INNOVATION AS ECONOMIC POWER IN GLOBAL VALUE CHAINS[1]

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1. INTRODUCTION

The Global Value Chain (GVC) concept, previously named Global Commodity Chain, analyzes how international economic networks of firms are governed, paying special attention to market-power relations between leaders and the rest of the firms in a GVC (Gereffi, 1994, 2014; Gereffi, Humphrey, & Sturgeon, 2005; Ponte & Sturgeon, 2014; Sturgeon, 2009). Indeed, according to Serfati (2008), the notion GVC is used to emphasize that leaders control a significant share of the value creation process by capturing part of the value produced in different parts of the chain. It thus becomes a central aim of this framework to explain how and why leaders appropriate most of the value generated in all the GVC. In GVC related literature

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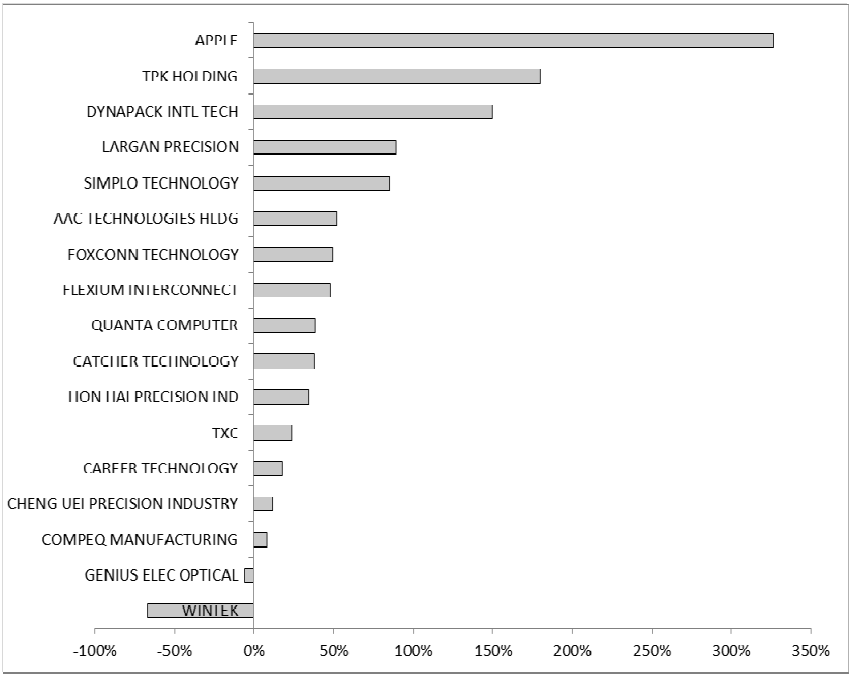
the term Global Production Network (GPN) includes actors that influence, shape and constitute those networks and global production as a whole, rather than just firms. Among others, they consider positional power of workers, nation states, regional and global institutions (Mahutga, 2014; Neilson, Pritchard, & Yeung, 2014; Parrilli, Nadvi, & Yeung, 2013; Rainnie, Herod, & McGrath-Champ, 2013; A. Smith, Pickles, Buček, Pástor, & Begg, 2014). As well as for GVC approaches, power relations are an open field of research among these authors.

Apple Inc. (hereafter Apple) is a vivid example of a GVC or GPN leader (Chan, Pun, & Selden, 2013; Clelland, 2014; Dedrick, Kraemer, & Linden, 2009; Kraemer, Linden, & Dedrick, 2011; Linden, Kraemer, & Dedrick, 2009). Apple is a super star firm (Autor, Dorn, Katz, Patterson, & Van Reenen, 2017) with a profit rate consistently higher than that of the other enterprises of its chain (Figure 1).

Figure 1. Apple's GVC[2]. Average profit rate between 2007 and 2015



Source: Compustat

2 According to Fubon Research analysis of Apple's GVC in 2011 (https://www.ventureoutsource.com/contract-manufacturing/apple-supply-chain-impacts-suppliers-foxconn).

Profit rates were calculated dividing Operating Income After Depreciation over Property, Plant and Equipment—Total (Net) (Basu & Vasudevan, 2012).

An underlying feature of profit rate persistent differentials is that inside GVC enterprises are not exchanging on equal terms. They instead develop power relations which have been conceived as the exercise of a market-power explained by entry barriers. According to different authors, GVC leaders generate different types of rents because they dominate scarce assets which generate those barriers (Gereffi, 2001; Kaplinsky, 1998; Mahutga, 2014).

However, GVC and GPN literature has been criticized precisely for its lack of a more comprehensive theory capable of explaining not only present governance, as it is done in multiple empirical studies, but also the conceptual emergence of GVC (Grinberg, 2016; Neilson *et al.*, 2014; Starosta, 2010a, 2010b). Furthermore, it has been recently stressed that the concept of power in these frameworks was left under-theorized (Dallas, Ponte, & Sturgeon, 2017; Sturgeon, 2009). We precisely expect to contribute to this shortfall by providing an explanation for the emergence of leaders, thus of the genesis of power relations between firms, considering not only market-power but also power relations in the production sphere. By doing so, we will be able to offer an explanation for the emergence of power using Apple as an example.

In a nutshell, in this article we explore the conceptual genesis of power between firms and we look at its implications on production relations. As it was initially presented by Levín (1997), we show that monopolizing innovation can be conceived as a lasting source of power relations, differentiating firms. We state that growing gaps between enterprises' innovation capacity inside a branch force those non-innovative to prefer being dominated. In this scenario, leaders not only exercise market-power but also plan the production processes of the whole GVC, thus expanding the effects of power to the production sphere. Concerning long-term dynamics for GVCs, we will suggest that, in order to keep its powerful position, the leader must systematically plan innovation circuits, which can be preliminary defined as the interlocking of all the actors and institutions that produce an innovation through integrated and planned phases (Levín, 1977).

The rest of this paper is organized as follows. Section 2 suggests that monopolizing innovation can be conceived as the genesis of power relations witnessed in GVCs. Next, section 3 further explains two effects of firms' differentiation: leaders' capacity to plan the whole GVC and profit rates differentials between types of firms. Section 4 proposes a long term dynamic for GVCs explained by the capacity of the leader to withhold its monopoly on innovation. Sections 3 and 4 also present a more complex typology of subordinated enterprises, which is another novelty of this article. Section 5 rethinks Apple's GVC and innovation circuits. Final remarks are presented in Section 6.

