity of products. The first is based on the hierarchy of product classifications, such as ISIC and HS. Products that are located under the same classes are considered to be related. Criteria that are used to define and delineate each class vary from one classification system to another. ISIC, for instance, is constructed, based on the inputs and factors of production, the process and technology of production, the characteristics of outputs, and the use to which the outputs are put. Economic activities, which are similar in respect of these criteria, will be grouped together within the same ISIC categories (United Nations, 2008), with some preferences. While lower and detailed classifications are mainly grouped, based on the process and technology of production, higher-level classifications are mainly defined by characteristics of outputs and the use to which outputs are put. The second approach is based on the similarity between upward and downward linkages, such as in an I-O table (Fan and Lang, 2000), or the similarity in the mixes of occupations (Farjoun, 1994). Principally, two or more products, which use similar inputs, employ similar mixes of occupation or produce similar outputs, are considered to be related.

There are some drawbacks to both approaches. The first is rather technical and related to data availability and coverage. I-O tables are usually constructed by countries or regions. Different countries may have different I-O structures, which probably result in different levels of relatedness as well. Two related products in one region could be unrelated in others. The second shortcoming is that, although both approaches take into account the similarity in inputs and factors of production, technological intensity used in the process of production, and the characteristics of output, they unconsciously assume a similarity in other broad conditions, such as institutions, infrastructures, physical environments and climates. To illustrate, textile products are somewhat related to cotton products in the sense that textiles require cotton as their main inputs. However, cotton may be produced in other places, which require a different climate, soils, physical infrastructures, and institutions. Thus, even though textiles and cotton products are strongly linked within the same chains of production, the two may not necessarily be produced together in the same region or country. Ironically, we often find two linked products resulting in conflicting institutional demands, as both have different interests. Murmann (2003) offers a good example of how the two related products of textiles and dyes had conflicting tax institutions in England at the beginning of twentieth centuries. Textile industrialists preferred to procure cheaper synthetic dye from Germany and lobby for lower import taxes, which was desperately challenged by domestic producers of natural dye, who campaigned for protection through higher taxes. In fact, a more or less similar situation still occurs in the Indonesian textile industries where upstream industries (weaving) are calling for protection from foreign competitors, while downstream industries (garments) lobby for cheaper cotton sheets from import.

The third approach that has recently gained in popularity is co-occurrence analysis. The idea is that two related products tend to be present together because they intuitively require the same institutions, infrastructures, soil, inputs, factors of production, technology and so on. To illustrate, regions that produce refrigerators will probably have all of the conditions suitable for producing air conditioners as well. The regions certainly have the cooling technology, enough specialists and skilled workers to be re-employed for air conditioners, facilities to treat the production waste, and probably a similar tax system and trade regulations, which can be redeployed in the production of air conditioners. Hidalgo et al. (2007), Boschma et al.(2013),and Lo Turco and Maggioni (2016) analyse co-occurrence at the country level using international trade data, while Neffke et al. (2011) analyse it at the plant level using national manufacturing data (Sweden).

All reviewed studies on technological relatedness in China also adopt the co-occurrence method (Guo and He, 2017; He et al., 2016, 2017; Zhou et al., 2016; Zhu et al., 2017). The main issue, however, is that those studies apply the method to a national dataset. This, we argue, somehow reduces the accuracy of measurement for some reasons. First, although China has a large manufacturing sector, we doubt that it has all industries in its manufacturing sector. Thus, the absence or weak presence of certain industries in China carries with it risks in the measurement accuracy. Second, as also discussed in He et al. (2016), Zhu et al. (2017) and Howell et al. (2016), the role of government's intervention particularly in the form of industrial subsidy for laggard regions and significant influences of global links in China may inflate the relatedness values of industries being measured. For example, with a subsidy in place, fifty regions manage to establish an industry with comparative advantage. However, if the subsidy is lifted, that industry is only present in, say, thirty regions. This may deflate the relatedness value of that industry. Third, as previously mentioned, the use of a country level dataset makes the result less comparable. Two pairs of industries may be related in China only, but not in other countries.

For this reason, our research follows Hidalgo as constructing proximity based on large international trade data which might minimize the measurement bias particularly related to the broad conditions and representativeness of data.

4.2.2 Methods and data

The flow of discussion in this sub-section is organized into four analyses. We first measure proximity between products. Using this proximity measure, we then conduct a network analysis by constructing a product space to visually investigate the pattern of new emergences and declines of products. In the next step, we perform some simulations to figure out the potential threshold of proximity to allow for a branching process to take place. Lastly, we perform a statistical analysis to provide more systematic evidence. How the analyses are carried out is discussed in the following.

When measuring product relatedness, this research adopts the proximity method introduced by Hidalgo et al. (2007), who developed a proximity measure based on the co-occurrence concept of two products being exported by a country in tandem. Formally, they defined proximity between products *i* and *j* as 'the minimum of the pairwise conditional probability of a country exporting a good given that it exports another' (p.484). The formal representation of product proximity is defined in Equation (1).

In constructing the product space, we used Cytoscape network builder software (Shannon et al., 2003). The software offers various layouts, which provide us with alternatives, such that we can choose one that is most suitable for our needs. For the purpose of revealing the product space structure, the edge-weighted spring-embedded layout is considered to be the most appropriate layout. According to the manual, the spring-embedded layout treats network nodes 'like physical objects that repel each other. The connections between nodes (links or edges) are treated like metal springs attached to the pair of nodes. These springs repel or attract their end points according to a force function. The layout algorithm sets the positions of the nodes in a way that minimizes the sum of forces in the network', which, in this case, is weighted by the value of proximity[36].

Given the standard trade classification of the Harmonized System at four-digit level, there will be a network that consists of 1,241 nodes (industries) and 1,540,081 links. As the proximity between the same product (e.g., t-shirts and t-shirts) must be equal to one, there will be no point to include this into the network. Moreover, as the value of proximity between products 'i' and 'j', and vice versa are, the same, only half of the cells (769,420 links) in the matrix are counted to construct the network.

[36] Cytoscape_3 UserManual, Revision History 2014-02-03 20:27:53, Kristina Hanspers, Revision 33, Added privacy policy.

For its size, depicting all the nodes into the network representation of product space produces a very dense, crowded network, which does not help the analysis at all. After some experimentation with various cut-off values, it is decided that the best visual representation of the network structure emerges with a cut-off proximity value of 0.4. This means that only those links with proximity values greater or equal to 0.4 are included in the network. In order to enhance eligibility of the graphs, information about the position of products within the product space is added through colour-coding different industry groups. Furthermore, we depict the proximity information in the product space by the degree of transparency of the links. The rule is that the darker links represent a higher proximity (i.e., closer products). In addition, the total export values of the industries are represented by the size of the nodes. The larger the size of the nodes, the larger is the global export value of those industries. In comparison to product values, we also consider some alternative measures of product sophistication level, such as the ubiquity (Hausmann and Hidalgo, 2010) and PRODY (Hausmann et al., 2007) of products[37].

Provinces may fail to reach the richest parts of product space, as it is simply too far to reach and the ‘road’ to get there is not really connected. Imagine a situation in which we want to cross a river, but there is no bridge or canoe to get us across. The transformation of provinces’ productive structure towards a more sophisticated one could fail if provinces are unable to develop the ‘bridge’ first. This tempts us to further investigate the plausible paths of provinces’ product development. To do that, we use two provinces’ product spaces to run simulations on plausible transition paths by setting several proximity values as threshold and trace forward the plausible paths of regional products evolution. To reach the potential threshold, we gradually increase the threshold values until reaching the expected situation in which regions cannot diffuse further towards new industries.

The proximity values can be used to perform some statistical analyses in order to evaluate whether provinces really develop new products that are cognitively close to the current product structures. In doing so, we apply a closeness measure as discussed in Section 3.1.2. We link the closeness of industries to provinces’ portfolio with the probability of those industries entering, exiting or remaining in those provinces. We expect a positive relation for entries and remainers, whereas a negative relation is likely for exits. For a robustness check, we also apply a density measure with similar analysis.

[37] Alternative Product Spaces using ubiquity and PRODY enhancement are displayed in the Appendix 4.

The analysis uses trade data, both at international and provincial levels from 2000 to 2012. The use of international trade data for measuring proximity is to avoid measurement bias as discussed in Section 4.2.1.2. International trade data are downloaded from the United Nations website http://data.un.org/, while provincial trade data are provided by the BPS. The trade data are classified based on Harmonized System at the four-digit level (HS4). As the classification was revised three times in 1996, 2002 and 2007, all data are converted to the HS4 1992 classification by using conversion tables[38].

The HS4 1992 data consisted of 1,241 product classifications. Our unit of analysis is at the province level and includes 33 provinces. Thus, we have 40,953 entries of province-product combinations. We perform the analysis for the period 2000 to 2012 with three-year gaps: 2000, 2003, 2006, 2009 and 2012. The reason is mainly based on the assumption that provinces need at least three years to set up a new industry of a particular product. Thus, in total, we have 204,765 data entries comprising five three-year datasets with 40,953 entries each. This provides us with enough ammunition to decipher the evolutionary pattern of product development at the province level in Indonesia.

4.2.3 Results and discussions

In the section above, we discussed the concept and measurements of product relatedness. In this section, we apply those measures along with empirical data to calculate the proximity between products, construct product space, perform some simulations on it and compute the closeness of products to provinces' portfolio.

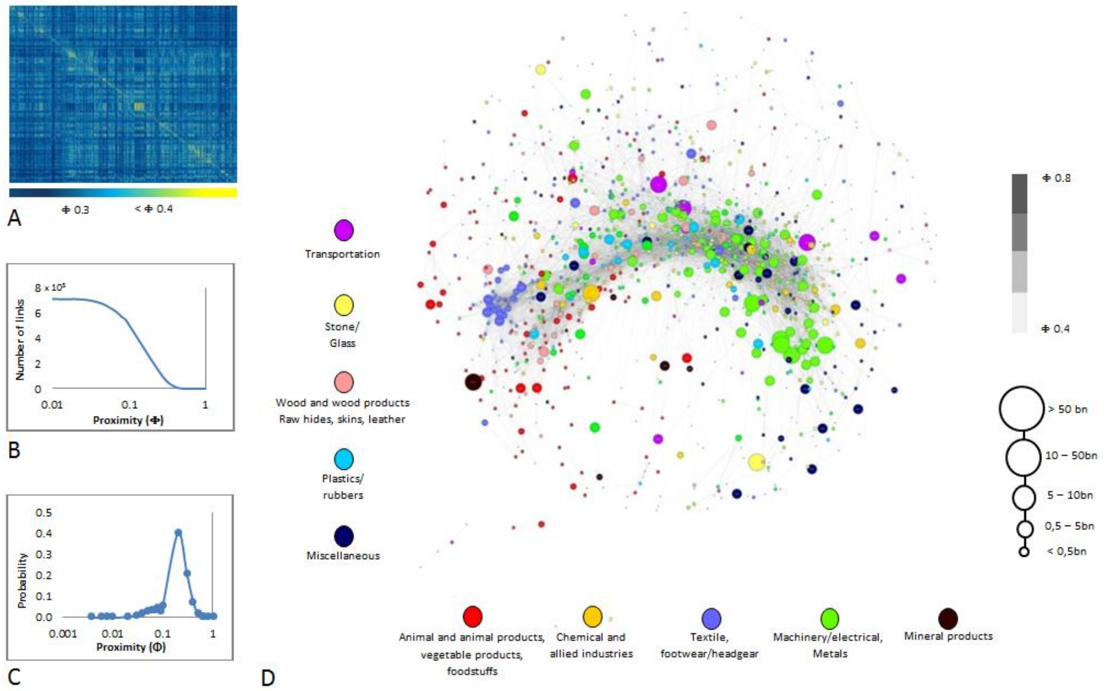
4.2.3.1 Measuring proximity between products

A 1,241 x 1,241 proximity matrix is calculated by applying Equation (1). The main diagonal of the proximity matrix equals one, meaning countries that export product A must also export product A. The proximity matrix is symmetric, meaning that the proximity between products A and B is exactly the same as the proximity between products B and A. Figure IV-1A colour-codes the pairwise proximity values. Figure IV-1B depicts the distribution of proximity values cumulatively, while their frequencies

[38] Conversion table are available and can be downloaded freely in the following link: http://unstats.un.org/unsd/trade/conversions/HS%20Correlation%20and%20Conversion%20tables.htm.

are depicted in Figure IV-1C. A sample of proximity values of some agricultural products is displayed in Table IV-1.

Figure IV-1 Proximity Matrix and Product Space



Source: Author's calculation based on international trade data for 2000.

Note: A. Proximity matrix in colour representation; B. Cumulative distribution of proximity values; C. Density distribution of proximity values; D. Product Space. Source: author's calculation based on international trade data 2000.

Table IV-1 Sample of Proximity Values of Agriculture Products

HS4 1992	101	102	103	104	105
101	1				
102	0.41	1			
103	0.10	0.26	1		
104	0.36	0.52	0.16	1	
105	0.19	0.22	0.19	0.31	1

Source: Author's calculation.

The proximity matrix reveals that most products are basically unrelated with very low or zero proximity. Around 90% of product pairs have proximity values less than 0.3 (dark blue colour), around seven per cent of product pairs have proximity values between 0.3 and 0.4 (light blue) and less than three per cent have proximity values greater than 0.4 (yellow). This finding is somewhat similar to what was developed by

Hidalgo et al. (2007) for a proximity matrix based on trade data in 1998. The burning question concerns whether the proximity matrix changes over time. To check this, we calculate correlation coefficients between the proximity values in 2000, 2006 and 2012. The results are presented in Table IV-2. A high correlation between proximity values in different years suggests that the proximity values may change but the structure remains stable. This means that strong links remain strong and weak links remain weak. We then juxtapose the results against Hidalgo's calculation for the earlier periods (1985, 1990 and 1998), which yielded similar results. Nevertheless, changes in the proximity matrix over time offer an interesting topic for future research.

Table IV-2 Correlation between Proximity Matrices

This Research			Hidalgo et al. (2007)		
2000	2006	2012	1985	1990	1998
1	0.71	0.59	1	0.701	0.696
	1	0.68		1	0.616
		1			1

Source: Author's calculation.

4.2.3.2 Constructing product space and analysing provinces' product space

To visualise the product space, we represent the proximity matrix as a network. Using network builder software and after some adjustments, the complete product space representation is displayed in Figure IV-1D. As we can see, the product space reveals a core-periphery pattern. The core of the product space shows a denser and darker network, whereas the periphery consists of a sparser and transparent network. As expected, products such as transportation, electrical, machinery, chemical and metal products are mostly concentrated at or near the core of the product space, whereas natural resource-based products, such as vegetable, food and oil products are located further away from the core. Some exceptions do occur. For example, although they are considered to be resource-based products, many wood products are found near or at the core of the product space. Stone and glass industries are equally distributed across the product space. Thus, we can find many of these products both at the core and at the periphery of the product space. Textile products are concentrated at the edge of the product space core, but we can also find some of them at the core and some others at the outer sections of the product space.

It is interesting to explore the product space by looking at some more examples. The large dark brown node on the left side of the product space is oil. By looking at the size of the node, oil is a valuable product in international trade. However, its relative position at the edge of the product space tells us that oil is not closely related to many other products. Countries or regions endowed with oil products have strong incentives to persist with such products for two reasons. First, oil is a valuable product in the global market, thus there is no reason for turning away from it. Second, it is difficult to develop other products, as they are not close enough to 'jump to'. One may ask why oil is located rather close to the periphery of the product space, even though oil products are crucial inputs in the production process[39]. From an input-output perspective, it is true that oil is an important input for almost all production processes. Thus, oil is supposedly found at the core of the product space within this perspective. However, the co-occurrence measure has a different logic to input-output measures. The co-occurrence measure asks whether provinces endowed with oil products are cognitively capable of generating other products, which may be produced by using oil as one of the inputs. According to the co-occurrence measures, the answer would be 'no'. From a co-occurrence perspective, oil has, on average, a low proximity to other products, suggesting that countries exporting this product may not be capable of producing other products. A similar case is demonstrated by the diamond product, that is, the large yellow node at the bottom of the product space. Being large in terms of value in international markets does not necessarily mean that a product will be located at the core of the product space. Diamonds and oil are good examples of the so-called 'resource curse' in action. The high value of these products tempts countries to focus their energy on these non-renewable products, while neglecting other major products. In the end, they become highly dependent on these products and highly vulnerable to the price shocks of commodity products within global markets.

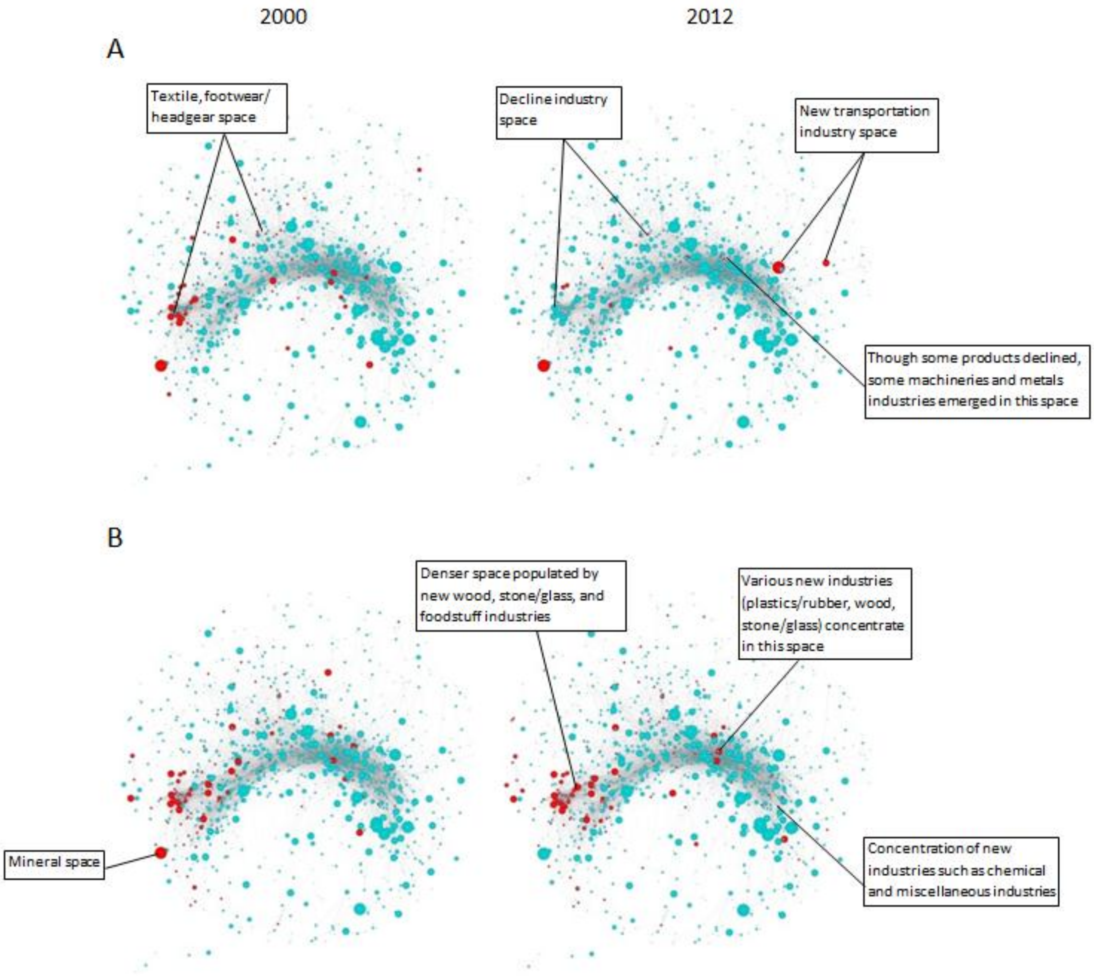
Using the product space as a template, we construct regional product spaces by depicting province exports in the network. We reapplied Equation (2) in order to calculate the RCA for each product exported by provinces and then depicted this in the network of product space. To reveal the evolutionary changes of regional industries, regional product spaces are constructed at two points of time, i.e., for 2000 and 2012.

The two provinces' product spaces in Figure IV-2 provide overviews of two different paths of regional industry development. In 2000, both West Java and Central Java had distinguished comparative advantage in textiles, footwear and headgear products. In 2012, West Java lost its comparative advantages in textile products, as well as in many other products, while Central Java successfully maintained its dominance regarding those products. West Java, however, managed to develop a promising new

[39] This question was actually asked by a participant at a conference attended by author. The participant argued that oil products should be located at the core of the product space, given its crucial roles in the production process.

transportation product in 2012, which seemed to have weak relatedness to its product space structure in 2000. Similarly, Central Java also introduced some new products, such as plastics/rubber, wood, stone/glass, chemical, and miscellaneous products, to its 2012 product space; but, unlike West Java, the new products seem to have been closely related to its 2000 product space.

Figure IV-2 Regional Product Spaces



Source: Author's calculation.

Note: A. West Java's product space in 2000 and 2012; B. Central Java's product space in 2000 and 2012. The red dots represent regional products with an RCA greater than unity, which populate the product space.

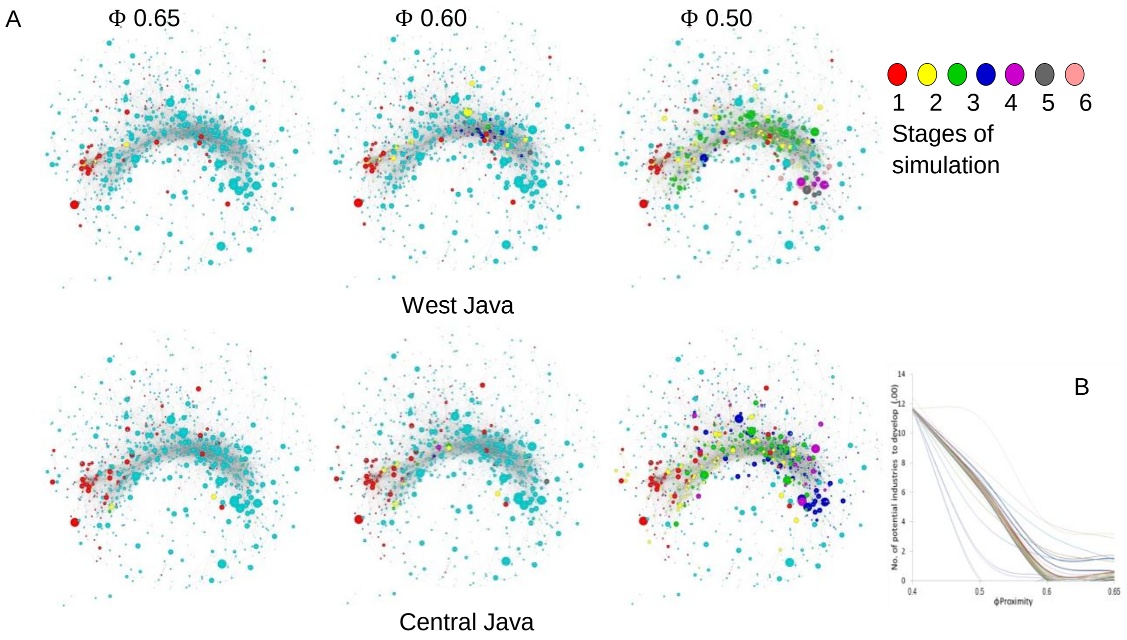
4.2.3.3 Simulating the transition and potential threshold

One may ask whether there is a threshold for proximity that provinces could afford to be able to go through the industrialization process. When considering that all provinces can develop new products, regardless of the proximity of the products to their current productive structure, then logically after a certain period of time, all provinces will gradually be able to develop every product in the product space. If that is the case, traditional economic theory is not incorrect when it claims that, in the end, provinces will eventually converge. In fact, the persistent differences in welfare across provinces, and even across countries, imply that something structural and non-tradable must be influencing the development of new products, which motivates the idea of threshold.

In addressing this inquiry, a series of simulations have been performed using various proximity values as the threshold. By gradually increasing the proximity values, it is expected to arrive at the 'threshold' value. The results are displayed in Figure IV-3 and suggest two important things. First, there is a certain threshold for the proximity to be met in order for new industries to emerge, and in the case of West Java and Central Java, the value should be ϕ0.60. At a lower proximity value (<ϕ0.60), both provinces manage to reach the sophisticated area at the core of the product space. Interestingly, at proximity of ϕ0.60, West Java still manages to diversify its industries by up to seven stages and populate the core of the product space. Second, regions that fail to meet this threshold cannot develop new products, tending instead to experience locked-in in old and probably declining products, leaving these provinces behind. In the simulation, when the proximity was set at ϕ0.60, Central Java failed to develop new products and stopped at the fifth stage of simulations. When increasing the proximity threshold up to ϕ0.65[40], both provinces get stuck at where they are. If that is the case, provinces that are endowed with diverse product structures would obviously be at great advantages when it comes to finding nearby products, which meet the threshold, as opposed to regions that start with sparse product structures. These two factors, i.e., current product structures and proximity threshold, may explain why provinces evolve towards different development paths.

[40] Using cross-country analyses Hidalgo et al. (2007) find that the threshold for countries to be able to converge with industrialized countries is at a proximity level greater than ϕ 0.65.

Figure IV-3 Simulation of Transformation



Source: Author's analysis.

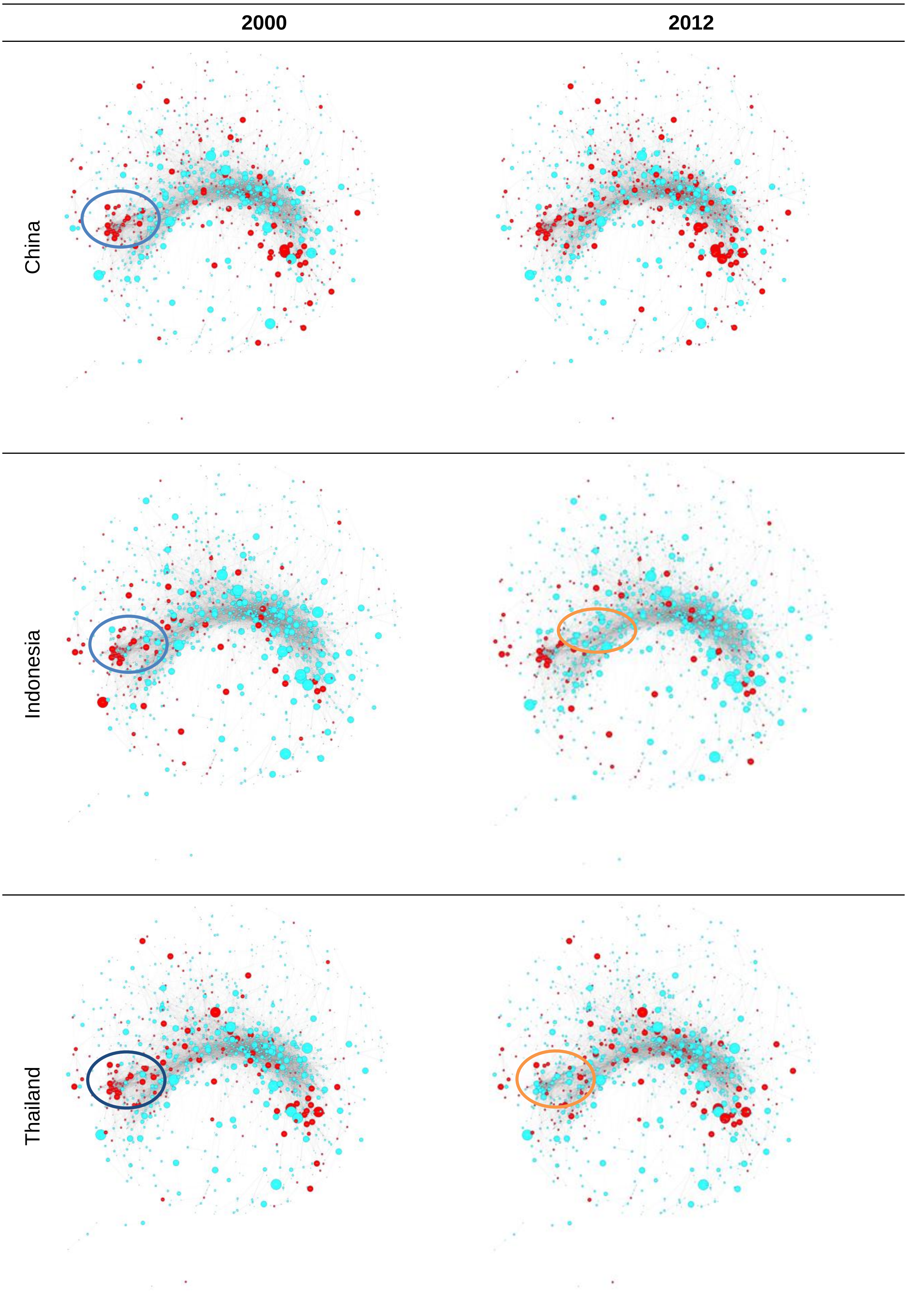
Note: A. visual transformations for the product space of West Java (top row) and Central Java (lower row); B. results of simulations for all provinces.

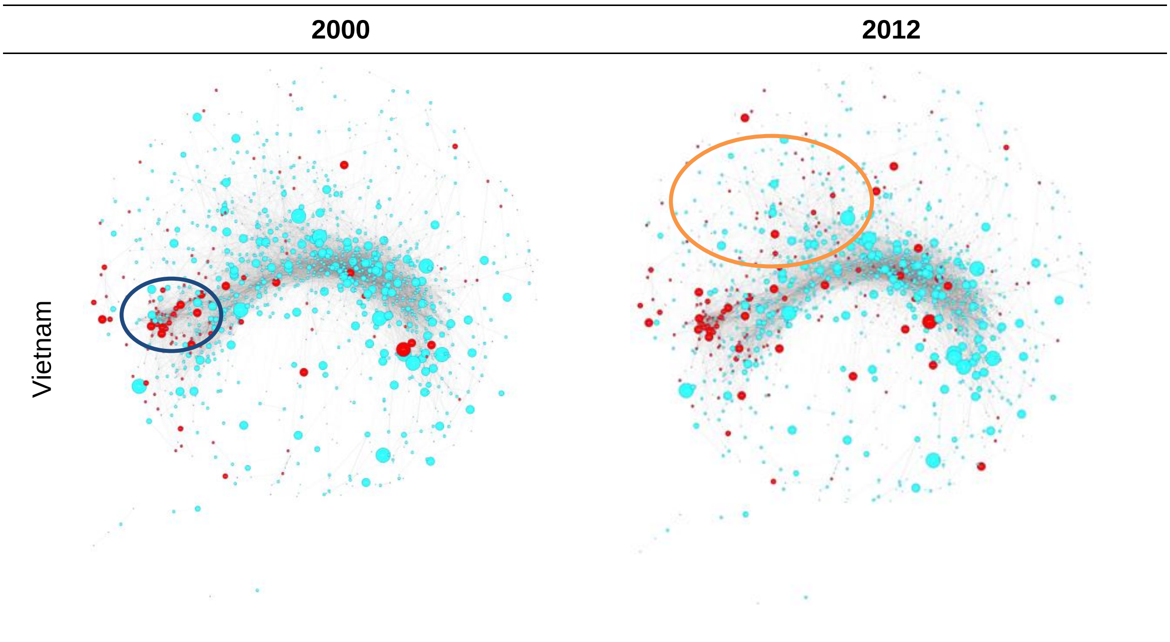
4.2.3.4 Product space of selected countries in the Global South

In order to escape from the risk of losing context in the analysis, here we display the product space of selected countries in the Global South. As we have discussed in Section 3.1.1.2, we purposively focus on four countries, i.e. China, Indonesia, Thailand, and Vietnam because of their similarities in terms of level of industrialisation and governance capacity (see Figure III-7).

One thing that the four countries shares in common in year 2000 is that the structure of their product space is populated by textile industries (blue circled in Figure IV-4). The landscape does not change much in 2012 except for China and Thailand. China's product space looks much denser, particularly at its core, suggesting a successful industrial transformation taking place in the country. Similarly, Thailand's product space becomes fairly denser at its core, populated mostly by electrical and machinery products, but it starts losing its textile industry in 2012 (golden circled). Meanwhile, Indonesia barely manages to diversify toward the core of the product space, at the same time it is losing its comparative advantage in some wood and rubber products (golden circled). Similar to Indonesia, although Vietnam manages to develop few new products at the core of its product space, the trajectory of its industrial transformation seems to embark to the direction of food and miscellaneous products (golden circled).

Figure IV-4 Product Space of Selected Countries in the Global South





Source: Author's analysis.

Note: The red dots represent regional products with an RCA greater than unity, which populate the product space.

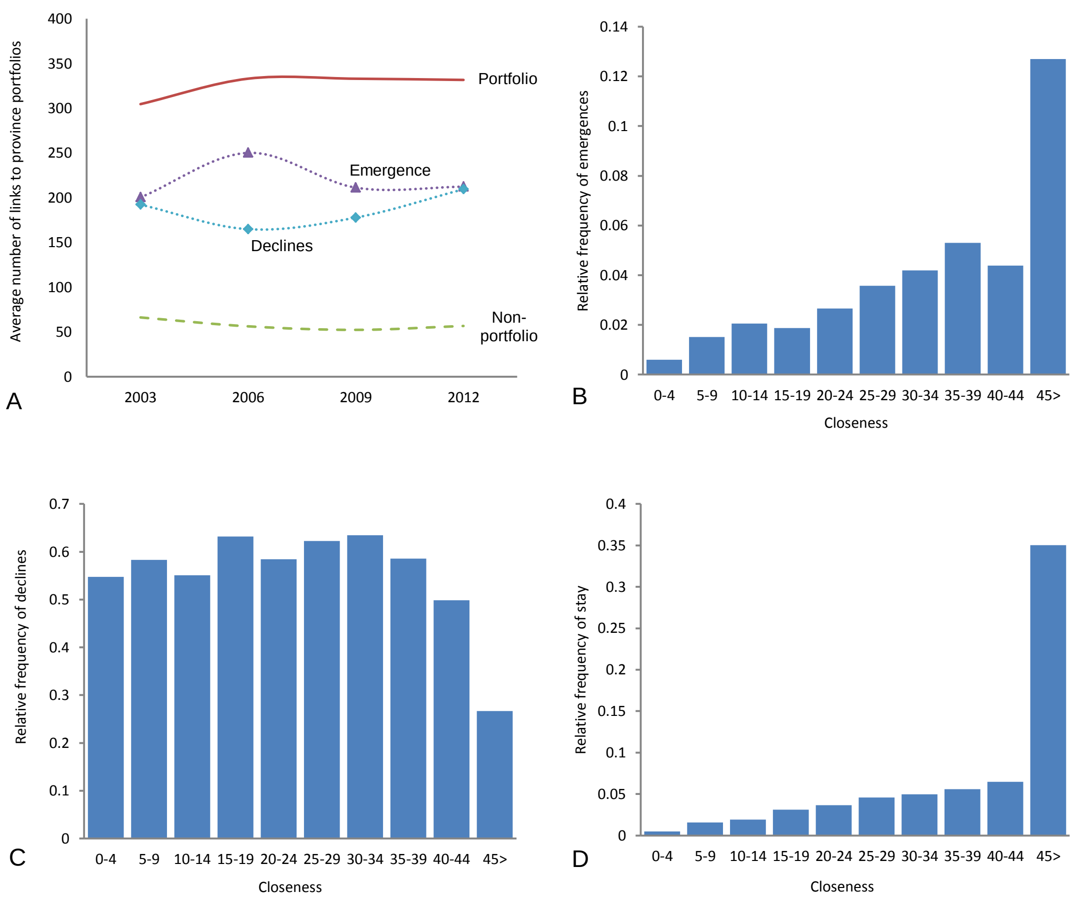
It is worth to note that although Indonesia and China has equal level of industrialisation in terms of its share to GDP (see Section 3.1.1.2), both have contrast structure of product space. While China rapidly diversifies to more advance products at the core of product space, the structure of Indonesia's product space seems to be stagnant.

In sum, even though countries with similar profile in terms of level of development, level of industrialisation, and control of corruption, each of them has unique trajectories of industrial development. Regardless the path a country chose to travel toward industrialisation, it seems that they started the journey from the some light industries such as textile.

4.2.3.5 Closeness and the emergence and decline of products

Beyond the visual analysis, do provinces really develop products that are close to the existing products? We used statistical analysis to investigate this question. First, we looked at the relation between the probabilities of new products to emerge as a function of their closeness to the export portfolios of provinces. To do this, we calculated the closeness of every product outside the provinces' portfolio (non-portfolio products) to the provinces' portfolio by applying Equation (4). Here, portfolio products are defined as products that have a non-zero value at time *t* in province *p*, whereas non-portfolio products are otherwise. As a comparison, we also calculate the closeness among portfolio products as depicted in Figure IV-5A. Averaged across product-province combinations for each three-year period, the closeness among portfolio products (bold line) is always above the closeness of non-portfolio products (dashed line). This means that provinces' portfolios is always cohesive where portfolio products are more related to each other relative than their counterparts with non-portfolio products. Moreover, the rather flat and smooth portfolio line tells us that the cohesiveness (averaged closeness) of provinces' portfolios tends to be stable over time.

Figure IV-5 Closeness and Probability of Entries, Exits, and Membership



Source: Author's calculation based on regional trade data from 2000-2012.

Note: A. Portfolio products are always more related to each other than to non-portfolio products, suggesting a cohesiveness in provinces' portfolio; B. Products that are closer to provinces' portfolio tend to enter/emerge; C. Products that are relatively distant tend to exit/decline; D. Closeness to provinces' portfolio also ensure that industries stay.

Then we identify the emerging products, which are defined as products that did not belong to provinces' portfolio three years ago, but were present in the provinces' portfolio three years later. The calculations are applied for 1,241 products with four-digit HS codes in 33 Indonesian provinces pooled across five three-year periods between 2000 and 2012, resulting in 204,765 observations of product-province combination. In total, there are 7,576 events of emerging products. As emergence can only occur for products that were initially outside of provinces' portfolios, the potential products that have such chances will be the non-portfolio products at the beginning of the given period. Summed up across product-province combinations and years, we find 136,240 possibilities of emergence. Thus, the probability of emergence would be 7,576/136,240 = 5.6%. If we calculate the probabilities separately for each value of closeness, we can analyse the relation between the probabilities of products to emerge and their closeness to provinces' portfolio, as revealed by Figure IV-5B. The graph evidently suggests that new products tend to emerge when they are closer to provinces' portfolios. Reading horizontally from the right to the left, the probabilities of products with the largest closeness values (greater than 45) are 15 times higher than products with the smallest closeness values (less than 4) to become dominant products in the near future.

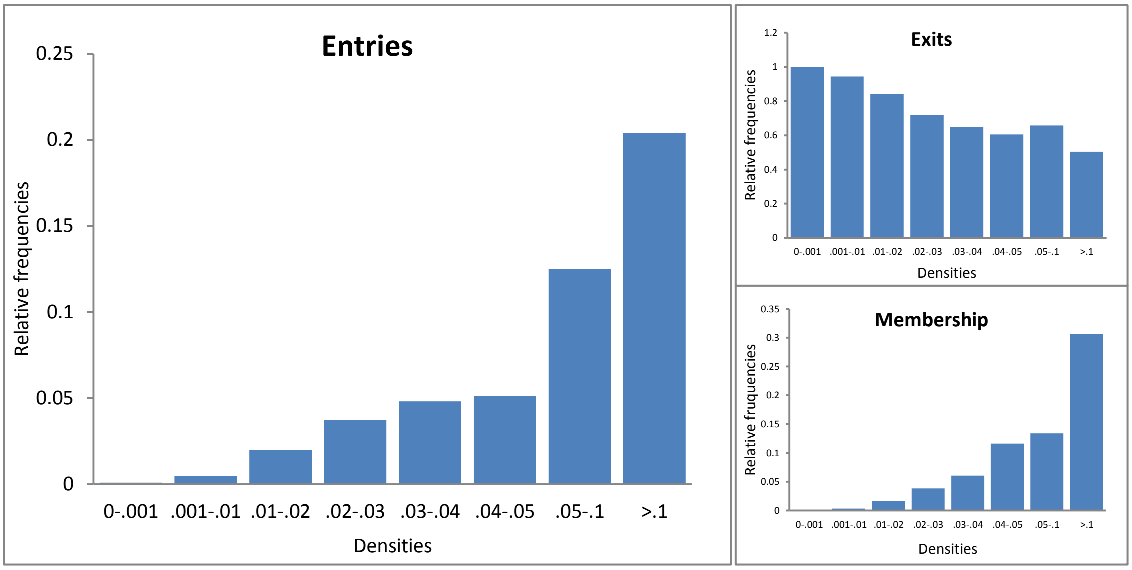
With a similar calculation, one can also investigate the reverse situation. Do products that are less related to provinces' portfolio tend to decline? Here, declining products are defined as products that were part of provinces' portfolio at the beginning of periods, but left the provinces three years later. We estimate 8,130 events of product-province decline out of 27,572 potential declines. In other words, the overall probability of decline is 29.5%. Elaborating the probabilities of decline by their closeness values, we come out with a somewhat contrasting graph, compared to the previous one (Figure IV-5C). Smaller values of closeness (below 40) display high probabilities of declining. The probabilities drop significantly for larger closeness values (greater than 40). This evidently suggests that low relatedness to provinces' portfolio increase the probability of products to decline.

Apart from emerging and declining products, some products do stay as members of provinces' portfolios over a certain period of time. They are part of provinces' portfolios at the beginning of periods and remain so by the end of periods. In total, there are 34,125 events out of 204,765 potential stays. Plotted by their closeness in Figure IV-5D, probabilities of staying follow the probability of emergence, that is, closer products tend to stay within the regions they belong to.

Let us now return to Figure IV-5A, on which the average closeness of emergences and declines are added to the graph. The dotted line with upward triangles (called the emergence line) plots the averaged closeness of emerging products, while the one with diamonds (called the decline line) plots declining products. The emergence line is closer to the portfolio line, compared to the decline line, thus suggesting that emerging products tend to be closer to provinces' portfolio than declining products. The similarity of required infrastructures, labours and raw materials, physical environments, climates, institutions and other factors that constitutes the closeness of products to their provinces' portfolio is believed to support those products to thrive in provinces they are close to. In contrast, in the case of declining products the perception is that that the required conditions became less and less supportive for their productive activities over time and increasingly push them down and even out of the provinces.

For robustness checking purposes, we apply a density measure using a similar procedure. The results, which suggest a similar pattern to the closeness measure, are displayed in Figure IV-6.

Figure IV-6 Density and Probability of Entries, Exits, and Membership



Source: Author's calculation based on regional trade data from 2000-2012.

Note: Interpretation of the charts above is similar to Figure IV-5.

It is worth noting two important things. First, all the analyses presented in this section are based on an evolutionary approach, which views that endogenous forces dominantly shapes the paths of product development. There are possibilities that the development of new products, particularly in developing countries such as Indonesia, is driven by exogenous forces, including foreign direct investments. How endogenous and exogenous forces, e.g., FDIs interact to explain the transformation of provinces' product structure and how their relative importance can we evaluated will be investigated in the next chapter.

4.3 Capability of provinces

The relatedness of products has brought us to an understanding of how new products emerge in provinces. We have also demonstrated how product proximity as a measure of relatedness can be used to measure the cohesiveness of product structures in provinces. In this section, we turn our attention to another measure, known as capability. We argued in Section 2.3.3 that the complexity of product structures reflects the capabilities of provinces to develop new improved products. Our analysis aims to analyse the complexity of Indonesian provinces using data on manufacturing outputs and international trade. In this section, we briefly review the development of this topic in the literature, elaborate the steps taken to perform the analysis, and finally discuss the findings.

4.3.1 The application of complexity metrics to measure the industrial capability of regions

In the literatures, very few studies specifically apply complexity metrics to their analyses. Nevertheless, the idea has been around for quite some time in the innovation literature (see Fleming and Sorenson, 2001; Sorenson et al., 2006). Fleming and Sorenson (2001), for instance, developed their measure of complexity based on Kauffman's (1993) framework of complexity in evolutionary biology, i.e., the interaction of size and interdependence[41]. The interaction between the number and interdependence of components constitutes the level of complexity of an innovation system. As a recombinant process, the success of an invention highly depends on this complexity. When the complexity of the technological landscape is low, an inventor may face a certain level of difficulty when recombining existing knowledge because of a lack of interdependency concerning established knowledge. When the complexity increases, the ease in mixing and matching also improves to the point at which complexity becomes too complex. At this point, inventors start to encounter what they call a 'complexity catastrophe' in which highly interdependent knowledge becomes a liability rather than an asset. Their empirical findings, informed by the US patent registrations from 1790 to 1989, support this argument.

The works that apply complexity metrics, based on countries' outputs, were initiated by Hidalgo and Hausmann (2010; 2009; 2009). Basically, their works constructed complexity metrics and applied them to international trade data. The complexity itself comprises two combined elements of diversification and sophistication (see Section 3.1.3). However, the comprehension of Hidalgo and Hausmann's complexity differs from what was measured by Fleming and Sorenson. The former referred to the productive capacity of a country or region, while the latter referred to the landscape of existing knowledge. Thus, both terms in fact describe opposing meanings. In Fleming

[41] This idea, we argue, is basically similar to the relatedness concept.

and Sorenson's definition, high complexity increases the difficulties when mixing and matching existing knowledge, thus hindering the process of invention. In contrast, for Hidalgo and Hausmann's metrics, their higher complexity reflects broader productive capacity. Their cross-country analysis empirically shows that the level of a country's complexity is a good prediction of economic performance (measured by standard GDP).

There is also one study from Tacchella et al. (2012), who modified Hidalgo and Hausmann's method for measuring complexity. They proposed adjusted complexity metrics by adopting a non-linear algorithm in the measurement. As with Hidalgo and Hausmann, the study applies international trade data, while producing results that contrast with those for Hidalgo and Hausmann's work. There is still an on-going debate over three competing methods of complexity in the literature. Considering the strengths and weaknesses of each method, we have decided to adopt the original one (2009 version). Nevertheless, alternative methods are worth applying in future research.

As the time of writing this chapter, we can only access one study, that by Balland and Rigby (2015), which deploys the Hidalgo-Hausmann's complexity index at the sub-national level. They employ data from patents registration in the US from 1975 to 2004 to assess the complexity of knowledge across US' cities. Knowledge complexity, according to their findings, is unequally distributed across the US cities, while the sophistication, rather than the diversification of patents contributes more to the complexity of cities' technological structures. The inadequate representation in the literature provides us with an additional motivation to apply this metric in our analysis. Apparently, our expectation is to uncover some empirical evidence from the Indonesian case.

4.3.2 Methods and data

We used the method of reflection, discussed in detail in Section 3.1.3, in order to investigate the industry structure in Indonesia. Here, we discuss the steps taken to carry out our analysis, as follows. First, we calculate the RCA using the formula defined in Equation (2). We then explore the diversification level of provinces by applying several threshold points of RCA to see whether different threshold points alter the diversification level of provinces. Second, using stylized facts, we try to explore the relationships between previous and existing diversification levels. In the third step, we move to analyse the sophistication level of products by applying Equation (6), which is based on the ubiquity of products. We then analyse the dynamics of the product sophistication level across time by revealing patterns, if any exist, of products' ubiquity. In order to check its consistency, we also compare ubiquity with alternative measures of product sophistication, based on aggregate income. In the next step, we combine the analysis of provinces' diversification and products' sophistication to reveal the relationship between the two. In the fifth step, we calculate the complexity of provinces' industry structure by applying Equations (7) and (8) iteratively. Some prominent cases revealed by this analysis will be the focus of our discussion. In the final step, we try to look at the relationship between provinces' diversification level and the ubiquity of new products produced by provinces in subsequent years.

For our empirical analysis, we employ data on large manufacturing plants in Indonesia, as surveyed by the BPS. A large manufacturing plant is defined as a plant with at least 19 employees. According to an official in the Statistics Office, the dataset is collected through a nationwide survey, which covers almost every large manufacturing plant established in Indonesia (almost a census). As an overview, the dataset provides us with very detailed information about ownerships, inputs (employment, material, energy consumption etc.), outputs, revenues and the market of individual plants. For the purpose of analysis, we use the dataset for the period between 1991 and 2012, which contains information on 177,923 individual manufacturing plants registered in that period. The main outputs of these plants are classified according to the Indonesian Standard Industry Classification (KBLI) at the five-digit level, which is highly similar to the ISIC. To maintain consistency with other datasets used in later analyses, we aggregate the dataset up to the four-digit level. We have also removed six product classifications from the analysis for the same reason[42]. Thus, to be exact, we have information on 124 product classifications, which are aggregated from 177,923 individual plants, entering the analysis.

In the analysis, we use data involving three-year gaps, with the assumption that technological changes can be more apparent when observed after three years. The geographical location of plants is provided at the regency and municipality levels by the dataset. As the unit of analysis is at the province level, we aggregate plant-level data up to this level. As commonly occurred in many places in this world, after the decentralisation law of 1999, provincial borders were redrawn and seven new provinces were established, resulting in 33 provinces in total. We use 26 provinces in our analysis of the period from 1991 to 2000 and include the new provinces in the

[42] The six product classifications include 1812, 1820, 2432, 2591, 2592 and 3099. We removed these products from our analysis because we used international export data to measure the ubiquity of products, which use a different classification regime, that is, the HS. Although a concordance matrix was available to convert HS into ISIC, the conversion process was more complex than we originally thought, particularly for the aforementioned six codes. We finally decided to remove these products from our analysis to avoid further bias.

succeeding period of analysis. This allows us to study some impacts of the border split on provinces.

A classical problem dealing with a long-term dataset concerns the changes in classification systems that can occur. In our period of analysis, there were three revisions to the KBLI, which took place in 2000, 2005 and 2009. These revisions were carried out to maintain its accordance with the ISIC, which was revised as well. The 2000 and 2005 revisions were minor and concerned certain codes of products. However, the latest revision (2009) was major and changed both the codes and the structures. Fortunately, concordance tables for converting codes across versions are available online, thus saving us much of our time. How the conversion process from the older to the latest versions is carried out will briefly be discussed in Appendix 9.

A small part of our analysis also uses countries' GDP, adjusted by purchasing power parity, in order to calculate PRODY. We use GDP data by country published by the WB on its website.