2. MONOPOLIZING INNOVATION AS THE GENESIS OF POWER RELATIONS INSIDE GVCS

Henderson *et al.* (2002) identified three forms of power inside GPN: corporate (enterprises), institutional (States) and collective (other actors not integrated in the previous forms such as NGOs, unions, etc.). Still, they do not explain how corporate power emerged. In this respect, Mahutga (2014, p. 157) pointed out that both in GPN and GVC 'the analytical scope in which power operates and the precise determinants of power are underspecified'. He tries to deal with this theoretical gap by suggesting a resource and relational based approach to power relations that results from multiple types of entry barriers. In particular, innovation leading to different technological intensities has been observed as a main responsible of the uneven balance of power between corporations globally (Parrilli *et al.*, 2013; Sturgeon, 2009). However, based on the ideas of the Oxford Economists' Research Group, Moudud (2013) stated that entry barriers have a relative porosity. When an enterprise enjoys an entry barrier, other firms (both incumbents and entrants) will pursue innovations to overcome it. If they succeed, they will be able to offer a substitute at a lower price, thus diminishing the entry barrier (Kurz, 2017; Moudud, 2013).

Moreover, entry barriers (porous or not) have been a common trait throughout capitalism, while the global dynamics that GVC and GPN try to describe emerged (or at least were accelerated) in the 80s when outsourcing became a widespread phenomenon (Gereffi & Korzeniewicz, 1994;

Milberg & Winkler, 2013). It seems that the general *entry barriers'* argument is thus not enough for understanding the emergence of power relations between firms. In the words of Starosta (2010a), GVC and GPN approaches lack from a coherent explanation of the emergence or genesis of leader enterprises, thus of dominant and dominated firms.

We propose to fill this blank with the concept of innovation's monopoly. Monopolizing innovations can be conceived as a lasting source of power relations between firms; a source of power that can lead to globally expanded unequal or asymmetrical market-exchanges. Drawing on Schumpeter's (1934) definition, an innovation is the creation of a new production technique, whether it is a more efficient way of producing the same product or a technique capable of producing previously inexistent products, or the creation of a new market (see also Fagerberg, Fosaas, & Sapprasert, 2012). Hence, we may consider that the latter includes brands that have the capacity to segment markets creating a different, new market. Furthermore, creating new production techniques does not only imply engineering transformations but also the creation of new designs. Summing up, we are referring to innovations understood as knowledge based creative results.

Innovations can be protected with copyright or patents, depending on their nature, or be kept as industrial secrets. We may distinguish between science based and non-science based innovations (Ernst, 2009). While the former points to major innovations, the latter refers to new techniques that are produced inside the production unit by using existing capacities in a different (new) way. They are early adaptations of new techniques. In our argument, science based innovations are of greater importance.

Innovations are, thus, an additional source of profits, a particular form of rent (Kaplinsky, 1998).[3] Innovations' capacity to trigger greater rents depends on their economic impact (greater consumer's preference means greater economic impact thus greater rent) (Fagerberg *et al.*, 2012; Schumpeter, 1934). If we initially assume, like Kurz (2017), that innovations'

3 Durand and Milberg (2018) present a taxonomy of rents associated to intangible assets. Their definition of intangible assets is broadly in line with our definition of innovation.

monopoly power is temporary because it will eventually be eroded by competing ideas, this implies that its associated rent is also temporary.

However, it is possible to conceive that some haphazardly successful firms, before exhausting (most probably science based) innovation rents, aiming to keep that pace, may decide to reinvest at least part of those extra profits in achieving another innovation. A second consecutive success, achieved before the other firms of the industry have completely adopted the first technical change, will lead to a renewal of that process and so on. In other words, after innovating and gaining an extraordinary profit, the most efficient firm will not reinvest that rent to further extend capital's accumulation (increasing investment). Instead, it will fund the development of new potential innovations that will expand rents in time. The result of multiple consecutive innovations for the same enterprise, according to Levín (1997), will qualitatively differentiate total social capital. In other words, some firms followed a monopolized process of cumulative causation where innovation successes were self-reinforced or led to a virtuous circle. This was, in fact, the case of Apple. According to Lazonick *et al.* (2013), the company pursued a retain and reinvest allocation regime, focused on innovation, at least until 2012 when it started to turn into a maximizing shareholders value strategy.

The cumulative dimension of innovations, finding that firms use and build on others' innovations, has been an observable characteristic of the software and the semiconductor industries (Ziedonis, 2003, 2004). However, as shown by Dosi (1988), since innovation is a cumulative process with economies of scale, it demands minimum knowledge thresholds to allow copies, leaving big companies in a better position to appropriate their own and others innovation's rent. Also in line with our argument, Pagano (2014, p. 1423) explains how firms that have more 'intellectual endowments will continue to do (possibly increasingly) better than those lacking this monopoly power'.

In line with our argument, a particular patenting strategy, chosen among other leaders by Apple, has been to fragment their innovations in as many different patents as they can think of (called patent thickets). By doing so, they increase enforcement transaction costs and their chances to threaten others trying to copy their products (Ernst, 2016; Noel & Schankerman, 2013). Indeed, Noel and Schankerman (2013, p. 514) found that 'patenting

by technology rivals reduces the firm's Research and Development (R&D) investment, patenting and market value'.

We believe these conditions contribute to explain how, once a firm started to continuously win the innovation race of its branch, the size of the resulting gap with the rest of that branch might block those losing the race. We should stress that our explanation is not limited to the impact of innovations as individual or particular hits. On the contrary, as we have just outlined, it is the capacity to monopolize innovation in a branch what we state constitutes a source of a lasting power that differentiates firms between leaders and subordinates. In other words, systematically winning the monopolistic competition for innovations entails a cumulative causation effect capable of explaining the emergence of leaders. Hence, innovation should be considered as a capacity owned by some enterprises rather than a haphazard, accidental result where every actor has the same chances to succeed, triggering just temporary extraordinary profits (Levín, 1997; Piqué, 2016; Rikap, 2017).