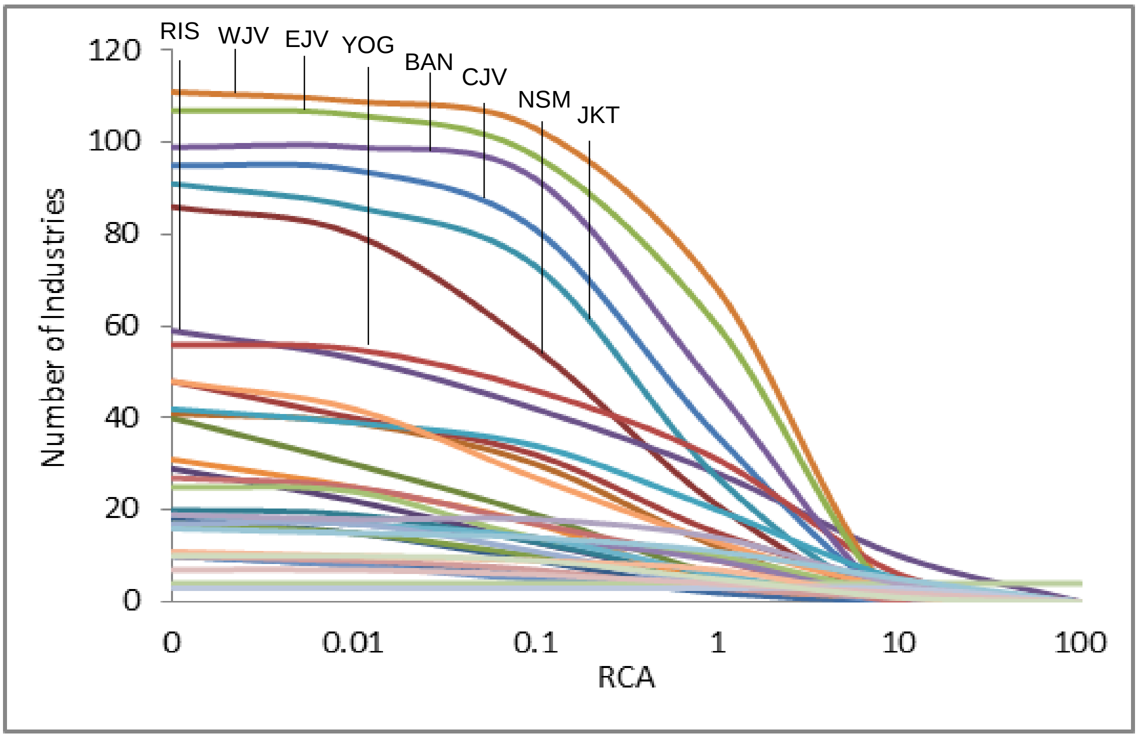
4.3.3 Results and discussions

In this section, we present the results of the complexity analysis using a manufacturing dataset covering a 22-year period (1991-2012). We divide the results into three discussions. In the first part, we discuss about measuring diversification level of provinces. After that, we discuss about measuring the sophistication level of products. We then discuss about measuring the complexity of provinces' industry structure before we end with a discussion in the conclusion.

4.3.3.1 Measuring the diversification level of provinces

As discussed in the methods chapter, to measure the complexity of provinces, we calculate RCA by using the formula defined in Equation (2). Products with an RCA value equal to or greater than 1 will be considered as products with RCA. RCA tells us that a province is a significant producer of a particular product. One way to study the distribution of products by RCA across regions is by depicting it in a single graph, as shown in Figure IV-7. As revealed in the graph, six provinces at the top of the graph manufacture most of products when RCA is set at its lowest value (RCA>0). These six provinces are amongst the most industrialized regions. When sorted by rank, they are WJV, EJV, BAN, CJV, JKT and NSM. These provinces hosted more than 85 products, which they were able to produce in 2012. What is interesting is that, when the RCA is set at a higher value, in this case, RCA>=1, the two lowest provinces of the top six, i.e., JKT and NSM, are surpassed by YOG and RIS. Although JKT and NSM manufacture more products, in this analysis, YOG and RIS are considered to be more diverse by having more comparatively significant products. Another thought-provoking fact is the steep fall in the number of products that provinces produced with RCA>=1. This empirical evidence seems to fit with the natural cutting-off point of RCA, when it equals or is greater than 1, as stated by Ballasa (1986). As the formula specifies, an RCA equal to or greater than 1 confirms that the share of a particular product in the province is larger than the product's share in the country. The evidence and formula suggest that the cut-off value is indeed a good threshold at which the specialization of a particular product is determined.

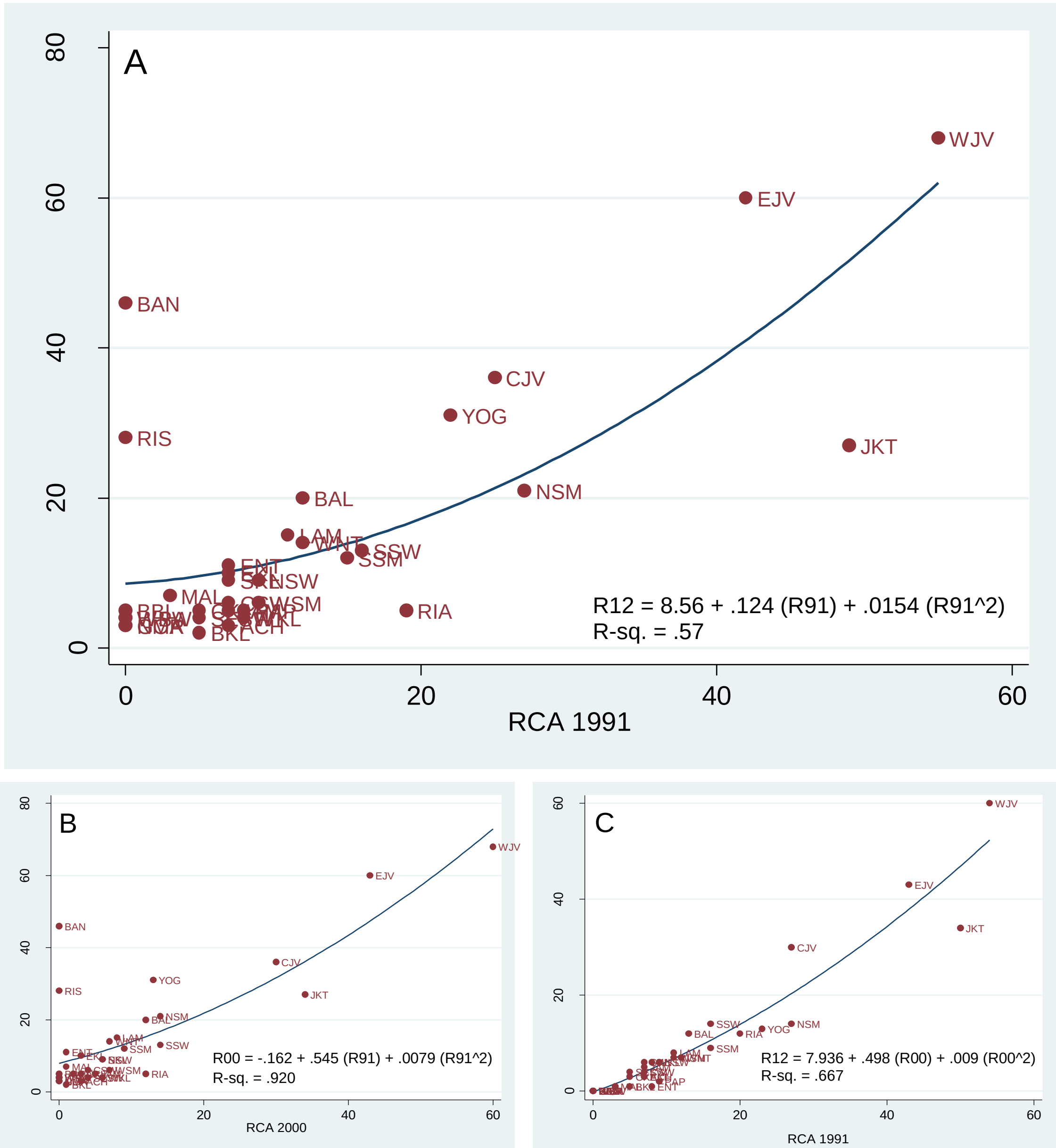
Figure IV-7 Revealed Comparative Advantages across Provinces in 2012



Sources: Author's analysis

From an evolutionary perspective, we can study the changes in a number of products with comparative advantage over time. One simple way to investigate this is by looking at the number of products with a comparative advantage in 1991 and comparing this with the number of products with comparative advantage in 2012, as plotted in Figure IV-8. The expectation is that the higher the number of products with comparative advantage that a province had in previous years, the higher the number of products with comparative advantage that a province would have in subsequent years. Theoretically, provinces endowed with larger dominant products have greater potential to recombine the knowledge required in producing those products in order to diversify into new related products (Hidalgo et al., 2007).

Figure IV-8 RCA in 1991 and 2012 by Provinces



Source: Author's calculation based on Indonesian manufacturing data, 1991 and 2012.

Note: Vertical and horizontal axes represent the number of industries with RCA. A. 2012 and 1991; B. 2000 and 1991; and C. 2012 and 2000.

As expected, provinces in Indonesia empirically show a positive, slightly non-linear relation[43] between the number of products with comparative advantage in 1991 and in 2012, as shown in Figure IV-8A. The non-linearity of the relations suggests the presence of increasing return effects. JKT, WJV, and EJV are three provinces that had the largest number of products with comparative advantage in 1991, and an even

[43] We also experimented with linear regression, but the R-squared value was slightly lower than the non-linear value we have presented here, meaning the latter model was a better fit for the data.

larger number in 2012, except for JKT. Figure IV-8B and Figure IV-8C split the analysis into two shorter periods, which show similar patterns.

Let us focus now on Figure IV-8A. Although the capital city of Jakarta still hosted around 30 products with comparative advantage in 2012, it experienced a significant decline from its 1991 level, when it manufactured 50 products with comparative advantage. The decline is inseparable from the geographical context of the JKT city province. The rapid expansion of the city in the 1980s and the limited space available in the city forced existing manufacturers at that time out of the city to new locations in adjacent districts, such as Bogor, Tangerang and Bekasi, which are part of WJV and BAN nowadays. Firman (1998) highlights that this outward relocation started at the end of the 1980s, particularly since the government had allowed the development of private industrial estates. He also found that, in the first half of the 1990s the capital city of Jakarta disproportionately absorbed investment in the service, commerce, hotel and restaurant, and construction sectors, while districts surrounding the capital attracted most investments in the manufacturing sectors, including those producing textiles, garments, footwear, plastics, chemicals, electrical goods, metal and foodstuffs. The transformation of the capital into a service-based city could explain the decline of manufacturing sectors in JKT.

Further discussion is appropriate on the other three provinces (i.e., RIA, BAN, RIS), which display some degree of deviation from what is predicted by theory. In 1991, RIA hosted 20 products with comparative advantage. In 2012, however, RIA lost 75% of its competitive products, which left it with only five products with comparative advantage. This drastic fall in manufactured products was a result of the split in 2004. Prior to the split, Batam as the main industrial district of the province fell within RIA's administrative borders. The split, however, located Batam into the new province of RIS (see Figure IV-9A). This is why RIS had no record of products in 1991, yet managed to develop many products with comparative advantage in 2012. A similar situation also occurred between WJV and BAN in 2000, but with different outcomes. The administrative split in this case equally divided the manufacturing sectors in the former WJV Province (see Figure IV-9B). However, as discussed earlier, the manufacturing spillover from JKT into these two provinces offset the effect of the split, fuelling further industrialisation in both provinces.

The figure also confirms another empirical fact about how previous diversification levels constrained the possibilities of new products emerging, as suggested by the notions of path dependence and relatedness. Provinces that are concentrated in the lower left area of the graph suggest that a lack of diversification restrains those provinces when diversifying towards different products. Combined with the observation in Figure IV-7, even when the RCA is set at a lower threshold (RCA>=0.01, for example), these provinces still had a relatively low diversification level in 2012. The red line on the graph is the unity line. Provinces above/below the unity line experienced an increase/decrease in the diversification level, respectively. For instance, the NSM, RIA and JKT diversification levels fell between 1991 and 2012, during which the latter two experienced the worst drop for the reasons explained above.

Figure IV-9 Administrative Split of Riau and West Java Provinces

Source:
1. http://d-maps.com/carte.php?num_car=133923&lang=en
2. https://upload.wikimedia.org/wikipedia/commons/b/b7/Lokasi_Riau_Kota_Pekanbaru.svg

Note: A. Riau province splits into mother province of Riau and Riau Island in which Batam is situated in the latter; B. West Java province splits into Banten on the left (Eastern part) and West Java. Maps are without scale.

All in all, from an empirical perspective, measuring diversification levels of provinces by tallying the number of products with comparative advantage demonstrates that more industrialised provinces on the main island of Java have strong tendencies to be more diverse than less developed provinces. Moreover, the positive relation between previous and subsequent levels of diversification strongly suggests that more diverse provinces tend to diversify their products even further. The fact that few irregular cases occurred is explained by the administrative separation of provinces and the urban sprawl phenomenon. More importantly, the natural threshold value of RCA, when equal to or greater than 1 empirically reflects the specialization pattern of provinces. Lowering the threshold may change the quantity of products produced by each province, but it does not alter the relative position of diversification levels among provinces.

4.3.3.2 Measuring the sophistication of products

Having more products does not necessarily mean having more capabilities. Provinces undoubtedly have capabilities to produce the products they are producing, while products require certain capabilities to be produced. Most products need simple capabilities, but others require more complex capabilities to produce. Consider two provinces with a similar level of diversification, but a different sophistication level for the products they produce. In this case, the province with better products will be considered to have more capabilities as it has all the abilities required for advance products.

Given the importance of the sophistication level of products when measuring the complexity of the industry structure of provinces, the ways it is measured vary in the literature. At least three approaches have been put forward, namely, the technology intensity-based measure, the income-based measure and the ubiquity-based measure. The first approach is used by UNCTAD to classify products into seven categories, based on the composition of inputs, skills and technologies employed in the production process[44]. One of the downsides of this measure is that it is a predefined measure and usually relatively fixed for a certain period of time. Meanwhile, sophistication is a dynamic concept that sometimes changes quickly. Moreover, countries or regions make the same product using a different composition of inputs, skill and technologies, depending on the abundance of factors in a country (Essletzbichler et al., 1998; Essletzbichler and Rigby, 2007).

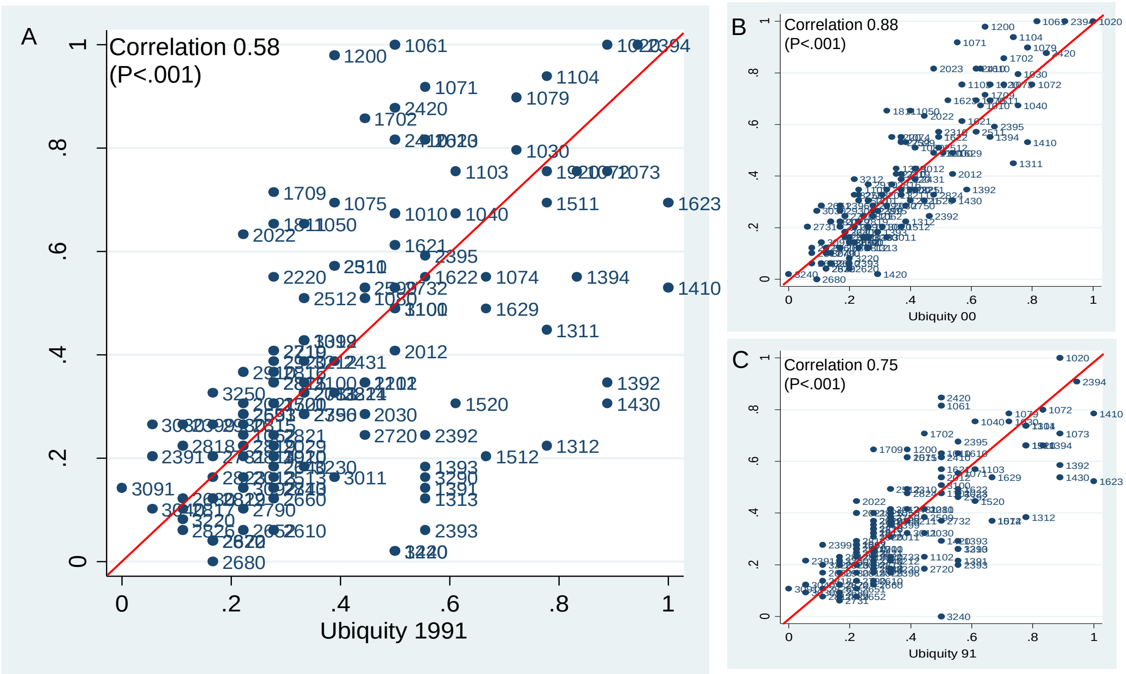
The second approach was developed by Hausmann, Hwang and Rodrik (2007) by combining two types of information: countries' aggregate income and the RCA of products that each country has. The sophistication of product, known as PRODY, is measured by averaging the aggregate income of countries that produced the product and then weighting the share of each country's RCA for the product. To calculate the sophistication of a country's productive structure, known as EXPY, the PRODY of products produced by that country is averaged, resulting in an index of that country's industry structure. One of the drawbacks of this measure is that the formulation of PRODY will result in a different value of sophistication for the same product in different countries, depending on the weight of RCA that a country has for the product. For example, by applying this definition, footwear products may be considered as more sophisticated in Indonesia, but less sophisticated product in other countries, say, the

[44] The seven categories are non-fuel primary commodities, resource-intensive manufactures, low-skill and technology-intensive manufacturing, medium-skill and technology-intensive manufacturing, high-skill and technology-intensive manufacturing, mineral fuels and unclassified products.

Philippines, which has a lower RCA for these products than Indonesia. If we do not consider RCA as the weight on the measure, or simply use the average aggregate income of countries that produce footwear, we may end up with a single value of sophistication. This, however, will introduce some biases as less sophisticated products are also produced by high-income countries, which will inflate their sophistication values. For instance, oil-producing countries may have a high aggregate income (GDP) earned from selling natural resources. However, intuitively, this is hard to accept when oil is considered to be a sophisticated product.

The third approach, which is adopted in this research, is ubiquity-based sophistication, recently introduced by Hidalgo and Hausmann (2009). In principle, less sophisticated products tend to be produced by most countries, while more sophisticated products tend to be produced by only a few countries. The idea underlying this measure is that less sophisticated products require simple or few capabilities that are possessed by most countries. In contrast, more sophisticated products require complex capabilities to make them, which are mastered by only a few countries. This measure of product sophistication is more appropriate as it can address the shortcomings faced by the other two measures. Given its definition, the ubiquity-based method relaxes the rigidity of the first measure by accommodating the different ways adopted by countries or provinces in making a product. Countries can apply different techniques and employ different inputs to create a product, but countries cannot make products if they lack the capabilities required to make them. One may argue that we cannot rule out the possibility of countries not producing a product, even though they are capable of doing so, which, according to this measure, could make a product less ubiquitous than it should be, thus, deceitfully increasing its sophistication level. This may be the case, but evidence points to an opposite conclusion. The situation presented in Figure IV-7 reveals that developed provinces tend to produce almost all products, which is also supported by cross-country data (Hidalgo and Hausmann, 2009). This method also eliminates the confusion introduced by the use of aggregate income in the formulation of PRODY. As argued by its creators, income information is actually well captured by countries' diversification level, due to the connection between countries and the numbers of products they have. In measuring the sophistication of products, the ubiquity method separates the income information, but takes into account information in the form of the diversification level when analysing the complexity of provinces' product structure. We will discuss this matter by comparing the results of PRODY and the ubiquity method shortly.

Figure IV-10 Ubiquity of Products in 1991, 2000, and 2013 (normalised)



Source: Author's analysis.

Note: A. between 1991 and 2012; B. between 2000 and 2012; and C. between 1991 and 2000.

Figure IV-10 depicts the ubiquity of products measured in 1991 and 2012. Ubiquity is measured by applying the formula in Equation (6) by using international trade data, which are converted into ISIC four-digit information. It is important to note that the ubiquity is measured at the international level using international trade data, rather than measured by using province data. The reason is that the small number of provinces in Indonesia, compared to the number of countries in the world, will not capture the actual prevalence of products. Moreover, some products are absent from Indonesia, making those products unobservable in terms of their ubiquities. In the graph, to make it comparable, the ubiquity of each product is normalized on a 0 to 1 scale[45]. The red line is the unity line. As more sophisticated products are usually made by only few countries, less common products are considered as more sophisticated products. Thus, the way the graph is interpreted is that the closer a product is to the value of 0, the higher the sophistication of that product. Therefore, products below the unity line are products that experience improved sophistication, and vice versa. As shown in Figure IV-10A, between 1991 and 2012, products such as magnetic and optical media, optical and photographic equipment (ISIC 2660-80) and machinery products (ISIC 2821-24) were enhanced in terms of their sophistication. In contrast, products such as processed foods (ISIC 1010-71) and paper-based products (ISIC 1701-09) were

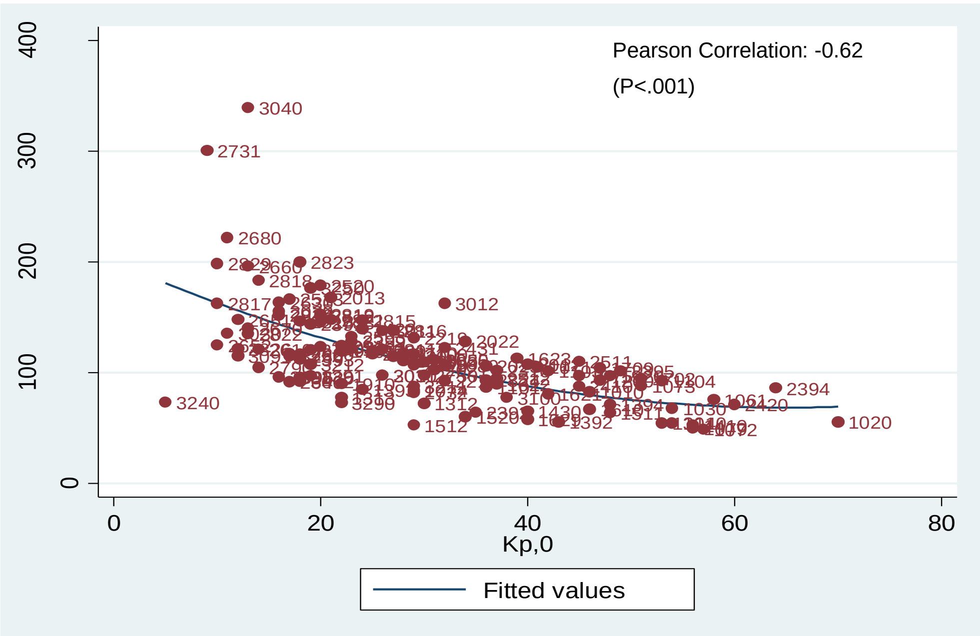
[45] The real values of the ubiquity of products across the years are presented in Appendix 5.

among the increasingly commonplace products during that period. Overall, around half of manufactured products increased in terms of their sophistication level during this 22-year period, according to this method. Figure IV-10B and Figure IV-10C split the observation into two periods of time: from 2000 to 2012 (B) and from 1991 to 2000 (C).

It is also important to note that most of the products are concentrated in the lower part of the graphs. For instance, 65% and 69% of products were below 0.5 in 1991 and 2012, respectively. When lowering the threshold, say, to 0.25, we find that 27% and 37% of products fell below this point in 1991 and 2012, respectively. This means that most of products were actually classified as sophisticated products, most of which were only made by a few provinces. Since the ubiquity method is a dynamic concept based on the relative prevalence of products compared with others, setting a threshold is actually an arbitrary process. Nevertheless, the plot visually indicates that 0.4 (normalised value) may be an appropriate cut-off value, if we require one.

As discussed earlier, another way to measure the sophistication of products is PRODY. We calculate this by using countries' GDP from 2000, adjusted by purchasing power parity, published by the WB. Given that, by applying this formulation, PRODY will have different values for each country. We average the PRODY across countries and plot the results, together with the results of the ubiquity measure (called Kp,0) for the same year in Figure IV-11.

Figure IV-11 Relationship between Ubiquity (Kp,0) and PRODY in 2000



Source: Author's analysis.

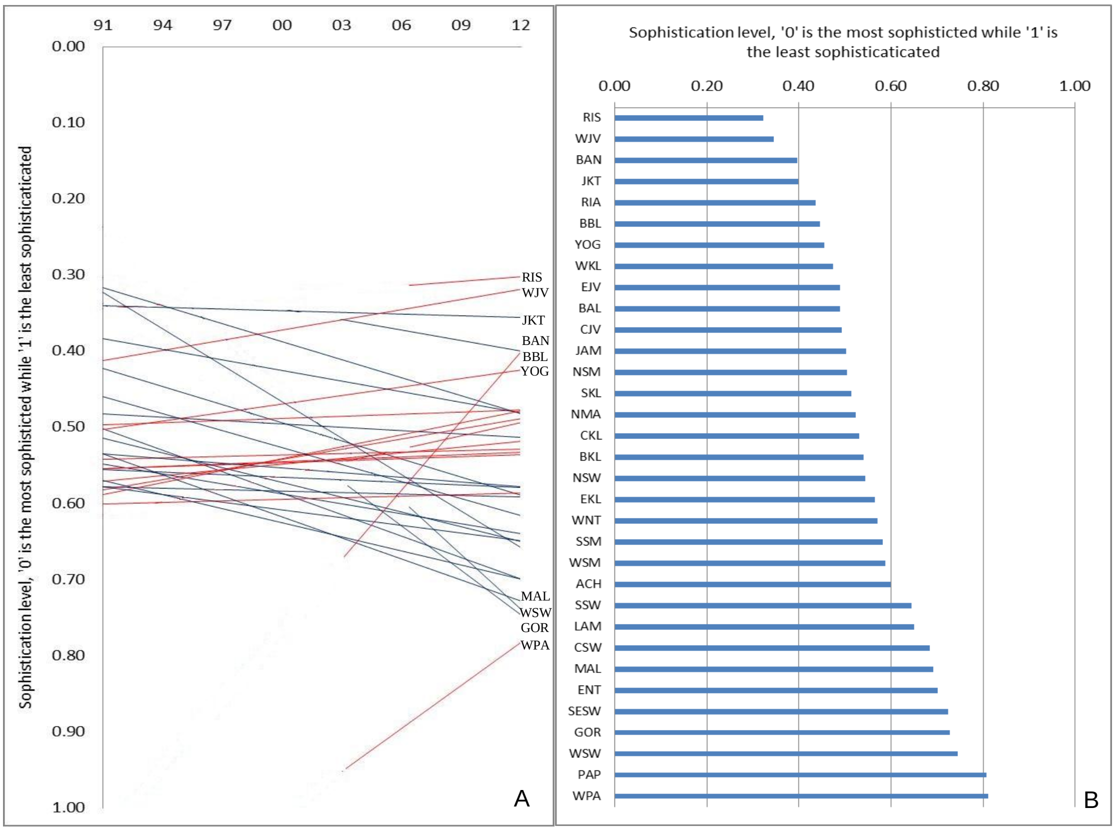
In interpreting the graph, we must bear in mind that a lower ubiquity value along the horizontal axis means higher sophistication. In contrast, a higher value of averaged PRODY along the vertical axis means a higher level of sophistication. At a glance, the graph clearly shows a negative relation between PRODY and ubiquity. However, in terms of their meaning, they actually have a positive relation, that is, a more sophisticated product measured by PRODY is also a more sophisticated product when measured by ubiquity. To quantify the relatedness of the two sophistication measure results, we calculate the correlation between them. As revealed by Figure IV-11, the correlation between the results for PRODY and ubiquity is -0.62, which is significant at P<0.001. This indicates that the two results are highly correlated to each other. We will explain why this is the case in detail shortly.

We measure the provinces' sophistication level by averaging the sophistication values of all industries in each province. As provinces' sophistication levels are highly dynamic across the years, we have enhanced the readability of the trend lines for each province displayed in Figure IV-12A. The scale on the vertical axes is in reverse order, meaning that ascending trend lines (bold red colour) indicate improved sophistication, while descending trend lines (dashed blue colour) indicate the opposite. Overall, 14 provinces experienced improved sophistication levels, while the other 19 experienced downgrading. Regardless of the trajectory, some provinces entrenched themselves as provinces with the most sophisticated industry structures in 2012. Figure IV-12B shows provinces' sophistication levels in 2012 sorted by their normalized values. According to the figure, on average, RIS hosted the most sophisticated manufacturing industries, followed by WJV, BAN and JKT. These provinces were among the most diverse provinces in the previous years (see Figure IV-7). Meanwhile, WPA had the least sophisticated manufacturing industries, followed by PAP, WSW and GOR. This is not surprising, as these provinces were among those with the lowest diversification levels in the previous years.

4.3.3.3 Measuring the complexity of provinces' industry structure

We have separately discussed the level of diversification among provinces in Indonesia and the level of sophistication concerning products. Now we are going to combine those two measures iteratively, as required by the reflection method of complexity (Hidalgo and Hausmann, 2009). Before applying the method, it is interesting to see how diversification and sophistication (ubiquity) are related by using the original data. In doing so, we sort the RCA matrix of products by its diversification and sophistication value for three points in time, i.e., 1991, 2000 and 2012. The diversification is set at RCA>=0.5, while sophistication is set, based on the ubiquity in international markets. Thus, the very first column on the left is the province with the most diverse products, while the first row is the most common product produced by most countries in the world. To enhance its readability, we applied colour codes for the actual values of RCA. The results are displayed in Figure IV-13.

Figure IV-12 The Dynamics of Provinces' Sophistication Levels

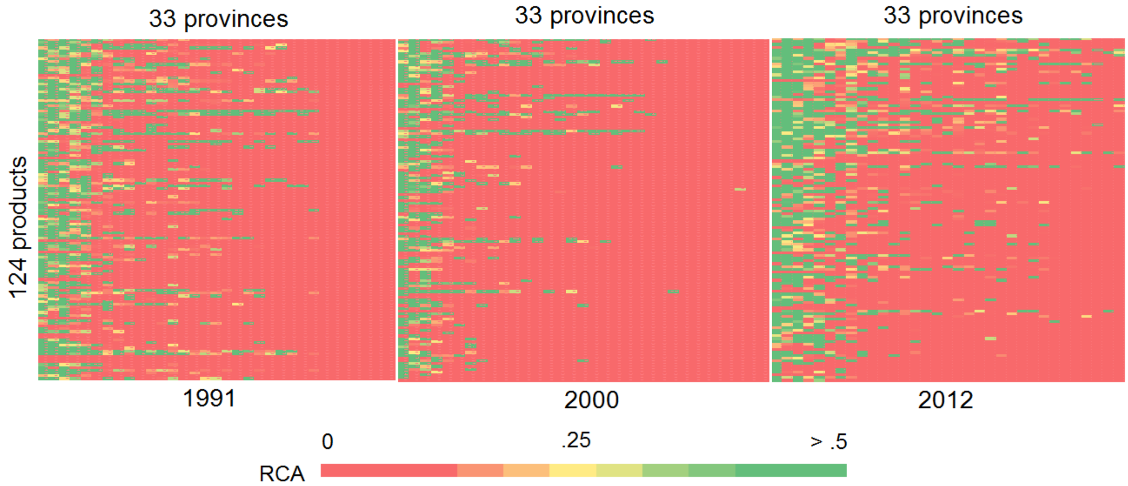


Source: Author's calculation based on international export data and Indonesian manufacturing data from 1991 to 2012.

Note: A. changes in provincial sophistication levels between 1991 and 2012 are indicated by trend lines, with red trend lines indicating improved sophistication and blue trend lines indicating otherwise; B. sophistication level of provinces by normalized value, 2012.

When looking at the sorted matrices, the first impression is that there are no particular patterns that can be traced downwards. However, looking chronologically from the left (1991) to the right (2012), a stronger pattern somewhat starts to emerge. It is easier to interpret those matrices from the right. For 2012, a triangular shape, formed by the coloured codes, suggests that more sophisticated products (lower rows) tend to be produced by provinces with more diverse products (left columns). This triangular shape is not well formed in the 2000 matrix, although some features, particularly at the bottom of the matrix, have emerged. Only a few provinces with diverse skills of production manage to make sophisticated products. The top part of the matrix seems a bit far from what is expected, that is, less sophisticated products are likely to be produced by low-skill provinces in the far right columns. This observation is quite different from the 1991 matrix in which some 'anomalies' occur. The 1991 matrix demonstrates that some provinces manage to produce sophisticated products regardless of their low product diversity.

Figure IV-13 Ubiquity-Diversification Matrix for 1991, 2000, and 2012



Source: Author's analysis.

Note: Rows represent ubiquity and columns represent diversification; the values of RCA are colour-coded.

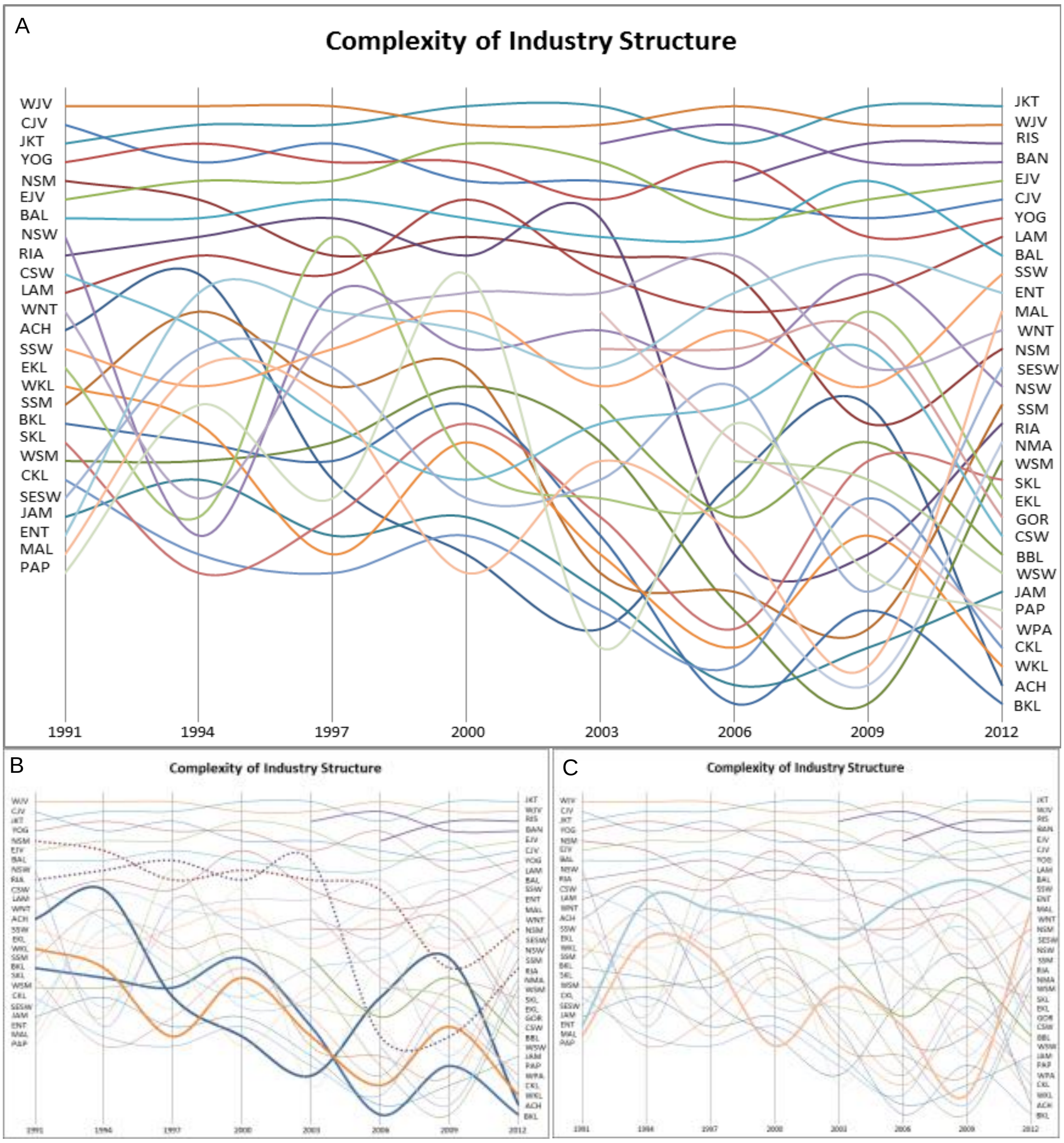
In principle, the method of reflection takes into account the two measures of diversification and sophistication, and then blends them iteratively into a single measure of complexity. Both diversification and sophistication are viewed as forming a bipartite network, which links provinces with products they make. The number of links connecting each province to products it produces is defined as diversification, while the number of countries producing a particular product indicates the sophistication level of that product. We have analysed diversification and sophistication separately. Going forward, we now apply the method of reflection to measure the complexity of product structure.

We calculate the complexity index at eight points in time between 1991 and 2012. Following Hidalgo and Hausmann (2009), instead of comparing its absolute values, we analyse the complexity of product structure by looking at the changes in the relative position of each province against other provinces[46]. We present the changes in the complexity ranking in Figure IV-14. As suggested by the method, we iteratively calculate the combination between diversification and sophistication for several rounds until the relative position of provinces no longer changes. Thus, the number of iteration runs for each year differs, depending on how quickly the iteration reaches a stable

[46] The nominal values of the complexity index are presented in Appendix 6.

state of results. For example, in the calculation for 1991, a stable result is achieved after 14 iterations; thus, we adopt Kc,14 as the final complexity index for 1991. Similarly, for 2000 and 2012, the iterations are stopped at Kc,14 and Kc,24, respectively.

Figure IV-14 Complexity of Provinces by Ranking



Source: Author's analysis.

Note: A. overall ranking; B. same as a, but with declined provinces highlighted; C. same as a, but with provinces that moved up the rankings highlighted.

It is important to note that, during this period of time, the number of provinces in Indonesia increased from 26 provinces to 33 provinces in 2012. Seven new provinces were created immediately after democratization and decentralization took place in Indonesia between 2000 and 2005. Performing the calculation consistently on 26 provinces throughout the time period under analysis sounds like a good idea. However, the fact that less than half of the time period under analysis involves 26 provinces (1991 to 2000), while the number of provinces subsequently increased (2000 to 2012), offsets the idea of applying the analysis to 26 provinces. Nevertheless, the reduction will take the analysis away from reality. Although the use of ranks may, to some extent, resolve this issue, some confusion may still exist while reading the graph, which is engendered by the different number of provinces in 1991 and 2012. For example, which rank is better between, say, YOG, which ranks four out of 26 in 1991, and YOG, which ranks seven out of 33 in 2012? The easiest way to solving this problem is by normalizing the ranks using a 0 to 1 scale, which would rank YOG at 0.88 within the new scale for 1991, while having a lower rank (0.8125) in 2012. However, this idea may cause the graph to look slightly complex and difficult to maintain in terms of its simplicity. For analysis purposes, it is better to read the graph by dividing it into two periods of time: 1991 to 2000 (26 provinces) and 2006 to 2012 (33 provinces). The graph still displays the full period of analysis (1991-2012) needed to capture the long-term pattern of changes regarding complexity.

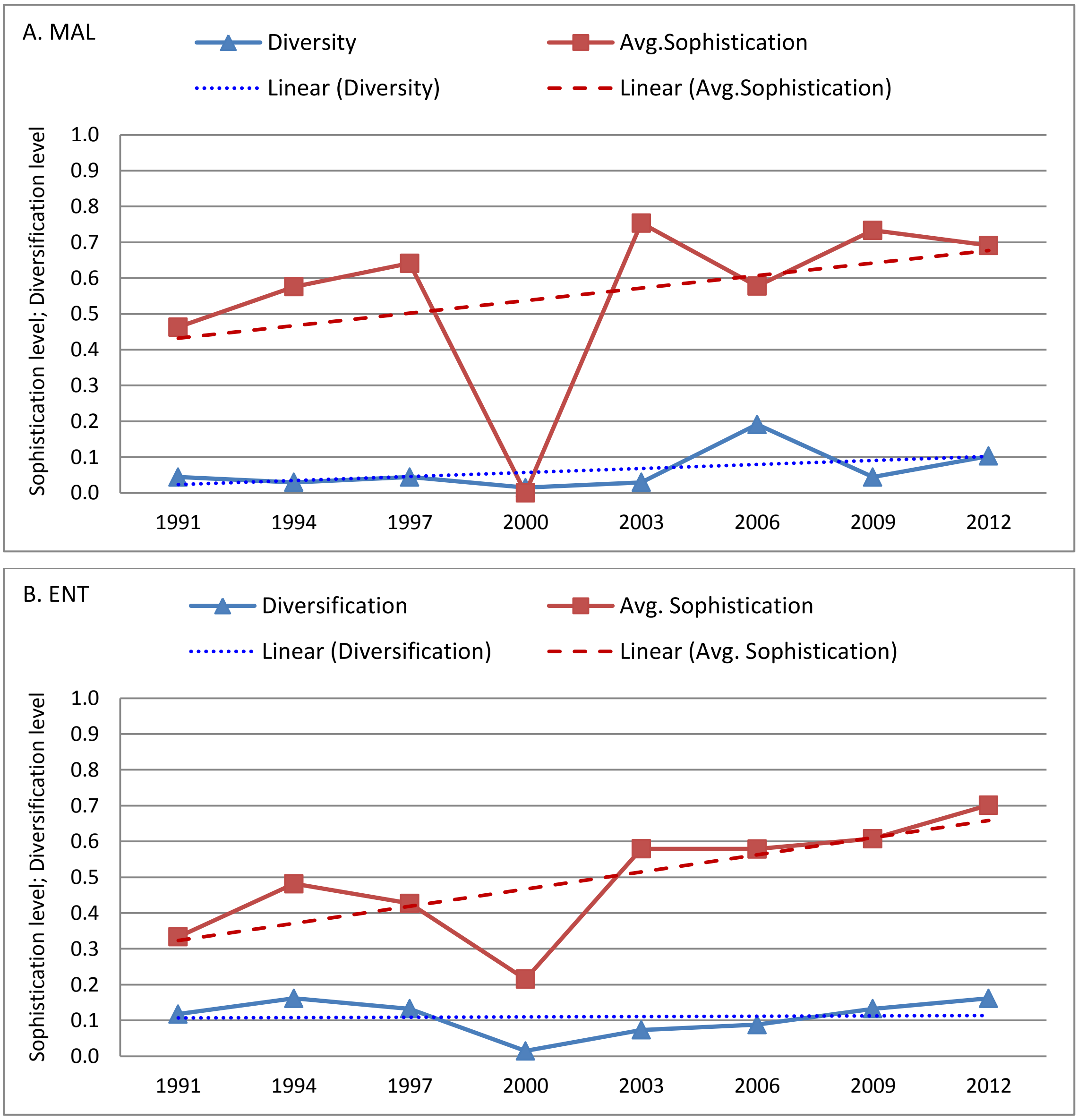
In the upper left of Figure IV-14A (1991-2000), the lines show a stable movement, meaning that the complexity of the top eight provinces does not change much within this period of time. Provinces with high complexity remain in this state. In fact, this pattern holds until 2012, except for two provinces: NSM and RIA. These two provinces significantly drop in their relative position (see dotted line in 4.10B). Apparently, the drastic drop experienced by RIA is related to the split of that province into RIA and RIS. This is confirmed by the appearance of the new province RIS at the very top of the rank in 2006, suggesting an imbalanced split in the manufacturing sector, which is heavier in the new province. However, the drop experienced by NSM in 2009 seems to have different causes. Further scrutiny of the dataset reveals that the province lost it diversity in many industries, including food and beverage (ISIC 10-12), wood products (16), rubber and plastic products (22), metal products (23-24), electronic and optical products, and electrical machinery equipment (26-28). This is exacerbated by the fact that some of those declining industries have a high level of sophistication. The specific reasons for the decline are beyond the scope of this analysis. As an educated speculation, it could be linked to the relatedness of those industries to their host province or caused by external shocks, such as a global crisis at that time. Nevertheless, NSM is a worthy candidate for serious attention as this province displays irregularity from what is expected, that is, a province with a higher complexity level is likely to be able to expand its complexity level.

The two better performing provinces are ENT and MAL (Figure IV-14C). Starting at ranked position 24 and 25 (out of 26), respectively, both provinces managed to climb the ladder of complexity up to rank 11 and 12 (out of 33), respectively. It is quite tempting to dig further as to what has been happening behind these increases. Thus, we investigate the changes in the level of diversification and averaged sophistication for those two provinces during the 1990s and 2000s. The results are summarised in Figure IV-15. In constructing the graphs, we normalise the scale of diversification and sophistication, such that both have comparable scales fitted to the graphs. The dotted blue line depicts the changes in the diversification level of each province, while the dotted red line depicts the levels of sophistication averaged across the products made by each province. The bold straight lines are fitted linear lines, which reveal the overall trend of the changes, blue represents diversification and red represents sophistication. The important factor to bear in mind concerns the way in which sophistication is interpreted. The ubiquity concept defines more sophisticated products as less common products. Thus, lower values on the vertical axis of the graph mean two different phenomena: they mean less diversity for the blue lines, whereas they mean more sophisticated products for the red lines. Figure IV-15 suggests that, in general, the diversification levels of ENT and MAL increased, although both provinces diversified towards relatively less sophisticated industries. Nevertheless, that was sufficient to significantly move them up the rankings.

Another feature of the graph, which is worthy of attention, concerns the initial levels of diversification and sophistication from which the two provinces evolved. MAL started with very low levels of diversification and sophistication compared to ENT. However, MAL successfully managed to diversify its products up to four basis points, which is much better than ENT with only two basis points. Even though, in general, ENT started with a higher level of sophistication (lower value indicated by the bold red line), in 2012, both provinces made products that typically had an equivalent sophistication level.

In contrast, there are three provinces that experienced a deep decline (more than five ranks) in terms of their complexity, namely, ACH, WKL and BKL (see bold line in Figure IV-14B). In general, these provinces are categorized as less developed provinces, leaving little or no doubt as to why they are in the position they are in. Among these provinces, ACH experienced the worst decline. This is due to a consistent decrease in ACH's diversification and sophistication level during this period (see Figure IV-16A). Major armed conflicts and a mega tsunami could have contributed to this decline. In addition, both WKL and BKL were in a stable position during the 1990s, with small ripples in 1997. However, in the 2000s, these two provinces' position plummeted with a small bounce back in 2009, before WKL and BKL ended in ranked position 31 and 33, respectively, in 2012 (Figure IV-14B). A detailed scrutiny of the level of diversification in those two provinces in the 2000s reveals a decrease in the level of diversification (follow blue line in Figure IV-16B and Figure IV-16C). However, WKL managed to slightly improve its sophistication level, which was captured by a complexity index that was higher than those for BKL and ACH. This indicates that the decreased complexity of these three provinces was likely caused by the decrease in their diversification level relative to other provinces. Another plausible explanation is that other provinces improved in their level of diversification and/or sophistication, which pulled other provinces' rank up higher than that achieved by WKL and BKL, placing them in the bottom part of the list.

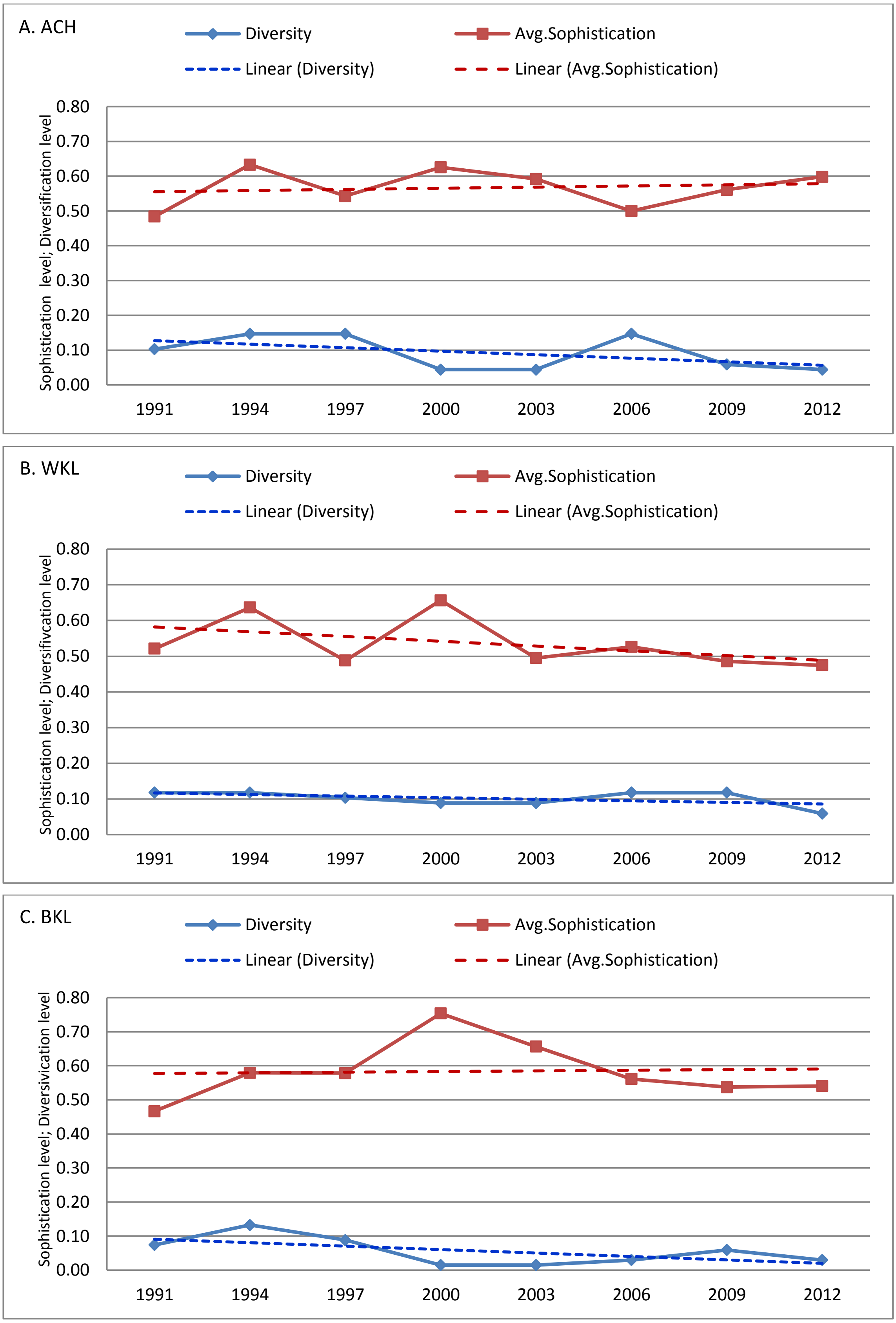
Figure IV-15 the Changes of Diversification and Sophistication Level of Best Performing Provinces



Source: Author's calculation based on Indonesian manufacturing data from 1991 to 2012 and international export data for the same period.

Note: Bold lines are the normalized values of diversification (with diamonds) and sophistication (with squares), while dotted and dashed lines are the trend lines of the bold lines; A is MAL and B is ENT. Lower values on the vertical axis indicate two different meanings: less diversity for solid lines with triangle markers; more sophistication for solid lines with square markers.