Once a leader, this position is underpinned not only by looking for systematic innovations, but also by exercising a political power. From lobbying to bribing, big corporations bargain with political representatives of the countries where they settle their headquarters, where they outsource and/or offshore stages of their value chains and innovation circuits and also where they just sell their products (Zingales, 2017). Moreover, leaders use their power and global scale to offshore intellectual property and part of their core operations to low-tax countries. This is the case of Ireland where Apple profited from an exclusive and preferential tax scheme for the last 10 years. However, after a claim from the European Union competition commission, Apple agreed to start paying back more than USD 15 billion in tax breaks to Ireland while appealing that decision.[4] More generally, the European Union is discussing a 3% digital tax that will particularly affect Apple and other leaders like Google, Amazon and Facebook. The rationale behind this tax is that tax systems are outdated, still thinking in national terms while leader companies are global and profit globally,

4 Retrieved from https://www.ft.com/content/9ee3943e-47d3-11e8-8ae9-4b5ddcca99b3 on September 1, 2018.

not only where they set their headquarters. Hence, digital leaders pay proportionally less taxes than classic manufacturing companies.[5]

Furthermore, monopolizing innovation in a branch is not the only source of a lasting economic power relation between firms. For instance, a National State can grant an enterprise with a monopoly. However, the latter seems not enough to explain the global power relation between firms, described by GVCs, which goes beyond national scopes. Other sources of power in a particular industry are a high minimum efficient scale (like in the steel industry) or the domination of a key non-reproductive resource (typically oil). These sources of differentiation between firms are explained by specific characteristics of certain industries and cannot be applied to the whole system. On the contrary, monopolizing innovation can be expanded to every industry and it also has the capacity to, eventually, overcome those other sources of power. Electric cars in the automotive industry, and 3D printers for the spare parts industry could become, in the future, examples of this transformation. In fact, Gereffi (2014) pointed out that more tangible entry barriers have tended to fall, while current GVC's dynamics are increasingly relying on intangible assets, including patents, copyright and goodwill, among other assets.

Empirical evidence is in line with our argument (Barkai, 2016; Durand & Milberg, 2018). Barkai (2016) concluded that there is a decline in competition among non-financial corporations in United States since mid-80s evidenced by a fall in labor share (in line with neoliberal policies) and an even more dramatic drop in capital share, while profit share is increasing. According to the author, capital share decreased due to a reduction in capital costs. Still, the latter did not lead to a reduced profit share. To explain these stylized facts, Barkai (2016) uses a general equilibrium model with imperfect competition where there is no conceptual explanation for the assumed growth in the mark-up, nor does he study what triggered a decline in competition. On the contrary, from our framework, a drop in capital share in the US points to the capacity to offshore and outsource. Meanwhile, the increased in profit share in a country with probably the highest concentration of leader enterprises is in line both with the

5 Retrieved from https://www.theguardian.com/business/2018/mar/21/facebook-google-and-amazon-to-pay-fair-tax-under-eu-plans and from https://www.bna.com/digital-tax-rankling-n73014482158/ on September 3, 2018.

capacity to reap value generated in other parts of the value chain (the offshored and frequently outsourced stages) and to collect (innovation) rents, which in Barkai's (2016) analysis are undistinguished from profits.

Summing up, from the GVC and GPN standpoints, singular innovations have been considered as a source of differentiation and power inside the chain, but how and why only certain enterprises have structurally greater technological intensities (Carballa Smichowski, Durand, & Knauss, 2016), remained as an open question. Singular innovations build entry barriers that allow for the appropriation of technological and organization rents (Kaplinsky, 1998). However, an isolated innovation is a porous entry barrier (Moudud, 2013). In our explanation, entry barriers are constantly reinforced after each innovative success. Therefore, some firms' constant flow of innovations overcomes entry barriers' porosity. As a result, polarization arises from the differences in innovativeness between firms (Pagano, 2014). Since innovation is systematically renewed throughout time, it triggers a technological differentiation between those owning and those lacking from the capacity to innovate. This differentiation is further expanded by other mechanisms that are accessible only to those firms that are already in a powerful position such as successful lobbying. Both firms' technological differentiation and its effects on profit rate differentials, such as the observed in Apple's GVC, are discussed in the next section.

3. FIRMS' TECHNOLOGICAL DIFFERENTIATION AND ITS EFFECTS: PLANNING AND PROFIT RATE DIFFERENTIALS INSIDE GVCS

So far this paper's contribution has been to explain how the emergence of leaders can be conceived as the result of innovation's monopoly. But innovations' monopoly is a dual process because the technological enhancement of the leaders simultaneously reduces the remaining firms' possibilities to invest in future innovations as much as those intellectual monopolies (Pagano, 2014).[6] Drawing on Levín (1997) and on GVC literature, our proposed firms' differentiation process is summarized in Table 1, including three different types of subordinated enterprises, that we will further

6 Just investing in possible innovations as much as leader enterprises would not be enough to reach them. Anyway, it is certainly a necessary condition.

explain in this and the following section. Traditional GVC literature does not distinguish between different types of subordinate firms (Gereffi, Humphrey, & Kaplinsky, 2001; Gereffi *et al.*, 2005). We consider the latter as a shortfall of this framework that we try to overcome in this article.

Tableau 1. Types enterprises' main characteristics

Type of enterprise	Leader	Technological	Simple	Small
Participates in GVC?	Yes	No	Yes	Yes
Participates in Innovation Circuits?	Yes	Yes	No	Yes
Position in Power (Planning) relation	Dominant	Subordinated	Subordinated	Extremely subordinated
Profit Rate	Highest	Consistently above interest rate	Consistently above interest rate	Lowest, usually below interest rate

Simple capital enterprises have lost innovation's capacity, hence losing their technical autonomy, but are still capable of adopting innovations (Levín, 1997) even if they are incapable of reaching leaders' continuous technical change. Subordinating to leaders is their best survival strategy. As a whole, we state that simple capital enterprises compete with each other in order to belong to leaders' area of influence, fulfilling the production and commercial conditions imposed by those leaders.

In this context, competition between leaders is not mainly organized by prices in the market but by winning in the innovation race. Market competition (where reducing prices is a winning strategy) should be differentiated from technological competition, which is based on obtaining and renewing technical advantages (Levín, 1997, p. 330-331). Eventually, leaders may also compete with each other for the domination of the most efficient (thus probably the cheapest) simple capital enterprise of an industry. Still, as we will see afterwards for Apple's GVC, simple capital enterprises try to invest enough to fulfil leaders' demands without losing possible sales, while becoming giant production units.