Figure IV-16 Changes in Diversification and Sophistication Level of Underperforming Provinces

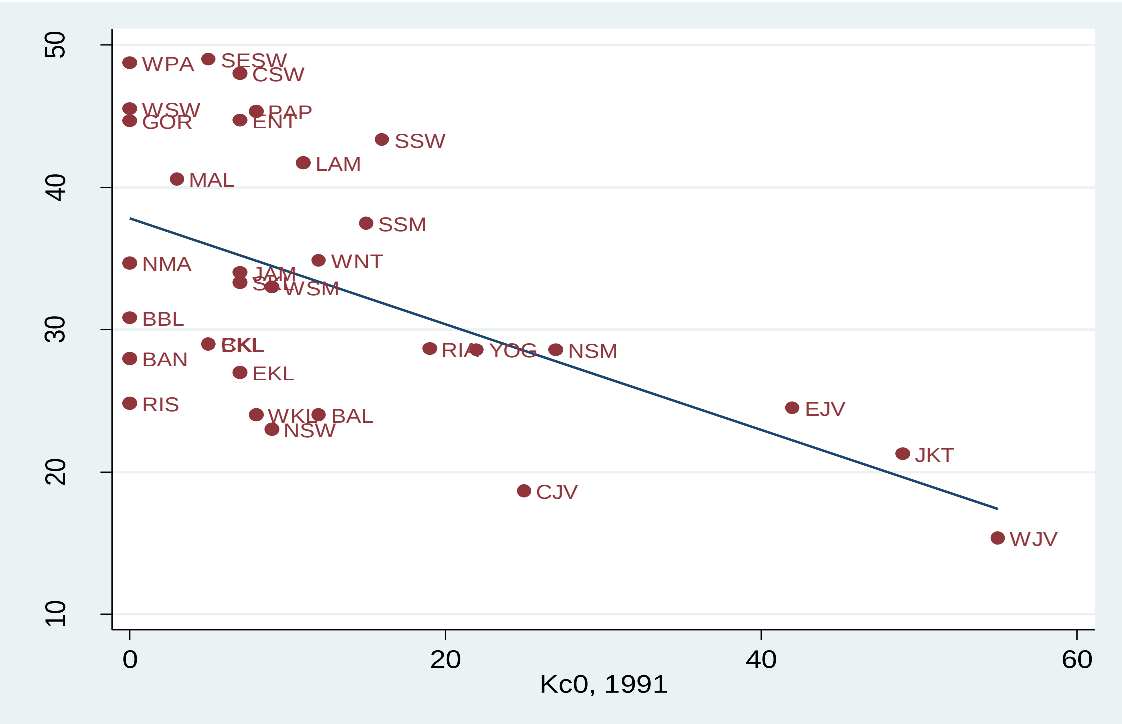


Source: Author's calculation based on Indonesian manufacturing data from 1991 to 2012 and international export data for the same period.

Note: Bold lines are the normalized values of diversification (with diamonds) and sophistication (with squares), while dotted and dashed lines are the trend lines of the bold lines; A is ACH, B is WKL and C is BKL.

As discussed in the previous section, the method of reflection that is used to assess the complexity of the industry structure of provinces is based on the bipartite network, which links provinces and the products they make. Can existing provinces' diversification level, or *Kc,* predict the ubiquity of new products (*Kp*) in later years? We examine this by plotting the results from the method of reflection (Kc and Kp) into a single graph. We define new products as products with an RAC<=0.1 in 1991 and an RCA>=1 in 2012. As provinces have many products with various levels of sophistication, we average the ubiquity of all products in each province. The plot is presented in Figure IV-17, and we also fit the regression line onto it. The relation between Kc0 and Kp0 can be easily read from the coefficient of the regression (-0.372, significant at P<0.01). This means that more diversified provinces tend to be able to produce more sophisticated new products in the future. Combining this result with what is suggested by Figure IV-13, we can conclude that more diverse provinces tend to develop more new products, which are likely to be more sophisticated. The correlation, or the closeness of the data to the regression line, also shows quite a high value (-0.55) and statistical significance (P<0.01).

Figure IV-17 Relationship between Diversification Level of Province (Kc,0) and New Sophisticated Products (Kp,0)i



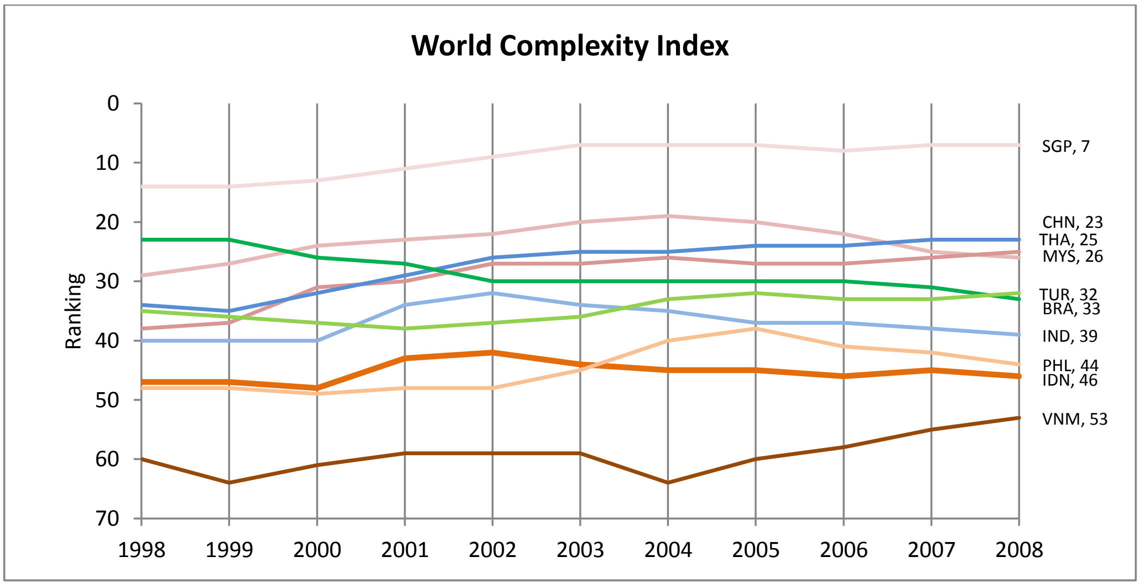
Source: Author's analysis.

4.3.3.4 The complexity of selected countries in the Global South

This research does not specifically calculate the industrial complexity of countries. Indeed, other research has genuinely done it. Here, we cite the complexity rank calculated by Hausmann et al. (2014) to portrait Indonesia within broader and comparative perspectives (Figure IV-18). In order to match the product space analysis in 4.2.3.4, here we highlight only four countries, which are China, Thailand, Indonesia and Thailand.

In general, the complexity of selected countries in the Global South shows an improving trend, except for Brazil. China and Thailand have a better rank (23 and 25, respectively, of total 128 countries) compared to Indonesia (46) and Vietnam (53) in 2008. Both China and Thailand have improved their rank consistently. The product space of both countries in Figure IV-4 indicates that their industry continuously diversify toward more sophisticated products. Vietnam's rank is also improving in a rather fluctuated way. Its product space suggests that Vietnam's industry keeps diversifying but toward products that seems to be less sophisticated (mostly textile and food industries) than those produced by China and Thailand. The relative position of Indonesia, however, does not change during the period 1998-2008. Does this imply stagnancy in Indonesia's industrial development? The value of complexity index shows an increasing trend, from -0.19 in 1998 to -0.01 in 2008. This suggests that Indonesia's industrial capability is improving although it is not significant enough to boost Indonesia's relative position up in the world complexity rank.

Figure IV-18 Complexity Index of Selected Countries in the Global South



Source: Hausmann, Hidalgo et al.

4.4 Conclusion

The proximity matrix tells us that many products are cognitively close to each other, but it also tells us that most products are not truly related. It is also evident that the proximity between products tends to be stable; that is, close products tend to stay close to each other, and vice versa. The analysis also confirms the claim made by path dependence theory that new products are more likely to emerge in a region if they are close to existing provinces' portfolio. Moreover, this research also produces a certain threshold value of proximity, which influences the trajectory of provinces in the development of new products. Diverse product structures provide provinces with many alternative routes by which to reach the sophisticated parts of the product space. In contrast, provinces with less related and homogenous product structures may find it difficult to get there, as it is simply too far to reach and the 'road' to this destination is not truly connected. This calls for industrial policies that focus on connecting these paths.

We also examined the product structure of provinces, particularly the diversity and sophistication features of the structure. Our analysis found that there is a systematic relationship between the two characteristics at the subnational level. Specifically, this research observes an imbalanced distribution of manufacturing production across provinces in Indonesia. Our analysis also detected an increasing returns pattern: the likelihood of diverse provinces to develop more new products than their less diverse counterparts. Conversely, it can also be argued that less diverse provinces tend to be trapped in a lock-in situation. This evidently suggests a diverging implication in the development path.

The sophistication of a product does change over time. Some products become technologically improved as fewer countries can afford the technical intricacies needed to make them. At the same time, other products decrease in terms of sophistication as the technology required to make them becomes prevalent and accessible by many countries. Interestingly, regardless of the dynamics of their relative ubiquity, the empirical evidence reveals that, generally, the sophistication level of products shows some degree of stability. Common products stay common for quite some time, and vice versa. Furthermore, looking at the distribution of products, most manufactured products are categorized as sophisticated when referring to their commonness. In addition, this research also observes a specific pattern that emerged in 2012, where more sophisticated products tended to be produced by only a few diverse provinces. However, such patterns have not been observed as yet in the previous period.

We also documented a diverging pattern among provinces in terms of the complexity of their industry structures. Provinces with a high complexity stayed as they are during the period of analysis. Certainly, in their evolution process, we detected some achievers and underperformers. The best two achievers improved their complexity, mainly due to increased diversity, rather than improved sophistication of the products they make. Underperformers such as ACH, WKL and BKL have failed to maintain their diversification level, although WKL have managed to slightly improve its products. Finally, we found a systematic relationship between the diversity of provinces and the sophistication of products they produced. More diverse provinces tend to develop more new products, which are likely more sophisticated.

The discussions above have presented us with empirical evidence of the cohesiveness and complexity of provinces in Indonesia. These findings can thus far be regarded as this analysis' contribution to the literature. However, we also acknowledge the presence of limitations identified over the course of analysis. Though these limitations should be borne in mind while reading through the analysis, some of them can also be viewed as prompting inquires for the attention of future research.

Most of the limitations have in fact been discussed here or elsewhere in the previous chapters. Allow us to revisit the two that are the most conspicuous. First, the relatedness measure of co-occurrence used in the analysis is not impeccable. The measure limits itself to existing products that are currently available and already linked. It is unable to measure the relatedness of products for which links have not been created. For example, given the current state of technology, the relatedness between machinery products and plastic products is quite low, as most items of machinery are currently made of steel. In the near future, however, there is the possibility that machinery will be made of, say, plastics, which will alter the relatedness between the two products. Second, the data used in the empirical analysis may contain bias. Trade data, which are used to measure relatedness, do not necessarily reflect the real productive structure of countries. There are possibilities that countries export negligible amounts of a particular product, even though they in fact produce a significant amount of that product for domestic consumption, such as rice in Indonesia. Ideally, relatedness should be measured by real outputs, instead of countries' exports. However, these kinds of data covering the whole range of products, arranged by country and year, are not available at the moment. Moreover, the use of trade and manufacturing data in the analysis at province level involves a trade-off, as discussed in Section 3.2.1. Regional trade data cover more products (including products in the agricultural and mineral sectors), but may show a bias on account of where the data were recorded (usually recorded in ports, not in the plants where they are made). Conversely, manufacturing data record actual products at the plant level, but cover only manufactured products, and not those in agriculture and mineral sectors.

The discussions in this chapter also expose some gaps that could be filled by future research. We have shown that changes in the proximity matrix over time are an interesting topic for further study. The discussion also captures a kind of 'anomaly' in the 1991 and 2000 province-product matrices (see Figure IV-13). Why do some provinces with low-level diversification manage to develop products that are considered to have high-level sophistication? Is it purely endogenous forces that drive those provinces to produce such sophisticated products? Or are the roles of exogenous forces more likely to enable them to do so? These questions call for more systematic investigations, which we will address in the next chapter.

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CHAPTER V
WHAT SHAPES INDUSTRIAL DEVELOPMENT IN INDONESIAN PROVINCES?

5.1 Introduction

In the previous chapter, we revealed that industry relatedness and productive capability are two evolutionary forces, which play crucial roles in transforming the industry structures of provinces. The empiricism that we have presented in Chapter 4 confirms the path dependence theory (Arthur, 1989; Martin and Sunley, 2006), that is, the propensity of provinces to develop new industries hinges on the existing industry structures and the closeness of those prospective industries to their structures. Moreover, we have also found evidence that point to a tendency among provinces to evolve towards more sophisticated industries, which lead to even more complex industry structures. The findings imply that the evolution of regional industries in Indonesia is incrementally built and endogenously shaped by extant structures. However, the findings may also provoke inquiries to the contrary, that is, the possibility of leapfrogging and the roles of other factors of production, such as capital and labour costs.

In this chapter, we respond to those inquiries. We mainly look at the role of FDI in promoting the development of new industry. Although foreign capital has become a common phenomenon in a globalising world, the literature seems inconclusive about its impact on host country development (Iršová and Havránek, 2013; Iwasaki and Tokunaga, 2014). The net impacts seem to depend on the interaction between two opposing forces, i.e., the motives of MNCs to internalize domestic resources, compared with the policies of host countries to externalize the influences of MNCs' presence in their countries as much as possible (Phelps, 2008). Whether FDI promotes the emergence of new industries or merely takes advantage of domestic resources and incentives provided by host provinces will be the subject of investigation of this chapter.

It is argued here that the role of relatedness is more dominant than FDI. We base our arguments of the weak roles of FDI on branching processes because of a country's position within a global production network (see Massey's spatial division of labour from 1984) and parasitical behaviour of FDI in relation to its host regions (Phelps, 2008). The rather peripheral position of Indonesia in the global production network has placed the country in the context of lower value-added activities, such as resource extractions or labour-intensive industries, which foreign investors eagerly seek to exploit (Lindblad, 2015). This also means that foreign investors have few reassurances when they make risky investments beyond the position of a region or country in the global production system. MNCs are aware that uncertainties exponentially increase if they operate beyond of what existing regions' knowledge and resources are capable of sustaining.

By saying that we are not necessarily pessimistic that foreign capital brings no good for industrial development in developing countries. In fact, many studies concerning the effect of FDI on Indonesia economy suggest a positive effect (e.g. Arnold and Javorcik, 2009; Takii, 2009; Sjoholm and Takii, 2008). Those studies, however, concentrate largely on the performance of firms with foreign portfolio, such as improvement in productivity, exports, and wages. Our analysis, on the contrary, specifically investigates the effects of FDI on the industrial branching process within provinces that surprisingly is still unexplored yet by FDI literature on Indonesia.

We expand the analysis by taking into account several other influencing factors. Firstly, we consider the direction of industrial branching processes that is often assumed, but has never been investigated, in the relatedness of literature thus far. The direction of diversification towards either more or less sophisticated industries does matters, recalling what is argued by Hausmann et al. (2007), that what we produce is more important than how much we produce it. Therefore, whether regions are able to transform their economic development towards a higher level hinges on their capability to diversify into more sophisticated industries. In doing so, we utilise the sophistication metric, as constructed in the previous chapter. Bear in mind that the sophistication level both at the industry and region levels is also endogenously determined by the industry structure.

Secondly, we look at the factor costs that are considered to influence firms' locational decisions. According to Hausmann and Rodrik (2003), one of the reasons why firms prefer a certain region over others for their production location is that it offers lower domestic costs. In most cases, labour constitutes the major domestic costs, particularly in the manufacturing sector (Wood and Roberts, 2010). On the other side of the coin, wages also explain why firms avoid or leave regions. Regions are always in a state of competition by attracting investments and creative talents from elsewhere (Boschma, 2004). Higher regional wages attract creative talents at the expense of less productive firms. Likewise, lower regional wages attract firms with low productivity, while making regions less attractive for potential talents.

In addition, we also include employment in the analysis, mainly to control the industry and region size (Essletzbichler, 2013; Neffke et al., 2011). Industry and region size may engender inertia effects, such that large industries tend to stay where they are, while large regions are inclined to attract, as well as retain, more industries.

The chapter has three related objectives. Firstly, we seek empirical evidence on the relation between relatedness and industrial branching processes. We want to detect the extent to which endogenous evolutionary forces are at work in the industrial development processes. Secondly, we attempt to reveal the direction of the branching process in terms of whether provinces move towards more or less sophisticated industries. Thirdly, we aim to weight the relative importance of industrial relatedness against other factors particularly foreign capital and cost of factors.

The arrangement of this chapter is set as follows. The next section reviews the empirical evidence on relatedness and FDI. Section 5.3 revisits the methodological issues, including econometric considerations, and variables and data deployed in the analysis. Moving forward, the results are presented in Section 5.4, along with some robustness tests and discussions. Section 5.5 concludes the chapter.

5.2 Literature review

In this section, we present a conceptual discussion about what is missing from existing empirical works and argue about which factors should be taken into account in the empirical analysis. We depart from our review on the role of relatedness in Chapter 4 and develop our arguments further, based on that review. We place our emphasis on FDI because of its ambiguous role in industrial development in general.

5.2.1 What is lacking in the relatedness literature?

In Section 4.2.1.1, we reviewed a bulk of empirical works on the relation between relatedness and diversification. Regardless of the estimation technique used, almost all of those studies report statistically non-zero effects of relatedness on the branching process. That is, cognitively-related products or industries are preferred for future development. It is interesting to note that those studies are multiscalar in nature and conducted with different units of analysis. Moreover, the way in which the branching processes occur is shaped by different factors and within different contexts. Firm-specific factors, such as size, age, productivity, ownership and market orientation, as well as region-specific characteristics, such as laggard/advanced regions, rural/urban areas and coordinated/liberal economies, to various extents also show determining effects on the development of new industries. Recently, some works have started to take into account the influences of global linkages on the diversification process, while serious attention has been given to the role of institutions and government interventions.

Nevertheless, the empirical evidence for relatedness effects on the branching process persistently seems to be incomplete because one can easily point to the gap exposed by the fact that most of the evidence is derived from developed countries in the US and Europe. If we combine all the works on relatedness, as listed in Appendix 7A-B, only seven out of 34 studies address this theme within the context of less developed countries. If we are specific about the loci of those seven studies, they represent only two middle-income countries, namely, Turkey and China. Therefore, closing this gap by adding empirical evidence from a country in the Global South would make a significant contribution to the efforts in building up a 'systematic accumulation of empirical material' (Essletzbichler, 2013, p. 4) in the field of EEG.

Moreover, most, if not all, these studies seem to focus on the mechanics of how new products or industries emerge and which factors might shape the process, such as the characteristics of firms, regions or even institutions in which the diversification process took place. While the direction of diversification is often assumed, in fact, the choice by firms to diversify is open to any direction. As argued by Penrose (1980), the motivation of firms to produce more or establish new productions is basically to optimize spare resources within these firms. This implicitly suggests that the products to be developed are not necessarily more advanced than the core products. Even some might view the firms' strategies to utilise dormant resources is one of profit maximising. That is, as long as the new production yields additional profits, regardless of sophistication, deploying it will be a better option than leaving them underutilised. This particular view is mainly inspired by Penrose's idea known as the resource-based view (Neffke and Henning, 2013). Clearly, the resource-based view emphasizes that the branching process occurs mainly through internal development and does not necessarily lead to more advanced, albeit related, products. Certainly, there are counterarguments suggesting otherwise, which are mostly based on the knowledge-based view. Motivation in terms of dominating the competition in the market, thus accumulating larger profits, has driven firms to purposively invest in expensive R&D for new and better products, even when the uncertainty is considerably high. Temporary monopoly power (Romer, 1990) derived from genuinely newly invented products offers firms the utmost rewards, which they try to retain as long as possible through property rights. The prediction of this knowledge-based view about the direction of diversification is apparent, which is that more advanced and, sometimes, less related or even more radical products result from the utilisation of new knowledge. In this regard, our review on Tanner (2016) has shown that, even in the case of what is thought as radical diversification, such as the development of the fuel cell industry, highlight different kinds of relatedness to the existing knowledge base. Our analysis will not investigate whether firms diversify, based on their dormant resources or new knowledge, but rather consider the overall direction of the diversification outcomes. Specifically, we ask whether or not provinces diversify into more sophisticated products by making inferences from the complexity measure as discussed in detail in Sections 3.1.3 and 4.3.3.

Furthermore, we also note that those empirical works seem to neglect the role of cost of factors on the locational decision of firms[47]. The entry, survival and exit of products or industries in regions cannot be separated from the locational competition between regions. Regions are always in a state of competition, trying to attract investments and creative talents from elsewhere (Boschma, 2004). In fact, some firms and/or industries survive and stay within regions, while others are pushed to exit or are attracted to enter regions. The question concerns how regions actually compete. Regions do compete, but not in terms of direct competition, as firms do (Budd and Hirmis, 2004). Regions neither enter and exit markets, nor act like firms, as the former do not migrate when situations become too harsh, for example. The competition between regions can actually be observed through the locational decision of firms concerning their production activities. Bottazzi et al. (2007), for instance, base their formal explanation on the interplay between two simple explanatory factors: the intrinsic attractiveness of individual location and the presence and number of firms already operating there (agglomeration). Attractiveness is here defined in relation to common factors that are attractive to all entrants, such as natural assets, including rivers, coastlines and ports. This line of argument is supported by Venables (2005) and Glaeser (2008), who emphasize the role of first- and second-nature geography[48]. It is probably true that firms prefer to locate to a particular region over others for these reasons (i.e., endowment and agglomeration); however, this does not explain what makes firms avoid or even leave regions. Frenken and Boschma (2007) propose a framework of evolutionary analysis at the region level by introducing negative feedback in the form of higher wages. As regions grow, wages tend to rise to an extent that is not compensated by higher productivity (Brown and Medoff, 1989; Glaeser, 2008; Storper, 2013). This could punish inefficient firms and force them out of regions to cheaper locations, with the cost of losing the premiums offered by the regions in question. The level of wages can also be thought as a mechanism for selection, which attracts low

[47] In fact, there is one study, that by He et al. (2016), which takes into account the land fee. However, its inclusion is used as a proxy for government intervention, rather than for local cost considerations.

[48] Here, first-nature geography refers to natural assets, while second-nature geography emphasizes the interaction between economic agents, in particular, the increasing return to scale as a result of dense interaction and agglomeration (Krugman, 1991).

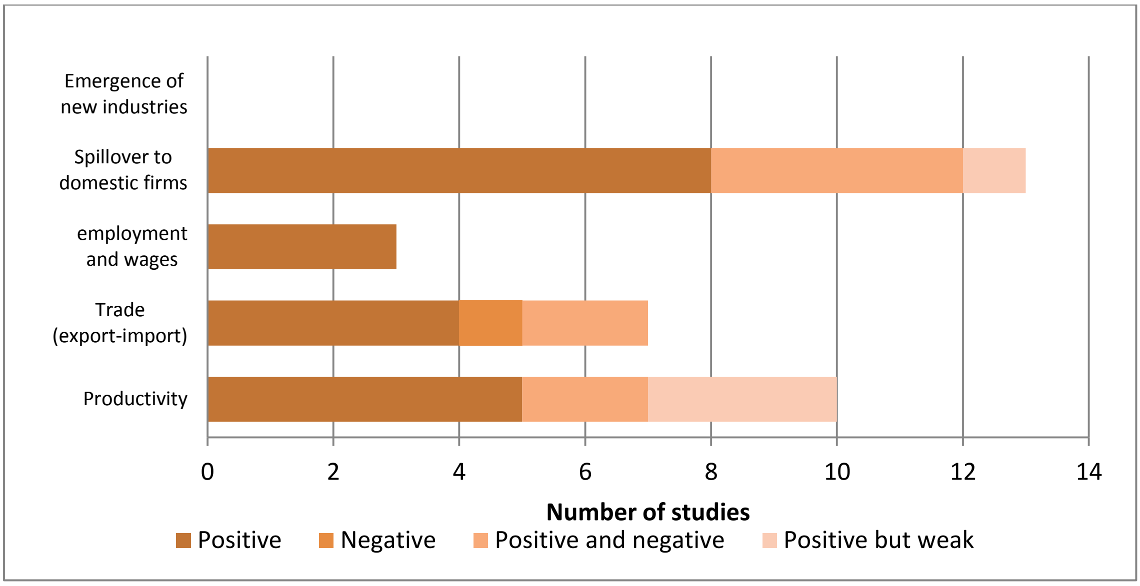
productivity or less efficient firms into low-wage regions because they are looking for cheaper labour, as well as repels them from more innovative high-wage regions. In contrast, productive firms insist on remaining in relatively high-wage regions to take advantage of the premium offered by those regions. For the reasons outlined above, it is important to take the factor costs into account, for instance, by adding minimum wages to the equations.

Another obvious gap that seems to be less explored by the empirical analysis thus far concerns the role of FDI in shaping the industrial branching process of regions. In fact, some authors, particularly from China, have combined FDI with other proxies of extra-regional linkage in their analyses. However, on closer examination, these works reveal that information on FDI is obtained from manufacturing dataset and measured as a share of firms' ownership, rather than capital flow into manufacturing industries. Although this arguably reflects external linkages, we also argue that the effects of such linkages are undetermined, or at least difficult to infer, unless we know exactly when a particular foreign ownership started. For instance, foreign ownership could have been high in a certain industry for the previous decade and, as a result, new industry emerged three years later (i.e., seven years ago). If we measure FDI based on the share of ownership today, we may find that the latter is still high (assuming there has been no divestment), but we may no longer be able to observe any emergence as a result of this high level of foreign ownership. Yet, the way in which FDI is measured as proportional to industry outputs, rather than industry assets, may exacerbate the bias. As FDI is one of our main interests, we discuss it in a separate section.

5.2.2 Inconclusive effects of foreign direct investment on industrial development in Indonesia

The effects of FDI inflow on the Indonesian economy have been widely studied in the literature. Lipsey and Sjoholm (2011) compile 20 academic works on this matter and surprisingly demonstrate that FDI provides the country with consistent benefits. We expand the compilation by including 13 other empirical works. We summarise the survey in Figure V-1 and provide brief detailed explanations in Appendix 8. Based on the focus of the studies, we classify the effects of FDIs into five categories, namely, effects on productivity, on trade (export-import), labour market (including employment and wages), spillover into domestic firms and the development of new industries in regions. In addition, we supplement the bar chart with information about the direction taken in each category. For example, 'positive but weak' means that the relationship between FDI and response variables is positive, but statistically insignificant, while 'positive and negative' means that two different relationships are found in relation to different aspects (e.g., negative and positive for intra- and inter-industries, respectively) or different time periods (e.g., negative and positive for before and after liberalisation policies, respectively). As we can see, most (20 out of 33) empirical studies suggest the positive impacts of FDI on the Indonesian economy. This finding seems to contradict what has been suggested by cross-countries analyses, as discussed in Section 2.3.4. One plausible explanation is that most of these studies focus on the internal performance of firms or plants. Changes in ownership from domestic to foreign owners improve the productivity of plants, increase wages and employment, and open up trade. However, FDI's externalities in terms of spillover into domestically owned firms show fairly different outcomes. Although positive relationships are still dominant, the share of inconsistent evidence of spillovers cannot be ignored. Interestingly, none of the empirical works that we have covered here investigates the effects of FDI on the emergence of new Industries, which guarantees the novelty of this work.

Figure V-1 Empirics of Foreign Direct Investment Effects on the Indonesian Economy

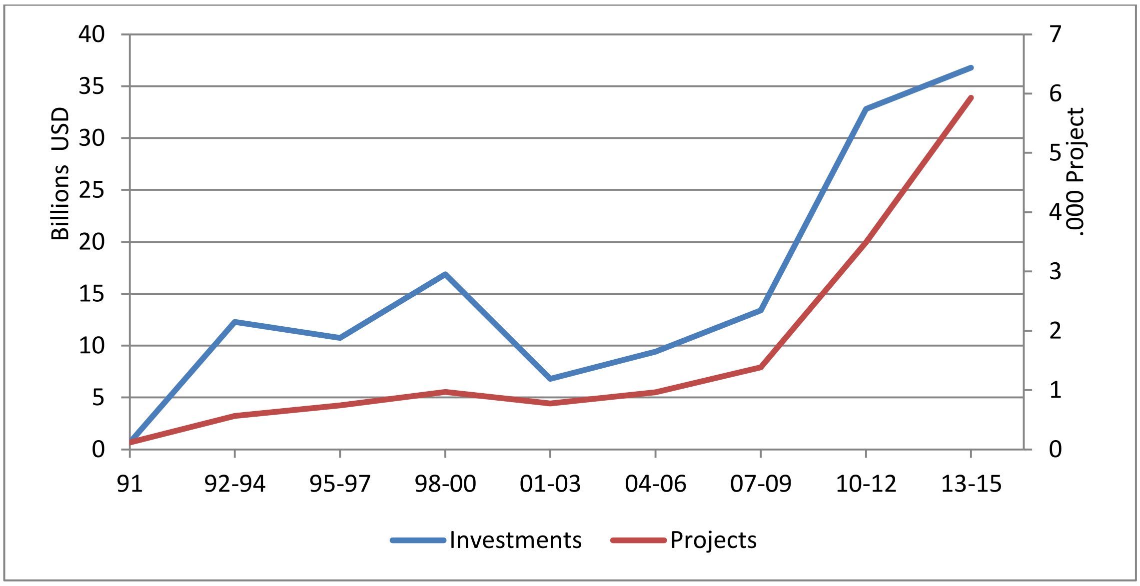


Sources: Author's review

Despite the less conclusive evidence for FDI effects, the flow of FDI into the country keeps growing in terms of the amount of money and the number of projects (see Figure V-2). There was a sharp decrease in the few years after the Asian crisis of 1998, but an increasing track soon returned. The rapid increase of FDI flow is basically in line with what is expected by the government, given that the BKPM, the country's investment coordination board, has set higher targets over the years. In contrast, we should not expect provinces to be able to develop new industries at the same pace as the speed of FDI inflow. This circumstance, we argue, is likely to make the relationship between

FDI and new industries rather weak or less significant at best. We will test this preposition with the use of econometric analysis.

Figure V-2 Foreign Direct Investment Flow into Indonesia 1990-2015



Source: BKPM's database

5.3 Methodological issues

5.3.1 Econometric considerations

To estimate the province model, several estimation techniques will be used for comparison. We start with a straightforward OLS estimation with a cluster-robust option, ignoring the dynamic panel nature of the specification (lagged value of the response variable on the right-hand side of the equation). This constitutes our base results. However, some econometric issues are present and call for further adjustments to make the estimation less biased and more efficient. Firstly, as stressed by Baum (2006), such estimations suffers from entity-level unobserved heterogeneity problems. Although the potential correlation between entity errors over time can be addressed by the cluster-robust option, it does not account for the potential effects of unobserved heterogeneity within the entities. We take into account the panel nature of data and use FE estimation[49] to address this issue. Secondly, the inclusion of a lagged value for the response variable in the regression engenders some endogeneity issues. For OLS

[49] Principally, unobserved heterogeneity is addressed by applying 'within (demeaning) transformation', as in the one-way FE model (Baum, 2013). Demeaning transformation is performed by subtracting the individual mean value from each variable.

regression, this creates a positive correlation with the error, which biases the estimated coefficients upward (Baum, 2013). For FE regression, however, the presence of a lagged value for the dependent variable creates what is known as the Nickell bias (Nickell, 1981), particularly for regressions with a small T and a large N. Demeaning[50] transformation generates a correlation between the regressor and error, but this time negatively affects the coefficient, thus resulting in a downward bias (Baum, 2013). Thirdly, the presence of a lagged value for the dependent variable and the panel nature of the data have led us to apply estimators specifically developed for dynamic panel data, such as a difference or system GMM (generalized method of moments). The GMM is a method ‘in which the model is specified as a system of equations, one per time period, where the instruments applicable to each equation differ’ (Baum, 2006). The underlying idea of the estimators is that removing the first differences[51] of the model should eliminate the individual FEs; thus, we would be unable to create instruments for the lagged dependent variable by using further lagged levels of the dependent variable as instrumental variables (known as a difference GMM). A system GMM modifies the difference in the GMM estimator by including lagged levels, as well as lagged differences, as instrumental variables. These estimators are well addressed the Nickell bias, as discussed above, and provide more efficient estimates in the context of dynamic panel data.

Province-industry models have binary response variables: 1 for industries with no comparative advantage, and 0 otherwise. There are some models that deal with this binary response situation, namely, linear probability, logit and probit models. The LPM suffers from three common problems, that is, the non-normality of the error term, heteroskedastic errors, and potentially nonsensical predictions. The distribution of the error term is important when performing a hypothesis test on the estimated model. In the LPM, for any given independent variable value, error term (e) takes one of two possible values: -e when dependent variable Y=0, or 1-e when Y=1. Therefore, it is not possible to have a normal distribution of the error term in the LPM. Heteroskedastic problems are present due to the inconstant variance of the error term, as it correlates with the value of the independent variables. The LPM also suffers from out-of-range predicted values. The linearity of the model allows the predicted values to be greater than 0 to 1 probabilities. For instance, it is nonsensical to interpret a probability with negative values. The drawbacks have led us to look at logit and probit models. Both binary models are basically the same, but they are different in the referred distribution

[50] Subtracting each observation of a variable with its own mean.
[51] Subtracting each observation within a variable with its own lagged value.

(Torres-Reyna, 2007). The logit model adopts the cumulative standard logistic distribution, while the probit model is based on the cumulative standard normal distribution. Nevertheless, the results of logit and probit models are usually similar. In our model, we have selected the logit model.

Fixed or random effects? One of advantages of using panel data is that these kinds of data allow us to control for unobserved variables, such as cultural factors across regions or differences in routines across companies, or for variables that change over time, while tending to be constant across regions or entities, such as national regulations or gender. In constructing a panel data model, there are two commonly used techniques, i.e. fixed effects (FE) and random effects (RE). We use FEs when we want to explore how the changes within entities (in this case, within a province or industry) affect the outcome variable at the same time as it controls other characteristics within a province or industry that do not change over time (time-invariant). Thus, we can estimate the net effects of the independent variables on the dependent variable. Unlike FEs, we use REs when we have a good reason to believe that differences across entities could have some effects on the outcome variable. For instance, time-invariant variables, such as gender, can be included in an RE model if we suspect that gender will somehow influence the response variable. In an FE model, gender variables will be dropped and captured by the constant in the model. Which technique is preferred can be tested by simply running the Hausman test, where the RE technique is preferred for the null hypothesis.

5.3.2 Data and variables

5.3.2.1 Data

The analysis mostly uses data from the annual manufacturing survey (AMS) conducted by the BPS for 1991, 1994, 1997, 2000, 2003, 2006, 2009 and 2012. The survey covers medium and large plants in the Indonesian manufacturing sector[52]. In the survey, plant outputs are classified using the KBLI, which is itself based on and has been revised several times to keep it concordant with the ISIC[53]. Thus, the AMS also used whichever version of the KBLI was applicable at the time the survey was conducted. For example, AMS 1991 used KBLI 1990, while AMS 2003 used KBLI 2000. As consequence, conversions are required before the dataset is ready to be

[52] In the ISIC, the manufacturing sector includes all codes between 1010 and 3290 and consists of 130 industries.
[53] Basically, the KBLI can be regarded as the Indonesian version of the ISIC. ISIC Revision 4 has a total of 425 industry classifications at the four-digit level. Only two industry classifications, i.e., 0150 and 4923, have no equivalent in KBLI 2009.

analysed. How the conversion process from KLBI to ISIC and from the oldest to the latest version is carried out is briefly discussed in Appendix 9. Variables that are directly withdrawn or calculated from these datasets include the number of industries with comparative advantage, density and employment.

Data on FDI are extracted from the BKPM database[54] for the same years. Fortunately, the investments data are classified using the latest version of KBLI 2009, making them convenient to use.

Relatedness between products or industries is measured by using international trade data provided by UNStats, while trade data are classified based on the HS. Fortunately, the query facility on the UNStats website makes the data easily downloadable in any HS version utilized[55]. For convenience when converting the data into ISIC, trade data are pooled into HS 1992.

Information on regional minimum wages from 1997 onwards is provided by Directorate-General for Industrial Relations and Labour Standards, which falls under the Ministry of Manpower and Transmigration. The minimum wage data for 1994 are retrieved from archives in the Bappenas. The minimum wage for 1991 could not be traced and were treated as missing values in the analysis.

5.3.2.2 Variables

In performing the analysis, the variables are derived from the model's specification, as elaborated above. There are six variables used in the province models, as discussed below:

- *ca3* is the number of industries with RCA in provinces after three years (year *t+3*). RCA is calculated by the formula described in Equation (2), using the monetary value of industry outputs. The rule is that industry with an RCA value equal to or greater than 1 is defined as an industry with comparative advantage. By applying the rule, we come up with the number of industries with comparative advantage for each province. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as a dependent variable.
- *density* is the variable of interest in the model. This is a measure that is constructed to reflect the cohesiveness of the industry structure in a

[54] Thanks to Andria Buchara of the BKPM who helped me in accessing the database.
[55] http://data.un.org/.

province. Higher density means that a province has a more cohesive industry structure in which industries are more closely related, particularly with the dominant ones. How to calculate density for each province has been discussed in detail in Chapter 3. The results of the density calculation for each province are listed in Appendix 3. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.

- *fdi* is the amount of FDI in USD thousands invested in provinces. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *complexity* is a measure of the sophistication level of provinces' industries. Sophistication level is measured by the ubiquity of industries hosted by provinces. Provinces that host more commonplace industries have a lower sophistication level (see Chapter 4 for more details). Technically, we choose to use the value of $K_{c,7}$. Higher values of $K_{c,7}$ mean that, on average, a province has industries with a relatively lower sophistication level, and vice versa. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *minwage* represents regional minimum wages in IDR thousands. Minimum wages can be considered as one of the most influential industrial policy factors at the province level. The minimum wage is adjusted every year and legalised by gubernatorial decree. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *employ* is the number of manufacturing jobs in provinces. The number of jobs is directly drawn from the AMS data set. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the province model as an independent variable.

For province-industry models, there are 10 variables used in the model, as discussed below:

- *entry* represents industries with a comparative advantage that were absent in provinces three years before (year *t*) and are present in the provinces three years later (year *t+3*). This is a binary variable, where industries with comparative advantage take the value of 1, and 0 otherwise. This variable enters the model as a dependent variable.

- *exit* represents industries with comparative advantage, which were present in provinces three years before (year *t*), but are absent in the provinces three years later (year *t+3*). This is a binary variable, where industries with comparative advantage take the value of 1, and 0 otherwise. This variable enters the model as a dependent variable.
- *remain* represents industries with comparative advantage that were present in provinces three years before (year *t*) and are still present in the provinces three years later (year *t+3*). This is a binary variable, where industries with comparative advantage take the value of 1, and 0 otherwise. This variable enters the model as a dependent variable.
- *Close_pf* is the closeness of industries to the portfolio industries. This is the number of links that connect industries to other industries belonging to provinces (see Chapter 4 for a detailed explanation). The greater the links owned by an industry, the closer the industry is to the portfolio industries. It is important to note that the same industry may have different manifestations of closeness to two different provinces. For example, same industry A may be closer to province B, but further from province C. This interpretation applies to all variables in the province-industry models below. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *Close_npf* is the closeness of industries to non-portfolio industries. This is the number of links that connect industries to other industries not belonging to provinces. The greater/fewer the links owned by an industry, the closer/further the industry is to non-portfolio industries (or the further/closer the industry is from/to the portfolio industries). This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *density* is the density of industries by provinces. If industries have a higher density, this mean that those industries have many strong industries surrounding it. Theoretically, this reflects their chance of emerging as new dominant industries in the near future. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *fdi* is the amount of FDI invested in each industry by provinces in USD thousands. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.

- *sophistication* is a measure of the sophistication level of an industry. Sophistication level is measured by the ubiquity of an industry. An industry that produces common products is considered to have a lower sophistication level, and vice versa. Technically, this is the value of K_p (see Chapter 4 for more details). A higher value of K_p means that the industry has a relatively lower sophistication level, and vice versa. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *employi* is the number of manufacturing jobs in particular industries and in particular provinces. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.
- *employr* is the number of manufacturing jobs in provinces. This variable is standardised to have a mean of 0 and a standard deviation of 1, and enters the model as an independent variable.

Because the independent variables, both in province and province-industry models, are in different unit of measurement (e.g. thousands of dollar for FDI, number of links for closeness, and so on), the estimated coefficients would not reveal their relative importance vis-à-vis to response variables. In order to make the coefficients comparable we standardise the variables (z-score).

5.4 Empirical results

5.4.1 Province models

5.4.1.1 Some descriptive statistics

Summarising panel variables by running the *xtsum* command in Stata results in the following matrix (see Table V-1). By construction, the panel identifier, *provinces*, does not vary within panels, i.e., it is time-invariant. This is confirmed when the within-standard deviation is equal to 0. Similarly, by default, the between-standard deviation of the time variable, *year*, is 0. Remember that any variable with a within-standard deviation equal to 0 will be dropped from the FE model. Variables with a small within-standard deviation may not be well identified, meaning that they could either be dropped or remain in the model. The table below shows that all variables do not have small value of within-standard deviation, meaning they would be well identified in the FE model. Note that all variables have a mean value close to zero and a standard deviation value equals one, because all variables are in standardised form. The use of standardised variables would allow us to rank predictors (or independent variables) as they eliminate the units of measurement of variables. As a result, the coefficients in the model would be also in standardised value that can be directly ranked to see their relative importance or influence on dependent variables. The most important variable of the model would be the one with the maximum value of standardised coefficient.

Table V-1 Summary of Variables

Variable		Mean	Std. Dev.	Min	Max	Obs.	
ca3	overall	2.01E-09	1	-.969165	3.896479	N =	208
	between		.98089	-.7833245	3.313615	n =	26
	within		.265314	-.8362825	.988334	T =	8
density	overall	-6.00E-10	1	-.9710716	3.901419	N =	208
	between		.980079	-.7698593	3.299773	n =	26
	within		.268195	-.8491603	1.047146	T =	8
fdi	overall	-2.28E-09	1	-.2906035	8.134876	N =	208
	between		.782668	-.2906035	3.500516	n =	26
	within		.638863	-3.080202	4.979631	T =	8
complexity	overall	5.40E-10	1	-1.015797	3.678531	N =	182
	between		.387945	-.7862962	.6178539	n =	26
	within		.924385	-1.373652	3.19884	T =	7
employ	overall	-1.98E-09	1	-.4563587	4.965239	N =	208
	between		.999839	-.4549683	4.004855	n =	26
	within		.184737	-1.666655	.9603836	T =	8
minwage	overall	-9.01E-10	1	-1.131879	2.815374	N =	182
	between		.209462	-.2554353	.5104652	n =	26
	within		.97856	-1.473947	2.3438	T =	7
provinces	overall	13.5	7.518094	1	26	N =	208
	between		7.648529	1	26	n =	26
	within		0	13.5	13.5	T =	8
year	overall	2001.5	6.890447	1991	2012	N =	208
	between		0	2001.5	2001.5	n =	26
	within		6.890447	1991	2012	T =	8

Source: Stata output

The presence of multicollinearity in a multiple regression model can be detected by a high correlation between predictors. High correlation implies an overlapping between predictors that make it difficult to separate the unique effects of each variable over a response variable. Multicollinearity can be a problem, as it inflates the variance of the coefficient, thus reducing the precision of the estimated coefficients (Ariefianto, 2012). The output of pairwise correlation in Table IV-2 below alerts us that some predictors, including employment (*employ*), density (*density*) and FDI (*fdi*), may potentially suffer from the collinearity problem. However, panel data have certain characteristics that are robust against some violations of assumptions, including multicollinearity (Wooldridge, 2006, in Ariefianto, 2012). Therefore, multicollinearity is not necessarily a serious issue in the panel model being constructed. Nevertheless, we will perform some tests to check the presence of collinearity, for example, the variance inflation factor or standardise beta coefficient test. If collinearities are detected, dropping one of the suspected variables can sometimes resolve the problem.

Table V-2 Correlation of Variables

	ca3	Density	fdi	complexity	employ
density	.9991*				
	0				
	208				
fdi	.6511*	.6509*			
	0	0			
	208	208			
complexity	.0676	.0563	-.0247		
	.3647	.4501	.7409		
	182	182	182		
employ	.9072*	.9073*	.7746*	-.0014	
	0	0	0	.985	
	208	208	208	182	
minwage	-.022	-.0145	.0838	-.5458*	-.0076
	.7684	0.8463	.261	0	.9184
	182	182	182	182	182

Source: Stata output

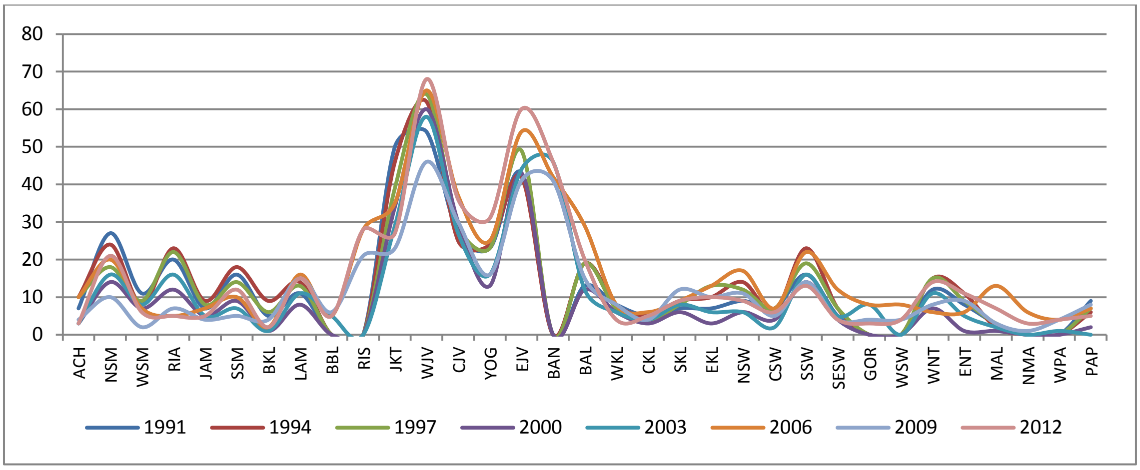
Note: *p* values and number of observation are on the second and third row of each variable, respectively.

It is a good idea to go through the data used in the analysis. The response variable is the number of industries with RCA in provinces three years later. We have discussed it in Section 4.3.3.1. Here, from Figure V-3 to Figure V-8, we juxtapose the data of dependent variable with data of independent variables. By doing so, we wish to extract some patterns and speculate with relations they may have. Before that, it is important to bear in mind two important things while reading the data from the figures. First, the scale of FDI data is transformed into logarithmic scale base 10. Second, the complexity data are in a normalised form and its scale is in reverse order. The reversed scale means that lower values refer to more sophisticated industry structures, and vice versa.

Intuitively we may observe a highly similar pattern between the number of industries with comparative advantage in Figure V-3 with data of density in Figure V-4 and employment in Figure V-7. The data inform us that only few provinces, particularly those situated in Java Island, have greater number of industries with comparative advantage, much denser or cohesive industry structure, and more employees. The pattern may suggest a relationship between the three variables. Indeed, the positive relationship between density and the number of industries, to some extent, has been explored in Figure IV-6. Moreover, as argued by Essletzbichler (2013), the gravity of large region with more employment to attract new industries and to retain the old ones more easily suggests a positive relation between employment size with the number of industries hosted by provinces.

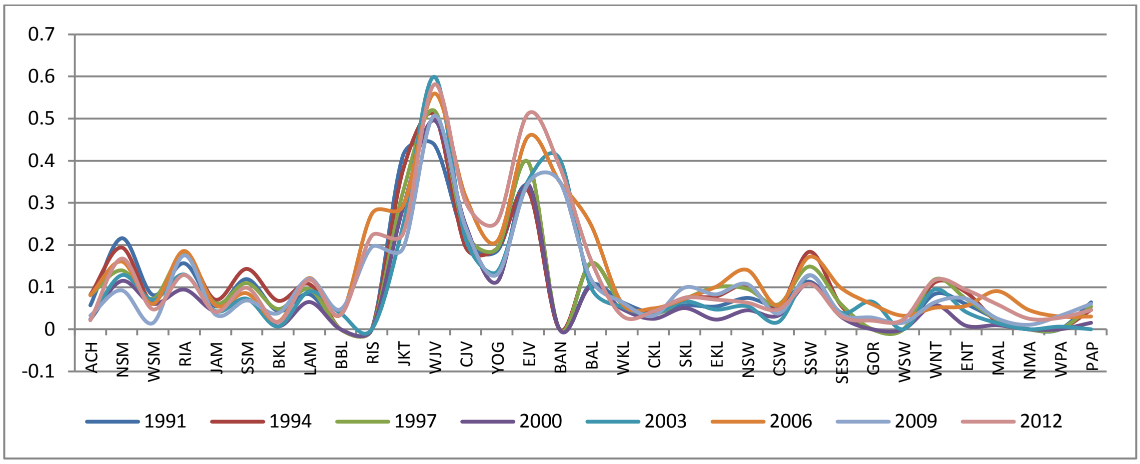
To a lesser extent, data on complexity in Figure V-6 and FDI Figure V-5 somehow still display a corresponding pattern with data of dependent variable, suggesting a weaker relation of the two variables with the dependent variable. Meanwhile, data on provincial wages seem to display a different pattern. What kind of relation the data may reveal to dependent variable is difficult to predict at this stage. In the following, econometric technique will be applied to infer the relationship between independent variables and response variable.

Figure V-3 Number of Industries with Comparative Advantage by Provinces



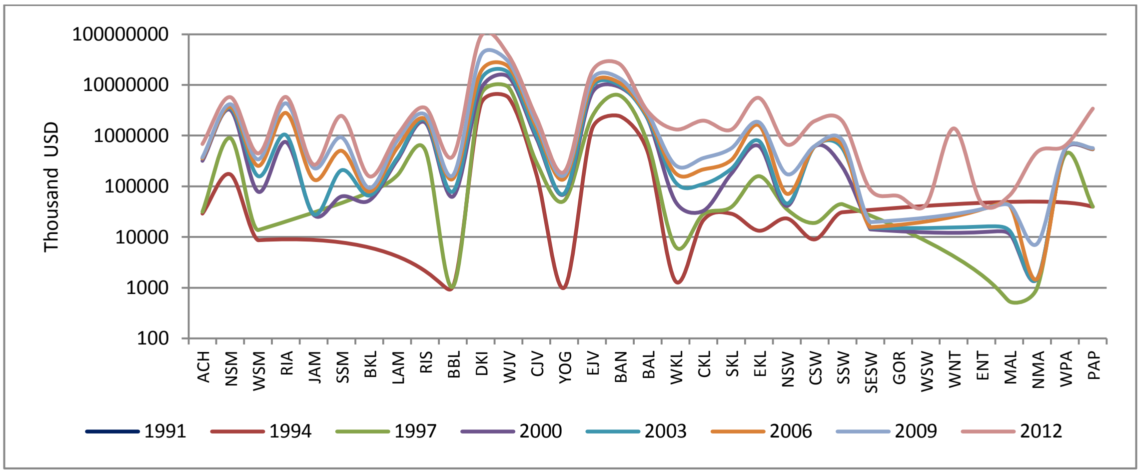
Source: Author's analysis

Figure V-4 Density by Provinces



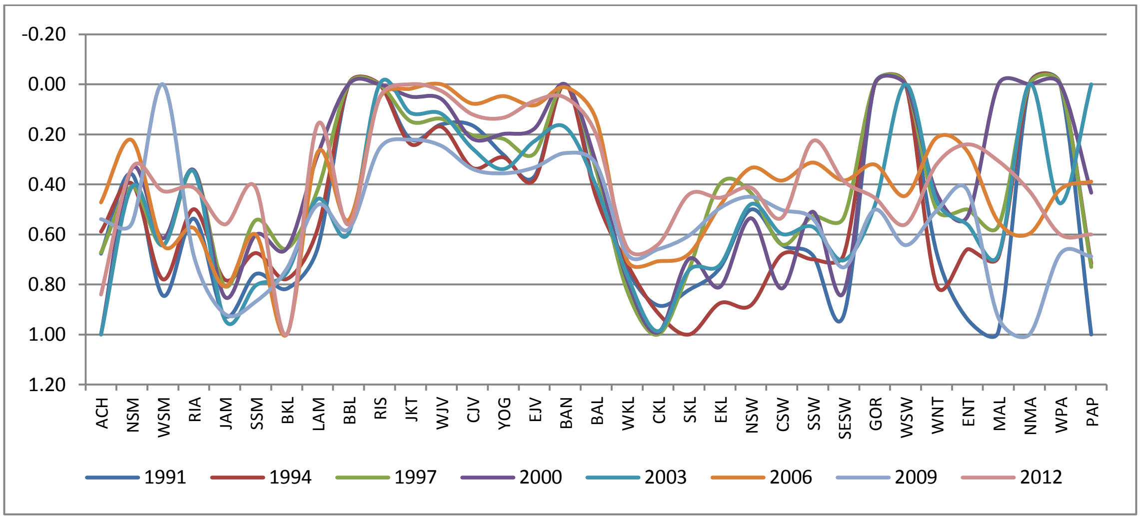
Source: Author's analysis

Figure V-5 FDI by provinces



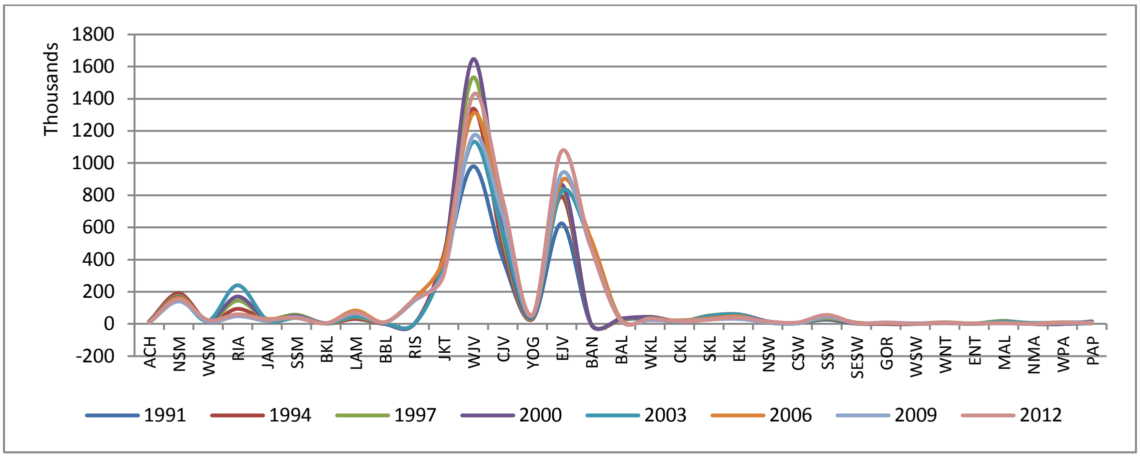
Source: Author's analysis

Figure V-6 Complexity of Provinces



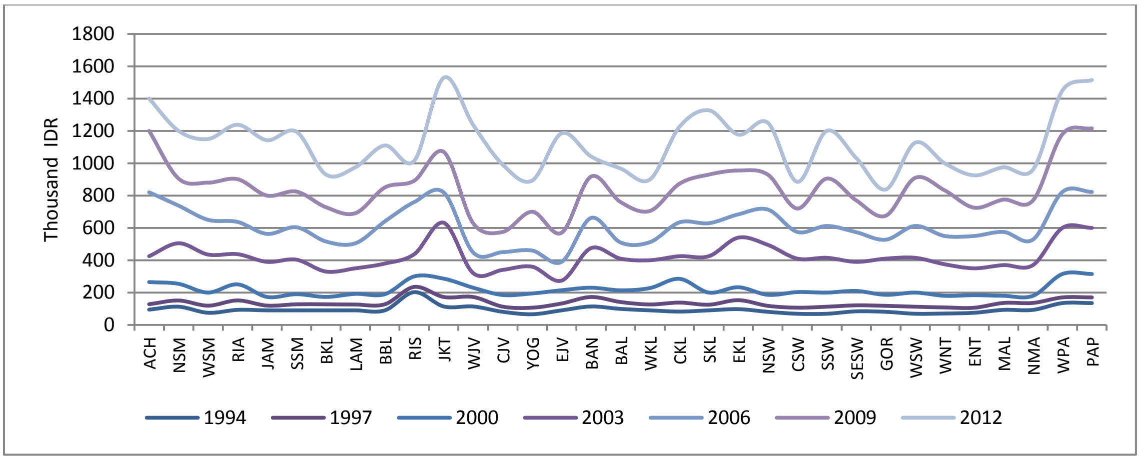
Source: Author's analysis

Figure V-7 Manufacturing Employment by Provinces



Source: Author's analysis

Figure V-8 Minimum Wages by Provinces



Source: Author's analysis

5.4.1.2 Estimating province models

In this section, model specification in Equation (11) is estimated. As the objective of this analysis is to infer the relative importance of evolutionary variables against other variables representing some factors of production, we standardise the coefficients so we can directly rank them over their influence on the development of new industries within provinces. The results show that almost all predictors' coefficients exhibit the expected and consistent signs, except for *complexity* and *employ* which are changing sign across the models. Regardless the models, *density* is very likely the most important variable to promote new industrial development within provinces, followed by the previous number of industries within the provinces (lag *ca3*). Foreign capital, *fdi*, seems to have little, but positive, influence on the development of new industries within provinces. Similarly, labour cost, *minwage*, also has little influence, but it affects the industrial development negatively. Meanwhile, *complexity* and *employ* variable have mix effects on the development of new industries in provinces depending on the technique of estimation (will be discussed shortly). Let's go through the models one by one.

Table V-3 Results of Estimation for Province Models

Variable	OLS	FE	RE	GMM
ca3				
L1.	.02971704	.03132828**	.03091272*	.03980238*
density	.96086747***	.96553067***	.96242136***	.98097017***
fdi	.00470782	.00471259	.00313326	.00531287
complexity	.00502262	-.00669448	.0004904	-.00560344
employ	.00532942	-.07112936	.00228107	-.08947577
minwage	-.00957974	-.00523446	-.00658131	-.00598963
yr1	(omitted)	(omitted)	(omitted)	
yr2	(omitted)	(omitted)	.00863749	.01309143
yr3	-.0096651	-.02591359**	-.00852828	-.01080442
yr4	-.0342509	-.05682401***	-.03599348	-.03540105
yr5	-.01470714	-.03957591*	-.01821405	-.0163547
yr6	-.00364888	-.02807616	-.00879322	-.00940317
yr7	-.012008	-.0481005	-.02154774	-.02743888
yr8	.00907053	-.02144414	(omitted)	
_cons	.00496811	.02854012	.00783954	
N	182	182	182	156
F	71507.432	1297.9317		1379.8359
ll	343.14216	383.35321		
chi2			298618.57	
r2	.99867125	.98678581		

Source: Stata output

Note: The dependent variable is ca3, i.e. the number of industries with RCA in provinces after three years (year *t+3*). For the GMM model, the endogenous variables are lag response variable, density, and complexity. The Arellano-Bond test for AR(1) in first differences: z = -3.14 Pr>z = 0.002; Arellano-Bond test for AR(2) in first differences: z = 1.37 Pr>z = 0.171. This means that there is no evidence for order-2 serial correlation of the error term. Hence, we could use lagged levels of endogenous variables from lag-2 onwards as instruments for the transformed equation. The Hansen test for overidentifying restrictions: chi^2 (66)=13.71; Prob>chi^2=1.000. This means the instruments appears to be independent of the error distribution (Baum, 2006, p. 231). * p<0.05; ** p<0.01; *** p<0.001.

We start with a straightforward OLS estimation, as shown in the OLS column in Table V-3. We include a set of dummies for years to capture the effect of the time cycle. Almost all predictors' coefficients exhibit the expected signs, except for *complexity* and *employ*. The previous number of industries (L1.*ca3*) seems to have positive effects on the development of new industries within provinces (coefficient

0.029, $p > 0.05$). A 1 standard deviation increase in the previous number of industries results in an increase, on average, 0.029 standard deviation of the number of industries three years later. The result seems to be consistent with previous studies (e.g., Boschma et al., 2013; Hausmann and Klinger, 2007) in that the current diversification level affects the outcomes of the diversification process. The outcomes of diversification itself should affect the next and subsequent diversification processes, which initiate an increasing return process (Arthur, 1989). The endogenous nature of industrial diversification processes has made OLS estimation less efficient at capturing that effect. Nevertheless, the OLS estimation provides us with at least an idea of the positive effects of this endogenous variable.

The *density* coefficient exhibits substantial and significant effects on the development of industries in a province, holding other variables in the model constant (coefficient 0.960, $p < 0.001$). Note that density is in a standardised form. Thus, for every one standard deviation of increase in density results in a 0.960 standard deviation increase in the number of industries with RCA in provinces three years later, holding other variables constant. This means that provinces in Indonesia prefer to develop industries that are surrounded by related industries. This piece of evidence raises confidence about the role of endogenous evolutionary forces, even in the context of developing countries. One of the main reasons offered by the literature on why provinces chose related industries, rather than alternative industries that could be much more advanced and profitable, is their limited knowledge to develop the latter (Cohen and Levinthal, 1990; Nooteboom, 2000). Learning totally new knowledge is not impossible, but clearly requires much greater efforts to possess it, of which only a few provinces are capable. Another reason is that the risks of failure are relatively high, even though the returns of highly advanced industries are promising (Maskell and Malmberg, 2007). Costly knowledge acquisitions and uncertainties accompanying radical development have driven provinces towards more incremental paths.

Another variable of interest is *fdi*, which has positive effects on the transformation of industry in the provinces. However, its coefficient seems to be ignorable and cannot statistically be differentiated from 0 (standardised coefficient 0.0047, $p > 0.05$). An increase in one standard deviation of *fdi* leads to an increase in 0,0047 standard deviation of the number of industries with RCA in provinces three years later, controlling other variables constant. This negligible evidence casts some doubt on the roles of FDI in industrial development; at least the Indonesian case seems to suggest so. Positive and vertical (inter-industry) effects, such as backward and forward linkages with domestic industries and imitation effects, are evenly offset by negative and horizontal (intra-industry) impacts of FDI, as they are viewed as competitors for similar domestic firms and hijackers of domestic talents. In other words, FDI could promote new industries in different industries at the expense of declining industries in the sector in which FDIs invest. Therefore, the overall effects of FDI are difficult to conclude as it simultaneously stimulates and demotes the development of industries. Nevertheless, the estimations result in small and positive coefficients of FDI, implying its positive effect on the development new industries at province level.

Variable *complexity* indicates a province's sophistication level in terms of industry structure. The coefficient has a fairly moderate value with a positive sign, 0.0050. The *t* test cannot reject the null hypothesis that the coefficient equals 0 with a p-value > 0.05. Remember that a higher value of this variable (K_{c7}) means a lower sophistication level of industry structure. Thus, the interpretation of the coefficient is a tricky one. The positive sign could mean that, when the industry structure becomes less sophisticated, a province tends to promote new industries, or that provinces with less sophisticated industry structures promote more new industries. Whether or not provinces in Indonesia develop new industries towards greater levels of sophistication cannot be directly inferred from OLS estimation. FE estimation is perhaps more appropriate to infer the information that will be shortly discussed. For now, we simply interpret the coefficient as follows: for every 1 standard deviation increase of variable *complexity* (meaning lower sophistication level) increases standard deviation of the number of industries with comparative advantage 0.0050. At this stage, this empirical evidence demonstrated by this model does not appear to support complexity theory, which postulates that provinces with more capability are able to develop more industries.

The last two predictors are employment (*employ*), representing the size of the manufacturing sector in provinces, and minimum wage (*minwage*), representing both factor cost and local government industrial policies. Larger employment levels in the provinces tend to attract more industries to enter or to develop the existing ones, indicated by a positive sign for the *employ* coefficient. Although statistically insignificant (p>0.05), the positive sign of the coefficient appears to confirm the expectation that larger provinces are more likely to be attractive to manufacturing industries than smaller ones. One plausible explanation is that new entries could largely be labour-intensive industries, which rely on the quantity rather than the quality of labour. Moreover, the coefficient of minimum wage (*minwage*) is statistically insignificant with a negative sign. Intuitively, a higher minimum wage will increase production costs, leading to negative sign of the coefficient. However, the extent to which minimum wage affects the development of new industries seems negligible, according to this estimation technique.

We have discussed that OLS estimation is less efficient if the right-hand side of the equation involves a lagged value of the response variable. The OLS estimation will suffer serial correlation and tend to be biased upward (Baum, 2013). We run the Breusch-Godfrey autocorrelation test and the result rejects the null hypothesis of no serial correlation (see Table V-4)[56]. Moreover, we also check for collinearity by performing the variance inflation factor test. The result suggests that some variables suffer from collinearities, including the existing number of industries (*ca3*), density (*density*) and employment (*employ*). Some suggest that the presence of collinearity causes no problem as long as it does not involve our variables of interest. Therefore, keeping the variables on the specification is a better option than excluding it in a way that illusively solve the problem but create another one involving specification bias. If it does involve the main variables, this can inflate the standard error of the involved variables and make the estimated coefficients unstable, i.e., highly sensitive to small changes in observations, for instance. However, the involved variables cannot be dropped, as they are simply the variables from which conclusions will be drawn. Alternatively, we check the extent of the collinearity affect standard error and confidence interval in the estimation result. We find that they are not too wide, which indicates the estimation to be sufficiently precise (i.e., a low inflation in the standard error caused by the collinearity). We turn to the standardised beta coefficient to check the effects of collinearity on the coefficients. We find that the beta values of involved variables are still within their natural range of -1 and +1, suggesting the collinearity effects are not deteriorating as imagined. As discussed above, another issue regarding OLS estimation is unobserved entity-level heterogeneity. In dealing with this estimation problem, we perform a second estimation, i.e., the FE model.

Table V-4 Serial Correlation Test

Lags (p)	**chi2**	**df**	**Prob > chi2**
2	13.907	2	.001

Note: Breusch-Godfrey LM test for autocorrelation. H0: no serial correlation.

When performing the FE model, we have to be aware of the Nickell bias overshadowing the FE model with a lagged value of the response variable, or with potential endogenous variables, particularly when using panel data with large N and small T (Baum, 2006). Theoretically, the estimated coefficients of the endogenous variable tend to be underestimated. However, the result shows that the coefficient is greater than the OLS estimation, albeit statistically significant. In terms of the coefficient signs, the FE estimation shows consistent results with OLS, except for two

[56] The results are consistent for higher-order autocorrelation.

variables of *complexity* and *employ*, which change from positive to negative. It will be discussed shortly.

Bear in mind that the way we read the standardised coefficient in FE model is the same with the OLS model. That is, one increase in standard deviation of independent variables results in an increase in standard deviation of dependent variable as much as the value of the coefficient. However, the way we interpret the FE model is slightly different from OLS model, as FE estimation focuses on the changes within provinces. Thus, the coefficient of the minimum wage, for example, estimates the effect of minimum wage changes within provinces over time, not wage differences across provinces. The small, insignificant and negative sign means that the increase in the minimum wage over time appears to offset industrial growth in provinces. Similarly, employment negatively affects industrial transformation within provinces, but the effects are considered to be small and statistically insignificant. The negative coefficient gives the impression that growing employment size in provinces over time could be a liability, rather than an asset, for industrial development. This could be the case if the bulk of labour is unskilled, less educated, and less cooperative.

In term of sophistication, the negative coefficient of *complexity* suggests that provinces evolve towards more sophisticated industries over time. The negative coefficient informs us that one standard deviation increase in *complexity*, meaning a less sophisticated industry structure in our reversed scale, reduces some 0.0067 standard deviation of the number of industries three years later, holding other variables constant. Put another way around, as the sophistication level of industry within provinces improves over time, the possibility of new products to emerge increases slightly. It is important to note two things: first, *complexity* is endogenously accumulated within the industry structure, such that this variable may suffer from Nickell bias in the FE estimation; second, even though the negative sign of *complexity* in the FE estimation implies the direction of the branching process, the coefficient is not statistically significant.

Lastly, our main variables of interest, *density* and *fdi*, have positive effects on the transformation of regional industries and are statistically significant for the former but insignificant for the latter. The effects of FDI inflow seem weak and negligible, specified by a small and insignificant coefficient of *fdi*. In contrast, increased cohesiveness of industry structure strongly facilitates the branching process towards related industries, as indicated by the substantively and statistically significant coefficient of *density*. The endogeneity of this variable warns us to be cautious about the Nickell bias. We address this issue by performing different estimation techniques, i.e. GMM model.

Some tests are run to diagnose the appropriateness of the technique used in the estimation. We perform the Hausman test to check whether FEs or REs are more appropriate techniques for estimation. The null hypothesis is that the preferred model is an RE model. The test rejects the null hypothesis ($p<0.001$), that is, the preferred model is an FE model. We also test for time-FEs (testparm) to check whether the time-FEs technique is needed when estimating the model. The null hypothesis is that the coefficients for all years are jointly equal to 0. If they are, no time-FEs are required. Again, the test rejects the null hypothesis ($p<0.05$), that is, time-FEs are needed in the estimation. For comparison purposes, we include, but will not discuss, the result of the RE estimation in Table V-3. We do not run a test to diagnose heteroskedasticity, as we have selected the *robust* option while performing the estimation.

In the final model, we perform the Generalized Moment of Method (GMM) estimation to deal with the Nickell bias in the FE model. Apart of the presence of lagged value of the response variable on the right-hand side, we also strongly suspect that the main variable of density and control variable of complexity are endogenous. Our suspicions are based on the fact that both variables are built on inherent characteristics of industry structure. Putting it differently, the two variables are basically the representation of evolutionary forces extracted from within the industry structure itself (see Chapter IV). Thus, we treat both variables along with the lag variable as endoegenous in GMM estimation. In addition, the use of panel data with a rather small number of years (i.e., eight years in this case) has driven us to run the GMM technique in our models, at least to improve the estimation of the previous FE model.

Overall, the Stata output of the GMM estimation looks consistent with the FE estimation. All coefficients of endogenous variables, i.e., lagged value of response variable (*ca3*), relatedness (*density*), and sophistication (*complexity*), are larger than those in FE model. This result is in line with the expectation that endogenous variables would likely to have larger values in GMM than in FE estimation. This is because the presence of endogenous variables in FE estimation would induce a downward bias in the estimated coefficient for those variables (Baum, 2013). This may be a useful guide that, if the estimation is efficient, the estimated coefficients of the endogenous variables in GMM model would be likely larger than those in FE model. Indeed, that is the case here.

The interpretation of the coefficients is as follow. The previous number of industries is statistically significant, though it has only little effect on the development of new industries within provinces. In a more technical language, an increase 1 standard deviation in the previous number of industries results in an increase, on average, 0.039 standard deviation of the number of industries three years later. The same way of interpretation applies to other coefficients. Our coefficient of interest implies that relatedness has a substantively and statistically significant role in industrial development. The positive sign of *density* variable indicates that denser regional industry structures result in greater numbers of industry three years later. Meanwhile, the FDI coefficient indicates a weak and indecisive role in industrial transformation. The coefficient value is close to zero and statistically it cannot be differentiated from zero. Nevertheless, it still shows a positive effect on industrial development within Indonesian provinces. The model weakly suggests that provinces diversify toward slightly more sophisticated industries, indicated by negative and small value of its coefficient (standardised coefficient -0.0056, $p > 0.05$). That is, holding everything else constant, the new industries that emerge in the next three years would probably be more sophisticated. Similarly, minimum wage negatively affects industrial development in provinces. Its effect on the emergence of new industries, however, seems to be very small and statistically insignificant (standardised coefficient -0.0059, $p > 0.05$). Hansen's J test accepts the null hypothesis that instruments are uncorrelated with the error terms. We expect to reject the test for AR(1), while accepting it for the AR(2) test. The model statistics confirm that this is the case, suggesting a robust and successful model. It is expected that the coefficient value of the three endogenous variables, i.e., lag variable, density and complexity, are greater than estimated FE values. The result tells us that that is the case, assuring the precision of the estimated coefficients.

All in all, our analysis offers empirical evidence that industrial transformation at the province level in Indonesia is evolutionary in nature. The emergence of an industry is likely shaped by the presence of dominant industries surrounding it. The coefficient of evolutionary variable, i.e. *density*, consistently suggests positive and dominant effects compared to the non-evolutionary variables (e.g. fdi and *minwage*), regardless the estimation used. Moreover, the diversification level in the previous period also plays a rather decisive role, which implies an endogenous process during industrial transformation. These two pieces of evidence suggest that industrial transformation in Indonesia shows path dependence that is characterised by an endogenous process. However, we cannot say much about the direction of industrial branching that takes place in Indonesian provinces. Nevertheless, the estimation subtlety hints that provinces evolve towards slightly more sophisticated industries. We also find that foreign capital in the forms of FDI, wages and employment play relatively small roles at best in the diversification process. FDI has small but consistently positive effects, regardless of the techniques used for the estimation. In contrast, the minimum wage negatively affects the diversification process in provinces, but the effect is considerably small in terms of magnitude. Lastly, the effect of employment size is negligible according to the estimations. Now, let us turn to the province-industry model.

5.4.2 Province-industry model

In this section, we divide our econometric analysis into three models of entry, exit and remaining, as specified in Equation (12). All models are estimated using the FE logit technique. We start with some descriptive statistics.

5.4.2.1 Descriptive statistics

A summary and correlation of the variables are displayed in the two tables below (Table V-5 and Table V-6). Note that all the predictor variables have a mean close to 0 and a standard deviation of 1. They are so because they are standardised. Overall, the within-standard deviation (within-SD) of the variable is well identified. Some variables even have a higher within-SD than a between-SD, such as *entry*, *exit* and *fdi*, which indicates higher heterogeneity across time than across entities. Thus, the risk of being dropped from the estimation is considered to be low. In terms of correlation, if we use the classification suggested by Acock (2012), that (r)<0.1 is a weak correlation, that 0.1<r<0.3 is a moderate correlation and that r>0.3 is a strong correlation, most of the pairs have weak but significant correlations. Thus, multicollinearity does not seem to be much of an issue for the estimated models. However, some variables do have fairly strong correlations, such as between the response variable *remain* and the closeness to portfolio (*close_pf*) and regional employment (*employr*), between *close_pf* and *employr*, and between *employi* and *sophistication*.

Table V-5 Summary of Variables

Variable		Mean	Std. Dev.	Min	Max	Obs.	
close_pf	overall	-6.84E-11	1	-.95502	4.432635	N =	25792
	between		0.914963	-.95502	3.625966	n =	3224
	within		0.403819	-1.93897	2.745633	T =	8
close_npf	overall	-2.24E-09	1	-1.6815	2.766457	N =	25792
	between		0.774976	-1.67525	1.9106	n =	3224
	within		0.632119	-2.3989	2.717501	T =	8
fdi	overall	-3.00E-09	1	-.06757	63.02547	N =	25792
	between		0.579635	-.06757	18.73297	n =	3224
	within		0.814932	-16.8666	49.56832	T =	8
sophistication	overall	-6.54E-10	1	-1.69679	3.30901	N =	25792
	between		0.780174	-1.22089	2.136877	n =	3224
	within		0.625695	-2.89949	1.542281	T =	8
employr	overall	-2.31E-09	1	-.45745	4.977121	N =	25792
	between		0.982921	-.45606	4.01444	n =	3224
	within		0.184737	-1.67064	.962682	T =	8

Variable		Mean	Std. Dev.	Min	Max	Obs.
Employi	overall	-6.00E-10	1	-.5028	8.998831	N = 25792
	between		.950255	-.50232	6.602525	n = 3224
	within		.311867	-2.62249	2.575531	T = 8
Entry (DV)	overall	.061547	.240337	0	1	N = 22568
	between		.103831	0	.428571	n = 3224
	within		.216758	-.36702	.91869	T = 7
Exit (DV)	overall	.059509	.23658	0	1	N = 22568
	between		.096595	0	.428571	n = 3224
	within		.215968	-.36906	.916652	T = 7
Remain (DV)	overall	.241714	.428131	0	1	N = 22568
	between		.369117	0	1	n = 3224
	within		.216991	-.61543	1.098857	T = 7
Regind	overall	1612.5	930.7066	1	3224	N = 25792
	between		930.833	1	3224	n = 3224
	within		0	1612.5	1612.5	T = 8
Year	overall	2001.5	6.873997	1991	2012	N = 25792
	between		0	2001.5	2001.5	n = 3224
	within		6.873997	1991	2012	T = 8

Source: Stata output

Note: all independent variables are in standardised form. This explains why they have mean close to zero and standard deviation equals to one.

Again, it is a good idea to explore the data to better understand the pattern and plausible relation they may reveal. Let's start with the main independent variable of closeness. Consistent to Figure IV-5, Figure V-9 and Figure V-10 suggest that closeness to portfolio and to non-portfolio are likely to have opposing values. That is, industries that are close to portfolio industries (e.g. larger values of closeness to portfolio) tend to be distant to non-portfolio industries (e.g. smaller values of closeness to non-portfolio). If we put a cutting line at the value of 200 on Figure V-9, we can observe a pattern that most industries under the ISIC code 1010 to 2599 have higher closeness value to portfolio. This means that these industries are likely to enter or to stay in provinces, if they are already present. They include food and beverage products, textiles, leather and wood products, paper and printing products, petroleum and chemical products, rubber and plastic products, non-metallic mineral products, and metal products. Conversely, manufacture of computer, electronic and optical products (ISIC 26), electrical equipment (27), machinery products (28), vehicles and transport equipment (29-30) tend to have lower values of closeness.

Table V-6 Correlation of Variables

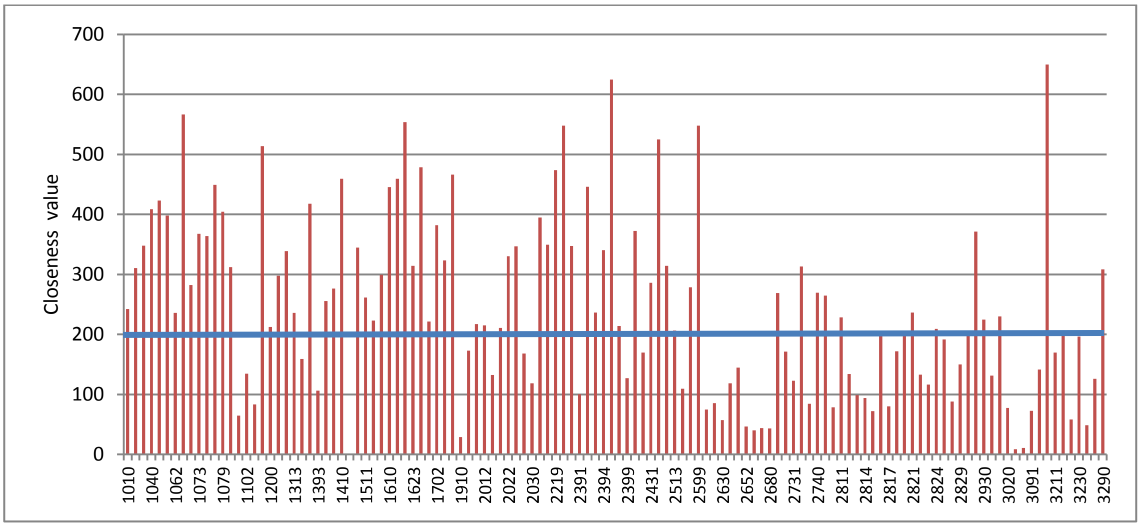
	entry	exit	remain	Close _pf	Close _npf	fdi	Sophis-tication	employr
exit	-.0644*							
	0							
	22568							
remain	-.1446*	-.1420*						
	0	0						
	22568	22568						
Close _pf	.0939*	-.0126	.5632*					
	.00E+00	.059	0					
	22568	22568	22568					
Close _npf	-.0271*	.0072	.0259*	.0136*				
	.00E+00	.2807	.0001	.0289				
	22568	22568	22568	25792				
fdi	-.0082	-.011	.1063*	.0999*	.0232*			
	2.18E-01	.0972	0	0	.0002			
	22568	22568	22568	25792	25792			
Sophis-tication	.0761*	.0906*	.1689*	.2135*	-.0561*	.0197*		
	0.00E+00	0	0	0	0	.0015		
	22568	22568	22568	25792	25792	25792		
employr	-.0091	-.0006	.4971*	.6232*	.0451*	.1872*	.0290*	
	1.71E-01	.934	0	0	0	0	0	
	22568	22568	22568	25792	25792	25792	25792	
employi	.0543*	.0282*	.1916*	.0997*	.0229*	.0318*	.3233*	.0044
	.00E+00	0	0	0	.0002	0	0	.4831
	22568	22568	22568	25792	25792	25792	25792	25792

Source: Stata output

Note: *p* values and number of observation are on the second and third row of each variable, respectively.

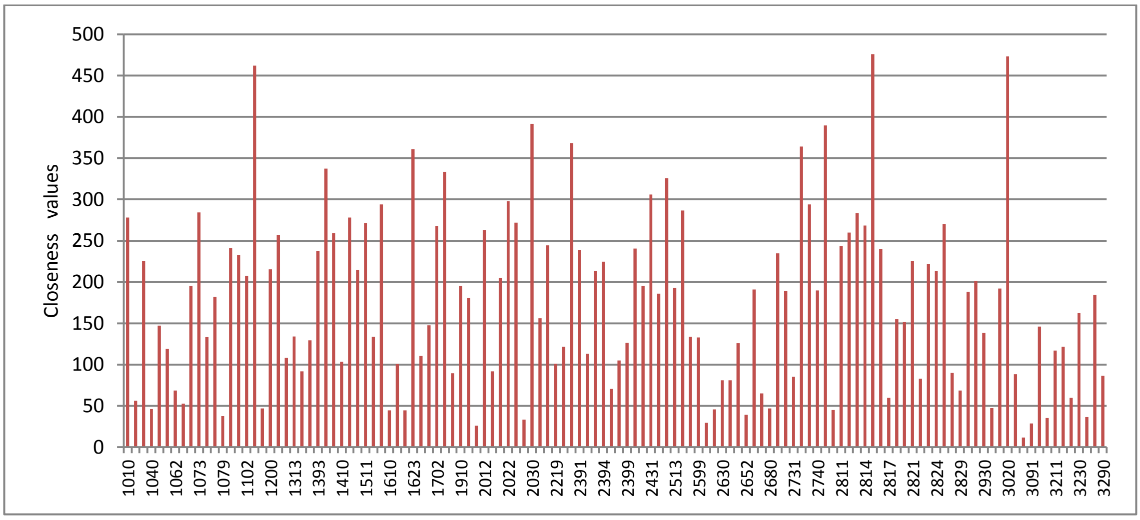
The flow of FDI to industries is highly concentrated in a few industries, such as basic chemical products (ISIC 20), stone products (23), parts of motor vehicles (29), rubber tyres (22), and pulp and paper products (17). In addition, food industry (1040), spinning textile and wearing apparel (1311 & 1410), plastic products (2220), basic metal products (2420) and electronic component (2610) also receive considerable amount of FDI inflow. Those industries, in general, have high closeness value to portfolio, except for electronic component and parts of motor vehicles products. The presence of greater amount of FDI in only few industries has casted a doubt on the role of FDI in industrial transformation in Indonesia. We investigate this more systematically in the following section.

Figure V-9 Averaged Closeness to Portfolio



Source: Author's analysis

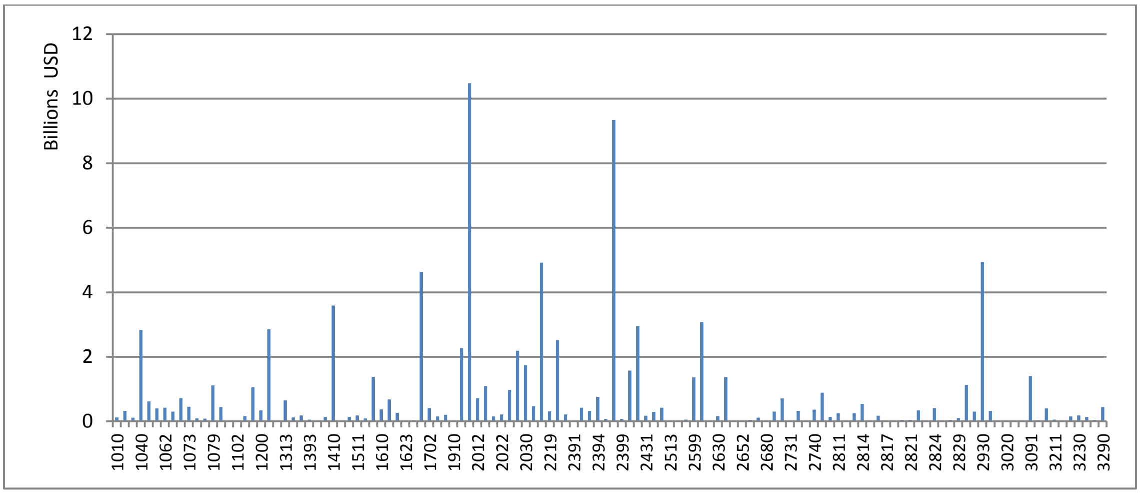
Figure V-10 Averaged Closeness to Non-Portfolio



Source: Author's analysis

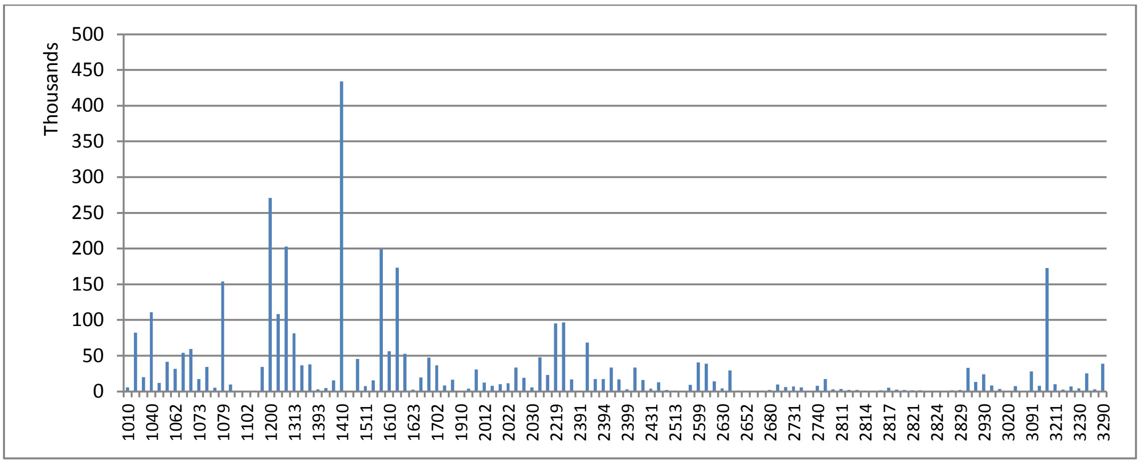
Manufacture of textile (including weaving–1312, wearing apparel–1410, and footwear–1520) and manufacture of tobacco (1200) are the two largest industry in terms of employment, followed by manufacture of furniture (3100), wood-panel (1621), and other food products (1079). These industries are considered as Indonesian traditional industries that have been around for quite some times (mature industries). As argued by Essletzbichler (2013), also by Neffke and Henning (2013) and Neffke et al. (2011), large industries 'are likely to enter and less likely to exit a region' (Essletzbichler, 2013, p. 257). While large industries incline to enter and tend to stay, smaller industries may be more dynamics in terms of their choices of location. We suspect, therefore, smaller industries would probably have higher chance to exit than larger industries. Drawing on this argument, we speculate that the relation between entry/exit and the size of industry would probably be positive/negative, respectively.

Figure V-11 FDI Inflow by Industries 1991-2012



Source: Author’s analysis

Figure V-12 Manufacturing Employment by Industries (averaged)



Source: Author’s analysis

5.4.2.2 Estimating logistic fixed-effects entry model

Let us start by estimating the entry model specified by Equation (12). Here, the dependent variable (y) is *entry*. We add the variables one by one into the estimations to observe their effects on the response variable *entry*. We start with model_A, which includes just two variables, closeness to portfolio (*close_pf*) and closeness to non-portfolio (*close_npf*), as estimators, while controlling the lag values of both variables. For model_B to model_D, one by one, we add the variables of *fdi*, *sophistication*, *employr* and *employi* as estimators, while, at the same time, controlling their lags. The results are presented in Table V-7. In general, all the estimated coefficients have expected signs, except for *fdi*. The coefficient of *fdi* turns into a negative once the variables of *sophistication*, *employr* and *employi* are included in the estimations. The interpretation of the coefficients is more or less similar to the province model. The differences relate to the unit of analysis of the variables and the response variables, which are specified according to three different variables, which are entry, exit and remain. Furthermore, in this province-industry model, we use closeness to measure relatedness, but we also use density as a relatedness measure, in the same way as in the province model, for comparison and robustness checking.

Table V-7 Logistic Fixed-effects Entry Models

Variable	model_A	model_B	model_C	model_D
close_pf	1.4186927***	1.418693***	1.5945796***	1.5413325***
L1.close_pf	-1.5157252***	-1.5171126***	-1.4458182***	-1.4314463***
close_npf	-.07704795	-7,68E-02	-.12323407**	-.13314938**
L1.close_npf	-.01082988	-.01195856	.00915767	.01241067
fdi		.01050151	-.00751272	-.00753057
L1.fdi		.0499786	.02698838	.02979382
sophistication			-.93557341***	-.89412371***
L1.sophistication			.80278789***	.79563963***
employr				1.0867302***
L1.employr				-.86351344**
employi				.29942718***
L1.employi				-.38515494***
N	6902	6902	6902	6902
ll	-1953.6171	-1953.2807	-1887.6149	-1875.4911
df_m	4	6	8	12
chi2	753.27674	753.94955	885.2812	909.52869

Source: Stata output

Note: Dependent variable is entries of industry. Entry is defined as industries with a comparative advantage that were absent in provinces three years before (year *t*) and are present in the provinces three years later (year *t+3*). This is a binary variable, where industries with comparative advantage take the value of 1, and 0 otherwise. * p<0.1; ** p<0.05; *** p<0.01.

Focusing on model_D, overall, the most influential variables to promote new entries of industries is closeness to portfolio (*close_pf*), followed by employment in the province, and sophistication level of industries. This result, again, provides supportive empirics on the role of relatedness in industrial development. We find that new industries tend to enter provinces when they are closer to the latter's industry portfolios (*close_pf*=1.5413, p<0.01). Remember that the way we read the standardised coefficient in logistic regression is rather different to those of unstandardized one in non-logistic model. Here, a 1 standard deviation increase in closeness to portfolio (*close-pf*) produces, on average, a 1.5413 increase in the log odds of getting industries entering. This reading of coefficient applies to all models of entry, exit, and remain.

New entrants have a negative relation with non-portfolio industries, meaning that, if an industry is closer to a non-portfolio industry, it is unlikely to enter a province (*close_npf* = -.1331, $p<0.01$). In a more technical language, a 1 standard deviation increase in closeness to non-portfolio (*close-npf*) produces, on average, a .1331 decrease in the log odds of getting industries entering. With regard to FDI, the coefficient of *fdi* has an unexpected negative sign. The presence of FDI seems to prevent new industries entering provinces. In other words, FDI tends to invest in industries that are already established in provinces, rather than in non-portfolio industries. Nevertheless, the effect of FDI on new entrants is considerably negligible and we cannot distinguish it from zero (*fdi* = -.0075, $p>0.1$).

One of our concerns is whether province-industry evolves towards more sophisticated industries. We find that this is the case. The negative coefficient of *sophistication* suggests that more sophisticated industries are likely to enter provinces in Indonesia. The coefficient is also significant in terms of statistics (*sophistication* = -.8941, $p<0.01$). With regard to employment, the size of employment, both in industries and in provinces, affects the emergence of new industries positively and significantly (*employi* = .2994, $p<0.01$; *employr* = 1.0867, $p<0.01$). This finding, although expected, is somewhat inconsistent with the FE and GMM estimation in the province models.

In comparison, we estimate the same specification with a different relatedness measure, i.e., *density* in model_E. The result is juxtaposed in Table V-8. In general, both models show similar results: new, related and more sophisticated industries tend to enter provinces, while the size of employment at both the industry and province level endorses the entry process. Consistent with model-D, the relatedness variable of *density* stands up as the most influential variable. What makes it interesting is the changing role of FDI. The use of *density* as a relatedness measure turns the coefficient of *fdi* into a positive sign. The results of *fdi* thus far are inconclusive, not only in terms of its statistics but also in terms of the direction of influences (*fdi* = .0063, $p>0.1$).

We perform two diagnoses to check the appropriateness of the model, i.e., the Hausman test and time-FEs test of (testparm). Both tests confirm that FEs are appropriate for estimating the model. The Hausman test rejects the null hypothesis ($p<0.001$), that the RE approach is the preferred technique. Meanwhile, the time-FEs test rejects the null hypothesis ($p<0.001$) that no time-FEs are required (see Appendix 11 for detailed results of the tests).

Table V-8 Closeness (Model_D) Versus Density (Model_E)

Variable	model_D	model_E
close_pf	1.5413325***	
L1.close_pf	-1.4314463***	
close_npf	-.13314938**	
L1.close_npf	.01241067	
Fdi	-.00753057	.0063778
L1.fdi	.02979382	.02352252
Sophistication	-.89412371***	-.43448538***
L1.sophistication	.79563963***	.55378249***
Employr	1.0867302***	1.3945869***
L1.employr	-.86351344**	-.57593591
Employi	.29942718***	.3473797***
L1.employi	-.38515494***	-.39141489***
Density		1.8455804***
L1.density		-1.1506608***
N	6902	6902
ll	-1875.4911	-2045.3166
df_m	12	10
chi2	909.52869	569.87773

Source: Stata output

Note: Dependent variable is entries of industry. * p<0.1; ** p<0.05; *** p<0.01.

5.4.2.3 Estimating the logistic fixed-effects exit model

This time, we estimate Model Specification 12 to investigate the influence of independent variables on the probability of exits. The dependent variable (*exit*) is a binary value of which 1 indicates the probability of industries to exit, and 0 otherwise. Logically, we expect that exit model's results would be the opposite of those for the entry model. The estimation results, in the form of standardised coefficients, are displayed in Table V-9.

As we have interpreted the same variables in the entry model, we will go through it briefly. As per model_I, all coefficients have expected signs. An exit is negatively affected by industries' closeness to portfolio (*close_pf* = -1.5776, $p<0.01$). Industries that are close to their host portfolio have no reason to leave their host provinces. Neighbourhood effects do have influences. Closeness to non-portfolio industries removes industries at the frontier from their host provinces (*close_npf* = 0.1243, $p<0.01$). The relative effects of both coefficients, however, seem considerably distinct. The effects of closeness to the portfolio seem much stronger to avoid industries from exits than the centrifugal effects from non-portfolio industries to pull the industries out. Nevertheless, both coefficients are statistically significant.

Although it has an expected negative sign, the role of FDI is again questioned for its weak coefficient (*fdi* = -0.0157, *p*>0.1). Similarly, the size of employment seems to have indecisive effects on exits (*employi* = -0.0079, *p*>0.1; *employr* = -0.3682, *p*>0.1). Lastly, *sophistication* shows a decisive value affecting the exit process (*sophistication* = 1.0821, *p* <0.01). That is, less sophisticated industries have higher chances of leaving their host provinces. We get a highly similar result when replacing the closeness variable with a density variable (model_J), as juxtaposed in Table V-10. The use of FE regression is appropriate, as confirmed by the Hausman test and the time-FEs test with p<0.001 (see Appendix 11).

Table V-9 Logistic Fixed-effects Exit Models

Variable	model_F	model_G	model_H	model_I
close_pf	-1.6306759***	-1.6281166***	-1.5768579***	-1.5776409***
L1.close_pf	1.6230406***	1.6250719***	1.5250892***	1.5524762***
close_npf	.13876502**	.13717845**	.1256762**	.12437867**
L1.close_npf	-.05943277	-.05817462	-.07617904	-.07667273
fdi		-.01159907	-.01193441	-.01575654
L1.fdi		-.36369694	-.32761721	-.35469073
sophistication			1.0752556***	1.0821695***
L1.sophistication			-.21539322***	-.31736697***
employr				-.36823169
L1.employr				1.2805926***
employi				-.00794274
L1.employi				.30399942***
N	7056	7056	7056	7056
ll	-1817,6412	-1816,6191	-1760,7057	-1746,063
df_m	4	6	8	12
chi2	1011,9871	1014,0311	1125,858	1155,1434

Source: Stata output

Note: Dependent variable is exits of industry. Exits is defined as industries with comparative advantage, which were present in provinces three years before (year *t*), but are absent in the provinces three years later (year *t+3*). This is a binary variable, where industries with comparative advantage take the value of 1, and 0 otherwise. * p<0.1; ** p<0.05; *** p<0.01.

Table V-10 Closeness (Model_I) Versus Density (Model_J)

Variable	model_I	model_J
close_pf	-1.5776409***	
L1.close_pf	1.5524762***	
close_npf	.12437867**	
L1.close_npf	-0,07667273	
fdi	-0,01575654	-0,01078
L1.fdi	-0,35469073	-0,43113
sophistication	1.0821695***	.93985072***
L1.sophistication	-.31736697***	-.21766051***
employr	-0,36823169	-0,01601
L1.employr	1.2805926***	0,038863
employi	-0,00794274	-0,10393
L1.employi	.30399942***	.33995892***
density		-2.4365105***
L1.density		2.0516465***
N	7056	7056
ll	-1746,063	-1885,09
df_m	12	10
chi2	1155,1434	877,0889

Source: Stata output

Note: Dependent variable is exits of industry. * p<0.1; ** p<0.05; *** p<0.01.

5.4.2.4 Estimating the logistic fixed-effects remain model

What we mean by remain is that industries, which exist in provinces at time t, are still there at a later time (t+3). We have found a piece of empirical evidence to confirm that closeness to provinces' portfolio encourages industries to enter. We have also been convinced by evidence that neighbourhood effects push industries out of provinces. Logically, what makes industries stay should be a combination of strong pull-in and weak push-out forces, which is similar situation to that of the entry model. Reflecting this logic, our model (model_N in Table V-11) comprises a strong and positive coefficient of variable closeness to portfolio (*close_pf*=0.077, $p<0.001$), as well as a weak and negative coefficient of variable closeness to non-portfolio industries (*close_npf* = 1.3060, $p<0.01$).

As in other models, FDI unsurprisingly plays no significant role in this regression (*fdi* = -0.0067, $p>0.05$). The negative sign of *fdi*, however, points to an expected direction. When we use *density* to replace closeness in model_O (Table V-12), the *fdi* coefficient switches sign, confirming the inconsistent roles of FDI in developing or retaining industries within provinces. The size of employment is an interesting case. Industries tend to remain in host provinces specifically due to the size of the labour force within the industries, not because of the size of overall employment in the provinces. This estimation, however, does not apply when the *density* is used as a relatedness measure replacing closeness. Finally, it is in the interest of provinces to retain the most sophisticated industries and get rid of the old and less productive ones if necessary. This behaviour is well captured in our model by the statistically significant coefficient of sophistication (*sophistication* = -04174, *p*<0.01). The Hausman test and the time-FEs test confirms that FE regression is robust for the estimation with p<0.001.

Table V-11 Logistic Fixed-effects Remain Models

Variable	model_K	model_L	model_M	model_N
close_pf	1.3969244***	1.3974141***	1.2964628***	1.3060011***
L1.close_pf	.9862949***	.98663815***	.96929161***	.96477448***
close_npf	-.11865972**	-.11837336**	-.07586553	-.08279009
L1.close_npf	-.18232912***	-.18218305***	-.23189909***	-.23920186***
fdi		-.01155953	-.00283286	-.00670728
L1.fdi		-.00987028	-.00250756	-.00402642
sophistication			-.67898338***	-.6945665***
L1.sophistication			-.56055071***	-.63534467***
employr				-.44938056
L1.employr				.74111402***
employi				.29095474***
L1.employi				.22480167**
N	5369	5369	5369	5369
ll	-1931.2099	-1931.1629	-1721.9126	-1709.6613
df_m	4	6	8	12
chi2	663.35315	663.44732	1081.9478	1106.4504

Note: Dependent variable is remains of industry. Remains is defined as industries with comparative advantage that were present in provinces three years before (year *t*) and are still present in the provinces three years later (year *t+3*). This is a binary variable, where industries with comparative advantage take the value of 1, and 0 otherwise. * p<0.1; ** p<0.05; *** p<0.01.

5.4.3 Robustness of the results

In order to assure the robustness of our econometric analysis, we take several steps to minimize error and bias. Firstly, we use two different units of analysis, which are provinces and province-industry. We find that the results of the province-industry model are statistically better than for the province model, although, to a great extent, both exhibit consistent results. The explanation may relate to the size of the sample used in the analysis. In the province model, all of the data are pooled into 26 provinces with eight three-year periods of time, which provide us with 208 observations for each variable. In contrast, the province-industry model consists of more than 25,000 observations for the same period of analysis. Secondly, we juxtapose two different metrics of relatedness, which are density and closeness. The reasons are simply to obtain more accurate measurements and diagnose the sensitivity of the result based on the metrics used. The two metrics produce highly consistent results. Thirdly, we apply different estimation techniques in the hope of minimizing the bias and improving the precision of the estimation. For additional cautiousness, we run some post-estimation tests to ensure the appropriateness of the estimations and the presence of influential outliers. We detect negligible outliers (three out of 156 observations) in the province model and temporarily remove them from the analysis. Since we yield unnoticeable changes in the coefficients, we insist on putting them back in the analysis.

Table V-12 Closeness (Model_N) Versus Density (Model_O)

Variable	model_N	model_O
close_pf	1.3060011***	
L1.close_pf	.96477448***	
close_npf	-.08279009	
L1.close_npf	-.23920186***	
fdi	-.00670728	.02959783
L1.fdi	-.00402642	.02270732
sophistication	-.6945665***	-.41740851***
L1.sophistication	-.63534467***	-.85711658***
employr	-.44938056	.41409058
L1.employr	.74111402***	.02619582
employi	.29095474***	.38775108***
L1.employi	.22480167**	.16346131*
density		.88389285***
L1.density		.91608046***
N	5369	5369
ll	-1709.6613	-1918.9814
df_m	12	10
chi2	1106.4504	687.81025

Note: Dependent variable is remains of industry. * p<0.1; ** p<0.05; *** p<0.01.