In the bottom of the hierarchy, we find small or pseudo-capitals, always occupying the weakest positions (Iñigo Carrera, 2016; Levín, 1997). Small

capitals are those that consistently fail to adopt the new techniques demanded by leader enterprises, thus cannot work as simple capital enterprises. Anyway, they still participate in the GVC but with outdated techniques that are only suitable for performing extremely simple jobs. Hence, we conceive small capitals as those in charge of the most repetitive and simple tasks inside GVCs. Furthermore, in order to be hired, they sell at the cheapest price; trade values are structurally below commodities' reproductive values. Small capitals are typically small enterprises where the owner hires workers whose labor conditions are precarious and flexible (Graña, 2014). In the limit, small capitals include self-employed workers that formally sell the product of their work instead of their workforce (Iñigo Carrera, 2016).

Following Bettleheim's (1975, p. 57) distinction between possession and property, simple and small capitals have 'the ability to put the means of production into operation' (possession) but, as we will explain next, they partially lack from the 'the power to dispose of the products obtained with the help of these means of production' (property).

The other side of capital's differentiation is labor's differentiation or segmentation. Although the latter is not the focus of this article, we will briefly provide hints that we expect to further develop in future research. In a nutshell, capitals' technological differentiation, which may deepen due to automation, robotics and digital technologies, widens the gap between qualified and non-qualified jobs. While in leaders and technological capital corporations we find mainly the former, the latter are the predominant jobs of simple and small capitals. In high-income countries where we find a higher concentration of leaders and technological capital companies, Timmer *et al.* (2014) observed that, between 1995 and 2008, the value added by high-skilled workers increased (5%) while medium and low-skilled workers' contribution decreased (8%).

Not only do working conditions, salaries and benefits differ, but also the future of each type of labor. Qualified or high-skilled jobs will probably benefit from the introduction of new technologies, while non-qualified jobs performing routine tasks will be and are being more affected both in terms of wages and employment (Conseil d'orientation pour l'emploi, 2017; Milberg & Winkler, 2013; Timmer *et al.*, 2014). After this brief presentation of two of the three different types of subordinated firms we may argue

that, from the standpoint of leaders, the subordination of simple and small capital enterprises confers additional profits, because the former will be able to appropriate part of the value created in the latter which contributes to explain the gaps in salaries and working conditions we have previously referred to.

Summing up, leaders enjoy two sources of additional profits: innovation rents and value reaped from subordinated firms. As a result, leaders have larger cash holdings at their disposal. Cash holdings confer additional power. As explained by Orléan (2014, p. 110), money gives its owner a great strategic autonomy, it is 'the unrivalled instrument of market power'. This is the power of the buyer. The owner of the commodity surrenders to the money holder. Cash holdings are directly exchangeable for any other commodity. While the seller depends on the will of the buyer, the buyer can directly obtain whatever s/he wants since money only depends on its owner's will to be exchanged. Since production has been outsourced, leaders have fewer investment requirement. Although they must destined part of that cash to consistently fund the reinforcement of their intellectual advantage and they pay dividends and do stock buy-backs, they keep colossal cash holdings as a potential source of greater power.

3.1. Planning as the social relation ruling GVC

Drawing on Levín's (1997) technological differentiation of capital enterprises, the power relation that takes place in the market can actually be conceived as the expression of a deeper power relation that subverts the private and independent character of capitalist production. We state that the leader not only sets prices (i.e. exerts market-power), but it also plans all the production processes of the GVC. Hence, it is possible to reconceive GVCs as planned portions or subsystems of global capitalism born from the capacity of leaders to dominate in their own favor capital's accumulation in other firms.[7]

We suggest that the leader plans simple and small capital enterprises by directly controlling management's critical parameters. The leader decides

7 In line with GPN concept, and as we will see for Apple's value chain, leaders can also dominate the productive capacity of non-enterprises, such as NGOs, universities and state dependencies. For instance, Author (2016, 2017) analyzes universities under this framework.

in advance the kind of product, its quantity, and the production technique that those other enterprises will use. It also defines clauses of exclusivity, commercial credit conditions, quality standards and other regulatory matters. Leaders set 'performance requirements and standards that condition entry and mobility within GVCs' (Gereffi, 2014, p. 28). Additionally, the leader has the capacity to create and impose new regulations. Still, leaders do not necessarily exert a direct control by commanding subordinated enterprises what to do and how to do it; planning can be accomplished through handling the latter's key productive parameters.

In this context, the remaining bargaining power of subordinated capitals directly depends on the distance they take from their own competitors. Indeed, if that company is the only one capable of fulfilling a leader's need, it will enjoy more bargaining power than if its competitors are on his heels. While there are generally multiple small capitals prepared to perform all the required routine activities, in the case of simple capitals there is a higher chance of finding a corporation that is outperforming or even temporarily monopolizing a production stage within different GVCs. In this case, this simple capital company will retain higher profits as long as that advantage remains, in comparison with those simple capitals that participate in GVCs producing without a technical advantage over their competitors. That is why simple capitals compete both for prices and techniques to ensure their place in GVCs.

All in all, innovation's monopoly enhanced some enterprises transforming them into value chain leaders, while those lacking that capacity occupy different subordinated positions. The industry is reconfigured conforming value chains where leaders assign portions of production processes to different types of enterprises with whom the former relates in an unequal, asymmetrical way, developing a power relation that goes beyond the market-power that has been depicted by GVC and related literature. The leader also plans (thus controls) the working process that takes place inside simple and small capital enterprises. Next, we use these theoretical insights to understand profit rate differentials inside GVCs.

3.2. Structurally differentiated profit rates

Different authors have tried to determine the patterns by which leaders appropriate most of the profits that are generated inside GVCs (Carballa

Smichowski *et al.*, 2016; Contractor, Kumar, Kundu, & Pedersen, 2010; Gereffi *et al.*, 2005). Leaders have the highest rate of profit because they repeatedly raise their own workers' productivity through a constant flow of innovations (Levín, 1997; Piqué, 2016). Furthermore, Kurz (2017) observed a correlation between firms' value of intangible assets and their surplus wealth, thus supporting the explanation that suggests that monopolizing innovation results in the highest profits and profit rates.