5.5 Conclusion

In this chapter, we seek to understand the roles of provinces' industry structures vis-à-vis the roles of other forces, particularly foreign capital and cost of factors (i.e., wage). By far, the literature seems to converge on the roles played by relatedness as an endogenous force in promoting new regional industries. However, empirical works developed thus far are highly skewed towards the developed economies. This has motivated us to seek out genuine empirical evidence, which can at least complement existing works with content derived from the Global South context. Moreover, very few of those works specifically address the roles of external capital and the cost of factors, which are key elements in the production processes, not least from a mainstream economics perspective. Given the huge volume of FDIs and their perceived positive impacts on the Indonesian economy, as suggested by the literature, it is rather surprising that the effects of FDI on the industrial branching process in the country are still neglected in academic investigation. Therefore, comparing the relative effects of endogenous industrial capacity against other factors of productions on industrial diversification processes is not only academically interesting, but also urgently needed in order to raise awareness of policymakers in the country about this issue. This is actually what this chapter aims to achieve. Furthermore, what is no less important is that the ways in which industrial branching processes take place, as well as the direction they take. Branching into more sophisticated industries is expected, but diversifying towards less sophisticated industries is apparently easier. Which path is taken by Indonesian provinces will be revealed by this analysis.

The inferential analysis points to some important findings. The process of industry diversification in Indonesian provinces is likely to be shaped endogenously by the initial condition of the existing industry structures and the relatedness of potential industries to those structures. Meanwhile, the roles of FDIs in that process are likely to be small and statistically inconclusive. Whether the branching process results in more or less sophisticated industry structures is clarified, in that the latter seems to be the case. The estimation, however, seems to suggest that the speed of industrial upgrading process occurs very slowly. Furthermore, the minimum wage seems to play subtle and weak roles in the diversification process. Lastly, the size of employment in the industries plays a more crucial role in shaping the diversification process than the size of employment in the provinces, which are undetermined in their roles.

We try to articulate these findings with the policy implications. Firstly, nowadays, regional industrial policy is often associated with cluster policy (De Propris and Driffield, 2006, p. 288). Indeed, that is the case in Indonesia, which is pursuing an optimistic plan to develop 36 new industrial clusters, of which 32 will be built in laggard provinces outside the main island of Java by 2035[57]. This policy is driven by two interrelated objectives, i.e., to accelerate the pace of national industry and to extend industrial

[57] http://kemenperin.go.id/artikel/10112/Pembangunan-Kawasan-Industri-Diarahkan-Ke-Indonesia-Timur.

development across the country. Echoing the relatedness literature, our findings suggest that policy should be implemented with caution. Gathering unrelated industries into a cluster would increase the risk of failure and knowledge-sharing among industries seems unlikely to materialise. Therefore, the development of clusters, particularly in less industrialised provinces, should take into account the relatedness of industries residing within these clusters. With regard to FDI-led clustering policy, the evidence for Indonesia seems to converge on a conclusion in favour of FDI. In the policy realm, FDI has become a sort of 'development mantra', which drives government policy to attract FDI as much as possible into the country. This research, along with other cross-country analyses, however, seems to be in doubt about what FDI can contribute to industrial branching. As warned by Felker (2004, p. 88), FDI-led industrial clusters in South East Asia are far from what was conceptualised in Porter's (1990) competitive cluster. Instead of supporting the development of industrial clusters, FDI enterprises actually exploit it by absorbing incentives within the clusters provided by regional policy and only sharing agglomeration benefits among themselves. The key to the success of an FDI-led cluster, according to Phelps (2008), hinges on the intervention of the government in assembling policies and incentives that maximise externalities to indigenous firms.

Apart from the contribution we have described, there are a few potential biases that one needs to interpret with caution. Firstly, we indirectly measure the proximity between industries and the sophistication level of industries by using international trade data, so as to take advantage of the extensive amount of information available and minimize measurement bias. The results are then converted into manufacturing data that use different classifications. Manufacturing classifications have evolved several times during the period of study, which complicates the process. Although conversion processes are made much easier by the availability of concordance tables, the involvement of multiple stages in the process may cause some biases. Secondly, we conduct the analyses at two different levels, i.e., province and province-industry levels. We find consistent results for the relatedness effects, regardless of the metrics used in the estimation (i.e., density and closeness). However, that is not the case for the effects of FDI. The coefficient seems to be highly sensitive towards different dependent variables. One might suspect that the quality of data or the way FDI is measured may cause issues. Nevertheless, this kind of suspicion cannot be addressed by the existing data we have. Thirdly, as commonly exposed in many inferential analyses on the topic of the direction of causality, the emergence of new industries is attributable to the changes in FDI, although FDI itself may be influenced by the presence of new industries. Although this cannot be fully eliminated, we minimise this confounding issue by applying panel data with the *t-1* specification on the right-hand side of the equation.

As we argue that this kind of study is relatively new in the Indonesian context, it offers a wide range of issues waiting to be explored. Firstly, the roles of institutions and government policies in the industrial branching process are open to question. Secondly, the inconclusive roles of FDI require further clarification, for example, by applying different measures of FDI or performing in-depth analysis by using case studies. Thirdly, departing from our study, future research could sharpen the analysis of the effects of relatedness on the industrial diversification process, for instance, by differentiating between the effects on advanced and laggard areas, or urban or rural areas, or between different settings of regional institutions. We deal with the latter in the next chapter.

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CHAPTER VI
OLD AND NEW INDUSTRIES

6.1 Introduction

6.1.1 Qualitative institutional analysis

In the previous two chapters, we captured industrial transformation in Indonesian provinces by applying statistical analysis. The quantitative findings suggest a relationship between the relatedness of an industry to its region's portfolio and the rise and fall of that industry. However, we also identified some potential divergent-cases, which seem to be beyond the explanation of the mentioned relationship (see Figure IV-2 in Chapter 4). Anomalies often go ignored in quantitative analysis as it focuses on capturing regularities by deciphering seemingly complex and irregular data. Although neglecting some divergent cases is sometimes required to reveal the general pattern of the data, meaningful information may be overlooked, particularly if the cases are found in dominant entities of the sample or population. The qualitative part of this thesis attempts to address this issue and seek explanations for the cases. One of the many qualitative research approaches is to comparatively study anomalous cases (Silverman, 2013). Moreover, a qualitative case study can also be used to provide deeper explanations as well as corroborations for what has been inferred from quantitative analysis (Schoenberger, 1991, p. 181). By interacting directly with the industries, we aim to capture the dynamics of evolutionary processes, which involve the real struggles of individual industries to survive evolutionary pressure. Moreover, in order to guide the investigation, we adopt the institutional framework of VOC (Hall and Soskice, 2001).

The motivations for adopting qualitative institutional analysis are twofold. First, it is an attempt to partly respond to the scale and level issue shadowing the GD-PD framework (see the discussion in Section 2.2). By including institutions in the analysis, we demonstrate how the evolution of regions interdependently occurs at two different levels of analysis (i.e., industry and institution). Second, we have witnessed in recent years that the literature on relatedness seems to be much closer to a quantitative type of analysis. Of course, there is nothing wrong with that, since this kind of analysis helps to provide systematic empirical evidence of branching processes across spaces. In our view, both kinds of analysis complement each other. Thus, this chapter reflects on the efforts to maintain a balance between the two.

6.1.2 The foundation and main argument

Before going into detail, it is important to lay solid groundwork as to why qualitative analysis is required in this research by looking at the anomalies that we seek to explore. Figure IV-2 provides a discussion on two different paths of regional industry development. The figure suggests that CJV demonstrates evolutionary industrial development as envisioned by path dependence theory: that is, industries that are cognitively close to the existing portfolio tend to emerge, whereas less related industries tend to decline. In contrast, WJV seems to display a deviating pattern from what is expected by path-dependence: that is, less related industries are emerging, while related industries are declining. Table VI-1 provides a more accurate explanation with numbers. The average density metric demonstrates that both WJV and CJV have developed industries that are relatively distant from their current industry structures[58]. Comparing the two provinces, WJV has a lower average density value (0.107) than CJV (0.155). This means that, in general, WJV has managed to develop less related industries, while CJV has expanded into more related industries. Interestingly, WJV has lost its relatively related industries, while preferring less related industries that are supposedly subject to a process of selection. This phenomenon is confirmed by the higher value of average density for declining industries (0.135) than for persistent industries (0.129). Theoretically, persistent industries should have higher values, suggesting that they are more strongly tied to existing industry structures.

Table VI-1 Averaged Density Values of New, Declining and Persistent Industries

Industries	Averaged density	
	West Java	Central Java
New	0.107	0.155
Declining	0.135	0.160
Persistent	0.129	0.191

Source: Author’s own calculation.

On looking more closely at the industries, Figure IV-2 shows that the two provinces’ product spaces displayed comparative advantages in the textile, footwear and headgear industries (we later focus exclusively on the textile industry) in 2000. By 2012, WJV had lost much of its competitive advantage in the textile industry, while CJV had maintained its dominance in that industry. In contrast, WJV has managed to

[58] These are indicated by lower values of the average density of new industries relative to both declining and persistent industries.

develop an advanced aircraft industry, which seems to have a weak proximity to its regional portfolio, while CJV has just given up[59]. Table VI-2 attempts to link the phenomena with the relatedness of industries to their regional portfolio, as measured by averaged density values. The textile industry in both WJV and CJV had comparable averaged densities in 2000 of 0.144 and 0.161, respectively. However, WJV lost its comparative advantage in relation to 66 textile products within the 2000-2012 periods, compared to only 10 products for CJV. While 12 new textile products have emerged in CJV, replacing these 10 products, none has come into WJV. The interesting question concerns *how WJV suffered such huge losses in specialization in its textile industry, whereas CJV's textile industry, which has comparable averaged density, gained more specialisations.* Furthermore, *what are the explanations for their departures from WJV, and their arrivals in CJV?* Notice that textile products, which have remained in WJV, have almost similar density values (0.149) to those that had left, suggesting that they may leave as well. Similarly, products in the transportation industry were tied more closely to their portfolio in CJV than in WJV. This raises another interesting question: *how was WJV able to develop an aircraft industry that is technologically distant from its regional portfolio in 2000?* Although these details are lost in quantitative analysis, a qualitative case study offers proper analytical tools to investigate the two cases in reasonable depth.

Table VI-2 Averaged Density Values of the Textile and Aircraft Industries in West Java and Central Java Provinces

Industries	Averaged density of the textile industry (number of products)		Averaged density of the aircraft industry (number of products)	
	West Java	Central Java	West Java	Central Java
New	-	0.169 (12)	0.070 (2)	0.083 (0)
Declining	0.144 (66)	0.161 (10)	-	-
Persistent	0.149 (7)	0.206 (49)	-	-

Source: Author's own calculation.

On withdrawing from the quantitative results, the main argument of this chapter is that evolutionary forces are present, even in the deviant cases of the 'related decline' of the textile industry and the 'unrelated emergence' of the aircraft industry. This chapter endeavours to provide in-depth case analysis on the evolution of the industrial transformation process by intertwining the broad 'patternistic' view with the specific internal dynamics of regions. The thick information required by the analysis has left us

[59] The averaged distances of the aircraft industry in WJV and CJV are 0.071 and 0.081, respectively.

with no choice but to focus on two provinces, i.e., WJV and CJV, and two industries, i.e., the textile and aircraft industries. Here, we adopt a rather interpretative method to provide an explanation in a detailed and meaningful way, rather than merely presented a factual, but thinly interpreted, account (Geertz, 1973, p. 312). In terms of research method, we primarily adopt an interviewed-based analysis approach, coupled with the content analysis of relevant documents and triangulated with secondary data (Schoenberger, 1991; Silverman, 2013) in order to construct an empirical framework and narrative about industrial evolution in both provinces.

The interviews with stakeholders in the textile industries of WJV and CJV highlighted some prevailing factors, which could explain the exit of the textile industry from WJV, including differences in minimum wage, industrial relations and the capacity of the industries to learn internally. Our examination of those factors corroborates the latter two, but disputes the former. Favourable labour-employer relationships translate into centripetal forces attracting similar industries to locate to CJV. In contrast, the textile industry resides uncomfortably in WJV due to its adverse industrial relations. Nevertheless, hysteresis forces do exist there. Being 'pushed out' by less favourable industrial relations does not necessarily prompt industries to exit. Indeed, they fight back and reassert their spatial claim in the region by improving efficiency and productivity through capitalisation. The influence of wages, even when it was part of the story, was minor at best.

People were fast to point to the roles of the state in the rise of the aircraft industry in WJV. The fact is that both the industry and the region were picked and highly supported by the government. In the form of state-owned enterprises, the industry has hugely invested in physical and human capital, developed favourable institutions and established networks with global players in the industry (McKendrick, 1992a, pp. 46-9). Links to the local technical university have been forged in order to assimilate the acquired technology with local knowledge. As a result, the industry has expanded, even though it was cognitively distant, in a relative sense, from its regional knowledge base. It did not take long until selection forces sensed their prey, namely, inefficient industries. The Asian crisis changed the whole story of the Indonesian aircraft industry. Ambitious projects involving bigger passenger aircraft were forcedly halted for financial feasibility reasons, although the real reason could have been the fear of becoming a potential competitor of the 'big boys' in the industry. Excessively strong external links and excessively weak internal links have paid off. The industry has learned quickly and responded swiftly by overcoming its weaknesses, while maintaining its strongest assets. In other words, the industry is approaching its regional portfolio and becoming 'rooted' over time. This progress is somewhat captured in the quantitative analysis as an emerging specialisation of the aircraft industry. There is evidence of an incremental increase in local content in its products in the I-O table and a decrease in foreign experts both in engineering and in management (McKendrick, 1992a, p. 47).

The flow of discussions is arranged as follows. The next section reviews the general industrial policies and the evolution of textile and aircraft industries within those policy regimes. We discuss about how we collect and analyse the data in Section 6.3. Moving forward, our empirical results are presented and discussed thoroughly in Section 6.4. We close this chapter by theorising the findings in the conclusion.

6.2 The evolution of industrial policies and the historical development of the textile and aircraft industries

Although two industries will be the focus of the analysis, this chapter is not necessarily about the textile or aircraft industry. Rather, it is more about the regional institutions that shape the economic behaviours of industry. These behaviours must say something about broader social and economic structures in which they are embedded (Granovetter, 1985). Different behaviours suggest different institutions. Therefore, by studying their behaviours and the underlying reasons for such behaviours, we may be able to construct those institutional structures. Moreover, the evolutionary idea of path dependence also suggests that differences in regional institutions are engendered by its historical roots. In our case, for instance, the historical decision to locate the aircraft industry or establish textile institutions in WJV led to completely different trajectories of development. In order to explain the differences in regional industrial institutions, one must look back to the origin of existing institutions. Simmie (2012) argues that historical barriers of path dependence could lead to a selection environment, taking the form of institutional hysteresis, which favours the prevalent routines and behaviours. Therefore, in order to explain institutions, we need a combination of a bottom-up process by looking at the behaviours of economic agents, and a backward-forward process by exploring their historical progenies. In that context, the next section concisely reviews the evolution of industrial policies in Indonesia and the origin of the textile and aircraft industries. The interviews cover this subject as well. However, the information captured from the interviews is in a piecemeal format, making it difficult to assemble chronologically. For that reason, we rely a great deal on written sources rather than verbal explanations.

6.2.1 The evolution of industrial policies in Indonesia

Industrialisation in post-independence Indonesia arguably started after the political turmoil of 1965. The ‘New Order’ government adopted different industrial policies during its period in power (Haryo Aswicahyono et al., 2011; Hill, 1997). In its early stages (1965-1984), industrial policies were oriented towards import substitution policies, which aimed to develop domestic industries by substituting import products with their products. The policy was arguably a response, rather than an intended strategy (Ishida, 2003, p. 13). The enactment of two important laws concerning foreign and domestic investment in 1967 was basically liberalisation, rather than representing import restriction policies. The calls for protection from domestic producers, coupled with a windfall from the oil sector, led the government to gradually abandon its liberalisation policies (Winters, 1996). In this period, the state-owned oil company Pertamina sponsored early industrialisation programmes, including the establishment of several strategic, yet ambitious, industries, such as the aircraft industry in 1978 and the development of the Batam Bonded Warehouse in 1971. All of these efforts aimed to boost industrialisation by focusing on certain strategic industries and economic zones. Further government intervention occurred in the late 1980s with what was called 'triangular diplomacy'[60], in the form of the Indonesia-Malaysia-Singapore growth triangle (Phelps, 2004). The development of the Batam Bonded Warehouse itself involved a high proportion of FDI, particularly from Japan and Singapore. The end of the oil boom era in 1982 shifted industrial policies back onto a more liberal track. Nevertheless, the government continued to pursue and fully fund a number of strategic industries involving high-tech and capital goods, such as the aircraft, machinery and maritime industries.

With the enactment of Bill 5/1984 concerning industry, the government began unleashing liberalisation packages on trade and investments. The overall aim was to encourage foreign investment and exports, while the policy marked a fundamental recognition that 'industrial development cannot be achieved by leaving protection from import competition to work its magic, and there is a need to ensure the emergence of competitive firms' (ADB, 2014, p. 8). As a result, a new wave of foreign investment flowed into Indonesia, mostly from Japan, fuelling further industrialisation. Two important observations are worth noting here. First, in this period, Presidential Decree no. 53/1989 on Industrial Estates was issued, paving the way for the major expansion of industrial estates on the outskirts of Jakarta (Tangerang, Bekasi, Cikarang) during the 1990s. Indeed, by 1994, 40% of industrial estates in Indonesia were concentrated in this area (Firman, 1998, p. 238). Second, the 1980s and 1990s represented a golden era for the textile industry in Indonesia.

[60] A combination of state-state, state-firms and firms-firms diplomacy.

When the Asian crisis hit the economy harshly in the late 1990s, the manufacturing industry broke down. A sharp depreciation in currency caused by the crisis failed to stimulate export as most of the input from manufacturing was actually imported. Furthermore, the fact that the manufacturing industry was built on foreign debt exacerbated the situation. The textile industry collapsed, while the aircraft industry experienced even worse.

The period of 1998-2004 was consolidation period for the manufacturing industry, and the economy as a whole. Industrial policies were focused on labour-intensive and export-oriented industries, such as the textile industry (GOI, 2001). Meanwhile, ambitious high-tech industrialisation projects, for example, in the aircraft industry, were halted as a result of pressures from international agencies. After the crisis, the manufacturing industry faced two challenging situations (ADB, 2014). Firstly, on-going democratisation and decentralisation processes heightened political and institutional uncertainties, which eventually increased the costs of doing business in Indonesia. Secondly, pro-labour pressure had caused significant hikes in minimum wages across the country. The latter obviously hit labour-intensive industries, such as the textile industry, quite hard.

In the post-crisis era (2004 onward) national industrial policies changed orientation. One important lesson learnt from the crisis was the fact that national industry was so fragile. The government realised that the industry structure must be strengthened along with export-oriented policies. Therefore, industrial policies, as set out in the RPJPN, aim to improve efficiency, modernisation and value addition in the primary sector (GOI, 2007). Moreover, they are also intended to strengthen forward-backward value chains, integrate SMEs into the chain and promote stronger inter-industry relations. Specific to the manufacturing industry, the RPJPN lays down criteria for selecting priority industries, namely, being employment generating, fulfilling domestic needs, adding value to domestic natural resources and having export potential. Based on these criteria, the government poorly picked 10 industry clusters[61] as specified in the first RPJMN for 2004-2009 (GOI, 2004). Unsurprisingly most of those chosen industries were traditional Indonesian industries, which are categorised as less sophisticated in our analysis in Chapter 4, except for two clusters, i.e., the electric machinery and electronics cluster and the petrochemicals cluster. Both the criteria and the chosen industries are criticized as they reflect the propensity of the government to favour established industries rather than promote potential new industries (USAID, 2008, p.

[61] Food and beverage, marine resource processing, textiles and garments, footwear, oil palm, wood products, rubber and rubber products, pulp and paper, electric machinery and electronics, and petrochemicals.

10). One might conclude that the post-crisis industrial policies still reflected the political influence of the old industries. In addition, the aircraft industry was apparently kept off the list, whereas the textile industry was put on the list and received special treatment in the form of credit facilities.

On the brink of the GFC in 2008, the government once again changed the course of its industrial policies by announcing new national industrial policies (GOI, 2008), followed by its implementing strategies two years later (GOI, 2010). Two parallel strategies have since been adopted to implement the new policies. The first is the development of industrial clusters to boost collective competitiveness through industrial networks. This is a central government initiative, but local participation us encouraged. There are 35 industrial clusters[62] explicitly identified in the documents. This suggests a much broader scope, which means that the government risks losing its focus. However, the new list includes some creative and sophisticated industries, which is a good sign of a government vision for knowledge and technological mastery. Both the textile and aircraft industries are included on the list.

The second strategy concerns the development of potential regional industries. This is a bottom-up approach in which regions are encouraged to identify their own core industrial competences and produce a consolidated road map to promote those industries. However, our content analysis of 11 documents suggests that regions tend to promote extant traditional industries, which have gained comparative advantage, instead of promoting new and more sophisticated industries. This is probably engendered by an excessive orientation towards export competitiveness, rather than innovation and product development. For example, CJV has selected the textile, food, cigarette, furniture, steel and automotive component industries as its core industrial competences (Government of Central Java, 2008). Meanwhile, WJV has chosen the automotive component, telecommunication, textile and footwear, agro and creative industries (Government of West Java, 2013). Apparently, both provinces still have high expectations for the textile industry. The difference is that WJV has started to give attention to new promising telecommunication and creative industries, while CJV prefers to persist with its established traditional industries.

A recent development in Indonesian industrial policy is the new Industrial Bill 3/2014 (GOI, 2014). Some suggest that the new bill is highly interventionist (ADB,

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[62] They consist of the following: agro-industry (12 clusters), transportation equipment industry (four clusters), electronics and ICT industry (three clusters), base materials industry (four clusters, one of which is the iron and steel industry), machinery industry (two clusters), labour-intensive manufacturing industry (two clusters), supporting and specific creative industry (three clusters), and specific small and medium industry (five clusters).

2014), as it gives a great deal of discretionary power to the government to carry out the necessary industrial actions in order to protect domestic industries against global competition. The bill addresses, for instance, the development of industrial estates (Article 63) and control over strategic industries by the government (Article 84). If we make reference to the definition of strategic industry, as stipulated in Presidential Decree 59/1983, it includes the aircraft industry.

A brief review of the evolution of industrial policies in Indonesia indicates that, in the early stage of industrialisation, there was a serious attempt to develop high-tech, capital goods industries. However, the Asian crisis forced efforts in a backward direction onto the primary sectors and labour-intensive manufacturing industries. Resources-based, labour-intensive and export-oriented industries have dominated the country's industrial policies, although concern about value addition, efficiency, technological deepening and innovation has also been addressed in those policies. The post-crisis industrial policies have placed more weight on the regional approach of industrial clusters. However, we have observed a bias in the selection of industries in favour of established ones, suggesting strong political influences of old industries over local governments' policies. Furthermore, despite the continuation of the liberalisation programmes recent moves of the government indicate a more proactive, but protective, stance with regard to its industrial policies. On one hand, the government is highly criticised for its stance to assist the declining industries rather than to promote new potential industries (ADB, 2014; USAID, 2008). On the other hand, the government's effort to promote new high-tech industries is often negatively perceived as wasting public money.

6.2.2 The evolution of the textile industry

As historically described by Pierre (2007), textile production involving growing raw cotton, spinning cotton yarn, weaving cotton sheets, and dyeing (especially batik) existed on Java even before the presence of Dutch colonials. Some argue that the textile industry played a major role in the early industrialisation of Indonesia (Hill, 1991; Negara, 2010). The expansion of the textile industry, particularly the weaving sector, can be traced back to Dutch colonial policies, which sought to boost the development of the textile industry in Indonesia to address the prolonged supply crisis at that time (Pierre, 2007). There were two factors driving the development of the textile industry in Indonesia. First, the first World War had caused insufficient supply from Netherland to meet the local demand, which compel the colonial government in Indonesia to accelerate the development of textile industry in Indonesia. One of the initiatives involved the establishment of textile technology institute of Bandung (TIB) in 1921, which fulfilled two important elements for the industry: skilled workers and improvement of technology (Pierre, 2007). Second, the Indonesian market was secured under import protection except from the Netherlands. However, Dutch exports failed to recover because of World War II, paving the way for mass production in Indonesia.

The post-independence development of the textile industry had been mostly impressive, with some ups and downs along the way. During the period 1950-65, the government supported the industry in order supply clothes as one of the country's basic needs. However, output was stagnant (Hill, 1991). Textile producers started to form employer associations during this period, reflecting more organised industrial institutions. Over the period 1970 to 1985, the textile industry grew slowly and was primarily aimed at meeting domestic demand (import substitution period). Starting from 1986, the textile industry grew rapidly for two reasons. The first was the favourable business environment as the government focused on non-oil manufacturing industries. The second was massive investment, particularly from Japan, which improved the technology used in textile production (see the discussion on the liberalisation period in 6.2.1). As a result, output increased not only in terms of quantity, but also in terms of quality, which made the industry competitive enough to meet international demands. This period represented the peak for the textile industry in Indonesia until the 1997 Asian crisis devastated the industry. The years after the crisis (1998-2003) were the most difficult times for the textile industry. Apart from the troublesome explained above, the sharp hike in minimum wages exacerbated the situation (see the discussion on the 1998-2004 periods in 6.2.1). Within five years, the minimum wage in WJV and CJV increased by 100% and 160%, respectively (BPS). Furthermore, textile industries were labelled as a high-risk industry by the central bank, which limited its access to financial sources (Narjoko and Atje, 2007, p. 36). Even worse, some claimed that the textile industry was entering its sunset phase with little prospects in the future of Indonesian industrialisation (Thee, 2009, p. 576).

It was the government that came to rescue. Regardless of being in their mature stage textile industries are still the largest employers among manufacturing industries (Hill, 1991). Textiles still play a strategic role to absorb the bulk of labour force in the country. Allowing the industry to die off would cost the government dearly in the form of rampant unemployment, which is undesired by any governments in the world. The situation worsened as the Agreement on Trade on Clothes (ATC) was terminated at the end of 2004. This agreement provided exporting countries privileged access (in the form of quotas) to established markets, such as the United States. At the same time, China's textile production grew rapidly since it joined the WTO in 2000. Much harsher competition hit the industry, not only on the global stage, but also in domestic markets. The Indonesian textile industry, which was undergoing a recovery process following the

Asian crisis, suffered a second shock in a relatively short time, leaving the government with no choice but to intervene. By mid-2007, the government started its restructuring programme for the textile industry. The aims were to revitalise old machinery in the industry by offering credit subsidies. As of 2015, according to an official in the Ministry of Industry, the programme was halted in order to review its compliance with international commitments[63].

A brief review of the evolution of the Indonesian textile industry provides some light for this research. The development of the textile industry by far seems to involve the injection of new technology from outside the country. Furthermore, in its development, the industry somehow benefits from the policy set by the government. We have highlighted how the colonial government accelerated the expansion of the textile industry by bringing in new technology to the country and protecting it from foreign competitors. We have also emphasised the massive investment in new technology from Japan during the liberalisation era (1980s-1990s), fuelling the growth of the textile industry in the country. In contrast, due to the lack of external support, the textile industry appeared to be stagnant, or grew slowly, for example, during the post-colonial and import substitution era (1950s-1970s). If this proposition is valid, one may question the role of foreign technologies in the textile industry during the post-crisis period. Upgrading the technical efficiency of the industry seems to be politically difficult, considering the tough labour issues in the country (Nauly, 2014). The textile industry has been and continues to be a 'prima donna' within Indonesian manufacturing due to its export and labour absorption capacity. Thus, expecting the government to do nothing when the industry is fading away seems to be improbable, at least for the foreseeable future.

6.2.3 The evolution of the aircraft industry

Bandung was the birthplace not only of the textile but also for the aircraft industry. Like textiles, the establishment of an aircraft industry was heavily set by the government. Unlike textiles, however, the aircraft industry was 'foreign' to Indonesian manufacturing industry. This means that the efforts required establishing the industry was much more difficult and costly. This section, though more chronologically, addressed the following questions: 1) Who started the industry in the first place and how did it happen? 2) From where and how is the knowledge accumulated? 3) Most importantly, how did the government orchestrate the whole process?

[63] Interview in Jakarta, 27 August 2015.

Written sources record that the first real aircraft built in Indonesia was the PW-1, registered as PK-SAM by Maurits Pieter Pattist and Laurens Walter Walraven in 1931 (Cockpit, 1965; Flight, 1934; PTDI, 2001; see Figure VI-1). The manufacture of the aircraft took place in Bandung involving local engineers, as quoted in the Cockpit Magazine[64] (1965), based on an interview with Mrs. Walraven: 'He [Walraven] claims to be the only constructor building aircraft in the tropics with the aid of natives. Indeed, those Indian boys [Indonesian] were craftsmen and did a great job.'[65] The quote suggests that local engineers had sufficient technical capabilities to manufacture light aircraft.

Figure VI-1 PW-1 in Commercial Advertisement in Flight Magazine, ed. June 1934

June 7, 1934

FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

Founded in 1909 by Stanley Spooner

FIRST AERONAUTICAL WEEKLY IN THE WORLD

DEVOTED TO THE INTERESTS, PRACTICE AND PROGRESS OF AVIATION

OFFICIAL ORGAN OF THE ROYAL AERO CLUB

No. 1328. Vol. XXVI. 26th Year — JUNE 7, 1934 — Thursdays, Price 6d. By Post, 7½d.

Editorial, Advertising, and Publishing Offices: DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1

A LIGHT PUSHER MONOPLANE

Details of an Interesting little Machine with a Pobjoy "R" Engine built in Batavia

UNUSUALLY good performance figures are quoted for a light monoplane built by the Walraven Company at their works at Bandoeng, Batavia, Dutch East Indies. The machine has a Pobjoy "R" engine arranged in a nacelle on "stilts" above the fuselage, and both the view and the comfort for the two occupants should be good.

Mr. H. G. Shaw, of Shell-Mex & B.P., Ltd., who saw it during his tour to Australia, speaks of it as an extremely smart as well as practical aeroplane. The data given are as follows:—

Length, o.a.	20·7 ft. (6·3 m).
Wing span	30·5 ft. (9·3 m).
Weight with two passengers	1·100 lb. (525 kg).
Top speed	121 m.p.h. (195 km/hr).
Landing speed	46 m.p.h. (75 km/hr).

Source: https://www.flightglobal.com/pdfarchive/view/1934/1934%20-%200592.html.

After independence in 1945, the national government started to develop the aircraft industry in a more orchestrated way. First, it sent students to Europe to master aircraft construction. Second, between 1961 and 1963, it established three important institutions, i.e., LAPIP (taskforces for the preparation aircraft industry), aircraft engineering programme at the Bandung Institute of Technology (ITB), and DEPANRI.(National Committee for Aeronautics and Space) in 1961-63. LAPIP, which was later renamed LIPNUR (Nurtanio Aerospace Industry Agency), soon organised two aircraft construction projects jointly with Poland (1961) and Fokker-Netherland (1965).

[64] The magazine was in the Dutch language. Thanks are due to a member of a historical flight group who voluntarily translated the article.
[65] The content in brackets is mine.

The most prominent figure in the Indonesian aircraft industry, B. J. Habibie, accelerated the level of progress. Through his influences in Messerschmitt-Bolkow-Blohm (MBB), a German aircraft company, some Indonesian engineers were purposely trained in that company as part of the preparation to establish a national aircraft industry. His appointment as the President's adviser on advance technology development in early 1974 gave him full access to Pertamina, the state-owned oil company (McKendrick, 1992a; Yuwono, 2002). The appointment clearly confirmed the willingness to combine knowledge and industrial networks (Habibie), resources from the oil industry (Pertamina) and political power (President) in order to realise the vision of a national aircraft industry. In the same year, Pertamina established the new Division of Advance Technology and Aerospace, as well as signed contracts with MBB-Germany and CASA-Spain to build BO-105 and C-212 aircraft.

Despite the uncertainties resulting from volatile oil prices, the government insisted on going ahead with its aircraft industry project. In 1976, IPTN was established with plants in Bandung. The choice of location was apparently driven by the advantage of being close to ITB.

In its development period from 1976 to 1997, IPTN received full government support, not only in financial terms but also in the provision of marketing, protection and many other facilities, such as import restrictions, 'forced' buying by other state-owned enterprises, and military/police and other government-to-government sales. IPTN was set up as one of the strategic industries by Presidential Decree 59/1989, which made sure it received special treatment from the government. Until 2001, IPTN successfully delivered a total of 546 units of aircrafts (fix-wing and helicopter). The transfer of technology also worked smoothly through joint production with global players, such as Bell Helicopter (US), Aerospatiale (France), Eurocopter (France), MBB (Germany) and CASA (Spain). Recently, cooperation with big names, such as Boeing (USA), Airbus (France/Europe), Sukhoi (Russia), have also been established (PTDI, 2001).

However, many consider that IPTN behaved more like a research institute than a business entity (Adenan, 2001). Many of its strategic decisions were driven by ambitious technological achievement rather than commercial considerations. As a result, despite its successful efforts to obtain technical capabilities, it was not sufficient to guarantee its commercial success (McKendrick, 1992b, p. 39). It came as no surprise that the industry collapsed when the Asian crisis struck.

In conclusion, the aircraft industry in the pre-independence era was purely initiated by a small group of individuals who had interests in civil aviation. How intensive the transfer of knowledge was in the manufacturing process involving local engineers at that time is difficult to substantiate. After independence, systematic efforts were made by the government to establish a national aircraft industry. These included human capital development, institutional setups, links with global players, funding from the state-owned oil company, and even trade facilities. However, such huge investments and special treatment had adverse effects on the efficiency and productivity of the state-led industry, thus threatening its long-term sustainability.

6.3 Methods

We use three tools to collect and analyse the data: in-depth interviews, content analysis of document, and tabulation of secondary data. First, in-depth interviews will be conducted to explore the effects of external shocks on industries, the policy responses by government to deal with the shocks, and the industries locational responses particularly in its relation to regional-specific institutions. Second, content analysis of documents will be conducted to investigate the specific industrial policies that might influence the performances of the textile industry in both West Java and Central Java provinces as well as the aircraft industry in West Java. Third, we utilise accessible secondary data to critically validate the interview-based empirics, or to triangulate both of them in order to improve the reliability of conclusion-drawing.

a. Interviews

The aim of the interviews is to directly investigate the effects of shocks, government policies, and regional characteristics on the industry being studied. Specifically, the key information to be retrieved from interviewees is summarised in the following questions:

1. What are the perceived effects of the shocks and industrial policies on the performance of the industry being studied?
2. What have been the general responses by the industry to those shocks and policies, and why?
3. What are the regional industrial characteristics (e.g., infrastructures such as labour, technology, local networks with suppliers and consumers, industrial organizations, raw materials) that influence the performance of the industry being studied?

The key questions act as a guideline for the interviews are formulated in Appendix 12. The responses provided by the interviewees are mapped into a VOC framework to be thoroughly investigated. As it was not possible to interview all the actors involved in the industries, interviews were conducted with relevant government officials as well as several industry representatives, both at national and at local levels. We interviewed 20 source persons, which were mostly conducted in face to face manner between August and September 2016. However, two interviews were conducted several months early and one interview several months later. We conducted two interviews by text messenger facility and by phone, respectively. Appendix 13 lists all the interviewees, while Appendix 14 presents a sample of interview summaries.

Most of the participants in the interview are categorised as an elite in the bureaucracy and industries, although two or three respondents represent medium enterprises or occupy middle managements position in his/her company or institution. However, the interviewee representing medium enterprises can be considered as an elite, given his influences and position as the owner of one of the oldest textile company in Majalaya. As a method, elite interview have its own advantages and disadvantages. Schoenberger (1991) concluded three advantages of conducting elite interview. First, elites are very resourceful person not only in terms of power, but also in terms of knowledge about their fields. It may help a researcher to comprehend the underlying reasons behind the complex processes of a subject being studied. Second, it has merit to understand the economic behaviour of firms as institutional agents. Third, elite interview can lend a researcher a tool for inductive hypothesis building about the subject being studied.

However, elite interviews cannot escape from criticism that we must be aware of. One of the criticisms that are frequently discussed in the literature is about power relations in the interaction between an interviewer and the interviewees (McDowell, 1992; Smith, 2006). Apparently, the elites may exert their powers to an interviewer during an interview, which may affect the course of the research. Moreover, some scholars, such as Oglesby (2010) and Cochrane (1998), raise other issues about gaining access to the elites and disseminating the result of the interviews. Accessing the elites is often an exhausting effort and the elites are highly sensitive to the results of the research, particularly those which are opposing their interests. However, other scholars, such as Kezar (2003) and Smith (2006), argue that the weight of power relation does not necessarily lean towards the elites, rather it is unpredictable and variable. Furthermore, they reiterate the appropriateness of collaborative approach in the context of elite interviews as a form of reciprocal learning rather than power relations. Our own experiences in conducting elite interviews suggested that gaining access to the elites was much more challenging than conducting the interview itself.

b. Document analysis

The main objective of the document analysis is to reveal whether or not governments adopt preferential policies in the development of particular industries. A selection of documents reviewing industrial policy in Indonesia, including specific policies on the textile and aircraft industries, has been produced by international development agencies, such as USAid, the Asian Development Bank and the WB.

Those documents can easily be accessed via those agencies' websites. Policy documents, such as development plans, decrees and bills, are now available online via many government's official websites. Local research institutes, such as Smeru and Akatiga, have also published reports related to the textile industry. The development and policy concerning the aircraft industry can be traced through speeches by B. J. Habibie, the most prominent figure in the Indonesian aircraft industry, and reports from the Ministry of Research and Technology. Specifically, the following key information is expected to be obtained from the document analysis:

1. What are the policy responses from government to deal with the shocks experienced by the textile and aircraft industries?
2. What are the rationales underlying those policy conclusions to either actively support or leave an industry to market competition?

c. Triangulation with secondary data

This is the way in which we reconfirm the validity of interview-based data. We either confirm or refute the empirical data drawn from the interviews by tabulating relevant secondary data. For a simple example, if the interviewees claimed there were higher wages in WJV than in CJV, we test the validity of that claim by displaying secondary data on minimum wages in both provinces. In cases where relevant secondary data support a claim, we conclude that the claim is valid; otherwise, we query the claim. In addition, secondary data are often useful to complement the probably incomplete or subjective information collected from the interview. The triangulation of interview-based information and secondary data would improve the validity and reliability of conclusion drawing. For secondary data, we use I-O data for 2000, 2005 and 2010, as published by the BPS. We distil some of the information about industrial relations from the official publication of the Ministry for Manpower and time-series data on regional minimum wages, as compiled by the BPS.

6.4 Empirical results

In this section, we address the lines of inquiry set out at the start of this chapter. We have presented some evidence of how WJV lost its specialisation in textiles, while CJV has gained more specialisations in recent years. We have also highlighted the unique phenomenon of the emergence of the aircraft industry in WJV, which leaves us with something to explain. Our interview-based analysis has put forward four factors concerning regional industrial institutions, which frame the explanation, i.e., labour market, industrial relations, inter-firm relations and network of knowledge. We begin with an important clarification on the role of the textile industry within Indonesian manufacturing.

6.4.1 The role of textile industry in manufacturing industry

The purpose of the discussion in this section is to clarify the position of the textile industry within Indonesian manufacturing. This discussion is necessary to avoid any confusion because the textile industry has existed in the country for quite a long time and now is in its mature phase. The prevalent expectation is that the industry should be on the brink of declining, instead of emerging. If that is the case, the emergence of the textile industry in CJV should be considered as a divergent case, while the decline of the industry in WJV should be viewed as a normal incident. Here, we clarify whether the textile industry is still growing in both provinces. This solidifies our stance that the textile industry in WJV is still evolving in the expected direction. Furthermore, we argue that the position of the textile industry has shifted not only within manufacturing, but also between regions.

After its golden pre-crisis era, the textile industry was judged as a 'sunset' industry (Bisnis Indonesia, 2015; Thee, 2009). The arguments are linked to notion of industrial transformation in which manufacturing industries move away from light consumer goods and resource processing towards heavier high-tech industries (Haryo Aswicahyono et al., 2011, p. 3). A similar tone has also been expressed by the Chairman of WJV's Department of Industry and Trade, who stated that the textile industry was even considered as a sunset industry in the last five to 10 years. However, it is unclear who initially make this claim and how it spread among stakeholders in the textile industry. No doubt the fierce competition from China, which has hit the textile industry very hard, has weakened its overall competitiveness, even in domestic markets[66].

We encounter the views on the sunset industry idea with manufacturing data in Table VI-3. In terms of output, added value and employment, official industry data confirm that the share of the textile industry in the country's manufacturing sector was declining between 2000 and 2012. Furthermore, the textile industry has become less important than it was in 2000 in terms of all those parameters.

[66] Interview in Bandung, 14 August 2015.

Table VI-3 Declining Contribution of the Textile Industry in the Manufacturing Sector

Year	Output	Added value	Employment
2000	14.58%	13.49%	26.27%
2012	7.41%	7.96%	21.96%

Source: Manufacturing Industry Survey, BPS.

Optimistic views, however, are also prevalent. Textiles were still a dominant industry in the manufacturing sector and ‘it would be a serious mistake to regard it as a ‘sunset industry’’ (James et al., 2003, p. 93). Sources internal to the industry itself seems reluctant to consider itself as a sunset industry, although representatives admit that the industry has been declining since the 1997 Asian crisis. As highlighted by the Chairman of WJV’s API, the textile industry seems to be a sunset industry. Many textile institutes/schools are closing down, while technologies and machinery used in the industry are worn out. Machinery must be imported, while capital goods are faced with high tariffs. Nevertheless, there have been efforts by the government to restructure the industry in the form of renewal programmes involving credit subsidies. Furthermore, the lack of macro infrastructures has caused high transportation costs[67]. It seems that the industry representative himself is a self-declared in-between position. On the one hand, he acknowledges the overall decline of the textile industry. On the other hand, he indicates that the industry is now undergoing a renewal process, thanks to the government’s supportive policies.

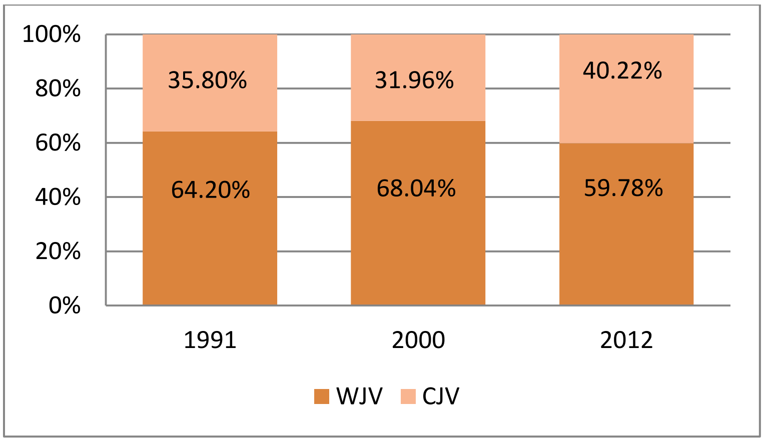
The Ministry of Industry, as quoted in the media in 2015 and published on its official website, states that ‘the sunset industry verdict has been proven deniable. The restructuring programme in the textile industry in the last seven years has successfully increased production capacity by 14-19%, improved productivity by 4-10%, and increased energy efficiency by 2-8%. Moreover, the industry has absorbed more than 100,000 workers’[68]. Even though this statement suggests an improvement in the performance of the textile industry since 2008, it implicitly admits the decline that was taking place before restructuring. However, one of the interviewees from the API’s Headquarters in Jakarta challenged the notion of a sunset industry by offering a convincing argument that the global demand for textiles has been high and promising[69]. Even the Vice President of the largest textile producer, Sritex, supported the argument by saying that it is good news that textiles not only satisfy primary needs but are also

[67] Interview in Bandung, 22 September 2015.
[68] http://kemenperin.go.id/artikel/13332/Menanti-Sunshine-Industri-Tekstil.
[69] Interview in Jakarta, 24 August 2015.

emotional goods. The demand for textiles keeps growing, whatever the situation[70]. These arguments are backed by a statement from a high-ranking official in Soreang's Bappeda. According to her, new investments in the textile industry are still flowing into the region (Soreang, WJV), particularly in the garment sector. This suggests that new players in the industry have actually moved to the region. She has witnessed the expansion of the garment sector, which constitutes the creative economy of the region, in the last few years[71].

If the data in Table VI-3 show that the industry experienced a consistent decline, how come different views exist on whether or not the textile industry is a sunset industry? This question brings us back to the facts on which we base our inquiries: WJV is losing specializations, while CJV is gaining specializations in textiles. In other words, the textile industry is still growing, at least in CJV. We can trace this phenomenon further by looking at the changes in the composition of plants between WJV and CJV. Figure VI-2 tells us that, even though WJV still has more plants than CJV, the share between the two has started to level out. What is more interesting is the fact that there were negative net entries in WJV during the 2000s, while net entries were highly positive in CJV (Figure VI-3). This suggests that the textile industry is thriving in the latter. Similarly, CJV's outputs, value added and employment situation are all improving relative to its neighbouring province of WJV. It is important to note that, in terms of nominal value, WJV's output and value added were increasing (Figure VI-4, Table VI-4). However, employment has been decreasing since 2006, suggesting improved productivity. Therefore, even though the weight of textile production shifted towards CJV in the 2000s, WJV's textile industry was in fact still growing.

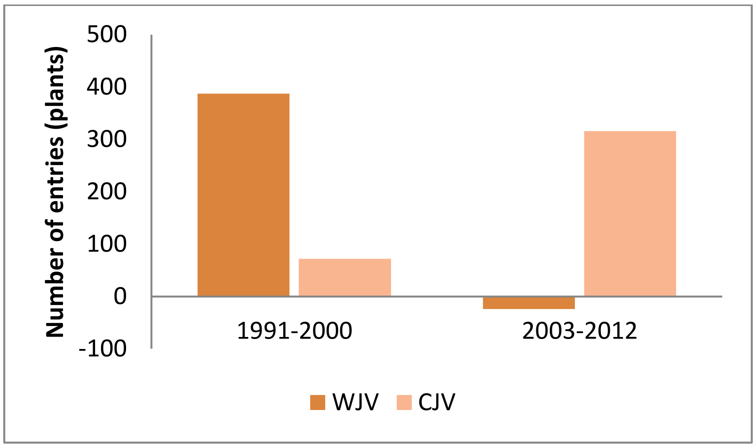
Figure VI-2 Share of Plants in the Textile Industry



Source: Manufacturing Industry Survey, BPS.

[70] Interview in Sukoharjo, 4 September 2015.
[71] Interview in Soreang, 20 August 2015.

Figure VI-3 Net Entries of Textile Plants

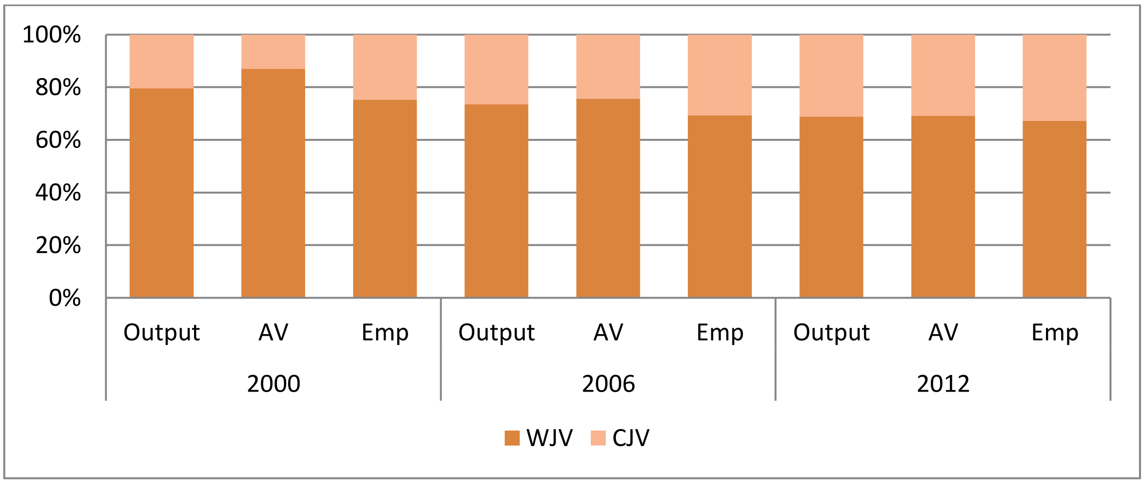


Source: Manufacturing Industry Survey, BPS.

Note: Calculated, based on three-year gap. This means that the entries refer to plants that did not exist three years before, but are present three years later. Exits are plants that were present three years before but do not exist three years later.

In sum, the roles of the textile industry have shifted, not only in manufacturing sector, but also regionally. While the share of the textile industry is being squeezed in manufacturing industry overall (see Table VI-3), regionally it is shifting from WJV to other provinces, particularly to CJV. As a matter of fact, the industry is still growing in West Java, Central Java, and Indonesia in general. Next, we identify some specific cost and regional factors, which emerged in the interview that counts to the phenomenon.

Figure VI-4 Output, Added Value and Employment in the Textile Industry in West Java and Central Java (2000, 2006 and 2012)



Source: Manufacturing Industry Survey, BPS.

Note: Nominal values are displayed in Table VI-4 below.

Table VI-4 Output, Added Value and Employment in the Textile Industry in West Java and Central Java (2000, 2006 and 2012)

		WJV	CJV
2000	Output	60,286,293,861	15,467,713,011
	Added Value	22,665,418,143	3,407,388,415
	Employment	654,867	214,592
2006	Output	68,547,420,845	24,776,966,533
	Added Value	26,337,462,435	8,451,070,162
	Employment	544,980	240,322
2012	Output	109,341,924,719	49,537,490,607
	Added Value	45,703,426,022	20,475,791,820
	Employment	533,975	259,183

Source: Manufacturing Industry Survey, BPS.

Note: Output and added value are in IDR thousands, while labour in people.

6.4.2 Differences in labour market: higher versus lower wages

Within the industry life cycle framework, mature industries, such as the textile industry, focus their efforts on improving efficiency through scale economies and cheaper production costs, rather than exploring new product development or technological innovation (Klepper, 1997; Utterback and Suárez, 1993). Mature industries are often characterised with standardised products and harsh competition for lower prices. Thus, cheaper production costs, for example, to cover raw materials, labour, energy, transportation, taxes and risks of uncertainty, are essential to sustain their existence. Those costs are sensitive to the locational choice of the plants. Therefore, such plants always seek regions with lower domestic costs for their production location (Hausmann and Rodrik, 2003). With regard to this analysis, some of those costs are invariant across provinces as they are set at a national level, e.g., energy tariffs, export/import levies, employment benefits/insurance, and major transportation facilities, such as seaports and highways. However, many of those costs are set by local institutions, such as labour costs in the form of minimum wages, local taxes and environmental costs. This section concentrates on minimum wages for two reasons. First, they reflect a factor cost (the cost of labour) and the institution of the labour market. Second, this issue stood out during the interviews. Despite the rather deterministic claim over its role in driving the textile industry to flourish in CJV, we argue here that the effect of a minimum wage on the expansion of the textile industry in this province, along with its contraction in WJV, is significantly exaggerated.

Our econometric province models in Chapter 5 show that a minimum wage has a substantively very small and statistically insignificant negative effect on the changes in the number of industries in a province (see Table V-3). One unit increase in a minimum wage negligibly reduces the number of industries in a province. This relation applies generally to all industries in all provinces, based on panel data on the manufacturing industry for 1991-2012. Our finding seems similar to that of Cameron and Alatas (2003), who said that 'there was no evidence of more firm closures or less openings resulting from the minimum wage increase for any type of firms' (p. 32).

However, our interviewees from the textile industry in WJV and CJV seem to contradict the econometric results. Most interviewees agree that wage differences between the two provinces represent a responsible factor, among others, behind textile expansion in CJV and its contraction in WJV. Interviewees in central government pointed to labour costs as representing one of the main drivers. An official in the Ministry of Industry, for example, stated that labour costs increased faster in WJV than in CJV[72]. Likewise, an interviewee from Bappenas raised the same concern by putting forward evidence that a group of textile industrialists from South Korea complained to Bappenas regarding labour issues. They were considering moving to CJV due to cheaper labour costs, but could not find suitable industrial estates to accommodate their plants, which is basically an infrastructure issue[73]. An official from the BKPM provided a more general opinion by saying that the main motivation behind investment has always been about market expansion and cheaper labour, highlighting that WJV is still preferred by foreign investors, primarily because of its markets and better infrastructure[74].

However, interviewees from WJV's administrations seemed reluctant to admit that labour cost is the primary cause for the contraction of the textile industry in their province. For example, an official of WJV's Department of Industry and Trade and Bandung District's Bappeda stated that increased minimum wages have been a pressing issue in WJV, without making specific reference to the relocation of textile plants to CJV[75]. In contrast, a CJV administrator (in Sukoharjo's Department of Industry) argued that a lower minimum wage has attracted some textile plants from WJV to her regions. According to her, at least five new textile plants established in Sukoharjo were previously operated in WJV. Their owners sought locations with affordable land and a cheaper and less resistant labour force[76].

Textile industrialists in CJV signalled interesting views. A migrating plant highlighted factors other than wages. As he pointed out, being located in CJV offers some

[72] Interview in Jakarta, 27 August 2015.
[73] Interview in Jakarta, 10 September 2015.
[74] Interview in Jakarta, 18 August 2015.
[75] Interview in Bandung, 14 August 2015, and in Soreang, 20 August 2015.
[76] Interview in Sukoharjo, 4 September 2015.

advantages. Besides cooperative workers, local institutions are conducive to doing business. The ease in obtaining a permit, exporting and dealing with environmental issues is important for exporting plants such as his. However, some infrastructural issues remain. Energy is sufficient, but the tariff is not competitive. A seaport is available and its services are relatively good; however, the supply distribution network is not fully established yet[77]. Note that the interviewee did not include lower wages as one of the advantages of being in CJV. However, when we asked about labour cost issues, he raised some concerns about the additional burdens borne by the company over a new social insurance system rather than wage issues. However, an existing industrialist in CJV articulated a dissenting view about textile industry expansion in CJV, concluding that the expansion has been dominated by 'old players'[78]. There were only a few new players in the industry. He also indicated that the minimum wage has not been a serious issue for the textile industry in the regions. This industry has still been a dominant one in the region and its influence in determining the minimum wage has not been negligible[79]. This implies a degree of political weight, which is usually exercised by mature industries. Nevertheless, the interviewee qualified his answer by stating that the minimum wage should not be set politically, but objectively by taking into account local living costs.

The contradiction between the results of econometrics[80] and the interviewees' statements has driven us to scrutinize the data on minimum wages more carefully. We calculate the ratio of minimum wages between the two provinces across time. Table VI-5 shows that the ratio was quite low during the 1990s (i.e., 0.73 on average), suggesting a wide gap in minimum wages between the two provinces in that period. However, the ratio significantly narrowed during the 2000s (0.93 on average). This fact suggests that, if minimum wages represented the primary driver for locational decisions of textile plants, the textile industry should have been flourishing in CJV in the 1990s instead of the 2000s. Table VI-6 further disputes labour cost arguments and informs us that labour productivity in the textile industry in WJV was around double that of CJV. Moving out to benefit from 10% cheaper labour costs, but 50% less productivity, seems to be unreasonable. Thus, the locational motivations behind cheaper labour costs (low minimum wage) should be read with caution and still open to questioning. Furthermore, the very small coefficient of a minimum wage in the econometric analysis signals its

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[77] Interview in Sukoharjo, 4 September 2015.

[78] It is unclear what he meant by 'old players', i.e., was he referring to existing industrialists in WJV or only those in CJV? Nevertheless, in the context of conversation, it would appear that he was referring to the textile industry as whole.

[79] Interview in Sukoharjo, 7 September 2015.

[80] Note that the econometric analysis is performed for all industries (not just textiles).

trivial influences. Other regional industrial institutions must play more important roles here.

Table VI-5 Minimum Wage 1994-2012 (in IDR Thousands)

Year	West Java	Central Java	Ratio
1994	114.0	81.0	0.71
1995	138.0	90.0	0.65
1996	156.0	102.0	0.65
1997	153.6	113.0	0.74
1998	160.0	130.0	0.81
1999	208.8	153.0	0.73
2000	230.0	185.0	0.80
2001	245.0	245.0	1.00
2002	280.8	314.5	1.12
2003	320.0	340.4	1.06
2004	366.5	365.0	1.00
2005	408.3	390.0	0.96
2006	447.7	450.0	1.01
2007	516.0	500.0	0.97
2008	568.2	547.0	0.96
2009	628.2	575.0	0.92
2010	671.5	660.0	0.98
2011	732.0	675.0	0.92
2012	780.0	765.0	0.98
2013	850.0	830.0	0.98
2014	1000.0	910.0	0.91
2015	1177.0	1100.0	0.93

Source of data: BPS (1997-2015) and Bappenas (1994-1996)

Table VI-6 Labour Productivity (Output/Labour)

	2000	2003	2006	2009	2012
WJV	84,735	77,601	90,924	117,490	176,315
CJV	29,837	37,546	45,232	86,464	95,543
Ratio	0.35	0.48	0.50	0.74	0.54

Source: Manufacturing industry survey, BPS.

Note: in IDR thousand per labour.

In sum, does a lower minimum wage really contribute to the expansion of the textile industry in CJV, and does a higher minimum wage suppress it in WJV? We find conflicting evidence when seeking an answer. The non-compliance problem might interfere with the observation (Pratomo, 2011) that it probably widens the gap between real wages received by workers in the two provinces. Some studies, however, suggest otherwise. Greater compliance with the minimum wage has been detected since the 1990s (Suryahadi et al., 2001, p. 56). The distribution of real wages has been concentrated close to the minimum wage, offsetting the non-compliance arguments (Cameron and Alatas, 2003, p. 13). During the interview, we also observed that interviewees often raised the issue about different attitudes of labour force between WJV and CJV. We investigate this issue in the following section.

6.4.3 Differences in industrial relations: more versus less organised labour unions

One of the issues that we seek to compare through the interviews is the industrial relations between the two provinces. It is argued here that WJV and CJV have two distinct institutions of industrial relations, with CJV being more favourable to the textile industry in this regard. When performing the investigation, we asked for the interviewees' opinion regarding labour behaviour and attitude, and how organised they are. We critically triangulate the empiricism constructed through the interview with relevant secondary data. Before that, the contrast dynamics of industrial relations prior to and after the Asian crisis will be briefly reviewed to familiarise readers with the broader political context surrounding the process.

Under Suharto's authoritarian regime, labour unions were tightly controlled by the government. The only labour union recognised and steered by the government was SPSI (Indonesian Labour Union) established in 1973. However, in the early 1990s, the labour movement started its struggles. Several independent labour unions were established initiated by popular activists and political figures. The struggles attracted attention of the International Labour Organization, which put the government under international pressure. However, the authoritarian regime at that time seemed undaunted by the pressures and responded by arresting prominent figures of the labour movement for subversive reasons. It was not until 1998 that the first independent labour union was officially recognised by the government. In 2000, a bill on labour unions was enacted (GOI, 2000) and pro-labour pressures have increased since then. Concern about these pressures was raised by an official from the BKPM, who said that industrial relations are still an unsettled nationwide issue, which had worried potential investors about the stability of their investments in Indonesia[81].

The general impression I had in mind after finishing all the interview was that labour in WJV was more resistant, militant and organised compared to labour in CJV. Several reports share similar impressions[82]. Those labour identities have cost WJV its textile industry. Indeed, WJV's API admitted that labour issues have been much more challenging in WJV than in CJV. The fact that skilled labourers are easily found in WJV is one thing, but that they are more difficult to manage is another thing. He added that labour in CJV is more diligent and obedient, but less disciplined[83]. At this point, the responses of the interviewees sound too subjective; however, both local governments and industrialists are echoing similar responses.

Bandung District's Bappeda, for instance, admitted that labour in the textile industry strike quite often, particularly at the end of the year when the next year's minimum wage discussions begin. Certainly, the strikes affect short-term productions[84]. In contrast, CJV's Bappeda stated that, in general, labour in its province strike less often than in WJV. In his opinion, labourers in CJV were probably less organised than those in WJV. However, he added, the labour force in CJV was considered to be 'less diligent' than in WJV. The labour force in CJV was characterised by a mixed skill set distributed between agriculture and manufacturing. Some labourers were still engaged in agriculture activities, even though they formally worked in a textile factory[85]. An official at Sukoharjo's Department of Industry confirmed the story by far. One of the motivations of any incoming textile plant was a less resistant labour force, apart from affordable land. When asked further why Sukoharjo's labour force was less resistant, the interviewee argued that the character and attitudes of Javanese people mean that they highly value obedience and loyalty as a way of life. The operation of the textile industry in Sukoharjo has been relative stable thus far, she added. Obviously, a well-behaved labour force has minimised the scale of industrial conflicts. There were some up and down in manufacturing industry, particularly in the electronic and rattan industry. However, in general, the textile industry in Sukoharjo has been less affected[86].

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[81] Interview in Jakarta, 18 August 2015.
[82] Juliawan (2011, p. 99) finds fewer labour conflicts in CJV, stating that 'it has since gained a reputation as a stable and friendly industrial area'. KPPOD (2016, p. 64) ranked CJV in top place in the category of managing industrial relations issues, while WJV was in 19th place out of 32 provinces.
[83] Interview in Bandung, 22 September 2015.
[84] Interview in Bandung, 20 September 2015.
[85] Interview in Semarang, 3 September 2015.
[86] Interview in Sukoharjo, 4 September 2015.

From industrialists' point of view, labour attitudes in CJV are more manageable. As revealed by an interviewee from an exporting company, who stated that industrial relations between the employer and employees in his company, and in CJV generally, have been highly conducive. Interaction and communication between the company and employees have been relatively smooth, thanks to the employees who prefer to talk rather than strike[87]. In addition, a prominent industrialist specialising in batik products echoed a similar view that workers are available and easy to recruit, and more cooperative culturally[88].

A less resistant or more cooperative labour force in Central Java could be a by-product of Javanese culture, which emphasises the value of obedience in society[89]. It can also be a by-product of an industry structure that is dominated by small family-based enterprises. Industrial relations in these enterprises are usually built on affinity and less formal in nature. Indeed, an official in Solo's Bappeda highlighted this issue by stating that managing workers in SMEs is not the same as managing workers in large manufacturing plants. The working relations in SMEs are based on affinity rather than an industrial relationship[90]. Nevertheless, one interviewee argued that the attitude of labourers somehow relates to the level of development. He stated that the labour force in WJV was less resistant and more obedient in the 1990s, just like CJV nowadays[91]. However, we have to read this claim cautiously by taking into account the fact that the authoritarian regime was still in power at that time.

Thus far, all responses point to a conclusion that CJV's labours are culturally more cooperative, obedient, and less organised than that in WJV. To what extent this prevalent view is validated by surveyed data? Table VI-7 juxtaposes some indicators on industrial relations for both provinces in 2013[92]. The number of labour unions[93] may suggest two opposing conditions. It can be viewed as representing a more organised labour force, or it can also be interpreted in terms of more fragmented structures. For example, labourers within a plant are arguably more organised under one union than under two or more unions. In this sense, more labour unions could suggest a more fragmented labour force. If we take into account the number of plants in WJV and CJV in Table III-2, it is reasonable to infer that the number of unions in CJV is relative high

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[87] Interview in Sukoharjo, 4 September 2015.
[88] Interview in Sukoharjo, 8 September 2015.
[89] Apart from the interviews, the writer's own experiences as a native Indonesian confirms this view.
[90] Interview in Solo, 9 September 2015.
[91] Interview in Jakarta, 24 August 2015.
[92] Time-series data are difficult to obtain. 2013 data are used to provide general ideas with which to contrast industrial relations in WJV and CJV.
[93] A labour union is an independent organization that can be established within or without a business/production unit. A plant may have more than one union, but a worker can only be a member of one onion. According to regulations, a union must have at least 10 members.

compared to WJV. This indicates that CJV has less organised, or more fragmented, labour than WJV. Moreover, if we look at the level of involvement of labour in industrial organisation, 8.57% of total 18.7 million labour forces in WJV were registered with a labour union, while only 3.60% out of 16.5 million were registered with a labour union in CJV in 2013. These statistics reasonably confirm that the industry structure in CJV is dominated by small and micro enterprises, in which industrial relations is based on affinity rather than formal industrial relations (see Table III-2).

Table VI-7 Industrial Relations Characteristics in West Java and Central Java (2013)

Industrial relations indicators	West Java	Central Java
Labour unions (units/members)	3,181/1,606,161	2,720/592,776
Bipartite body (unit)*	1,250	1,557
Working agreement (unit)**	1,189	784
Strikes (number)	157	10

* A body at the level of a business/production unit, which is established jointly by employees and employers

** Agreement between a labour union(s) and employers

Sources: Publication of the Ministry of Labour Forces.

Other features of industrial relations that are worth discussing are bipartite bodies[94] and working agreements[95] (commonly known as LKBs and PKBs, respectively). WJV has more labour unions but formed fewer LKBs than in CJV, suggesting there are more cooperative labourers in CJV. In contrast, formal agreements between unions and employers are prevalent in WJV, implying much more active labour unions in this province. Furthermore, labour strikes are commonly used to assert the solidity of organised labour. Official data show that WJV experienced many more labour strikes in 2013. We managed to find a longer record of strikes from the Global Database of Events, Language and Tone, as displayed in Figure VI-5. Apparently, CJV is 'much cooler' for industrialists than WJV.

In addition, tougher industrial relations in WJV have had significant impacts on the stability of national economic and politics, as it shares boundaries with the capital city of Jakarta. As an official at the Ministry of Industry highlighted, there were views that a labour-intensive industry like textiles could cause some problems if it was located too

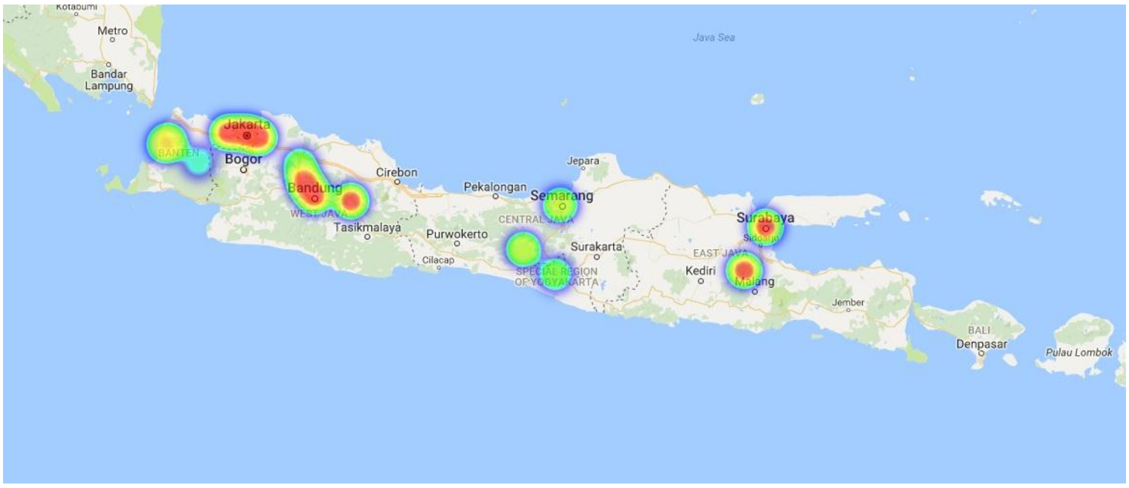
[94] An LKB is a body established jointly by employers and employees at the business/production level to facilitate communication and consultation in the interests of both parties.

[95] A PKB is formal agreement made by labour union(s) and an employer or group of employers concerning conditions, rights and obligations with regard to both parties.

close to the capital city. Labour strikes could affect the stability of not only economic activities in Jakarta but also nationwide politics. In some cases, labour strikes were so serious that they worried foreign investors and engendered economic losses. The textile labour force could be large in numbers, but labour strikes are usually initiated and organised by a labour union in other industries, such as steel. Labourers in the steel industry are well known for their militancy in campaigning for their interests to be met. Using union networks, labour unions in other industries, including textiles, are mobilized[96]. This somewhat explains why the government seems to support the relocation of the textile industry from WJV to CJV.

We dare ourselves to conclude that industrial relations characteristics between WJV and CJV are distinct. The languages and tones captured in the interviews emphasising the cooperative characteristics of CJV's labour force, such as being more obedient, less organised and less resistant, while preferring to talk than strike, are verified by official data. Therefore, the difference in industrial relations is arguably attributable to the flourishing phenomenon of the textile industry in CJV. This industry is labour-intensive, and textile industrialists are highly sensitive to this issue. In WJV, labour issues in the textile are much challenging than in CJV[97]. Textile industrialists in CJV also confirmed that labourers in their regions are more cooperative, which is echoed by local administration staff as well. Next, how the difference in industrial relations affects the techniques of production is discussed.

Figure VI-5 Heat Map of Labour Protests (1991-2012)



Source: http://data.gdeltproject.org/analytics_user/20170305220132.24822.heatmap.html.

[96] Interview in Bogor, 10 September 2015.
[97] Interview in Bandung, 22 September 2015.

6.4.4 Differences in inter-firm relations and technique of production

We have discussed the relatively greater labour pressures in WJV and increasing wages in both provinces. Here, we examine how the textile industry responds to those pressures and how the responses are different. In doing so, we highlight some forms of response introduced by industry, by discussing 'makloon' practices and capital deepening to improve productivity. The argument that this section tries to put forward concerns how the textile industry, instead of simply moving to new locations, tends to remain in its host regions by adapting and learning from what is locally available.

6.4.4.1 Practice of 'makloon' as a division of labour

As an industry reaches its maturity stage, one would expect innovation to be incremental, rather than radical; production should be on a mass scale, rather than customise; competition should be based on price/efficiency, rather than on quality; markets should be standardised, rather than early adopters; and barriers to entry should be high, rather than low (Klepper, 1997). The textile industry is a mature industry, which, one way or another, has reached a higher level of efficiency. Efficiency improvements through the division of labour, either intra-plant or inter-plants, has been empirically proven from Adam Smith through Fordism to the flexible production era. Here, we focus on examining how the textile industry in both provinces reaps the benefit of scale economies through different forms of the division of labour.

During the interview, we were struck by the fact that 'makloon' or subcontracting practices are less common in CJV. In contrast, 'makloon' to a third party is a common practice in WJV, particularly in small and medium industries. As an industrialist in Majalaya (WJV) admitted that in the 1980s, the 'makloon' system became popular among players in the industry. It was not clear how 'makloon' was introduced; however, the terms used were adopted from the Dutch language[98]. The prevalence of 'makloon' practices, at least in Majalaya, suggests the strong presence of the division of labour across firms. The common 'makloon' practice in WJV was verified by API headquarters as a division of labour to improve efficiency in the form of subcontracting ('makloon'); this has also been a common practice in JKT, but not in the case of CJV[99]. This also implies that the nature of inter-plant relations in WJV leans towards cooperation, rather than competition. This practice, according to an official in the CJV administration, is

[98] Interview in Majalaya, WJV, 21 August 2015.
[99] Interview in Bandung, WJV, 22 September 2015.

less common. Plants tend to internalise their production activities in their own plants[100]. Unlike WJV, this practice implies a more competitive nature of inter-plant relations in CJV.

We compare the findings from the interviews with available official data provided by the AMS, which asks every plant about its additional revenues, including from manufacturing services it sells to others. We normalise the 'makloon' revenue to total revenue of the industry. As a result, we end up with an interesting observation that, for the garment subsector, the level of 'makloon' is unprecedentedly similar in both provinces. In fact, 'makloon' activities in 2012 were slightly higher in CJV (24.81%) than in WJV (23.96%). However, the case was different for the weaving subsector. In 2012, WJV's subcontracting activities in the weaving subsector reached 9.13% of its total revenues, whereas it was only 1.72% in CJV. This figure seems to correspond with what the interviewees had in mind when comparing WJV and CJV. Note that a higher level of subcontracting activities does not necessarily mean more efficiency than in internal productions. Nevertheless, it tells us how plants respond differently within different regional settings. How different responses affect the overall productivity of plants will be discussed next.

6.4.4.2 Capitalisation of production for technical efficiency

Changing local environment has presented plants with two simple choices: adapt quickly or move to different locations. For instance, increased labour costs, *ceteris paribus*, automatically raise production costs, which in turn weaken market competitiveness. In this case, for instance, plants can either move to cheaper locations or improve efficiency through mechanisation. The latter seems to be the case for WJV's textile industry. Increasing wages and tougher pro-labour relations have put pressure on plants to take corrective actions regarding their production techniques. As an interviewee from API headquarters put it, an alternative strategy to encourage plants to stay in WJV involves improving labour productivity and relying on technology. In general, productivity is higher in WJV than CJV, and thus far WJV has demonstrated a consistent increase in productivity. The revitalisation of machinery[101], launched by the government in 2008, has been highly effective, with plants in WJV being highly enthusiastic about their involvement in the programme. This suggests a serious attempt by plants in WJV to improve productivity. In contrast, CJV seems to focus on

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[100] Interview in Sukoharjo, 4 September 2015.
[101] In the form of credit subsidies for capital goods.

promoting expansion, rather than improving productivity[102]. Consistent with that observation, an official from WJV's Department of Industry and Trade highlighted that the distribution of the programme is concentrated in WJV, which has received 60% of the benefits[103].

The official data confirmed the observation conveyed by interviewees. Table VI-8 demonstrates that productivity in WJV was rapidly sinking prior to the revitalization programme. After the programme started in 2008, WJV's productivity rapidly improved, approaching its 2000 level in 2012. Regardless of the decline, overall productivity in WJV was still higher than that of CJV, which also showed an increasing trend in productivity but at a slower pace. Even more interestingly, CJV's productivity was actually declining relative to its 2009 level after the initiation of the revitalisation programme. One of the causes of the decline in CJV seems related to the increase in the labour force size in the industry, whereas the opposite is true for WJV (see Table VI-4). This fact confirms the view that the textile industry in CJV Central Java concentrates more on expansion than on improving productivity[104]. In contrast, tougher industrial relations have left plants in WJV with no alternatives but to rely more on technologies to improve productivity and neutralize the risks.

Table VI-8 Productivity in the Textile Industry (Output/Input)

	2000	2003	2006	2009	2012
West Java	9.5	3.8	4.2	4.0	7.2
Central Java	2.4	2.6	2.8	5.8	4.5

Source: Manufacturing Industry Survey, BPS.

In conclusion, the labour-intensive textile industry continuously faces pressure from increasing wages and pro-labour movements. However, the way the industry responds to those challenges is different in different regions, depending on the extent of the pressures and industrial institutions in each region. While WJV focuses on technical efficiency, with the aim of improving productivity, CJV seems to prefer scale efficiency by expanding its production further. In addition, the division of labour, in order to improve efficiency, is carried out differently across provinces. WJV somewhat prefers to externalise its production process (e.g., via 'makloon' activities), whereas CJV tends to internalise it within the plants. Which one is more efficient is beyond the scope of our

[102] Interview in Bandung, 22 September 2015.
[103] Interview in Bandung, 14 August 2015.
[104] Coelli et al. (2005, pp. 3-5) refer to these as scale efficiency and technical efficiency, respectively.

analysis. The main point we attempt to highlight is that industry tends to behave according to its regional institutions, while utilising knowledge and practices that are regionally available.

6.4.5 Network of knowledge

We have discussed the historical development of the aircraft industry in Indonesia, which started independently at a private workshop in the pre-independence era. It was then heavily organised by the government for the purposes of technological acquisition in the pre-crisis period, then forced onto a commercial platform after the crisis. As the aircraft industry is highly driven by the state, it is not possible to ignore the role of government in the analysis. This analysis, however, is not about criticising industrial policies imposed on the industry. Rather, we try to frame it in terms of learning processes of how external knowledge is integrated with the existing local knowledge.

We argue that adopting external knowledge, which is cognitively distant from existing local knowledge bases, may be beneficial in the long run, but it may also be risky and costly if not supported by local knowledge. Therefore, in order to make new knowledge or technology commercially competitive, it must be integrated with existing regional knowledge. In the following, we briefly discuss recent development in the literature regarding connection between local knowledge and global production network. After that, we explore the evolution of regional knowledge using the case of Indonesia's aircraft industry.

6.4.5.1 Local knowledge and global production network

In the literature, knowledge creation can take place within organisations (Cohen and Levinthal, 1990), within clusters or regions (see the review on agglomeration in Table II-1), or through global pipelines (Bathelt et al., 2004). On the one hand, economic geographers (e.g. Storper, 1997) often put a strong emphasise on the role of geographical proximity with its endogenous 'relational assets' or 'untraded-interdependencies' in promoting regional development. These region-specific institutional settings facilitate intense interactions among local economic agents, leading to knowledge sharing and creation that eventually bring about regional development. On the other hand, those adopting a more macro or global perspective view regional development as part of dynamics in which regions or nations are increasingly integrated into global production networks (Coe et al., 2004; Gereffi et al., 2001). Regional development is thus viewed as to what extent regions fit within the network of global value chain. At this stage, the two strands of literature seem to suggest a split in the conceptual framework to deal with regional development.

In fact, economic geographers, particularly those who engage in Geographical Political Economy (see Section 2.1), are quite aware about the extra-region links that shape the process of regional development. The notion of Spatial Divisions of Labour (Massey, 1984) suggests that spaces and regions are actually parts of a broader production system, and each region plays a specific role, which is determined by its relative position in the production system (see also Table II-1). Some places, for their region-specific characteristics, may be chosen as the places for headquarters or R&D activities that put them in relatively strategic roles compared to other places with managerial or operational activities. These spatial-economic relations lead to uneven development, reflecting the position of regions within global production networks. Regions with higher value-added activities thrive and prosper, while regions with lower value-added activities usually get trapped in a locked-in situation.

In more recent literature, (e.g. Amin, 2002; Bathelt et al., 2004; Bathelt and Cohendet, 2014) economic geographers begin to acknowledge, even take into account, the influences of extra-territorial connections on the dynamics of regional economics. Amin (2002), for example, makes a serious effort to reinterpret place and space, at ontology level, in the new context of globalisation. Bathelt (2004) and Bathelt and Condehet (2014), for another example, stress the interwoven flow of tacit local knowledge and codified global knowledge. Conversely, the literature on global value chains increasingly recognises and incorporates local production structures, such as local industrial clusters and SMEs, into the analysis of global production network (e.g. Bair and Gereffi, 2001; Humphrey, 2003; Schmitz and Humphrey, 2000). This development has blurred the previous split between regionalism and global value chain literature.

The global production network literature is certainly relevant to this analysis. It emphasises the importance to conceptualise regions as part of a broader network of economic flows. Factors and processes external to a region may have significant impacts on the development destiny of the region. Regional development processes are then a result of region-specific histories and the links they develop to other regions and/or to global production network. The link is built not only through investment in regional assets and institutional structures that are a ‘fit’ with the requirements of actors in the global production network, such as infrastructure, skilled labour, cooperative industrial relations, rule of law, and so on; but also through struggles and tough negotiations in usually uneven power relations with those actors (Coe et al., 2004; Massey, 1984). In relation to our analysis of aircraft industry, knowledge as the most crucial element in building the aircraft industry is, in fact, mostly imported from abroad. The efforts of the industry, which were highly facilitated by the government, to gain access to the source of knowledge are of course an interesting story to explore. Indeed, it is part of our analysis as well. Another important and interesting process is, at least from the evolutionary way of thinking, the learning process of how the knowledge gained from the global network is absorbed and integrated with the existing structure of regional knowledge. The analysis, therefore, is focused on this internalisation process of external knowledge. The choice of focus is driven primarily by the adoption of evolutionary approach as the backbone of this research.

In the following, we demonstrate empirics of how extra-territorial knowledge is 'imported' from its sources in the global production network, and how that knowledge, albeit beneficial, is difficult to absorb because it is cognitively distant from the existing knowledge base. A major shock has somehow altered the structure of regional knowledge that is more supportive for aircraft industry.

6.4.5.2 Internalisation of external knowledge

In the early stages of the aircraft industry, the reservoir of local knowledge seems to be insufficient to initiate the industry. There were some domestic attempts to build aircraft; however, these efforts were limited to light aircraft production with simple technology. In order to obtain new knowledge, which was cognitively far from domestic knowledge bases, external knowledge is needed to be infused. The government acknowledged the limitation of local knowledge and built up global pipelines to tap the new knowledge into the country. At the same time, a new specific programme was established in local universities to internalise the newly absorbed external knowledge. This strategy of knowledge acquisition was clearly referred to in several speeches by the most prominent figure in the country's aircraft industry, B. J. Habibie. The strategy itself aimed to achieve broader industrialisation goals in which aircraft was one of the crucial elements. It was formulated in four steps: technology acquisition through the transfer of existing technology, the integration of newly acquired and existing technologies, the development of completely new technology based on existing technology, and the development of large-scale, albeit basic, research capabilities (Habibie, 1992).

Undoubtedly, technology acquisition, to some extent, has been achieved. The PTDI has managed to establish global links since its very early development with international players, such as Bell Helicopter (US), Aerospatiale (France), Eurocopter (France), MBB (Germany) and CASA (Spain). Quite recently, the PTDI has made a significant breakthrough by securing mid-term contracts with big names, such as

Boeing (US), Airbus (France/Europe) and Sukhoi (Russia). International cooperation has helped the PTDI to recover from the aftermath of the Asian crises, as it is now involved in global production chains as a component supplier to Boeing and Airbus. An official in the PTDI admitted that incomes earned from this global contract were sufficient to maintain the financial stability of the company, as well as releasing some resources with which to focus on developing its core business in the aircraft industry[105]. He also added that, while maintaining its roles in global supply chains, the PTDI is now expanding its core business by developing a new aircraft product (e.g. N219 passenger aircraft) and helicopters, and starting to explore the possibility of building a fighter jet.

At this point one may think that this global network that has been invested in and developed has paid-off. The PTDI has managed to reposition itself in global production chains. However, the global network has its own limitations. Once the PTDI decided to move further forward by developing a bigger plane (N-250, a 50-seater passenger aircraft) global players reacted by giving negative signals. According to an interviewee in the Agency for the Assessment and Application of Technology, the development of the N-250 was stopped for rather political reasons. There was increasing pressure from other producer countries to withdraw government support for the project. The interviewee suspected that this move could have been linked to the potential of the products to compete with those in other countries[106].

Technological integration seems to be much more difficult to realise. Although internalisation efforts, through the national university in Bandung, had been started as early as 1962, the results seem to be far from what was expected. After almost four decades of development, the question is how far the PTDI has channelled external knowledge into local knowledge bases. If we consider intermediate inputs as knowledge required to build an aircraft, intermediate inputs domestically reflect knowledge that has been embedded in regional knowledge. We have traced the backward linkage of the aircraft industry in the I-O table and found that, by 2000, most inputs (70.8%) used by the PTDI were actually imported. After seeking to learn for such a long time period, the low domestic inputs suggest that external knowledge is not that easy to absorb, especially that which is cognitively distant from domestic knowledge bases. Opening up the global pipeline is a necessary condition to obtain new knowledge; however, insufficient local learning capacities may hinder its acquisition. In addition, the scale of imported inputs indicates that the aircraft industry is a highly import-dependent one, which explains why it collapsed during the Asian crisis.

[105] Interview in Bandung, 19 August 2015.
[106] Interview by telephone, 1 May 2016.

An official from the PTDI claimed that local content has been significantly increased in relation what it produces. He said that, as a fully-fledged business entity, the PTDI has operated just like any other enterprise pursuing profit. It has also gradually increased the number of local components in its products, although some components, which are primarily related to avionic instruments, still need to be imported. In general, the percentage of local components used in PTDI products has reached 40-50%[107]. Table VI-9 confirms this claim. Based on the I-O table, local content in aircraft production increased significantly from a mere 29% in 2000 to 55% in 2010, suggesting a stronger linkage to local knowledge. This also indicates that the PTDI has transformed itself from a technological entity by seeking advancement into a commercial profit-seeking entity. It seems that the industry has learned at least two important lessons. First, relying too much on government support has indulged the industry with artificial success, but stifled its long-term competitiveness. Second, relying too much on external knowledge, while being loosely rooted in a domestic structure, may have undermined the industry's resilience against shocks.

Realizing the importance of local linkage, the aircraft industry has tried to build a network with the automobile industry, which is concentrated in WJV as well. An official from the Ministry of Industry confirmed this effort by saying that it is important to root the industrial base of the aircraft industry alongside more local industries. This should not only improve its chance to survive but also enhance its impact on the local and national economy. At the moment, the government is facilitating the establishment of an aircraft industry association. The proposed association will be combined with the automobile industry, which has a close relationship in terms of technology used. It is expected that the proposed association will induce knowledge collaboration between the two related industries[108].

Table VI-9 Intermediate Inputs of the Aircraft Industry

Input	2000		2005		2010	
Domestic	464,746	29.2%	1,416,307	29.8%	1,002,557	55.7%
Import	1,128,899	70.8%	3,336,930	70.2%	797,520	44.3%
Total	1,593,645		4,753,237		1,800,077	

Sources: I-O tables 2000, 2005, 2010 published by the BPS.

Note: Inputs are at producer prices, in IDR millions.

[107] Interview in Bandung, 19 August 2015.
[108] Interview in Jakarta, 14 September 2015.

In sum, the aircraft industry exhibits an attempt to acquire a new technology that is far from the existing knowledge bases. Acquiring new technology is necessary to make continuous progress, but internalising new technology into existing knowledge bases may be much more difficult, especially if the technology is quite foreign. Failing to integrate new technology has put the aircraft industry at risk in terms of its competitiveness and resilience against shocks. This riskiness has forced the aircraft industry to root its production activities closer to the domestic industry structure. The dynamics of the aircraft industry somewhat suggest that even radical attempts to develop new industries cannot escape the evolutionary force of path dependence.

6.5 Conclusion

We have investigated whether or not the textile industry was declining in WJV. As a matter of fact, it is still growing. We also have concluded that the difference in wages is inconclusive; thus, we dispute the arguments that cheaper labour costs are attributable to the flourishing of the textile industry in CJV. Instead, favourable industrial relations seem to represent the regional advantage of CJV, which is possibly attractive to labour-intensive industries such as textiles. We further found that increased competition, particularly from China, and a tougher business environment engendered by uncomfortable industrial relations have left the textile industry with no choice but to focus on efficiency. However, the way regions have improved their efficiency seems to be different. We have detected that the division of labour across plants is much stronger in WJV, whereas CJV's plants prefer to maintain a division of labour within its own plants. Furthermore, we are struck by the evidence to indicate that the former relies on capital deepening to improve technical efficiency, while the latter takes a more expansive path through scale efficiency.

While the textile industry in WJV has learned bitter lessons from its regions on how to be more efficient, an overly steep learning curve in the aircraft industry has left it with little to learn from its host region. As a result, the acquisition of new technology was not followed by its integration into local knowledge bases, which eventually lowered the industry's competitiveness and resilience. This is probably the most precious lesson that the aircraft industry has learnt from the Asian crisis. In the aftermath of the crisis, it has started diverting its attention to local knowledge bases, while maintaining its valuable assets of global networks.

The implications of these findings for an evolutionary framework are explained as follows. First, we argue that the relatedness of the textile industry to a region's portfolio plays crucial roles in sustaining the textile industry in WJV. Certainly, WJV's textile industry experienced some shocks during and after the crisis, such as harsh competition from China, the cessation of quotas at the end of 2004, increasing wages and more pro-labour pressures. Indeed, some plants broke down or moved out, most probably to CJV. However, many of them remained and reorganised their production techniques to increase efficiency and productivity. Their efforts have resulted in promising outcomes and improved their overall competitiveness. This has been possible, thanks to their relatedness to the existing structure. With regard to the fact that the textile industry has lost its dominance in WJV's manufacturing sector, we argue that this is due to the rapid rise of other sectors, rather than the decline of the textile industry. The textile industry is growing and still tightly attached to its regional structure in WJV, as indicated by its relatedness value (density index) stated at the outset of this chapter. The tight fit is enough to sustain the industry in WJV for some years to come. However, there are signs that the tight connections are getting looser recently alongside rapid industrialisation. WJV has begun to shift its focus onto other promising manufacturing industries, such as the automotive component, telecommunication and creative industries. Therefore, with regard to the first research question, we argue that favourable industrial relations, rather than differences in wages, have accelerated the level of the textile industry's development in CJV. In contrast, more problematic industrial relations in WJV, although influential, are offset by capital deepening in the industry. It is probable that a real threat may come from the rise of other manufacturing industries, which would divert WJV's attention away from textiles to those more promising and sophisticated industries. Nevertheless, we conclude that the evolutionary concept of relatedness holds for this divergent case.

Second, we have challenged the evolutionary concept of relatedness with another divergent-case involving the aircraft industry. We argue that the evolutionary concept also holds here for a simple reason: the industry collapsed just after the government withdrew its support. Loosely rooted to its region's portfolio, the industry has few defences when a major shock hit it. However, physical and human capital and global networks, in which the state invested for so long, has paid off. The aircraft industry has come through this financial crisis due to global linkages, rather than domestic networks. As the industry has learned its lesson from the crisis, it has attempts to align itself more closely to the domestic industry structure. With regard to the second research question, how could WJV develop an aircraft industry that is technologically distant from its regional portfolio? The simple answer to that is the substantial role played by the state in promoting the aircraft industry. However, the industry was unable to resist no more evolutionary forces that worked against it, particularly after the government withdrew its support. The only option left was to root its presence in domestic structures by building networks with related industries in the regions.

The two cases[109] reflect the dynamics of evolutionary processes. It is worthwhile highlighting two important factors. First, the previous quantitative analysis provides us with a much simpler logic for an evolutionary process: that is, once an industry becomes more distant from its regional structures, sooner or later, the industry is likely to decline or exit from the region. In the real world, the processes are much more complex and dynamic. The textile industry in WJV seemed to be pushing out from its domestic structures by increasing pro-labour pressures, but it has been fighting back to keep its place in the regional structure. Indeed, some plants have failed but many others have improved, giving them some more years to stay, perhaps until to the next shock or even longer. The story of the aircraft industry is the opposite of that of WJV's textile industry. The aircraft industry entered the region when it was technologically far from the domestic knowledge bases, thank to generous government supports. Once the support was eliminated, the industry had to root its presence more firmly in the region's industry structure in order to maintain its competitiveness. The bottom line is that, in the real world, closeness to a region's portfolio should be understood in a dynamic way. An industry may enter a region, even though it looks cognitively distant (e.g., aircraft industry), or may look to exit a region, even though it is close enough to its region's portfolio (e.g., textile industry).

Second, the cases to some extent also demonstrate the co-evolution of regional industry and its institutional base. We admit that co-evolution is not the main story that we try to demonstrate here. However, the institutional framework that we have adopted in order to explain the dynamics of an evolutionary process at the institution level has been unprecedentedly led to a co-evolution analysis. In the case of the textile industry, once pro-labour pressures increased after democratisation began in the late 1990s, industrial relations institutions evolved in light of those political reforms. However, the direction in which regional institutions have evolved slightly differs across regions, which, in turn, has influenced the responses taken by industries in each region. Industry in WJV has responded with capital deepening, while a more expansive strategy has been the response from CJV. In the case of the aircraft industry, the substantial changes in the role of the state and increased pressures from other producer countries have changed the way in which it has developed its knowledge bases. While the industry maintains an external network of knowledge, it has shifted much of its effort onto building a network with local knowledge.

[109] We do not highlight the third process here, i.e., the emergence of the textile industry in CJV, because we consider that it is a normal case, which fits well into evolutionary frameworks. However, we need the normal case to compare it with the what looks like a divergent case of WJV.

CHAPTER VII
CONCLUSION AND RESEARCH AGENDAS

7.1 Introduction

The ability of regions to carry out industrial transformation is partly determined by its existing industry structures. Regions benefit from the presence of diverse industries, which provide regions with broader options to develop new industries through 'mixing and matching'. The regions' ability is also influenced by the sophistication level of industries that constitute a regions' portfolio. That is, a more sophisticated portfolio provides regions with capability to deal with the intricacy of advanced products. While the concept of productive capability attempts to explain the potential of regions to transform their industries, the relatedness concept offers explanation about the process of the transformation. That is, regions tend to develop new industries that are cognitively related to their extant industry structure.

Literature has, to a large extent, confirmed the trend in favour of incremental development, even in sectors that are seemingly experiencing radical technology changes, such as in fuel cell technology (Tanner, 2016). Despite the emerging empiricism of evolutionary processes in regional economic growth, many studies evolve out of the context of the Global North, which has developed industrial capabilities. However, the applicability of evolutionary approaches in explaining economic growth in the regions of the Global South has not been explored yet. On the one hand, underdeveloped industrial capabilities have raised significant doubts about the presence of such endogenous forces in relatively peripheral countries, including Indonesia. On the other hand, the considerable amount of FDI flowing into Indonesia has warned us about the potential influences of such exogenous forces on the country's economy, raising the level of scepticism about the presence of evolutionary paths even higher.

The empirical work conducted in the course of this thesis responds to that scepticism. The fundamental conviction in this thesis is that untraded endogenous forces are more likely to be influential than tradable factors of production in initiating, shaping and constraining the economic development of regions. Differences in productive capability and relatedness to prospective industries may shed light on how regions evolve towards diverging paths and with different qualities. This consideration has led this research to the objectives formulated in Chapter 1, that is, to trace the presence of evolutionary forces in the context of industrial development in countries of the Global South, as well as confront its relative importance in relation to external economic links.

In the preceding chapter, we have measured the concepts of industry relatedness and productive capability. With these metrics, we have verified the presence of evolutionary forces of path dependence in industrial transformation at the subnational level. We have also investigated the relative importance of this endogenous evolutionary force in relation to factors that are exogenous as far as industry structure is concerned. Lastly, we have examined in detail two divergent cases in order to contest the presence of evolutionary forces by stretching out our explanation to the most radical cases, such as the aircraft industry's development in the country.

There are two main findings of our empirical analysis. The first concerns evidence for the presence of endogenous evolutionary forces in the industrial transformation of Indonesian provinces. The second is the indication of its significance, relative to exogenous forces. In the next section, we briefly discuss these two findings and draw-out theoretical reflections on them. This part constitutes the most important contribution of the thesis. In Section 7.3, we briefly discuss the implication of our findings for policy discourses. In the following section, we turn our attention to the limitations that we encountered in writing this thesis. Nevertheless, some of those limitations open up broader questions, while others call for a more detailed elaboration. In the last section, we summarise those lines of inquiry within a new research agenda. We propose the research agenda by outlining the reasons and speculating on what insights it might reveal.

7.2 Theoretical reflection on the main findings

7.2.1 Contribution to evolutionary economic geography frameworks

EEG is a relatively new branch within economic geography. At the time when we decided to adopt an evolutionary approach, the discussion about the positioning of EEG amongst its sibling fields was still going on. In order to provide this research with a solid theoretical foundation, we carried out a thorough theoretical review in Chapter 2 in order to explicate the genuine domain of EEG and its theoretical relations with nearby disciplines. Although this issue has been widely discussed in the EEG literature, we expected that our review can contribute to provide theoretical clarity about the original idea of EEG and what it has in common with its neighbour disciplines. Moreover, the clarity of the theoretical foundation allows us to confidently attribute our work as part of EEG's body of knowledge.

Within EEG theory, endogenous forces refer to the potential of regions to initiate new economic activities from within the regions themselves. The emergence of new products, technologies, institutions or macro systems in a region is fundamental feature within any EEG framework. 'If there were no variations, that is if all organisms in a population were equally successful in producing offspring, selection would have no bite' (Vromen, 1995, p. 92). While there seems to be strong agreement about the importance of new varieties in EEG, a common theoretical framework is still absent from the literature. We discussed this issue at length in Section 2.2. Our theoretical contribution lies in synthesizing two seemingly different, but actually equivalent, evolutionary frameworks, i.e. Generalised Darwinism and path dependence. Here, we do not register another new framework; rather, we simply demonstrate that both frameworks share many common elements than would ordinarily be the case for competing frameworks. Path dependence elements of path creation, path destruction and lock-in are a match for the Generalised Darwinian elements of variety, selection and retention. Path creation refers to the possibility of new varieties of development, such as the introduction of new technology or the development of new industries. Lock-in describes the process of the early adoption and stabilisation of new varieties in a population or system. Path destruction can be referred to as a selection mechanism combined with an individual path. We label this fusion of frameworks as the GD-PP framework.

The theoretical review also reveals a rather technical issue in the GD-PD framework, that is, at what level do evolutionary processes actually take place? Our qualitative analysis in Chapter 6 somewhat addresses this issue by demonstrating what the co-evolution of the textile industry and regional industrial institutions looks like. Although co-evolution is not the primary focus of our work, along the way, we feel the need to look beyond the industry level. This experience has reminded us that merely focusing on one level of evolution would be too simplifying of the complexity of regional evolution. The evolutionary framework should be expanded in the direction of a co-evolution framework if we wish to gain meaningful insights. The third framework, i.e., complex adaptive system (CAS) fits quite well with this co-evolution idea. Thus, a CAS can complement the GD-PD framework. Although we do not specifically adopt a CAS framework in this research, we have somewhat performed something of a coevolution analysis, which we consider to be another contribution in validating the plausibility of the unification of the three major EEG frameworks discussed in Chapter 2. We expand this issue in the section on future research.

7.2.2 Evolutionary forces in action

The empirical contributions of this thesis are presented in Chapters 4 and 5. The main results of our empirical analysis support the EEG theory of path dependence: industries that are close to regions' portfolio tend to enter and stay; otherwise, they tend to exit. This finding apparently converges with the empiricism that has been constructed so far, both in developed and in developing countries. What is new in our empiricism is that we have added the element of quality in explaining the diversification process. In previous works, the quality of new industries entering a region is often implicitly assumed to be sophisticated. We have argued theoretically that that is not always the case. Our empiric findings suggest that, in general, Indonesian provinces diversify into slightly more sophisticated industries. However, we also find that some provinces diversify quite well, but experience a decreasing sophistication level. Although that is enough to improve its economic position in relation to other provinces, these provinces are still far behind those with developed capabilities. This finding has theoretical implications. Diversifying into new industries does not necessarily make regions better off if the new industries are less sophisticated or just manufacture low-end products. Again, what a region produces matters more than how much it produces (Hausmann et al., 2007; Rodrik, 2006).

In Chapter 2, we have synthesised the element of path creation in the evolutionary framework with the learning and innovation literature. Learning to create new knowledge is basically a social process of combining pre-existing knowledge bases. Thus, new knowledge will be easily synthesised if it is cognitively close to the existing knowledge, but not too close that it diminishes what can be learnt. This idea leads us to predict that a larger endowment of pre-existing knowledge provides regions with greater opportunities to create new knowledge, while more advanced pre-existing knowledge allows regions to generate even more advanced, but still related, knowledge. We investigate the extent to which this assertion applies in the first half of Chapter 4 by deploying two measures, namely, closeness and density. Our finding supports the assertions. We have also detected a certain pattern of path creation and path destruction: that is, new industries are more likely to emerge in a region if they are cognitively close to provinces' industry portfolio. In contrast, those that are loosely attached to provinces' portfolio are likely to be winnowed out. With regard to the retention element of the evolutionary process, we documented a similar pattern with path creation. Higher relatedness allows industries comfortably to lock themselves in within their host provinces. In this context, lock-in is viewed positively as it means that an industry has reached a certain level of acceptance and become more settled within their host provinces. However, after a certain period of time, this positive lock-in may turn into a negative because provinces and industries have become tightly tied, constraining the former to introduce a new variety within their boundaries. This is the weakness of strong ties, according to Grabher (1993). All in all, our empirical findings fit comfortably within the evolutionary framework of path dependence.

The second part of our analysis in Chapter 4 captured the presence of negative lock-in within many laggard provinces. We deployed complexity metrics, which combined diversification and sophistication features of industry structures. Our analysis documented a fragmented pattern of provinces' productive capabilities. Few provinces with high complexity persisted, while the rest fluctuated in the lower ranks. Furthermore, we observed systematic relationships between the diversification and sophistication levels of industry structures. First, we detected the presence of positive increasing returns in the relationship. Diverse provinces are more likely to develop new industries than their less diverse counterparts. In contrast, less diverse provinces tend to be trapped inside a lock-in situation. Leaving them on their own could prevent these provinces from evolving. The finding suggests a diverging path of development between diverse and less diverse provinces. Second, we observed a subtle pattern in which more sophisticated industries tend to be produced by only a few provinces with a high level of diversification. In addition, we documented evidence on the degraded sophistication level of many provinces' industry structures. Only a few provinces with a high level of diversification were found to have improved sophistication levels.

All these findings, we argue, have analytical implications. The relationship between the diversification level and the sophistication level implies that the sophistication level of industries has some influence on the evolution of regional industries. Not only is the sophistication level useful when defining the direction of evolution, irrespective of whether it goes to high-end or low-end industries, it also affects the capability of regions to diversify into new, related and probably better industries.

The other main contribution of this thesis lies in the recognition of the fact that evolutionary forces may not be the only forces influencing the industrial transformation of regions. Thus, we contested the determinacy of evolutionary forces in two different ways. First, we juxtaposed it vis-à-vis the presence of other exogenous forces. Second, we challenged it with two seemingly radical cases.

The industrial branching processes, as discussed in the EEG literature, are often assumed to occur in relatively isolated regional containers. This is reasonable, as economic geographers are often motivated to highlight the roles of space or geographical proximity in shaping regional economic landscapes. The evolutionary framework therefore emphasises that industrial transformation is endogenously initiated, shaped and constrained by the pre-existing industry structure itself. In reality, other forces that are exogenous to the industry structure may have influences on economic changes within regions. These exogenous forces may take many forms, such as foreign investments, government intervention and other cost factors.