Empirical evidence also shows that chain leaders profit from deconcentrating capital, a process called outsourcing or externalization (Milberg & Winkler, 2013; J. Smith, 2016; Sturgeon, 2009, among many others). In fact, GVCs have been also conceptualized as a new form of the division of labor, with specific modalities of organization and power relations (Carballa Smichowski *et al.*, 2016), that relies on outsourcing and offshoring (Contractor *et al.*, 2010; Milberg & Winkler, 2013; J. Smith, 2016; Starosta, 2010b).

Still, outsourcing—which frequently includes offshoring—is a strategy that is used by leaders as long as it is the most profitable one. For instance, new technologies such as 3D printers and robotics may steer leaders to foster alternative strategies, such as reshoring and/or resourcing certain stages of their production processes. Even if there is not sufficient empirical evidence of the latter (Conseil d'orientation pour l'emploi, 2017; International Labour Organization, 2018), the eventual reshoring and/or resourcing is another reason for drawing on Levín's (1977, 1997) ideas to broaden the explanatory power of GVC approach. Thus, building on Levín (1977, 1997), the cornerstone of our reasoning is not offshoring nor outsourcing themselves, but capitals' technological differentiation as the genesis and dynamic of GVCs which ensures leaders the capacity to decide what to outsource and what to keep in-house. Indeed, the relevance of intellectual monopolies has recently been observed by Durand and Milberg (2018) who argue that the current economic dynamics of GVCs depend, to a greater extent, on intangible assets. According to the authors, 'the market power of lead firms is enhanced by intellectual monopoly' (Durand & Milberg, 2018, p. 9).

By reducing capital's commitment, leaders diminish associated risks (losses due to demand fluctuations, discontinuities in capital turnover, costs associated to technical change, to the fulfillment of labor legislations, future

workers' demands, etc.). Reducing capital's commitment also lessens exit barriers (Moudud, 2013). Inside GVCs risks are assumed by simple and small capital enterprises. Leaders focus on research, development, design, technology and business intelligence, which are strategic activities (Serfati, 2008). Meanwhile, their capacity to appropriate part of the value created in subordinated enterprises allows them to still profit from the outsourced capital, further improving their profit rate. This result is partly achieved by the super-exploitation of workers in subordinated enterprises (Levín, 1997; Marini, 1977; J. Smith, 2016).

Outsourcing is compatible with the tendency to 'reduce investment' observed among hegemonic countries' big corporations (Auvray & Rabinovich, 2017; Milberg & Winkler, 2013). In fact, the latter has been initially associated to financialisation. In a nutshell, it was argued that big corporations from core countries changed their accumulation pattern to maximize shareholder value (Lazonick, 2008) reducing capital expenditures (not R&D) while augmenting dividend pay-outs and stock buy-backs (Barradas, 2017; Clévenot, Guy, & Mazier, 2010; Hecht, 2014; Orhangazi, 2008; Stockhammer, 2004; Tori & Onaran, 2018). However, we believe this explanation is incomplete, thus misleading.

From our perspective, the possibility to occupy the stages of higher value capture in the GVC while outsourcing the lower ones is explained by leaders' position in innovation's monopolistic competition. Indeed, the links between offshoring and outsourcing, on the one hand, and higher R&D expenses has been repeatedly pointed out by the GVC literature (Gereffi, 2014; Gereffi *et al.*, 2005; Lee & Gereffi, 2015). Moreover, lately, some scholars have explicitly related the increase in intellectual property rights with the rise in monopoly power (Pagano, 2014) which then allows the increased distribution to shareholders (Durand & Gueuder, 2017; Durand & Milberg, 2018). Hence, building on Levín (1997), the argument could go as follows: monopolistic competition for innovations differentiates capitals. Leaders have the capacity to outsource those production stages that are not needed to remain at the forefront and still appropriate part of the value produced in those outsourced stages. Therefore, leaders do not need to invest as before, simply because manufacturing has been outsourced and subordinated capitals, in particular simple capital companies, are responsible for that capital expenditure. Since simple capitals—which are the companies that do invest systematically—are mostly located outside core countries,

the result in the latter is a reduced capital expenditure. Furthermore, both the value appropriation from all subordinated capitals and leader's innovation rents allow for greater distribution to shareholders.

Still, the result of this process is not that leaders will become smaller and smaller. On the contrary, they remain big and even bigger due to mergers and acquisitions (Serfati, 2008). That is why, looking at leaders, we may say that Marx's (1894, p. 72) syntagm *'concentration and centralization of capital'* is broken because the latter accelerates *pari passu* with capital's deconcentration (outsourcing).

Anyway, there is a limit in leaders' capacity to define prices both as buyers and sellers.[8] For instance, they cannot buy at such a small price that leaves simple capital enterprises with a rate of profit persistently below the interest rate. If this was the case, then the simple capital enterprise would be liquidated and its owner or shareholders will invest the remains in the financial system or in another business. In fact, in order to survive as simple capitals, systematically adopting the techniques demanded by leaders, their rate of profit must be persistently above interest rate, yet structurally below that of leaders. Simple capital enterprises may still concentrate capital (contrary to leaders' outsourcing). This is the case, for instance, of electronics' contract manufacturers (Starosta, 2010b) and of Foxconn in Apple's value chain as we show later in this article. The concentration of capital contributes to be better prepared to sustain a profit rate significantly above interest rate, while they fulfil leaders' demands, shorten product cycles due to innovation's constant flow and increasing product's complexity.

In the case of small capitals, although the owner survives with a profit rate that might be regulated by the interest rate, owners' salary will become the minimum condition for survival when they face exit barriers (Iñigo Carrera, 2016). Therefore, small capitals are extremely subordinated to other links, losing most (or even all) of their profits when exchanging with other enterprises. An illustrative example of the tactics or responses followed by small capitals to survive is given by Parker and Cox (2013) for the visual effects service firms. These enterprises have low (or even sometime no) margins and face power asymmetries in film's GVC, dominated

8 When selling to the public, the demand curve is still a limit.

by Hollywood leaders. Some firms provide cheaper low-technology services, avoiding over-engineering solutions. Another safer bet is to remain small enough to avoid idle capacity. When simple capitals hire small capitals, they squeeze their profits which, in the end, may end up in the hands of leaders.