The inferential analysis in Chapter 5 revealed that evolutionary variables exhibited more dominant effects regarding the rise and fall of regional industries than the exogenous variables of FDI and wages. The role of FDIs in that process seems to be substantively small and statistically inconclusive. Nevertheless, we are not the only ones to report the inconclusive effects of FDI in the literature. As a source of knowledge spillover, FDI may have positive effects on introducing new varieties. At the same time, however, FDI is also viewed as competition by existing firms, which puts inefficient firms out of business. Many instances of FDI are extractive in nature, motivated towards exploiting local resources and securing incentives offered by host regions. With regard to cost factors, wages seem to play weak and negligible roles in branching processes. While relatedness and complexity coefficients displayed the expected signs and were statistically significant at the industry level, the case is different for the latter at the province level.

Our findings here are considerably aligned with what has been reported in the EEG literature on the Global North. Certainly, more empirical evidence is needed from within the Global South context, but we should expect that a similar phenomenon will hold. Our overall conclusion, therefore, is that the industrial transformation of Indonesian provinces demonstrates the robust presence of an endogenous evolutionary process. Next, we challenged our own conclusion by comparing it with two divergent cases.

7.2.3 The dynamics of evolutionary development

We believe that the presence of evolutionary processes in industrial transformation is not as static as it appears from the statistical figures. This consideration has motivated us to look deeper into the dynamics of the evolutionary process. As such, we explored two seemingly divergent cases, that is, the textile and aircraft industries. The aims here were twofold: to reveal the dynamics of the processes and to see how far evolutionary forces can be stretched to explain extreme industrial branching and destruction processes. Another motivation was the fact that, in the last few years, the literature on relatedness seems to have been absorbed by quantitative analysis in order to provide systematic empiricism on branching processes across spaces. By saying this, we do not mean that systematic empiricism is unnecessary. Rather, we would like to emphasise that space-specific analysis is still at the very heart of the economic geography discipline.

We challenged the determinacy of the evolutionary process by detecting its presence in two specific divergent cases. The analysis in Chapter 4 reveals that the textile and aircraft industries, both of which are present in WJV, somewhat demonstrated a measure of nonconformity in relation to the evolutionary explanation. On the one hand, the textile industry seems to be tightly related to its local structure, but exhibits a declining survival rate. On the other hand, the aircraft industry seems to be loosely anchored to its local structure, but maintains its presence in the province. In a simple evolutionary sense, the textile industry should not have been the subject of selection because of its fairly tight relatedness to the host provinces. Similarly, the aircraft industry should never have emerged in the first place given the distant technological gap with their host province's portfolio. We have investigated the dynamic of these two divergent cases in Chapter 6.

The 1990s was the peak of textile industry in Indonesia. However, the industry experienced severe shocks during the 2000s due to changes in both the global and the local environment. The Asian economic crisis at the end of the 1990s, followed by harsh competition from China since its subscription to WTO in 2001 and the end of preferential quotas in 2005, as well as more organised labour as a result of political reforms and out-of-date production technology, have put the textile industry under continuous and extraordinary pressures. Some plants did break down, while others moved out of West Java, looking for more favourable locations in the neighbouring province of Central Java. However, we found that many of these plants have remained and adapted by reorganising production techniques in order to improve productivity, mainly through capital deepening (mechanisation) and, to some extent, through the division of labour across plants. These efforts have delivered promising outcomes. The overall competitiveness of the textile industry in West Java has been improving. The success can arguably be accounted to its closeness to its host province in the form of a more productive labour force, favourable industrial institutions and supportive infrastructures, which eventually preserve its existence in West Java province. However, we detected some signs that the aforementioned ties have loosened recently along with rapid industrialisation. WJV has begun to shift its attention to more promising industries, such as the automotive component, telecommunication and creative industries. Nevertheless, we conclude that evolutionary mechanics still apply in this divergent case.

The case of the aircraft industry demonstrates the opposite. From an evolutionary point of view, large technological gaps should have prevented the aircraft industry from evolving in West Java province. However, the direct and full involvement of the state in the industry represented artificial resources for its survival. Once the industry was disconnected from its main resources following a major crisis, the aircraft industry had no choice but to root its existence in its host province. We documented several pieces of evidence showing that, dictated by evolutionary forces, the industry has attempted to align itself more closely with its domestic structure by increasing the amount of local content in its end products and by networking with related industries, in this case, the automobile industry. Accordingly, the relatedness measure indicated that the industry was closer in 2012 than its cognitive position in 2000.

In sum, we have challenged the determinacy of evolutionary forces in shaping the economic landscape of Indonesian provinces by juxtaposing them with exogenous forces and approaching this issue with two seemingly radical cases. The results suggest that evolutionary explanations overcome these challenges. Our conclusion, therefore, reinforces our previous conclusion: that is, the industrial transformation of Indonesian provinces demonstrates the presence of a dynamic evolutionary process.

7.3 Implications for regional industrial policies

By far, we have documented the process of new path creation, lock-in (in both a positive and a negative sense) and path destruction in Indonesian provinces' industrial transformation. In this section, we attempt to draw links between the findings and discourses on industrial policies in Indonesia. We have briefly reviewed the dynamics of Indonesia's industrial policies and practices in Chapter 6. Here, we readdress those industrial policies within the evolutionary framework of path dependence.

With regard to path creation, in Chapter 4, we performed simulations in order to track forward plausible new paths of provinces. The simulations, however, were not intended to exercise the predictive power of the evolutionary framework; rather, they aimed to reveal the threshold value at which provinces were likely to fail, or at least experience much greater difficulties in diversifying if they did not have potential related industries that could met that threshold value. From a policy point of view, simulations can be useful in identifying a short list of potential related industries, which could probably emerge in a province. Provinces should focus their industrial policies on such prospective industries.

We have documented evidence on the degraded sophistication level of many provinces' industry structures. Industrial transformation is not merely about establishing as many industries as possible. It is also about developing better and more sophisticated industries. Industrial policies should therefore be directed at the promotion of new and more sophisticated industries. Moving towards more sophisticated industries is not an easy task, as it requires new capabilities in many respects, such as new knowledge and, to some extent, different institutions. Perhaps the most appropriate strategy is to diversify into related, but still more sophisticated, industries.

With regard to lock-in, a review of regional industrial policies in Chapter 6 revealed one important issue, namely, that provinces seem to prefer promoting existing industries, which have already gained comparative advantage, instead of promoting new sophisticated industries. This is probably engendered by a policy orientation that leans toward export competitiveness, rather than innovation and new product development. Lock-in, in a positive sense, as exemplified by the promotion of export-oriented industries may be a good industrial strategy. However, the emergence of new varieties is crucial in order to ensure the continuation of provinces' economic evolution. Industrial policies that focus too much on extant industries, rather than prospective advance industries, may lead nowhere, but to negative lock-in eventually. This is a situation in which provinces are bound too tightly to existing industries and stop evolving in the absence of new varieties.

The presence of negative lock-in is evident in many Indonesian provinces, as we have reported in Chapter 4. Therefore, industrial policies should be directed towards providing support to those provinces in order to promote new industries. Leaving industrial development to market mechanisms may work well for provinces with complex capabilities. However, it is very likely to exacerbate the situation for laggard provinces, leaving them even further behind. Specific industrial policies, such as establishing supportive institutions and facilitating network and knowledge creation, should be orchestrated with other relevant policies (e.g., education, infrastructure, monetary and fiscal policies) in order to assist these laggard provinces in escaping their situation. More importantly, within a decentralised system, the active role of local governments is necessary, not only in enhancing their own industrial capabilities, but also in creating favourable environment for new investments.

Policy discourse related to path destruction is more contentious rather than consensual. Apparently, international organisations, such as ADB and USAID, state that industrial policies should be focused on promoting new advanced industries, rather than reviving old and declining industries. However, our content analysis of industrial policy documents revealed strong support for existing mature industries, although the importance of innovation is also well prescribed in the policy documents. Our choice of the textile and aircraft industries as case studies, to some extent, reflects the dilemma faced by the government which is put under significant internal pressure to defend the former, while being forced to 'abandon' the latter due to international pressure. Our findings simply suggest that industries that are still 'close enough' to their hosts' portfolio may be worth defending, as in the case of the textile industry. Nevertheless, we consider this as a second-best industrial policy. Similarly, promoting new, but too distant, industries, as in the case of the aircraft industry, could involve a higher risk of failure, making it a second-best industrial policy as well. Perhaps, by making a reference to Maskell's (1998) work about low-tech but competitive furniture industry in Denmark, clustering the textile industry in order to promote exchange of knowledge among them would improve the competitive advantages of the industry, even in the case of increasing labour cost.

We would also like to address two prevalent views concerning industrial development in developing countries, such as Indonesia. First, regional industrial policy is, nowadays, often associated with cluster policy (De Propris and Driffield, 2006, p. 288). That was true in our case, as we came across the prevalent adoption of the cluster concept in national and regional industrial policy documents. We only briefly discussed the cluster concept in this thesis, but our findings suggest that relatedness is crucial if industries are to learn from each other. Therefore, the implementation of cluster policy should take into account the relatedness of industries residing in a cluster. Second, in the policy realm, FDI has become a sort of 'development mantra', which drives policies in developing countries in favour of FDI. Our findings, however, cast some doubt on how FDI contributes to industrial branching processes. More importantly, we are not alone in having doubts about the role of FDI. Many cross-country analyses also report inconclusive effects. With reference to FDI-led clusters, Felker (2004) warns us about the hidden motivation of FDI enterprises to exploit incentives provided by regional policies and share agglomeration benefits exclusively among themselves. Nevertheless, we view the inconclusive impacts of FDI as a policy matter, which hinges on how good the government is in assembling incentives that maximise FDI externalities (Phelps, 2008), including the transfer of know-how.

7.4 Some limitations of this thesis

Thus far, we have described a number of contributions made by this thesis to the literature on EEG and its implications for industrial policy discourses. However, there are some elements of this thesis that remain open to question and should be read with caution. We identify several limitations of this thesis related to measurements, data and the level of analysis. At the same time, these limitations open up some questions for future research.

The most conspicuous challenge of this work is the adoption of an evolutionary approach, which has still not settled on a common research framework. At the level of theoretical discourses, there are disagreements on the basic principles of what counts as an evolutionary approach, as discussed in Section 2.2. At a more operational level, determining the most appropriate levels of evolutionary analysis and the forces of selection at work is still under discussion. The problem concerning a multitude of approaches and research frameworks, to some extent, has affected the design of this work. In order to address those issues, we synthesised two evolutionary concepts of Generalised Darwinism and path dependence. We also carried out the analysis at different levels. One may view this as a source of confusion and a lack of focus for this work. However, we argue that it enriches the analysis of this thesis.

In this thesis, we investigated the evolution of regional economic landscapes by focusing our study on the changes of industrial structures. We then framed the changes to the industrial structure in an evolutionary framework of path dependence. We observed a regularity whereby the rise and fall of industries was somewhat linked to their relatedness to regional industry structures. From this, we confirmed the presence of evolutionary forces in the dynamics of industrial development, which works through the mechanics of relatedness. In other words, the selection ‘of’ the fittest industries happens ‘for’ their relatedness. However, we should admit that we did not theoretically argue about the choice of relatedness as a mechanism of selection, which led to path destruction. Relatedness is carefully chosen as a selection mechanism because, so far, the empirical evidence, rather than theory, seems to suggest that this is the case. In the literature, market competition is often regarded as the true selection mechanism by which less efficient economic agents are forced out of the market. This thesis argues that relatedness to regions’ portfolio indirectly affects the efficiency of plants, thus influencing their chances of surviving harsh market competition. In contrast, the theoretical link between the emergence of new varieties and relatedness is well rooted in the innovation and learning literature.

In this thesis, we have conducted analyses at different levels, i.e., the industry level in Chapters 4-6, the industry structure level in Chapter 5, and the regional institution level in Chapter 6. While the shift in the units of analysis may have resulted in different findings, it was a risk worth taking as it has offered us a comparative perspective in terms of how evolutionary forces work at different levels. After all, we find consistent results regarding relatedness effects, regardless of the level of analysis, while the effects are observable in the expected directions, as suggested by evolutionary theory. However, that is not the case for the effects of FDI. The coefficient seems highly sensitive to the different levels of analysis and to different dependent variables. One may suspect that the quality of data or the way in which FDI is measured may cause such issues. Nevertheless, this kind of suspicion cannot be addressed with the available data used in the analysis.

We are also aware of the limitation of the relatedness measure. The relatedness measure of co-occurrence used in the analysis is not impeccable. The measure limits itself to existing products, which are currently available and already linked. By design, it cannot measure the relatedness of products for which links have not yet been created. For example, given the current state of technology, the relatedness between machinery products and plastic products is quite low because most of the machinery is made of steel at the moment. In the future, however, there is a possibility that machinery will be made of, say, plastics, which alters the relatedness between the two products in a much close sense. However, this limitation seems to have no effects on the analysis because it is very unlikely such a radical emergence of new products happens in less developed/developing countries. The case could be different in advanced countries from where radical inventions of totally new products usually emerge.

Another limitation lies with our data. Trade data, which are used to measure relatedness, do not necessarily reflect the real productive structure of countries. There are possibilities that countries export negligible amounts of a product, even though that in fact they produce a huge amount of that product domestically, such as rice in Indonesia. Ideally, relatedness should be measured by real outputs, instead of countries' exports. However, those kinds of data, covering the whole range of products that are arranged by country and year, are not accessible at the moment. Moreover, the use of trade data and manufacturing data in the analysis at the province level involves their own trade-off as discussed in Chapter 3. Regional trade data cover more products, including agricultural and mineral products, but they may have a bias in terms of where the data are recorded (usually in ports). Some products may be produced in one province, but exported through ports located in other regions. Conversely, manufacturing data record actual production at the plant level, but it covers only manufacturing products, excluding those in agriculture and mining sectors. We use both data sets in the analysis throughout the chapters to partly address the trade-off. We use a trade data set for the industry-level analysis in Chapter 4 and a manufacturing data set for the inferential analysis in Chapter 5.

Another data-related issue concerns compatibility both across and within dataset. We use a trade data set to develop some of our main variables, i.e., relatedness and sophistication level, to take advantage of the extensive information it contains. The results are then converted into a manufacturing dataset, which uses a different classification system. Classification itself has evolved several times during the period of study, which complicates the process. Although the conversion processes are made much easier by the availability of concordance tables, the involvement of multiple stages in the process may cause biases, about which there is not much we can do.

There are some limitations that are more technical in nature. In Chapter 5, we use FDI to represent external capital, and wages to represent local costs, in order to examine the relative importance of endogenous evolutionary forces in relation to exogenous pecuniary forces. Ideally, all factors that could have influences on the development of new industries should be included in the equation, including regional infrastructure, institutions and human capital. Taking into account those indicators should either challenge or affirm the role of evolutionary forces in the evolution of industry space.

Finally, as commonly criticized in many inferential analyses concerning the direction of causality, the emergence of new industries is attributable to the changes in FDI, although FDI itself could be influenced by the presence of new industries. Although it cannot be fully eliminated, we minimise this confounding issue by applying panel data with a *t-1* specification to the right-hand side of the equation.

7.5 Future research

Previously, we have highlighted several issues that emerged in the course of this thesis. We have partly addressed these issues in our analysis and left the rest for future research to consider. Here, we attempt to sketch out a broader outlook for future research, based on the findings and framework of this thesis.

7.5.1 Co-evolution frameworks

In this piece of work, we focus on the evolution of regional industry structures. As we discussed in Chapter 2, one of the main challenges posed by the path dependence concept, which is probably shared by evolutionary studies in general, is related to the objects of study. In particular, at what level (firm, industry, cluster, technology, institution, city or region) does path dependence occur? In more technical terms, what is the most appropriate unit of analysis for evolutionary study? Evolutionary scholars articulate different views on this matter, ranging from the micro level of plants or firms, to the meso level of networks, sectors and institutions, and finally to the macro system-wide level of cities or regions, among others. According to Martin and Sunley (2006), it is possible to have multiple path-dependent trajectories within a region. These paths may be unrelated or related, i.e., they are path-interdependent because two or more paths are co-evolving and mutually reinforcing.

Although it is widely recognised in the literature that evolutionary theory is inherently a multilevel theory, which considers at least analyses at the level of individuals and population (Murmann, 2003, pp. 12-3), more empirical work is still needed to demonstrate these multilevel characteristics. Specifically, some conceptual questions concerning, for example, the most appropriate unit of selection and how to link evolution at the micro level with evolution in a larger unit of selection, such as institutions, cities, regions or even countries, are still shadowing evolutionary approaches in economic geography (Boschma and Frenken, 2011, p. 303; Essletzbichler, 2009, p. 163; Essletzbichler and Rigby, 2007, p. 554). Dopfer et al. (2004) propose adopting meso-level analysis as the most appropriate unit of analysis in evolutionary approaches in contrast with the dichotomy of micro-macro analysis. Arguing from a complex system perspective, they are minded that meso trajectory analysis can explain the changes both at the micro and at the macro level. Regardless of growing support for the meso level as the building block of an evolutionary approach, the definition of this meso level varies among evolutionary scholars. For example, Boschma and Frenken (2005, p. 293) define the meso level in terms of sectors and networks, while Bathelt and Glucker (2014) view institutions at the meso level, as they link the micro and the macro level of economic development (p. 12).

Departing from these theoretical inquiries about the level of analysis and its gap in empirical works, we propose that upcoming research should be shifted in this direction. Nelson (1995) and Schamp (2010) put forward the notion of co-evolution, which interactively analyses the changing behaviour of agents at the micro and meso scale with outcomes at the macro level. Indeed, this co-evolution notion has been one of the increasingly popular topics in empirical research in the field of EEG (Boschma and Frenken, 2011, pp. 302-3). As an example, research on how changes in the routines of plants alter technological networks and institutions, which eventually shape the agglomeration externalities at the city level, could offer theoretical and empirical insights to inform further advances in evolutionary approaches within economic geography.

7.5.2 More comparative research

As we have argued from the outset of this thesis, this kind of study is relatively new in the Indonesian context. A wide range of issues is waiting to be explored, with more comparative studies from other Global South countries expected to emerge. A body of empirical finding is required to transform EEG into a grounded theory and strengthen its credibility among other strands of research in economic geography (Boschma and Frenken, 2011). However, we have to be aware that comparative studies are becoming less comparable because of the use of different approaches, methods, and levels and quality of data. Indeed, the latter are still major issues when conducting quantitative analyses in developing countries.

As an emerging approach within the economic geography sub-discipline, EEG has not offered a unified body of theory to date (Schamp, 2010, p. 435). The heterogeneity[110] in its conceptualization poses a challenge when conducting comparative research. This may result in confusion even when the empirical analysis shows similar results. At a theoretical level, this is an important issue, which should be resolved by the discipline itself. Furthermore, methodologies also tend to be different within different studies. This makes findings more difficult to compare, regardless of the methodological improvements that have been achieved thus far. As methodologies advance, data requirements also increase, which creates another problem for comparative research. Obtaining high-quality data, with broad and deep geographical coverage, as well as encompassing an extensive historical timeline, is almost impossible. With regard to this thesis, despite a few modifications to the research design and the use of different inferential techniques, to some extent, we still maintain that there is consistency with previous works, such as in adoption of the same relatedness measures and the inclusion of similar control variables.

7.5.3 Evolutionary case studies

We combined two approaches in this thesis in the form of quantitative and qualitative case studies. With the former, we aimed to detect the regularity of evolutionary forces at work, while we studied the dynamics of how the forces work in more detail with the latter. Although we succeeded in deciphering patterns of the presence of evolutionary processes, we also detected some divergent cases, which we investigated further by deploying a qualitative case study. Having said that, we do not necessarily mean that the qualitative case study is merely complementary to the quantitative work. Instead, we enriched the analysis in terms of depth and greater detail, which was only possible by applying a qualitative approach.

Some factors involved in the evolutionary process are less tangible, such as institutions, networks, social norms and even cultures. These factors may be best apprehended through qualitative case study analysis. Those less tangible factors can be taken into account more squarely without condensing their real influence on numbers or indices. Evolutionary case studies form something of a tradition in the

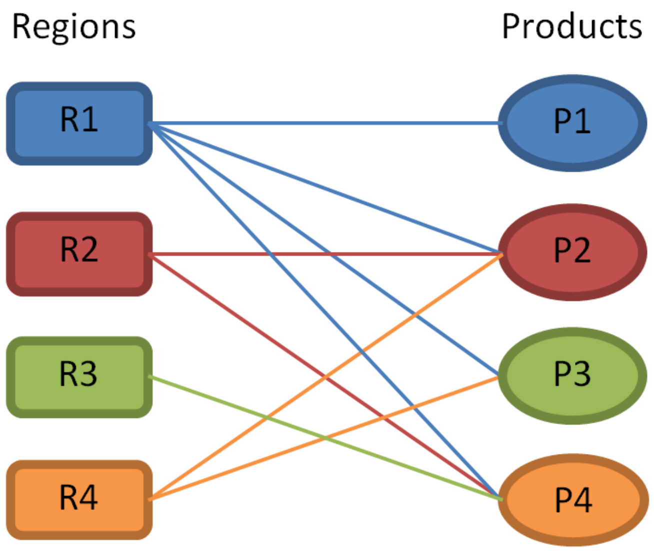
[110] Interestingly, as argued in the course of this thesis, heterogeneity or new variety is an important feature of the evolutionary process. However, lock-in, in a positive sense, is as important as heterogeneity in ensuring that the whole system continues to evolve.

economic geography literature in general, such as those by Boschma and Wenting (2007), Murmann (2003), and Saxenian (1994). More recently, however, works on relatedness seem to have a bias toward quantitative procedures. In the future, we expect more balanced research, not only in terms of the types of analysis, i.e., quantitative and qualitative case studies, but also in terms of the representativeness of the loci, i.e., the Global North and the Global South.

APPENDIXES

Appendix 1. Calculation of complexity index

Figure A1 Bipartite Network of Regions and Products



This hypothetical example is adopted from Hidalgo and Hausmann (2009). A bipartite network that links regions and products is illustrated in Figure A1. In this example, the diversification of each region (kr = kr,0) is:

- Region 1: $k_{r1,0}$ = 4 (as Region R1 produces all products P1, P2, P3, P4)
- Region 2: kr2,0 = 2 (as Region R2 produce products P2 and P4)
- Region 3: kr3,0 = 1 (as Region R3 only produce products P4)
- Region 4: kr4$_{,0}$ = 2 (as Region R4 produce products P2 and P3),

and the ubiquity of each product ($k_p = k_{p,0}$) is:

- Product 1: kp1,0 = 1 (this product is only produced by region R1)
- Product 2: kp2,0 = 3 (this product is produced by regions R1, R2, and R4)
- Product 3: kp3,0 = 2 (this product is produced by regions R1 and R4)
- Product 4: kp4$_{,0}$ = 3 (this product is produced by regions R1, R2, and R3).

The value kr1,0 = 4 means that the diversification level of region R1 is 4 as it produces four products with comparative advantage. Similarly, the value kp1,0 = 1 means that product P1 is only produced by one region i.e. region R1. In terms of network, the value of diversification represents the number of links that connects regions in the left side to products on the right side, whereas the value of ubiquity represents the number of links that connect products (right) to regions (left). In terms of diversification we can see region R1 is the most diverse region followed by R2, R4 and R3. In terms of ubiquity, product P2 and P4 are the most ubiquitous products, i.e. the least sophisticated products in this case as all regions can produce it, followed by P3 and P1 (the most sophisticated product in this case). In order to merge the ubiquity characteristic of product and diversification measure together, we conduct the iterations.

The first round of iteration (n=1), which consist of the average of product ubiquity and the average of region diversification are given as follows:

$k_{r1,1}$ = (1/4)(1+3+2+3) = 2.25	$k_{p1,1}$ = (1/1)(4) = 4
$k_{r2,1}$ = (1/2)(3+3) = 3	$k_{p2,1}$ = (1/3)(4+2+2) = 2.67
$k_{r3,1}$ = (1/1)(3) = 3	$k_{p3,1}$ = (1/2)(4+2) = 3
$k_{r4,1}$ = (1/2)(3+2) = 2.5	$k_{p4,1}$ = (1/3)(4+2+1) = 2.33

Here the value $k_{r1,1}$ = 2.25 is interpreted as the average ubiquity of products that are produced by region R1. Similarly, the value $k_{p1,1}$ = 4 is interpreted as the average diversification of region R1 that produces product P1[111]. Let us focus on regions, so we look at the value of $k_{r,n}$ with even value of n only. We run the second rounds of iterations (n=2)[112], which are the average of the first iteration, given as follows:

$k_{r1,2}$ = (1/4)(4+2.67+3+2.33) = 3	$k_{p1,2}$ = (1/1)(2.25) = 2.25
$k_{r2,2}$ = (1/2)(2.67+2.33) = 2.5	$k_{p2,2}$ = (1/3)(2.25+3+2.5) = 2.58
$k_{r3,2}$ = (1/1)(2.33) = 2.33	$k_{p3,2}$ = (1/2)(2.25+2.5) = 2.37
$k_{r4,2}$ = (1/2)(2.67+3) = 2.83	$k_{p4,2}$ = (1/3)(2.25+3+3) = 2.75

As we can see now, after two rounds of iterations the rank of regions' diversification level changes. At pre-iteration of $k_{r,0}$, region R1 is the most diversified region (with value 4), followed by region R2 and R4 with the same level of diversification (2), and then region R3 as the least diversified region (1). After taking into account the commonness factor, we can see that at $k_{r,2}$, region R4 (2.83) is actually more complex

[111] Remember that when the iteration at odd-th round (in this case n=1) $k_{r,1}$ is interpreted as general ubiquity measure while $k_{p,1}$ is interpreted as general diversification measure.
[112] At even-th round (in this case n-2) $k_{r,2}$ is interpreted as general diversification measure while $k_{p,1}$ is interpreted as general ubiquity measure.

than region R2 (2.5). This is because region R4 produces products that are less ubiquitous (P3 in this case) than region R2. The question is how many times this iteration should be done. According to Hausmann and Hidalgo (2010) this iteration keeps going up to the condition in which the rank of regions' diversification and product's ubiquity are stabilized, i.e. do not change any more. This analysis will reveal the relative complexity of regional industrial structures. Provinces with more complex industrial structures in terms of high diversity but low ubiquity are expected to own more capabilities to evolve toward more complex productive structures.

Appendix 2. Calculation of proximity

Consider a world of four countries (A, B, C, and D) and six products (M, N, O, P, Q and R). For simplicity, only countries with dominant products (defined as RCA > 1) are considered in the calculation and given in the Table A1 as follows.

Table A1 Countries and Dominant Products

Products	Countries				Number of Countries with CA in Product 'j'	Probability of Countries with CA in Product 'j'
	A	B	C	D		
M	1	1	1	1	4	1
N	1	0	1	0	2	→ 0.50
O	0	0	0	1	1	0.25
P	1	1	0	1	3	0.75
Q	1	0	0	0	1	0.25
R	1	0	0	1	2	0.50

> Only two out of four countries produce product N with comparative advantage.

The next step is to calculate the joint probability of two dominant products to be jointly produced by a country. This means that two different products that can be produced in tandem by one country are somewhat related. In our example, product M and N are jointly produced by two countries, which are country A and C. Product M and P are jointly produced by three countries A, B and D. So, the probability of two products jointly produced by countries is obtained by dividing the number of countries that jointly produce the two products by total number of countries. In our example for product M and N, the joint probability is thus two countries divided by four countries, i.e. 0.5. Joint probability for products M and P is 3 divided by 4 which are 0.75. By performing this calculation for all combinations of paired products we can produce the joint probability matrix (Table A2).

We then calculate the conditional probability. In our case, the probability of producing product M conditional of producing product N can be calculated by dividing the joint probability of producing product M and N together, which is 0.5 (see joint probability matrix in Table A2) by the probability of countries producing product N, which is 0.5 (see Table A1, last column, second row). Thus, the conditional probability P (M|N) is 0.5/0.5 = 1. Similarly, the probability of producing product N conditional of producing product M is calculated by dividing the joint probability of producing product M and N together, which is 0.5 (see Table A2), by the probability of countries producing product M, which is 1 (Table A1, last column, first row). Thus the conditional probability P (N|M) is 0.5/1 = 0.5. By applying this calculation to all six products, we obtained the conditional probability matrix (Table A3).

Table A2 Joint Probability

Products	M	N	O	P	Q	R
M	1	0.50	0.25	0.75	0.25	0.50
N	0.50	0.50	0	0.25	0.25	0.25
O	0.25	0	0.25	0.25	0	0.25
P	0.75	0.25	0.25	0.75	0.25	0.50
Q	0.25	0.25	0	0.25	0.25	0.25
R	0.50	0.25	0.25	0.50	0.25	0.50

Table A3 Conditional Probability

Products	M	N	O	P	Q	R
M	1	1	1	1	1	1
N	0.50	1	0	0.33	1	0.50
O	0.25	0	1	0.33	0	0.50
P	0.75	0.50	1	1	1	1
Q	0.25	0.50	0	0.33	1	0.50
R	0.50	0.50	1	0.67	1	1

As the proximity between product ‘i’ and ‘j’ is defined as the minimum of the two pairwise conditional probabilities (of countries producing product ‘i’ given that they also produce product ‘j’ and the probability of countries producing product ‘j’ given that they also produce product ‘i’), we only take the lower value of the conditional probabilities between two products. In our example, the conditional probability of producing product M given product N, P (M|N) is 1 while the conditional probability of producing product N given product M, P (N|M) is 0.5. Thus, the proximity between product M and N is the lower value of 0.5. By adjusting the conditional probability matrix (Table A3) to include only the lower value of the two pairwise conditional probabilities, we arrive at a symmetric matrix of product proximities as per Table A4.

Table A4 Product Proximity

Products	M	N	O	P	Q	R
M	1	0.5	0.25	0.75	0.25	0.50
N	0.50	1	0	0.33	0.50	0.50
O	0.25	0	1	0.33	0	0.50
P	0.75	0.33	0.33	1	0.33	0.67
Q	0.25	0.50	0	0.33	1	0.50
R	0.50	0.50	0.50	0.67	0.5	1

Appendix 3. Calculation of density and closeness

A. Density

Consider region 'k' exports six products of which two of them have RCA greater than 1, say product N and O. Given the proximity between products as in the Table A5, the density of each product is calculated as follow.

Table A5 Density Calculation

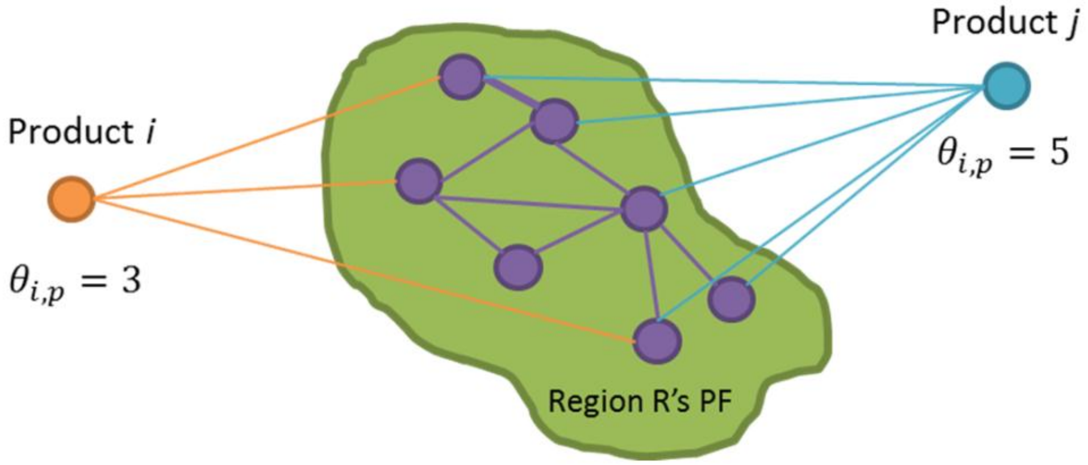
Row No.		Product M	Product N	Product O	Product P	Product Q	Product R
1	Product M		0.5	0.25	0.75	0.25	0.50
2	Product N	0.50		0	0.33	0.50	0.50
3	Product O	0.25	0		0.33	0	0.50
4	Product P	0.75	0.33	0.33		0.33	0.67
5	Product Q	0.25	0.50	0	0.33		0.50
6	Product R	0.50	0.50	0.50	0.67	0.50	
7	$\sum_i \Phi_{i,j}$	2.25	1.83	1.08	2.42	1.58	2.67
8	$\sum_i x_i \Phi_{i,j}$ (sum for products N&O only)	0.75	0	0	0.67	0.50	1
9	ω_j^k (Density)	0.33	0	0	0.28	0.32	0.37

Source: Author's calculation

B. Closeness

Consider two industries *i* and *j* as shown in Figure A2. Portfolio products are the whole products inside the region R (purple nodes) while product *i* (orange node) and *j* (light blue node) in this example are non-portfolio products. Product *i* has three links while product *j* has five links with proximity value greater than 0.143 to portfolio products. This means that closeness of product *i* and *j* to region R is three and five respectively. In this case, product *j* is closer than product *i* to region R.

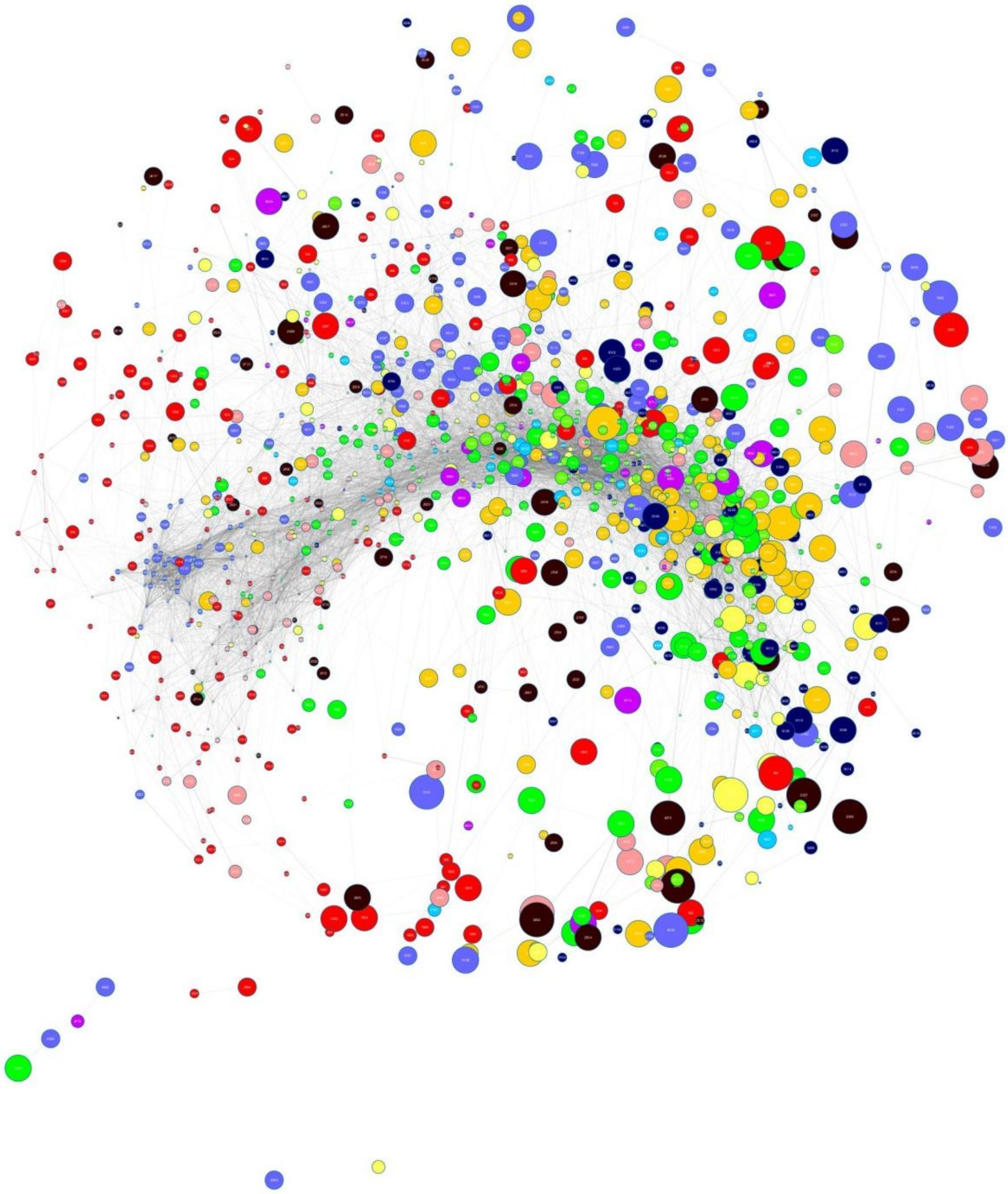
Figure A2 The Closeness Concept



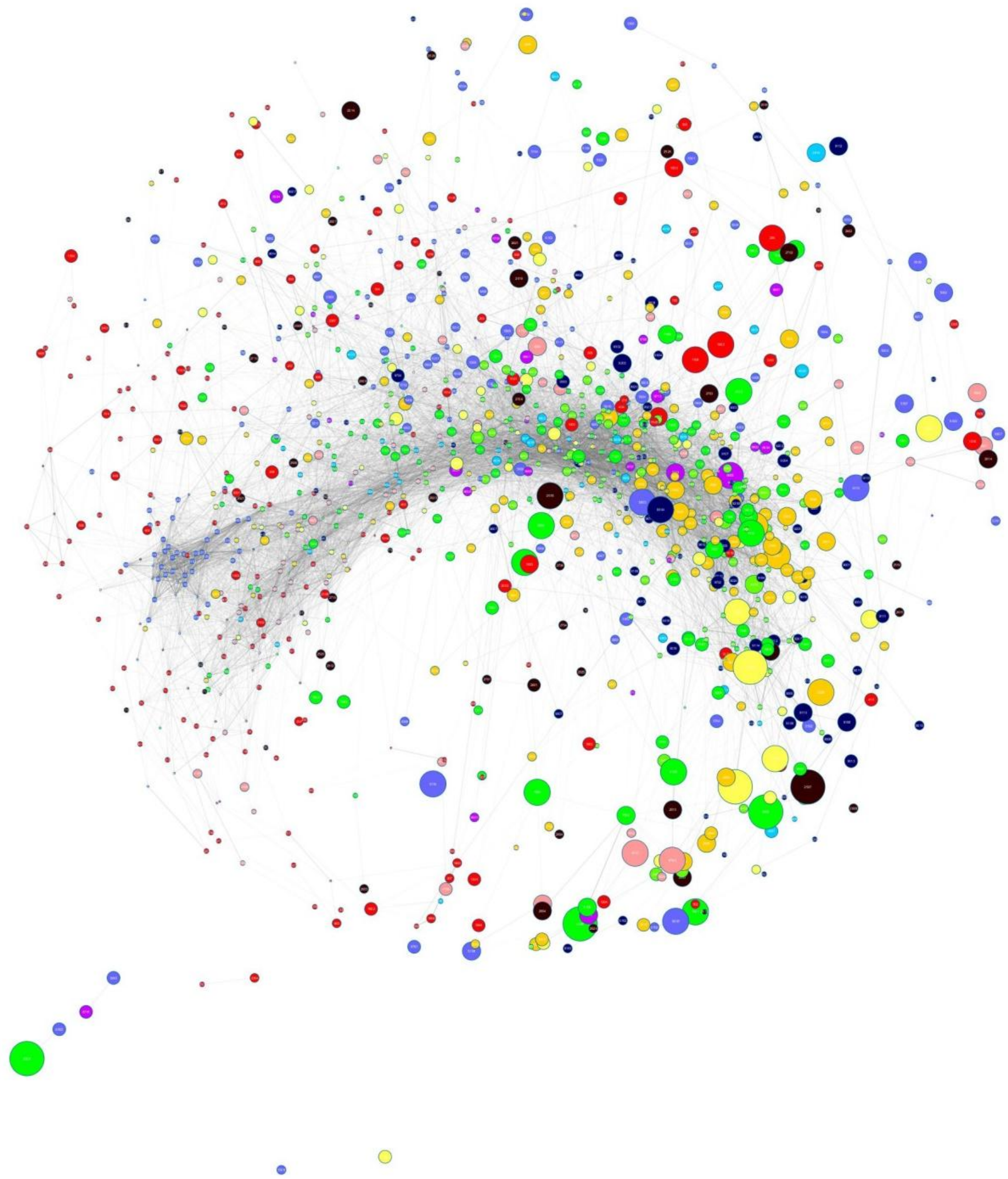
Note: Closeness is measured as number of links between a non-portfolio products and portfolio products.

Appendix 4. Alternative Product Spaces

A. By Ubiquity



B. By PRODY



Appendix 5. Ubiquity Values of Industries

Industries	Years							
	1991	1994	1997	2000	2003	2006	2009	2012
1010	10	28	36	46	43	46	41	42
1020	17	39	58	70	72	66	63	58
1030	14	34	49	54	56	62	63	48
1040	12	27	40	54	49	52	49	42
1050	7	18	26	31	35	39	47	41
1061	10	39	48	58	67	60	69	58
1062	5	11	14	23	25	31	28	21
1071	11	22	36	41	42	47	53	54
1072	16	29	45	57	62	60	53	46
1073	17	33	43	51	48	48	50	46
1074	13	26	27	29	35	34	36	36
1075	8	29	35	45	45	49	51	43
1079	14	31	51	56	55	57	58	53
1080	9	20	32	32	37	37	37	34
1101	10	24	31	36	33	37	38	33
1102	9	18	22	20	18	22	30	26
1103	12	31	37	42	45	46	49	46
1104	15	30	42	53	59	60	67	55
1200	8	21	38	47	51	58	65	57
1311	15	35	39	53	49	41	43	31
1312	15	22	32	30	29	28	29	20
1313	11	15	23	22	22	23	22	15
1391	11	11	17	19	16	15	21	16
1392	17	34	42	43	42	36	38	26
1393	11	23	16	24	22	20	26	18
1394	16	37	39	48	49	43	38	36
1399	7	16	23	28	30	37	44	30
1410	19	39	50	56	55	53	44	35
1420	10	21	26	24	14	12	11	10
1430	17	28	36	40	35	35	34	24
1511	15	32	43	48	47	42	45	43
1512	13	20	28	29	29	25	22	19
1520	12	23	29	34	32	32	34	24
1610	11	29	35	46	48	54	57	49
1621	10	27	33	42	39	45	48	39
1622	11	27	29	37	37	36	42	36
1623	19	26	32	39	32	35	41	43
1629	13	25	38	40	34	36	34	33

Industries	Years							
	1991	1994	1997	2000	2003	2006	2009	2012
1701	6	12	14	22	22	22	23	24
1702	9	30	48	51	41	48	57	51
1709	6	29	41	47	46	45	48	44
1811	6	13	23	26	28	32	38	41
1910	6	16	17	22	18	15	26	19
1920	15	28	37	48	54	52	45	46
2011	7	16	30	25	20	26	23	25
2012	10	24	37	40	42	40	37	29
2013	5	13	15	21	18	22	19	17
2021	5	21	27	31	32	32	25	24
2022	5	20	27	34	34	36	40	40
2023	11	24	36	36	35	43	48	49
2029	6	9	14	16	13	18	16	20
2030	9	30	31	26	22	20	26	23
2100	7	23	26	29	24	26	21	26
2211	9	24	23	32	30	29	27	26
2219	6	18	22	29	30	30	29	29
2220	6	20	23	27	32	43	48	36
2310	8	20	26	37	35	36	38	37
2391	2	10	17	19	15	19	19	19
2392	11	19	26	35	31	37	32	21
2393	11	17	23	18	23	20	22	12
2394	18	33	48	64	63	65	57	58
2395	11	36	44	49	43	50	42	38
2396	7	15	15	16	21	26	28	23
2399	3	14	16	23	25	21	25	22
2410	10	29	35	45	46	49	50	49
2420	10	25	42	60	55	54	53	52
2431	8	21	27	32	32	25	24	28
2511	8	24	32	45	42	46	46	37
2512	7	23	30	37	34	39	38	34
2513	6	15	19	17	17	17	17	17
2520	6	15	15	20	19	28	19	24
2593	5	13	15	23	21	20	25	23
2599	9	21	27	30	28	33	39	35
2610	6	8	14	14	12	12	13	12
2620	4	8	12	18	15	15	14	11
2630	3	11	16	16	18	19	14	15
2640	6	12	13	17	19	17	16	18

Industries	Years							
	1991	1994	1997	2000	2003	2006	2009	2012
2651	5	10	11	12	16	16	21	23
2652	5	7	10	10	15	15	13	12
2660	6	9	9	13	13	16	17	15
2670	4	9	16	13	16	10	9	11
2680	4	9	11	11	13	11	15	9
2710	6	18	21	28	23	19	30	29
2720	9	15	24	17	20	19	27	21
2731	4	9	11	9	17	19	17	19
2732	10	20	28	29	32	38	39	35
2733	7	17	20	20	23	17	24	25
2740	6	15	18	19	23	21	19	16
2750	7	23	23	30	28	34	33	23
2790	5	11	13	14	15	16	15	14
2811	6	14	15	26	28	28	28	26
2812	4	11	12	20	18	23	20	15
2813	6	14	12	18	19	17	18	16
2814	5	10	13	16	15	17	18	19
2815	5	14	21	24	18	25	23	22
2816	6	11	18	27	26	27	26	27
2817	3	8	9	10	14	13	24	14
2818	3	10	13	14	17	13	22	20
2819	5	10	16	20	14	18	18	20
2821	6	15	15	21	18	21	28	21
2822	4	7	13	13	13	11	15	11
2823	4	12	17	18	19	17	12	17
2824	8	18	28	36	36	29	38	25
2825	6	15	19	31	23	22	26	26
2826	3	7	9	12	10	13	17	12
2829	4	9	9	10	13	16	15	15
2910	5	10	17	22	23	28	28	27
2920	6	22	26	29	25	29	41	28
2930	4	10	14	16	17	21	21	22
3011	8	15	25	26	23	22	21	17
3012	7	20	22	32	27	33	30	30
3020	6	14	23	25	23	28	25	19
3030	2	8	7	11	14	16	18	22
3040	2	6	5	13	12	10	13	14
3091	1	6	9	12	15	20	19	16
3092	5	13	16	18	16	25	23	16

Industries	Years							
	1991	1994	1997	2000	2003	2006	2009	2012
3100	10	27	30	38	35	33	36	33
3211	8	19	28	29	33	36	28	25
3212	7	13	16	19	19	25	24	28
3220	3	9	14	18	17	17	11	13
3230	7	13	16	17	14	18	26	18
3240	10	8	6	5	5	9	9	10
3250	4	11	15	19	21	23	23	25
3290	11	14	17	22	21	28	24	17

Appendix 6. Complexity Values

Provinces	1991	1994	1997	2000
ACH	12.35669328	0.07066715	0.00253778	0.00033932
NSM	6.55558999	0.04762725	0.00154551	0.00011428
WSM	15.41713643	0.09357398	0.00242937	0.00020891
RIA	9.80467461	0.05990699	0.00129627	0.00011647
JAM	16.86921628	0.09373502	0.00304270	0.00028824
SSM	13.84081834	0.08096120	0.00204963	0.00020422
BKL	14.91808222	0.09340306	0.00247691	0.00022289
LAM	11.95703148	0.06936362	0.00159106	0.00009581
BBL				
RIS				
JKT	3.99665055	0.02862410	0.00055598	0.00001654
WJV	2.92272335	0.02035322	0.00051988	0.00001997
CJV	3.00048186	0.04008754	0.00076757	0.00007379
YOG	5.13026011	0.03503330	0.00082231	0.00006733
EJV	6.73879950	0.04590251	0.00104802	0.00006026
BAN				
BAL	7.81140419	0.05406162	0.00129564	0.00010682
WKL	13.49655647	0.08616403	0.00310896	0.00026480
CKL	16.13279691	0.10971605	0.00377367	0.00033672
SKL	15.00254144	0.12003287	0.00279267	0.00023679
EKL	13.40067269	0.10501392	0.00150324	0.00027480
NSW	9.14010301	0.10604227	0.00163703	0.00018161
CSW	11.70772176	0.08167322	0.00241615	0.00027684
SSW	12.47308844	0.08392748	0.00198868	0.00017282
SESW	16.85741356	0.08185801	0.00201327	0.00028240
GOR				
WSW				
WNT	12.25644591	0.09621404	0.00189077	0.00014785
ENT	17.13780603	0.07914234	0.00188796	0.00017931
MAL	18.02628694	0.08281157	0.00213544	
NMA				
WPA				
PAP	18.25631864	0.08603722	0.00275509	0.00014699

Provinces	2003	2006	2009	2012
ACH	0.00015057	0.00565648	0.00001922	0.00000079
NSM	0.00006161	0.00358725	0.00001978	0.00000041
WSM	0.00009688	0.00707948	0.00000000	0.00000048
RIA	0.00005247	0.00651318	0.00002444	0.00000047
JAM	0.00014157	0.00845648	0.00003272	0.00000058
SSM	0.00012106	0.00672742	0.00003096	0.00000047
BKL	0.00011347	0.01005422	0.00002629	0.00000091
LAM	0.00006903	0.00398927	0.00001718	0.00000028
BBL	0.00008958	0.00624518	0.00002064	0.00000058
RIS		0.00219123	0.00000914	0.00000020
JKT	0.00001716	0.00187463	0.00000789	0.00000016
WJV	0.00001775	0.00172667	0.00000877	0.00000018
CJV	0.00003856	0.00236909	0.00001205	0.00000025
YOG	0.00005102	0.00211900	0.00001268	0.00000026
EJV	0.00003428	0.00242537	0.00001186	0.00000021
BAN	0.00002577	0.00182272	0.00000980	0.00000020
BAL	0.00006128	0.00289765	0.00001137	0.00000031
WKL	0.00011480	0.00758459	0.00002421	0.00000065
CKL	0.00014859	0.00761550	0.00002350	0.00000064
SKL	0.00011185	0.00737079	0.00002155	0.00000049
EKL	0.00010866	0.00576731	0.00001764	0.00000050
NSW	0.00007215	0.00451272	0.00001602	0.00000047
CSW	0.00009004	0.00493072	0.00001789	0.00000056
SSW	0.00008578	0.00433087	0.00001913	0.00000033
SESW	0.00010590	0.00492509	0.00002609	0.00000045
GOR	0.00007314	0.00439546	0.00001788	0.00000050
WSW		0.00543701	0.00002292	0.00000058
WNT	0.00007009	0.00350420	0.00001803	0.00000040
ENT	0.00008440	0.00396029	0.00001509	0.00000034
MAL	0.00010271	0.00630375	0.00003326	0.00000039
NMA		0.00669663	0.00003565	0.00000048
WPA	0.00007165	0.00522328	0.00002415	0.00000061
PAP	0.00000000	0.00496595	0.00002452	0.00000061

Appendix 7. Summary of econometric analysis applying relatedness concept

A. Author's own review on relatedness and branching process (diversification to new industries/products/patents)

Authors	Scope	Main Data	Year	Relatedness method	DV	Main IVs	Controls	Related Varieties	Unrelated Varieties
Hausmann & Klinger (2007)	Cross-countries	World trade	62-00	Co-occurrence at country level	New products	- Density of undeveloped product - Density of developed product	Industry classification (Lall, Leamer)	- Undeveloped products: +++ - Developed products: +++	
Boschma & Minondo (2013)	Spain	- World trade - Province trade	88-08	Co-occurrence at country level	New products	- Density at country level - Density at province level	Pre-existing products	- Country level: + - Province level: +++	
Boschma & Capone (2015)	Coss-countries	World trade	70-10	Co-occurrence at country level	New products	Interaction between density and several institution indicators		Most of indicators ++	
Lo Turco & Maggioni (2016)	Turkey	- BACI International trade data - Manufacture dataset	05-09	Co-occurrence at country level	New products (restricted to related sector code)	- Density of firms - Density of provinces	Firms' characteristics	Advanced regions: - Firms: +++ - Prov: +++ Laggard regions: - Firm:+++ - Prov: +	
Neffke &Henning (2013)	Sweden	- Employment dataset - NACE classification - I-O tables	04-07	- Skill flow - Industry classification - Input & output relatedness	Probability of diversifications	- Skill relatedness - Industry classification - Input relatedness - Output relatedness	Employment	+++ (except for input relatedness)	
Borggren et al. (2016)	Sweden	Firm registration	96-10	Skill flows	- Survival - Acquisition - Exits	- Similar labour inflow - Related labour inflow - Unrelated labour inflow	- LQ - Type of industries - Firms characteristics (size, age, labour educ.) - Geographic characteristics (educ., Infrastructure, rural/urban)	- Survival: +++ - Acquisition: ++ - Exits: +	Survival: +++ Acquisition: +++ Exits: +++

Authors	Scope	Main Data	Year	Relatedness method	DV	Main IVs	Controls	Varieties Related	Unrelated Varieties
Cainelli & Lacobucci (2016)	Italy	Italian industry census	91-01	Industry classification (Entropy index)	- Related diversification - Unrelated diversificatio	- Related varieties - Unrelated varieties	- Type of Technologies - Geographic dummies - Group characteristics (size and productivity) - Populations	- Related diversification: ++ - Unrelated diversification: -	Related diversification: 0 Unrelated diversification:
Neffke et al. (2011)	Sweden	Manufacturing plant	69-02	Co-occurrence at firm level	- Membership - Entries - Exits	Closeness to portfolio	- Employments by industry and by region - Closeness to non-portfolio	Membership: +++ Entries: +++ Exits: ---	
Essletzbichler (2013)	US	County business dataset	77-97	Input-output chains	- Membership - Entries - Exits	Closeness to portfolio	- Employments by industry and by region - Closeness to non-portfolio	Membership: +++ Entries: +++ Exits: ---	
Rigby (2012)	US	Patents applications	75-05	Citations	New patents in t+1	- Related patents - Unrelated patents	Lag patents	Creating: +++ Retaining: +++	
Tanner (2016)	Europe	Patent registrations	92-07	Patent classes	New patents 3 years acc.	- Related patents - Unrelated patents	- Lag patents - Population	+++	-
Zhu et al. (2017)	China	Chinese Customs Trade Statistics (CCTS)	02-11	Co-occurrence at cities level	New industries	- Density at city level - Extra-regional linkages (FDI,	Regional variation (Theil index)	Related industries: +++	
He et al. (2016)	China	Annual Survey of Industrial Firms	98-08	Co-occurrence at prefecture level	- Entries - Exits	- Density - Global linkage (FDI, Trade) - Liberalisation - Gov't intervention	- Urban economy - Local economy	Entries: +++ Exits: ---	
Guo and He (2017)	China	Annual Survey of Industrial Firms	99-07	Co-occurrence at regional level	New industries (entry)	- Density - Gov't intervention (Tax, Loan, Subsidy, Fiscal)	- Sectors diversity - Numbers of city	Entries: +++ (-- for lagging regions)	

Authors	Scope	Main Data	Year	Relatedness method	DV	Main IVs	Controls	Related Varieties	Unrelated Varieties
He et al. (2017)	China	Annual Survey of Industrial Firms	98-08	Co-occurrence at prefecture level	- Entries - Exits	- Density - Regional factor (public spending) - Industry factors (SOEs, Export, R&D, labour intensity)	- Industrial Gini index - Industry growth rate - Population	Entries: +++ Exits: ---	
Zhou et al. (2016)	China	Annual Survey of Industrial Firms	98-08	Co-occurrence at prefecture level	Entries	- Exits - Regional-factor (market, fiscal)	- Localisation economies - Urbanisation economies - regional industrial diversity (LQ)	Exits: +++	
Hidalgo et al. (2007)	Cross-countries	World trade	98-00	Co-occurrence at country level	New products				
Fortunato et al. (2015)	Cross-countries	World trade	08-12	Co-occurrence at country level	New products by group	-		-	

B. Frenken and Content's review on relatedness and macroeconomic indicators

Author(s)	Geog. aggregate	Geog. area	Period	Data source	Main iV(s)	Digits	dV(s)	RV	UV
Frenken, van Oort, & Verburg (2007)	NUTS3	Netherlands	1996 - 2002	CBS	Related variety Unrelated variety	RV = 5 in each 2 UV = 2	Employment growth Productivity growth Unemployment growth	+ - 0	0 0 -
Saviotti & Frenken (2008)	National	OECD	1964 - 2003	OECD trade data	Unrelated export variety Semi related export variety Related export variety	UV = 1 SV = 2 in each 1 RV = 3 in each 2	GDP per cap Labour productivity	+ +	- -
Boschma & Iammarino (2009)	NUTS3	Italy	1995 - 2003	ISTAT	Export variety Related export variety Import variety Related trade variety Unrelated export variety Trade similarities	Variety = 3 RV = 3 in each 2 UV = 1	Employment growth Value-added growth Labour-productivity growth	M + M	0 + 0
Bishop & Gripaios (2010)	Subnational	Great Britain	1995 - 2002	NOMIS	Related variety Unrelated variety	RV = 4 in each 2 UV = 2	Employment growth at industry-level	M	M
Quatraro (2010)	Subnational	Italy	1981 - 2002	ISTAT and EPO	Total variety Unrelated variety Related variety	RV = 3 in each 1 UV = 1 TV = 3	Productivity growth	+	0
Brachert, Kubis & Titze (2011)	Local labor market	Germany	2003 - 2008	Federal employment office	RV, UV, functional specialization (ratio of WC and BC workers)	RV = 5 in each 2 UV = 2	Employment growth	+	0
Falcioğlu (2011)	NUTS2	Turkey	1980 - 2000	Turkish statistical institute	Variety Related variety	Variety = 3 RV = 3 in each 2	Productivity growth	+	
Boschma, Minondo & Navarro (2012)	NUTS3	Spain	1995 – 2007	INE, Ivie and Agencia Tributaria	Frenken, Porter and Hidalgo measures of relatedness	RV = 6 in each 2 UV = 1	Value-added growth	+	0

Author(s)	Geog. aggregate	Geog. area	Period	Data source	Main iV(s)	Digits	dV(s)	RV	UV
Hartog, Boschma & Sotarauta (2012)	NUTS4	Finland	1993 - 2006	Statistics Finland	Related variety RV-Hi-Tech RV-Low-Tech Unrelated variety	Variety = 5 RV = 5 in each 2 UV = 2	Employment growth	+	0
Mameli, Iammarino & Boschma (2012)	Local labor market	Italy	1991 - 2001	ISTAT	Variety Related variety Unrelated variety	Variety = 3 RV = 3 in each 2 UV = 1	Employment growth	+	+
Colombelli & Quatraro (2013)	NUTS3	Italy	1995 - 2011	ISTAT	Knowledge variety Related knowledge variety Unrelated knowledge variety Cognitive distance Knowledge coherence	KV = 4 UKV = 1 RKV = 2 each 4	Entrepreneurship	0	0
Tavassoli & Carbonara (2014)	Local labor market	Sweden	2002 - 2007	SCB	R&D investments Related variety Unrelated variety Trade related variety	UV = 2 RV = 5 in each 2 TRV = 5 in each 2	Patent applications as proxy for innovation	+	M
Castaldi, Frenken & Los (2015)	State	US	1977 - 1999	NBER	Related variety Semi-related variety Unrelated variety	UV = 1 SRV = 2 in each 1	Number of patents Share of super patents	+ 0	0 +
Cortinovis & van Oort (2015)	NUTS2	Europe	2004 - 2012	ORBIS, Bureau van dijk	Unrelated variety Related variety Specialization Technological regime	UV = 1 RV = in each 2	Employment growth Unemployment growth	+ M	0 M
Van Oort, deGeus & Dogaru (2015)	NUTS2	Europe	2000 - 2010	Amadeus	Related variety Unrelated variety	RC = 4 in each 1 UV = 2	Employment growth Productivity growth Unemployment growth	+ 0 0	M 0 0

Author(s)	Geog. aggregate	Geog. area	Period	Data source	Main iV(s)	Digits	dV(s)	RV	UV
Caragliu, de Dominics & De Groot (2016)	NUTS2	Europe	1990 – 2007	Cambridge Econometrics	Related variety Unrelated variety	RV = 2 in each 1 UV = 1	Employment growth at industry-level	0	+

Note: The columns RV and UV show the significance of related- and unrelated variety on the dependent variables shown in the column dV(s). + and – indicate significant positive or negative effects, respectively, whereas 0 and M indicate no significant- or mixed results, respectively.

Appendix 8. Review of FDI's Effects on Indonesia Economy

Authors	Period of analyses	Dataset	Response variables	Relationship	Remarks/causes	Categories of effects
Arnold and Javorcik (2009)	1983-2001	Manufacturing survey-BPS	TFP	FDI-productivity: positive	Increase productivity through investment, employment, wage, export/import	Productivity
Balasubranya-man (1984)	1974	Manufacturing survey-BPS	Value added (VA) per employee*	FDI-productive efficiency: positive	Improve managerial and labour skills and more capital intensive	Productivity
Langhammer (1988)	1967-1983	Investment board & Central Bank	-	FDI-trade effects: positive	Affect trade through imported inputs and machineries from home countries (intra-trade)	Trade
Thee Kian Wie (1984)	1967-1980	Investment board	-	FDI-trade effects: positive/negative	Intra-trade rather than inter-trade	Trade
Rahmaddi and Ichihashi (2013)	1990-2008	Investment board	Export	FDI-trade effects: positive/negative	Stronger in hi-tech (PCI, HCI, TI) than low-tech (NRI ULI) industries	Trade
Takii and Ramstetter (2005)	1975-2001	Manufacturing survey-BPS	Labour productivity	FDI-labour productivity: positive	MNCs have persistently much higher labour productivity than local plants	Productivity
Takii (2009)	1990-1995	Manufacturing survey-BPS	VA, wages	FDI-productivity and wage growth: positive	FDI correlates to productivity gain of locally-owned plants	Spillover
Takii (2005)	1990-1995	Manufacturing survey-BPS	VA	FDI-productivity spillover: positive/negative	Apply if partly owned by foreigner and small technological gaps. Negative spillover in large technological gaps	Spillover
Todo and Miyamoto (2006)	1994-1997	Manufacturing survey-BPS	VA per employee	FDI-knowledge spillover: positive but weak	Spillover occurs only from FDI with R&D activities, but insignificant from FDI without R&D activities	Spillover
Negara and Adam (2012)	1995-2005	Manufacturing survey-BPS	VA per employee	FDI-productivity spillover: positive/negative	Sources of spillover are intra-industry and forward linkage. FDI fail to promote backward linkages	Spillover
Takii (2004)	1995	Manufacturing survey-BPS	TFP	FDI-productivity: positive	Foreign plants more productive than local plants. Plants' productivity is also influenced by share of foreign ownership, age, and differ across industries	Productivity
Takii (2011)	1990-2003	Manufacturing survey-BPS	VA	FDI by country of origins-productivity: positive	FDI from East Asian imparted positive externalities, whereas non-Asia did not.	Spillover

Author(s)	Period of analyses	Dataset	Response variables	Relationships	Remarks/causes	Categories of effects
Sjoholm and Takii (2008)	1990-2000	Manufacturing survey-BPS	Export	FDI-export: positive	Plants with any foreign ownership are likely to export	Trade
Sjoholm (2003)	1994-1997	Manufacturing survey-BPS	Export	FDI-export: positive	Plants with foreign network through ownership or import have positive effects on export	Trade
Sjoholm (1999)	1980 and 1991	Manufacturing survey-BPS	Growth in VA, VA per	FDI -productivity: positive	Productivity spillover occurs in competitive industries and with large technological gap	Spillover
Ramsetter (1999)	1992 and 1994	Manufacturing survey-BPS	Export intensities	FDI-trade effects: positive	Foreign ownerships induce trade	Trade
Okamoto and Sjoholm (2005)	1990-1995	Manufacturing survey-BPS	TFP	FDI -productivity: positive but weak	FDI has substantial effects on productivity in some sectors, but not others	Productivity
Lipsey, Sjoholm and Sun (2010)	1975-2005	Manufacturing survey-BPS	Growth in employment	FDI-employment growth: positive	Changes of ownership from domestic to foreign owner raise employment growth rate	Labour market
Sjoholm and Lipsey (2006)	1975-1999	Manufacturing survey-BPS	Wages per employee	FDI-wage: positive	Foreign acquisitions increase wage	Labour market
Lipsey and Sjoholm (2004)	1996	Manufacturing survey-BPS	Wages per employee	FDI-wage (domestic owned): positive	Wages increase in industries and in provinces with large foreign presence	Spillover
Blalock and Gertler (2008)	1988-1996	Manufacturing survey-BPS	Output	FDI -productivity: positive	FDI diffuse technology to improve productivity and increase competition among local suppliers, thus lowering input price	Spillover
Sjoholm (1999)	1980 and 1991	Manufacturing survey-BPS	Growth in VA, VA per	FDI -productivity: positive/negative	Positive for inter-industry at district level, but no spillover for intra-industry	Spillover
Lipsey and Sjoholm (2004)	1996	Manufacturing survey-BPS	Wages per employee	FDI-wage: positive	Foreign owned firms pay higher wage of given the same quality level of labours than local firms	Labour market
Blomstrom and Sjoholm (1999)	1991	Manufacturing survey-BPS	VA per employee	FDI -productivity: positive	Foreign owned plants have higher productivity that domestic plants can benefit from.	Spillover
Blalock and Gertler (2009)	1988-1996	Manufacturing survey-BPS	Output	FDI-technology spillover: positive	Domestic firms with R&D activities and highly educated workers benefit from FDI, and vice versa. Firms with wide tech-gap benefit more than small tech-gap.	Spillover
Temenggung (2007)	1975-2000	Manufacturing survey-BPS	Output	FDI -productivity: positive/negative	Negative in pre-liberalisation (75-86), positive post-liberalisation (87 forward), positive overall period	Spillover

Authors	Period of analyses	Dataset	Response variables	Relationship	Remarks/causes	Categories of effects
Lindblad (2015)	1965-2015	-	-	FDI-economic growth: positive but weak	Hinges on natural resources extraction, grown in restrictive climate but fail in more liberal conditions.	Productivity
Gopalan, Hattari and Rajan (2016)	1985-2005	World Development Indicators	Human capital	FDI-Human capital: positive	FDI enhances human capital in host countries	Spillover
Suyanto et al. (2009)	1988-2000	Manufacturing survey-BPS	TFP	FDI-productivity: positive	FDI spillover has positive relation with technological progress, technical and scale	Productivity
Khaliq and Noy (2007)	1998-2006	Annual GDP-BPS, Investment	GDP	FDI-economic growth: positive/negative	Few sectors show positive effects whereas one sector (mining and querying) show robust negative	Productivity
Dhanani and Hasnain (2002)	1990-1999	Various macro-economic data	-	FDI-domestic economy: positive/negative	Moderately positive for capital formation, export, manufacturing employment, supplier and support industries, transferring technology and generating	Productivity/ export/labour market, spillover
Iman and Nagata (2005)	-	Qualitative data (interview)	-	FDI-Backward linkages and global	Local firms are not ready yet	Trade/Spillover
Cross (1991)	-	-	-	FDI benefits economic growth***	Intra-Asia FDI is beneficial for Indonesia	Productivity
Lipsey and Sjoholm (2011)	-	-	-	-	-	-

*) Using correlation between value added per employee and capital intensity and wages rate
**) Considered as negative
***) Considered as positive but weak

Appendix 9. Data conversion

As mentioned in the data section, the data use different classification systems and versions to classify industries, i.e. KBLI, HS, and ISIC. As consequence, we need to convert the data to make it under the same classification and version. By considering the availability and structure of the data, and also the availability of concordance table to convert the data, it is best to pooled all the data into ISIC revision 4 classification. It will take a long space explaining the whole conversion process. For efficiency reason, in the following table I will explain only the main steps.

Main Steps in Data Conversion

<table>
<tr><th>Data</th><th>Classification used</th><th>Conversion process</th></tr>
<tr><td>International trade data</td><td>HS 1992 at 6 digit</td><td>Step 1
- conversion from HS92 to ISIC rev. 3 (using concordance matrix provided by the World Bank)
- conversion from ISIC rev. 3 to ISIC rev. 3.1 (using concordance matrix provided by the UN)
- Output1: trade data in ISIC rev.3.1 classification
Step 2
- conversion from HS92 to ISIC rev. 3.1 (using concordance matrix provided by the UN)
- Output2: trade data in ISIC rev.3.1 classification
Step 3
- Consolidation between output1 and output2 as there were some minor differences. This is manually done.
- Output3: consolidated trade data in ISIC rev. 3.1 classification
Step 4
- Conversion from ISIC rev. 3.1 (output3) to ISIC rev. 4 (using concordance matrix provided by the UN). As there are significant changes in the structure and number of classification codes, the conversion should be done manually by using the concordance matrix as general guidance.
- Output4: trade data in ISIC rev. 4 classification</td></tr>
<tr><td>AMS 1991</td><td rowspan="3">KLUI* 1990 at 5 digits</td><td rowspan="3">Step 1
- Conversion from KLUI 1990 to KLUI 1997. No concordance matrix available. However, similar structure and minor code differences make it easy to convert the data manually.
Step 2
- Conversion from KLUI 1997 to KBLI 2000. No concordance matrix available. However, similar structure and minor code differences make it easy to convert the data manually.
Step 3
- Conversion from KBLI 2000 to KBLI 2005. Concordance matrix is available.
Step 4
- Conversion from KBLI 2005 to KBLI 2009.</td></tr>
<tr><td>AMS 1994</td></tr>
<tr><td>AMS 1997</td></tr>
</table>

Data	Classification used	Conversion process
		Concordance matrix is available. Step 5 - Conversion from KBLI 2009 to ISIC rev. 4. Concordance matrix is available.
AMS 2000	KBLI 2000 at 5 digits	Similar conversion process to AMS 1991, 1994, and 1997. It is started from step 3.
AMS 2003		
AMS2006	KBLI 2005 at 5 digits	Similar conversion process to AMS 1991, 1994, and 1997. It is started from step 4.
AMS 2009		
AMS 2012	KBLI 2009 at 5 digits	The conversion process followed step 5 only.
FDI data	KBLI 2009 at 4 digits	
Min. Wage	by regions	-

*) Since 2000 KLUI was changed into KBLI

Some conversions can be done automatically using available concordance matrix. Some others should be done semi-manually as concordance matrix is not available. These manual works are time consuming as it involved manual work of sorting and matching for thousands of data rows.

Appendix 10. Density Values of Provinces

Provinces	1991	1994	1997	2000
ACH	0.056888	0.082039	0.081244	0.023418
NSM	0.215985	0.194055	0.139785	0.114662
WSM	0.081311	0.064639	0.072282	0.059968
RIA	0.156576	0.179729	0.177494	0.094257
JAM	0.054452	0.07019	0.061873	0.042538
SSM	0.119061	0.143247	0.109573	0.071682
BKL	0.043265	0.067664	0.04805	0.006878
LAM	0.083195	0.107126	0.095705	0.064724
JKT	0.412846	0.378719	0.326524	0.28844
WJV	0.438002	0.508226	0.518719	0.495542
CJV	0.213018	0.194983	0.228763	0.247675
YOG	0.185319	0.191472	0.190973	0.112049
EJV	0.337669	0.328446	0.396782	0.343818
BAL	0.106017	0.156506	0.15723	0.101144
WKL	0.064589	0.062707	0.059422	0.048346
CKL	0.039302	0.039632	0.035205	0.024818
SKL	0.056659	0.074506	0.071166	0.050326
EKL	0.05413	0.077811	0.09988	0.023088
NSW	0.074318	0.105485	0.095883	0.04517
CSW	0.057274	0.04813	0.059163	0.032596
SSW	0.11302	0.183985	0.148849	0.110133
SESW	0.032999	0.056783	0.059713	0.030027
WNT	0.083618	0.111093	0.118216	0.057369
ENT	0.059817	0.087887	0.072241	0.008423
MAL	0.024188	0.018135	0.023516	0.009495
PAP	0.064021	0.046019	0.053785	0.01542

Provinces	2003	2006	2009	2012
ACH	0.023516	0.080613	0.032539	0.021287
NSM	0.128432	0.160965	0.092345	0.167689
WSM	0.069715	0.060104	0.014861	0.047252
RIA	0.129987	0.185897	0.175397	0.128782
JAM	0.042775	0.057144	0.034873	0.041312
SSM	0.072549	0.085486	0.068371	0.098525
BKL	0.006583	0.018044	0.037963	0.016762
LAM	0.089801	0.121576	0.119928	0.11734
JKT	0.246553	0.293039	0.192367	0.227134
WJV	0.599109	0.5595	0.506898	0.581148
CJV	0.214321	0.314908	0.241664	0.302163
YOG	0.136087	0.20824	0.129552	0.25439
EJV	0.352987	0.457806	0.346833	0.511968
BAL	0.100745	0.248924	0.12015	0.165612
WKL	0.052935	0.061591	0.064433	0.032376
CKL	0.036192	0.049535	0.031848	0.042329
SKL	0.066122	0.0722	0.098829	0.074305
EKL	0.04686	0.100681	0.08289	0.070383
NSW	0.054874	0.140872	0.107342	0.063157
CSW	0.017209	0.056626	0.037401	0.046927
SSW	0.12787	0.172167	0.128506	0.107767
SESW	0.039668	0.098237	0.036495	0.031042
WNT	0.09445	0.050958	0.063977	0.116392
ENT	0.041195	0.055444	0.07243	0.093834
MAL	0.01466	0.090616	0.025567	0.059177
PAP	0.006165	0.030319	0.060376	0.045548

Appendix 11. Alternative Estimations for Province Model

A. Alternative estimation of which FDI variable is normalised by regional size

Dependent Variable: ca3 (number of industries with RCA in provinces after three years)

Variable	OLS	FE	RE	GMM
zca3				
L1.	.03045962	.02952265**	.03095969*	.0373161*
zdensity	.96096705***	.96501612***	.96187319***	.97975486***
znfdi	.00754015	-.003809	.00521477	-.00370147
zcomplexity	.00455376	-.00767138	.00064744	-.00682375
zemploy	.00333459	-.07064816	.00251242	-.08680039
zminwage	-.01017001	-.00535831	-.00734105	-.00616711
yr1	(omitted)	(omitted)	(omitted)	
yr2	(omitted)	(omitted)	.00506314	.01266591
yr3	-.00972528	-.02766289**	-.01136869	-.0133836
yr4	-.03336837	-.05756706***	-.0380367	-.0372361
yr5	-.01255765	-.04374764*	-.01925224	-.02190844
yr6	-.00150245	-.03102213	-.00952701	-.01347266
yr7	-.00966079	-.05103803	-.02161989	-.03146914
yr8	.01167037	-.02052609	(omitted)	
_cons	.0035425	.03044213	.00928059	
N	182	182	182	156
F	172801.5	881.11493		1233.6071
ll	344.85977	383.18194		
df_m	12	11	12	12
chi2			855536.5	
r2	.9986961	.98676092		

legend: * p<0.05; ** p<0.01; *** p<0.001

B. Alternative estimation of which FDI variable is normalised by natural logarithm

Dependent Variable: ca3 (number of industries with RCA in provinces after three years)

Variable	OLS	FE	RE	GMM
zca3				
L1.	.02514926	.03412919**	.03015662	.04761406**
zdensity	.95328722***	.95985819***	.95588078***	.97000407***
zlnfdi	.00863874	-.00120587	.00649782	-.00227657
zcomplexity	.0036252	-.0150866*	-.00175692	-.01095913
zemploy	.01407903	-.06354591	.0078694	-.08029342
zminwage	-.00316368	-.0125784	-.00832466	-.00134798
yr1	(omitted)	(omitted)	(omitted)	
yr2	(omitted)	.01652745	.01664705	.03215064
yr3	-.01449458	-.01999666	-.00455179	.00026503
yr4	-.04864709	-.06066974	-.0403001	-.03824974
yr5	-.03369407	-.03888425	-.0209572	-.01631713
yr6	-.02247136	-.01907941	-.00917893	-.00578345
yr7	-.03862314	-.04517448	-.02703874	-.04013283
yr8	-.02194839	(omitted)	(omitted)	
_cons	.02504457	.03519379	.00916175	
N	128	128	128	87
F	16204.579	1187.8035		981.00169
ll	228.29774	261.36396		
df_m	12	11	12	12
chi2			91840.868	
r2	.99861405	.98695554		

legend: * p<0.05; ** p<0.01; *** p<0.001

Appendix 12. Post Estimation Tests (Hausman test and test of time fixed-effects)

Hausman test for province FE model

```
Note: the rank of the differenced variance matrix (11) does not equal the
        number of coefficients being tested (17); be sure this is what you
        expect, or there may be problems computing the test.  Examine the
        output of your estimators for anything unexpected and possibly consider
        scaling your variables so that the coefficients are on a similar scale.
```

	Coefficients (b) FE	(B) RE	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
L.ca3	.0267648	.3846992	-.3579344	.046926
L2.ca3	-.0085293	-.0239351	.0154058	.0087257
density	118.212	117.8285	.3834888	.8015295
fdi	2.15e-07	1.18e-07	9.73e-08	3.78e-08
complexity	-.4832594	-.1344389	-.3488204	.2403977
employ	-4.76e-06	-1.05e-06	-3.71e-06	8.72e-07
minwage	-.0010477	-.0014185	.0003708	.0002575
L.density	-.2784872	-41.84405	41.56556	5.702448
L.fdi	3.48e-07	3.60e-07	-1.21e-08	2.24e-08
L.complexity	-.233834	.0338995	-.2677335	.0446395
L.employ	3.12e-07	1.03e-06	-7.17e-07	5.53e-07
L.minwage	.0011882	.0016161	-.0004279	.
yr3	.3915845	-.2786432	.6702277	.4178454
yr4	-.2656049	-.5460638	.2804589	.3850224
yr5	-.1192745	-.1365046	.0172301	.3065496
yr6	.0149034	-.1645985	.179502	.2126739
yr7	-.3493983	-.4505395	.1011412	.1205997

```
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(11) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       46.87
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Time-fixed-effect test for province FE model

```
. xtreg ca3 L(1/2).ca3 density fdi complexity employ minwage  i.year, fe

Fixed-effects (within) regression               Number of obs      =       156
Group variable: provinces                       Number of groups   =        26

R-sq:  within  = 0.9871                         Obs per group: min =         6
       between = 0.9971                                        avg =       6.0
       overall = 0.9956                                        max =         6

                                                F(12,118)          =    749.87
corr(u_i, Xb)  = 0.8670                         Prob > F           =    0.0000

------------------------------------------------------------------------------
         ca3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         ca3 |
         L1. |   .0256628   .0141718     1.81   0.073    -.0024012    .0537268
         L2. |  -.0041029   .0143367    -0.29   0.775    -.0324936    .0242877
             |
     density |   118.2729   1.663148    71.11   0.000     114.9795    121.5664
         fdi |   2.05e-07   1.16e-07     1.77   0.079    -2.42e-08    4.33e-07
  complexity |  -.7309299     .44104    -1.66   0.100    -1.604309    .1424493
      employ |  -4.84e-06   1.39e-06    -3.49   0.001    -7.59e-06   -2.09e-06
     minwage |   -.000465   .0005671    -0.82   0.414    -.0015879     .000658
             |
        year |
       2000  |  -.5706229   .2064702    -2.76   0.007    -.9794901   -.1617556
       2003  |  -.2803948   .2521972    -1.11   0.268     -.779814    .2190244
       2006  |  -.0736561   .3138959    -0.23   0.815    -.6952555    .5479433
       2009  |  -.4050053   .4398323    -0.92   0.359    -1.275993    .4659825
       2012  |   .1421973   .5678556     0.25   0.803    -.9823114    1.266706
             |
       _cons |   1.678821   .4603403     3.65   0.000     .7672223    2.590421
-------------+----------------------------------------------------------------
     sigma_u |  1.8549758
     sigma_e |  .47543547
         rho |   .9383582   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 118) =     3.19             Prob > F = 0.0000

. testparm i.year

 ( 1)  2000.year = 0
 ( 2)  2003.year = 0
 ( 3)  2006.year = 0
 ( 4)  2009.year = 0
 ( 5)  2012.year = 0

       F(  5,   118) =    2.35
            Prob > F =    0.0451
```

Hausman test for FE entry model

```
. hausman fe re

Note: the rank of the differenced variance matrix (9) does not equal the number of coefficients being tested (12); be sure this is what you
        expect, or there may be problems computing the test.  Examine the output of your estimators for anything unexpected and possibly
        consider scaling your variables so that the coefficients are on a similar scale.
```

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
close_pf	.0912546	.0930781	-.0018234	.0032757
fdi	-4.54e-07	-4.57e-06	4.11e-06	.
sophistica~n	-.0630395	-.0399153	-.0231242	.0058907
employr	3.11e-06	1.02e-06	2.10e-06	8.04e-07
employi	4.90e-06	5.59e-06	-6.84e-07	1.16e-06
close_npf	-.0066544	-.0052445	-.0014099	.0017759
L.close_pf	-.0847488	-.084212	-.0005368	.0025564
L.fdi	1.80e-06	-3.40e-06	5.20e-06	.
L.sophisti~n	.056096	.0526051	.0034909	.0017412
L.employr	-2.47e-06	-1.59e-06	-8.78e-07	5.08e-07
L.employi	-6.31e-06	-4.97e-06	-1.33e-06	9.61e-07
L.close_npf	.0006202	-.0008307	.0014509	.0015499

```
                  b = consistent under Ho and Ha; obtained from xtlogit
   B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

    Test:  Ho:  difference in coefficients not systematic

                  chi2(9) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       39.85
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Time-fixed-effect test for entry FE model

```
. xtlogit entry close_pf  fdi  sophistication  employr  employi close_npf L1.(close_pf
> ar, fe nolog
note: multiple positive outcomes within groups encountered.
note: 2238 groups (15666 obs) dropped because of all positive or
      all negative outcomes.

Conditional fixed-effects logistic regression   Number of obs      =      6902
Group variable: regind1                         Number of groups   =       986

                                                Obs per group: min =         7
                                                               avg =       7.0
                                                               max =         7

                                                LR chi2(18)        =   1254.12
Log likelihood  =  -1703.194                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         entry |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
      close_pf |   .0179377   .0066963     2.68   0.007     .0048132    .0310623
           fdi |  -1.10e-06   2.80e-06    -0.39   0.694    -6.59e-06    4.39e-06
sophistication |  -.0284101   .0100206    -2.84   0.005    -.0480501     -.00877
       employr |  -2.41e-06   1.20e-06    -2.01   0.044    -4.77e-06   -6.00e-08
       employi |   2.66e-06   2.15e-06     1.23   0.217    -1.56e-06    6.88e-06
     close_npf |  -.0039213    .002782    -1.41   0.159     -.009374    .0015313
               |
      close_pf |
           L1. |  -.0339468   .0065137    -5.21   0.000    -.0467134   -.0211803
               |
           fdi |
           L1. |   3.96e-06   3.62e-06     1.10   0.273    -3.13e-06    .0000111
               |
sophistication |
           L1. |   .0292872   .0081426     3.60   0.000      .013328    .0452463
               |
       employr |
           L1. |   1.78e-06   1.09e-06     1.63   0.102    -3.57e-07    3.92e-06
               |
       employi |
           L1. |  -3.11e-06   2.04e-06    -1.52   0.128    -7.12e-06    8.93e-07
               |
     close_npf |
           L1. |  -.0005513   .0025277    -0.22   0.827    -.0055055     .004403
               |
          year |
          1997 |  -.0400751   .1449421    -0.28   0.782    -.3241564    .2440062
          2000 |  -2.469458   .3429821    -7.20   0.000    -3.141691   -1.797226
          2003 |  -.8256257   .2465741    -3.35   0.001    -1.308902   -.3423493
          2006 |   1.116246   .2084199     5.36   0.000      .707751    1.524742
          2009 |  -.9784799   .2413019    -4.06   0.000    -1.451423   -.5055369
          2012 |   .4214713   .2114635     1.99   0.046     .0070104    .8359322
------------------------------------------------------------------------------

. testparm i.year

 ( 1)  [entry]1997.year = 0
 ( 2)  [entry]2000.year = 0
 ( 3)  [entry]2003.year = 0
 ( 4)  [entry]2006.year = 0
 ( 5)  [entry]2009.year = 0
 ( 6)  [entry]2012.year = 0

           chi2(  6) =  292.38
         Prob > chi2 =    0.0000
```

Hausman test for FE exit model

```
. hausman exitfe exitre

Note: the rank of the differenced variance matrix (10) does not equal the number of coefficients being tested (12); be sure this is what you
        expect, or there may be problems computing the test.  Examine the output of your estimators for anything unexpected and possibly
        consider scaling your variables so that the coefficients are on a similar scale.
```

	Coefficients (b) exitfe	(B) exitre	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
close_pf	-.0934043	-.0994546	.0060503	.0026697
fdi	-9.50e-07	-1.20e-06	2.54e-07	.
sophistica~n	.0762976	.0339554	.0423421	.006773
employr	-1.05e-06	-2.92e-06	1.86e-06	8.57e-07
employi	-1.30e-07	-7.56e-07	6.26e-07	1.13e-06
close_npf	.0062161	.0036366	.0025794	.0020048
L.close_pf	.0919144	.1012674	-.009353	.0029617
L.fdi	-.0000214	-.0001208	.0000994	.
L.sophisti~n	-.0223757	-.0115004	-.0108753	.0028099
L.employr	3.67e-06	3.11e-06	5.59e-07	5.56e-07
L.employi	4.98e-06	1.81e-06	3.17e-06	1.17e-06
L.close_npf	-.0038319	-.0044389	.000607	.0017584

```
                         b = consistent under Ho and Ha; obtained from xtlogit
          B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

    Test:  Ho:  difference in coefficients not systematic

                 chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       80.22
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Time-fixed-effect test for exit FE model

```
. xtlogit exit close_pf  fdi  sophistication  employr  employi close_npf L1.(close_pf
> r, fe nolog
note: multiple positive outcomes within groups encountered.
note: 2216 groups (15512 obs) dropped because of all positive or
      all negative outcomes.

Conditional fixed-effects logistic regression   Number of obs      =      7056
Group variable: regind1                         Number of groups   =      1008

                                                Obs per group: min =         7
                                                               avg =       7.0
                                                               max =         7

                                                LR chi2(18)        =   1765.15
Log likelihood  = -1441.0577                    Prob > chi2        =    0.0000
```

exit	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
close_pf	-.0155809	.0071051	-2.19	0.028	-.0295066	-.0016551
fdi	-5.91e-07	2.58e-06	-0.23	0.819	-5.65e-06	4.47e-06
sophistication	.0061018	.0097996	0.62	0.534	-.013105	.0253086
employr	1.82e-06	1.33e-06	1.37	0.171	-7.86e-07	4.43e-06
employi	-2.41e-06	1.60e-06	-1.51	0.132	-5.53e-06	7.22e-07
close_npf	.0007057	.0032054	0.22	0.826	-.0055767	.0069882
close_pf						
L1.	.0237029	.0063922	3.71	0.000	.0111745	.0362313
fdi						
L1.	-.000026	.0000248	-1.05	0.294	-.0000746	.0000226
sophistication						
L1.	-.0092346	.009528	-0.97	0.332	-.0279092	.00944
employr						
L1.	-1.33e-06	1.08e-06	-1.23	0.217	-3.44e-06	7.83e-07
employi						
L1.	4.08e-06	1.85e-06	2.21	0.027	4.64e-07	7.70e-06
close_npf						
L1.	-.000612	.0028749	-0.21	0.831	-.0062466	.0050227
year						
1997	.5841631	.2099763	2.78	0.005	.1726172	.9957091
2000	2.799676	.2491453	11.24	0.000	2.31136	3.287992
2003	.0041097	.3371744	0.01	0.990	-.65674	.6649594
2006	-.9834975	.3918953	-2.51	0.012	-1.751598	-.2153969
2009	2.309096	.2767027	8.35	0.000	1.766769	2.851423
2012	1.121761	.2951261	3.80	0.000	.5433249	1.700198

```
. testparm i.year

 ( 1)  [exit]1997.year = 0
 ( 2)  [exit]2000.year = 0
 ( 3)  [exit]2003.year = 0
 ( 4)  [exit]2006.year = 0
 ( 5)  [exit]2009.year = 0
 ( 6)  [exit]2012.year = 0

           chi2(  6) =  461.85
         Prob > chi2 =    0.0000
```

Hausman test for FE remain model

```
. hausman remainfe remainre

Note: the rank of the differenced variance matrix (10) does not equal the number of coefficients being tested (12); be sure this is what you
        expect, or there may be problems computing the test.  Examine the output of your estimators for anything unexpected and possibly
        consider scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |    remainfe     remainre      Difference          S.E.
-------------+----------------------------------------------------------------
    close_pf |    .0773218     .0927452       -.0154233        .0022488
         fdi |   -4.05e-07     3.14e-06       -3.55e-06               .
sophistica~n |   -.0489699     .0156048       -.0645748        .0046525
     employr |   -1.29e-06     2.22e-06       -3.51e-06        5.98e-07
     employi |    4.76e-06     9.44e-06       -4.68e-06        9.64e-07
   close_npf |   -.0041376    -.0012763       -.0028613        .0013599
  L.close_pf |    .0571195     .0726576       -.0155381        .0021487
       L.fdi |   -2.43e-07     5.09e-06       -5.33e-06               .
L.sophisti~n |   -.0447945    -.0658284        .0210339        .0017039
   L.employr |    2.12e-06     1.85e-06        2.76e-07               .
   L.employi |    3.68e-06     8.14e-06       -4.46e-06        1.00e-06
 L.close_npf |   -.0119546    -.0089822       -.0029724        .0011299
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtlogit
            B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

    Test:  Ho:  difference in coefficients not systematic

                 chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      269.17
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Time-fixed-effect test for remain FE model

```
. xtlogit remain close_pf fdi sophistication employr employi close_npf L1.(close_pf fdi
> nolog
note: multiple positive outcomes within groups encountered.
note: 2457 groups (17199 obs) dropped because of all positive or
      all negative outcomes.

Conditional fixed-effects logistic regression   Number of obs      =      5369
Group variable: regind1                         Number of groups   =       767

                                                Obs per group: min =         7
                                                               avg =       7.0
                                                               max =         7

                                                LR chi2(18)        =   1543.54
Log likelihood  = -1491.1181                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
        remain |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
      close_pf |   .0164007   .0069158     2.37   0.018      .002846    .0299554
           fdi |   1.50e-06   2.58e-06     0.58   0.561    -3.55e-06    6.55e-06
sophistication |   .0053369     .01056     0.51   0.613    -.0153603    .0260342
       employr |   6.99e-07   1.10e-06     0.64   0.525    -1.46e-06    2.86e-06
       employi |   8.28e-06   1.84e-06     4.49   0.000     4.66e-06    .0000119
     close_npf |  -.0023349   .0029772    -0.78   0.433    -.0081701    .0035003
               |
      close_pf |
           L1. |   .0194868   .0061177     3.19   0.001     .0074964    .0314773
               |
           fdi |
           L1. |   2.23e-06   4.01e-06     0.56   0.578    -5.63e-06    .0000101
               |
sophistication |
           L1. |  -.0333227   .0086427    -3.86   0.000     -.050262   -.0163834
               |
       employr |
           L1. |   1.71e-06   8.81e-07     1.94   0.052    -1.59e-08    3.44e-06
               |
       employi |
           L1. |   3.74e-06   1.87e-06     2.00   0.046     7.04e-08    7.40e-06
               |
     close_npf |
           L1. |  -.0072179   .0027038    -2.67   0.008    -.0125171   -.0019186
               |
          year |
         1997  |    .568721   .1469339     3.87   0.000     .2807359     .856706
         2000  |  -2.503968    .232006   -10.79   0.000    -2.958691   -2.049244
         2003  |  -2.378023   .2743486    -8.67   0.000    -2.915736   -1.840309
         2006  |  -1.693711   .2401338    -7.05   0.000    -2.164364   -1.223057
         2009  |  -.6090304   .2320216    -2.62   0.009    -1.063784   -.1542763
         2012  |  -.8796301   .2354348    -3.74   0.000    -1.341074   -.4181865
------------------------------------------------------------------------------

. testparm i.year

 ( 1)  [remain]1997.year = 0
 ( 2)  [remain]2000.year = 0
 ( 3)  [remain]2003.year = 0
 ( 4)  [remain]2006.year = 0
 ( 5)  [remain]2009.year = 0
 ( 6)  [remain]2012.year = 0

           chi2(  6) =  374.00
         Prob > chi2 =    0.0000
```

Appendix 13. Interview guideline: questions and explanations

This guideline has reference to Figure III-13 of the main text.

Q1. Issues and challenges (from perspectives of policy makers and industry)

a. How is in general the state of textile/aircraft industries in Indonesia/West Java/Central Java within the last fifteen years (2000-2015)?

b. What were crucial issues/challenges faced by textile/aircraft industries in the late 90s and early 2000s in Indonesia/West Java/Central Java? (Please provide evidences if possible)

Explanation: Q1.a is an introductory question to start with the interview. The aim is to reconfirm what secondary data have captured. For Q1.b, answer to this question will reveal the major issues faced by the industries in the late 90s and early 2000s. At national level, issues and challenges faced by textile/aircraft industries are likely to be similar. At regional level however, we may find both provinces were facing different issues/challenges with different magnitudes. This question is crucial as it leads to the responses taken by textile/aircraft industries in West Java and Central Java, as well as by government through its industrial policies. Different issues and magnitudes are likely to lead to different responses.

Q2. Policy responses (government perspectives)

a. What makes government decided to responses on those issues and challenge?

b. What were policy responses taken by governments at national/regional levels to address those issues/challenges?

c. And why are particular responses taken despite of other available alternatives?

d. What differences have been made of the imposed measures?

Explanation: For Q2.a, b, c, answer to these questions will actually confirm the formal policies taken by the government, and will reveal how the government framed and being framed by the issues/ challenges in question Q1b. It may reveal the political weight of textile/aircraft industries in shaping industrial policies both at national level (such as trade policies, taxes and retribution, financial and technological supports, etc.) and at regional level (such as in setting minimum regional wages, providing training center, etc.). It may also reveal what kinds of policies are taken (protection or competition). Importantly, this question is expected to reveal the differences of weight and priority put on textile/aircraft industries by the government within the context of regional industry development as a whole between West Java and Central Java (e.g.

textile industry could be a strategic industry in one province but less strategic in the other). For Q2.d, answer to these questions will confirm the effectiveness of policies being imposed in shaping the development path of textile/aircraft industries. The answers provide by government officials will be reconfirmed against answers provided by industry representatives through question Q3.b.

Q3. Industry responses

a. What were actions taken by firms or industry as whole in dealing with those issues/challenges, and why?

b. What are the effects of industrial policies imposed by government as perceived by the industries as whole?

c. What are the general responses has been taken by the industries against the policies, and why?

Explanation: Question Q3.a, b, c will allow us to analyze whether textile/aircraft industries in both provinces took similar or different responses to deal with issues and challenges they were facing as well as policies being imposed on them. Different responses somewhat will be linked to the performance of textile/aircraft industries in each region (obviously, similar responses cannot be used to explain different performance). Why the responses of textile/aircraft industries differ is probably influenced by the differences in characteristics of region.

Q4. Regional advantages and disadvantages (industry perspectives)

a. What are specific regional characteristics that are influential for the responses taken by industries in dealing against the issues and government's policies? Please explain.

- Wages and minimum wages
- Industrial organizations (large scale firms vs. small firms)
- Industrial relations (labour-employers relation)
- Local networks (supplier-distribution)
- Local knowledge and technology (access to designers, universities, training centers, etc.)
- Physical infrastructures (highways, railways, ports, etc.)
- Local labors and other factor productions (raw materials)
- Local taxes/retributions
- Other factors (explain)

Explanation: Answer to this question is expected to reveal specific regional factors (institutions, infrastructures, networks & organizations, local knowledge, factors of production) that have considerable influences on the responses taken by textile/aircraft industries asked in question Q3, which, in turn, affecting their development trajectory.

Appendix 14. List of interviewees

No.	Interviewee Position/Occupation	Locations	Date of interview
1	Deputy Director for Textile Industries, Ministry of Industry	Jakarta	27 August 2015, 10 September 2015 in Bogor
2	Director for Maritime, Airplane and Defence Industries, Ministry of Industry	Jakarta	14 September 2015
3	Deputy Chairman for Investment Climate and Development, National Investment Coordination Board-BKPM	Jakarta	18 August 2015
4	Director for Industries, Knowledge & Technology, and Economic Creative, National Development Planning Agency	Jakarta	10 September 2010
5	Interview with Deputy Chairman of BKPM for Investment Promotion	London	7 May 2015 (during his official visit to London)
6	Head of Department of Industry and Trade, West Java	Bandung, West Java	14 August 2015
7	Head for Economic Division of Regional Development Planning Agency, Southern Bandung District	Soreang, West Java*	20 August 2015
8	Head for Economic Division of Regional Development Planning Agency of Central Java	Semarang, Central Java	3 September 2015
9	Head for Economic Division of Regional Development Planning Agency of Surakarta City	Solo, Central Java*	9 September 2015
10	Regional Department of Industry of Sukoharjo District	Sukoharjo, Central Java*	4 September 2015
11	Chairman Officials Indonesian Textile Association (HQ)	Bandung, Jakarta	22 September 2015 24 August 2015
12	Chairman Indonesian Textile Association (Regional Office West Java)/Textile plant owner (name of plant is anonymous)	Bandung, West Java	22 September 2015
13	Head for Division of Technology Centre PT Dirgantara Indonesia (PTDI-aircraft industries)	Bandung, West Java	19 August 2015
14	Academician 1: Senior researcher at Indonesia Center of Reform on Economics (CORE)	Bandung, West Java	24 February 2015 via text messenger.
15	Textile plant 1 Dan Liris	Sukoharjo, Central Java	4 September 2015
16	Textile plant 2 Sritex/Indonesian Textile Association (In charge for Solo Office)	Sukoharjo, Central Java	7 September 2015
17	Textile plant 3 Danar Hadi/Indonesian Textile Association (In charge for	Sukoharjo, Central Java	8 September 2015

No.	Interviewee Position/Occupation	Locations	Date of interview
	Regional Office Central Java)		
18	Textile plant 4 SME	Majalaya, West Java	21 August 2015
19	Batik Association	Sukoharjo, Central Java	9 September 2015
20	Secretary of BJ Habibie Agency for the Assessment and Application of Technology – BPPT	Jakarta	1 May 2016 by phone

*) These are the locations where the textile industries in West Java and Central Java provinces are agglomerated

Appendix 15. Summary of interview

A sample of Interview Summary with Head of Department of Industry of West Java Province

According to Head of Department (HoD), modern textile industry began to emerge originally in Jakarta in 1970s to 1980s. The expansion of textile industry was mainly led by investment from Japan, known as KTSM which stands for Kukuh Tangguh Sandang Mills Limited Company. State owned enterprises also had significant roles in promoting the textile industry in its early stage. Geographically the textile industry was concentrate in a location called Patal Senayan in the southern part of Jakarta, just next to national stadium. Patal is actually an acronym of ‘Pabrik Pemintalan’ or weaving factories that is adopted by the city to mark the place of birth of modern textile industry. Currently, Patal Senayan is just a name of location in Jakarta with no association with weaving activities anymore. The growth of the city had forced the textile industries out of the city to the nearby province, flooding West Java with textile plants. Now West Java contributes around 55% of national textile products. In addition, Majalaya has been the centre of textile industry in West Java since long time ago.

However, in the last five to ten years, textile industry is considered as sunset industry. It is unclear who initially declare it, and how this issue spread among stakeholders in textile industry. Probably fierce competition from China that hit the textile industry very hard weakens its overall competitiveness even in domestic market. In dealing with changing environments, plants start to seek alternative locations to keep their business alive. Some owners decided to move their plants to Central Java and few others move abroad such as to Vietnam for cheaper production costs. Usually they start the process by establishing a small branch or relocating some of their activities in the prospective locations. Then gradually expanse According to HoD, however, big players of textile industry tend to stay in West Java [maybe they can survive through scale efficiency, or they are just too big to move]. The government, both Central and local government add some scenes in the story. In 2007, Central Government through Ministry of Industry initiated a restructuring program aiming to rejuvenate machineries used in the textile production. The government provide interest subsidies to encourage plants to modernise their machineries. The implementation of the program however is less effective with low approval rates of the submitted applications. Moreover, the distribution of the program is concentrated in West Java which received 60% of the program’s benefits.

Another challenge faced by the industries is hiking minimum wages. According to HoD, minimum wage has great impacts on textile industries. Politically set by local governments minimum wages directly affect production costs which eventually shape locational decisions taken by plant owners.

In terms of industrial value chains, textile industry has weak linkages between its upstream and downstream industries. Most of raw cottons are imported. In terms of skill, generally labours in textile industry have required skills. There is a minor issue that some skilled employees are recruited by overseas companies in Thailand or Vietnam for machinery maintenance job there.

Since 1990s West Java has transformed its industry to capital-intensive, high-tech industries. It has becoming apparent since early 1990s when private sectors are allowed by presidential decree to develop as well as to manage industrial estates. Industrial transformation in West Java was made possible by massive development of connectivity infrastructure (particularly highway) that connects the mushrooming industrial estates in borderline of Jakarta and West Java to the main seaport Tanjung Priuk in Jakarta. However, the transformation is geographically concentrated in the western part of West Java, which is next to the capital city Jakarta. Similar effort has been tried to imitate by the provincial government to the eastern part of West Java by attaching the industrialisation process to Cirebon city as new regional hub. However, the outcomes seem to be far from what has been seen in the western part. Asked whether industrial transformation in West Java were carried out by design, HoD argued that the transformation processes were implemented according to what was planned but led by central government. Provincial government has tried to copy the process by developing industrial estates at the surrounding of Cirebon city but seems to fail repeating the story. At the moment, Department of Industry focuses on developing local network by facilitating business linkages between capital-intensive high-tech industries residing mostly in industrial estates and local medium and small enterprises.

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