Overall, firms' hierarchical order inside GVCs results in profit rate differentials. This hierarchy can be conceived as a specific form of the power relation described by Dockès (2000). According to this author, power is developed through a hierarchy of concatenated agents where an agent accepts to be subordinated by its superior not only because it is dominated but also because, by integrating the hierarchical order, it will be allowed to subordinate those below.

So far, we have explained that once an enterprise monopolized innovation inside a branch, it becomes a leader. However, in order to remain at the top, leaders must keep on innovating, moving increasingly away from simple capital enterprises while preventing other leader enterprises from conquering their GVC. Therefore, in the next section we put in motion the static picture we have portrayed until here to contribute to understand GVC's long term dynamics. We do so by further developing the concept of a monopolistic competition for innovations through the innovation circuits' concept.

4. INNOVATION CIRCUITS: THE LONG-TERM DYNAMICS OF GVCS

In our framework, the leader is defined by its exclusive capacity to monopolize innovations (particularly science-based innovations) inside the GVC.[9] It must have had a systemic internal capacity to innovate for initially differentiating from the rest of the branch. Still, once it becomes a leader, innovations are not compelled to be produced (at least not entirely) in its

9 Leaders certainly profit from non-science based innovations, yet it is reasonable to think that science-based innovations are the main source of their systematically renewed rents.

R&D laboratories. In fact, along the different stages of an innovation process, leaders outsource capital (Ernst, 2008, 2009; Parrilli *et al.*, 2013).

Innovation circuits were initially defined by Levín (1977) as the interlocking of all actors and institutions that produce an innovation (ranging from marginal to radical creative transformations) through integrated and planned phases. Each innovation circuit is the sequence of projects that is conceived for a unique time and that modifies the structure of existing GVCs, eventually creating new ones or reconfiguring existing ones. They are planned and dominated by leaders, yet all the institutions involved in the innovation process, from the basic research discovery to the required industrial adaptations to adopt the innovation, participate in them (Cazenave & Gonilski, 2016; Levín, 1977). Innovation circuits can be completely performed inside the leader's R&D laboratories, or be partly or completely outsourced. Furthermore, leaders may plan innovation circuits that use already achieved scientific results or former innovations as inputs, such as the Internet in the case of the iPhone.

We suggest that major (generally science-based) innovation circuits walk over and transform existing GVCs. Every now and then, by succeeding in these major creative projects, leaders radically transform the structure of existing GVCs. Businesses associated to old techniques succumb while a new structure, organized by renewed forms of the economic *cum* power relations, is built.

It is possible to conceptually integrate innovation circuits with Global Innovation Networks (GIN). The latter were conceived under the GPN approach to explain how 'innovation is being sliced and diced into modular building blocks of specialized tasks for geographically dispersed R&D teams' (Ernst, 2009, p. 3). Recent empirical evidence supports this claim of a geographical dispersion of innovation processes, judging from patent co-invention data (OECD, 2017). Still, contrary to GVCs, GINs seem to remain concentrated at the global core (McKinsey&Company, 2012; OECD, 2017). The latter is in line with our general framework, considering that it is generally at the core where there is a higher concentration of technological capital companies (including top research institutions).

Ernst (2009) observes that GINs are created by global corporations in order to increase their return on investment, seeking to penetrate high-growth

emerging markets. Therefore, both the innovation circuits and the GINs have been conceived to explain innovation's vertical specialization, aiming to describe how innovation is produced in contemporary capitalism, assigning a central role to the leader. Nevertheless, while GINs are integrated to its broader framework as a particular type of GPN, we conceive innovation circuits as a different substructure of current capitalism in charge of recreating GPNs (or GVCs).

Furthermore, while innovation circuits can have a global, regional or local scale, the importance of knowledge geography can be enriched through GIN's account of innovation as a global and decentralized process. Innovation is not limited to a small number of big corporations, as was stated by the OECD (2008, quoted in Ernst, 2009), even if only leaders retain the capacity to plan innovation circuits and profit the most from them.

Leaders organize multiple innovation circuits simultaneously and must constantly plan new ones if they want to keep ahead. They control and orient R&D according to their interests. In that way, they plan innovation circuits (bearing in mind that creative activities cannot be completely planned in advance). The results remain uncertain, but the associated economic risk of this endeavor is not primarily assumed by the leader, which has the capacity to divert it to other links of the circuit (Author, 2017), eliminating a source of exit barriers.

National States are among the risk-takers. They have been major R&D investors especially behind most radical and path-breaking innovations (Mazzucato, 2015, Chapter 3). Whether they manage to play a leading (thus planning) position in those innovation circuits, or they occupy dominated positions (allowing leader enterprises to retain most of the profits that rely on mainly publicly funded innovations) is an open question.

Technological capital enterprises are the third type of subordinated enterprise planned by leaders (Table 1). They do not participate in GVCs but are in charge of producing at least one stage of innovation circuits. Still, at least part of the profits that derive from their creative activity are appropriated by leaders (Levín, 1997; Piqué, 2016). Technological capital companies compete with each other to belong to leaders' innovation circuits since this will grant a higher profit rate than trying to achieve innovations by

themselves and eventually try to sell the results in a market dominated by leaders. As well as for the case of leaders, technological capital companies compete for technology.

Leaders plan technological capital enterprises leaving them a wide degree of creative autonomy, which is needed to actually achieve creative results. Planning here is a long-term process where leaders provide the general orientations and desired results, of course without being able to anticipate every step that needs to be followed in order to achieve them. Successful start-ups are an archetypical example of technological capital enterprise. It is possible to conceive that also some small capitals may participate in innovation circuits, although they will be extremely subordinated to leaders.

In this context haphazard innovations are still feasible, but the maximum aspiration of whoever produces them (if it is not a leader) will be to sell them to a leader. Otherwise, the chances to profit from them will be reduced. We will see that this is the case of app developers in Apple's innovation circuits.

Finally, we may add that without a constant flow of innovations, leaders' hierarchical position eventually vanishes. This is why leaders must fund those R&D projects considered as strategic even if gigantic investments are required, although they will certainly try to outsource as much of those investments as they find convenient. Meanwhile, leaders also work together, in what could be called leader's technological cooperation.[10] By technological cooperation we mean that a series of GVC leaders may work together in, for instance, major basic research projects, whose results could be indispensable stages of multiple innovation circuits. This cooperation may also include joint purchases of patents such as the consortium of companies led by Apple, and including Research in Motion and Microsoft, that acquired Nortel's patent portfolio (WIPO, 2012, p. 22).

10 Needless to say that leaders may also exchange with other leaders in the market. And that technological cooperation may include market exchanges (such as the deal between Google and Samsung by which the latter's smartphones use Android from the former).

Summing up, so far we have conceived GVCs and innovation circuits as combined substructures of global capitalism dominated by leaders. GVCs (as well as GPNs) synthesize the structure of power relations between firms in a particular moment in time. Meanwhile, innovation circuits are the substructures whose results reconfigure GVCs throughout time. In innovation circuits planning is a long-term process and not a detailed anticipation of every task, since creative production cannot be completed planned in advance.

5. APPLE'S GVC AND INNOVATION CIRCUITS

In this section we illustrate the scope of our former contributions by performing a preliminary analysis of Apple's GVC and innovation circuits. Apple is a GVC leader (Chan *et al.*, 2013; Kraemer *et al.*, 2011; Linden *et al.*, 2009) with a superior profit rate compared to that of its suppliers (Figure 1). Furthermore, by concentrating its sells in the high-end phone segment of the market, it captures almost all the profits (around 90% by 2015) of the smartphone's market. The latter, even if it only sells 12% of total units sold (WIPO, 2017).

We reconstructed Apple's GVC partly from Fubon projected Apple supply chain by 2011 (Table 2).[11] To study Apple's GVC we used Compustat firm-level information for listed United States and Rest of the World corporations. These databases present consolidated data for the parent company (with its national and international subsidiaries), hence providing an approximate idea of those enterprises' worldwide activity. Some firms in Apple's GVC are not listed corporations, so we could not include them in the analysis.

11 Retrieved from https://www.ventureoutsource.com/contract-manufacturing/apple-supply-chain-impacts-suppliers-foxconn on December, 13, 2017

Tableau 2. Fubon projected Apple supply chain

Company	Product	Sales to Apple (as a share of total turnover) in 2011	Suppliers' headquarters
Hon Hai	EMS&ODM	25%	Taiwan
Pegatron	EMS&ODM	5%	Taiwan
Quanta	EMS&ODM	20%	Taiwan
Foxconn Tech	Metal casing	10%	Taiwan
Catcher	Metal casing	35%	Taiwan
Wintek	Touch panel	70%	Taiwan
TPK	Touch panel	75%	Taiwan
Chi Mei Industrial (CMI)	Touch panel	3%	Taiwan
Compeq	PCB	15%	Taiwan
Unimicron	PCB	8%	Taiwan
Tripod	PCB	5-8%	Taiwan
Career Tech	Flexible PCB	20-25%	Taiwan
Flexium	Flexible PCB	25-30%	Taiwan
Largan	Lens	35%	Taiwan
Genius	Lens	80%	Taiwan
Simplo	Battery	35-40%	Taiwan
Dynapack	Battery	50-55%	Taiwan
Cheng Uei	Connector	15-20%	Taiwan
TXC	Quartz crystal	23%	Taiwan
AAC	Acoustic	20-25%	Hong Kong

Source: Fubon Research. Sales to Apple are calculated as a percentage of total sales of each company

We will also look at Apple's innovation circuits. Technological start-ups working for Apple can be conceived as technological capital enterprises. Still, a limitation of our analysis is that, in general, these are not listed corporations. Thus, we will not be able to show their profit rates, nor other relevant information since their annual reports are not publicly available. The same happens with small capitals though we later provide two illustrative examples, one for Apple's GVC and apps developers as an example of small capitals participating in innovation circuits.

5.1. Apple's GVC

Apple outsources the production of almost all its hardware products, primarily in Asia (Apple Inc, 2017). This strategy differentiates it from other GVC leaders playing in the smartphones market (Huawei and Samsung) that internally produce components (WIPO, 2017). Concerning Apple's value chain, simple capitals have their headquarters in China's gateways, mainly in Taiwan and one in Hong Kong (see Table 2). Still, Apple's suppliers manufacture in mainland China where wages are lower contributing to assure Apple gets cheaper material costs, which allows the latter greater value capture from those workers. Some of its suppliers can be actually conceived as fully dependent on Apple, who buys most of their sales. In general, suppliers facing a dangerous reliance on a leader will try to fully comply with its demands. As we previously explained, some simple capitals have more margin to bargain with leaders. The latter depends on the proximity of their competition and, we may add, on the degree of reliance on a particular leader (Mahutga, 2014).

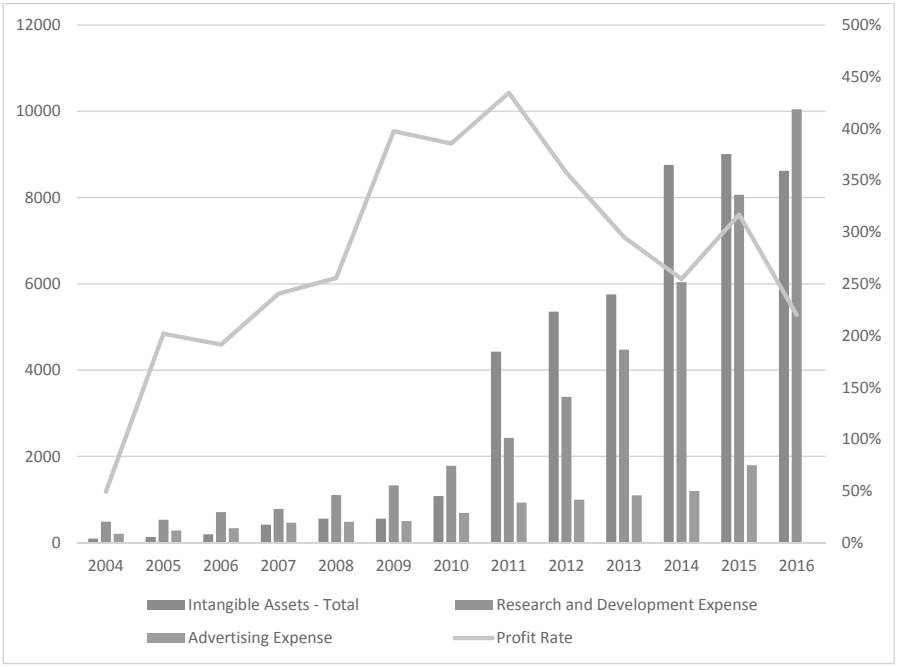
Outsourcing became dominant in 2004 when Apple was struggling in terms of profit rate (Duhigg & Bradsher, 2012). This decision was accomplished when a constant flow of innovations started positioning Apple as a global leader. As recognized by Steve Jobs in 2005:

> "We're thrilled to have concluded the best year in Apple's history, with 68 percent year-over-year revenue growth and 384 percent net profit growth," said Steve Jobs, Apple's CEO. "This is the direct result of our focus on innovation and the immense talent and creativity at Apple. We could not be more excited about the new products we're working on for 2006." (https://www.apple.com/newsroom/2005/10/11Apple-Reports-Fourth-Quarter-Results/)

Apple's dominance was boosted after the introduction of its major science-based innovation in 2007: the iPhone, which was followed by consecutive improvements every year since then and by other innovative products such as the Apple Watch. Hence, we may say that a constant flow of innovations, together with the possibility to outsource its manufacturing processes, is a reasonable explanation for Apple's skyrocketing profit rates

between 2004 and 2011 (Figure 2) positioning its profit rate way above that of the other companies in its GVC (Figure 1).[12]

Figure 2. Evolution of Apple's profit rate, R&D investment, Intangible Assets and Advertising Expense (millions USD)



Source: Compustat

The power exercised by Apple over its subcontractors, which results in the appropriation of part of their value, together with an detailed scrutiny of IPhone's value chain has already been widely documented (Chan *et al.*, 2013; Kraemer *et al.*, 2011; Linden *et al.*, 2009; WIPO, 2017). Still, Apple's planning capacity over these enterprises was not highlighted. Example of the former is the story of how Apple changed the screen of the IPhone weeks before it was launched, forcing an overhaul of the assembly line, and how Foxconn, Apple's main contractor, reacted to produce it:

12 Profit rates were calculated dividing Operating Income After Depreciation over Property, Plant and Equipment—Total (Net) (Basu & Vasudevan, 2012).

> In mid-2007, after a month of experimentation, Apple's engineers finally perfected a method for cutting strengthened glass so it could be used in the iPhone's screen. The first truckloads of cut glass arrived at Foxconn City in the dead of night, according to the former Apple executive. That's when managers woke thousands of workers, who crawled into their uniforms—white and black shirts for men, red for women—and quickly lined up to assemble, by hand, the phones. (Duhigg & Bradsher, 2012).
>
> Each employee was given a biscuit and a cup of tea, guided to a workstation and within half an hour started a 12-hour shift fitting glass screens into beveled frames. Within 96 hours, the plant was producing over 10,000 iPhones a day.
>
> 'The speed and flexibility is breathtaking,' the executive said. 'There's no American plant that can match that.'
>
> Similar stories could be told about almost any electronics company—and outsourcing has also become common in hundreds of industries, including accounting, legal services, banking, auto manufacturing and pharmaceuticals. (Duhigg & Bradsher, 2012).

Hence, we may point out that Foxconn is a simple capital enterprise. It compromised capital even before assuring Apple's demand. Moreover, it takes the risks and accepts being planned by Apple, while the latter gets even higher profit rates by appropriating part of the value produced in its subcontractors. As explained by Chan *et al.* (2013) Foxconn's profit rate, though significantly affected by Apple's pressures, remains positive partly by reducing labor expenditures, including cutting wages and benefits. In Chan *et al.* (2013) interviews, Foxconn employees also pointed out that Apple monitors onsite production processes and delivery times. These are characteristics that evidence Apple's planning capacity over Foxconn. In fact, according to former employees and suppliers interviewed by Satariano and Burrows (2011, p. 50), Apple controls every bit of its supply chain building a "closed ecosystem".

Furthermore, in line with our previous assertion concerning the size of simple capital enterprises, Foxconn is a gigantic corporation (since they highly concentrate capital). Actually, the Hon Hai Precision Industry (holding that owns Foxconn) was ranked 27th in Global 500 by Fortune Magazine in 2017, which ranks enterprises according to their revenues.

Finally, in Duhigg and Bradsher's (2012) description of Apple's GVC we find a clear example of a small capital. Apple hired an agency to check returned iPhones and iPads that will then be sent back to customers. For USD10 an hour and without benefits, the employees of this enterprise 'wipe thousands of glass screens and test audio ports by plugging in headphones'.[13]

5.2. Apple's innovation circuits

Since the iPhone—a major innovation that reconfigured Apple's GVC—was launched in 2007, Apple's investment in R&D grew systematically, in line with its skyrocketing profit rates. The dramatic increase in profit rate allowed Apple to reinvest gigantic sums in R&D in accordance with its retain and reinvest strategy (Lazonick *et al.*, 2013), while further investing in adverting was not the chosen strategy (Figure 2). This reinforces our suggestion of innovation's monopoly as a lasting source of economic power inside GVCs. In order to keep its leadership, Apple needed to increase its R&D investment looking for further innovations.

Additional R&D investments gave fruitful creative results judging by Apple's intangible assets' growth and by the number of patents granted every year (Figure 2). From less than 5 patents granted monthly by mid-2006, Apple went on to receive almost 60 monthly patents by mid-2012. Actually, the interviews performed for a WIPO's report stressed that 'companies in the smartphone industry appear to consider their patent portfolios as central to maintaining a competitive advantage in a dynamic marketplace' (Center on Law and Information Policy at the Fordham University School of Law, 2012, p. 32). Still, as shown in this report after looking at smartphone leaders' market shares and patent grant cycles, it is innovation rather than patents the key driver behind leading companies. Granted patents gather part of the effect of innovation and that is why they tend to follow the same path.

Considering our analysis so far, even if Apple has monopolized innovation by systematically achieving creative successes, as we have previously

13 Which enterprises participate in a GVC is not a set once and for all. As we said, simple capital companies are in a constant competition to accomplish the requirements of Leaders. For instance, Apple has replaced Qualcomm with Intel processors since IPhone 7 (WIPO, 2017).

stated, leaders shall not perform themselves complete innovation circuits. Indeed, Apple significantly benefited from R&D invested by other links of its innovation circuits. Apple's outsourced stages of innovation circuits have been observed by Mazzucato (2015). In particular, United States public funds for blue-sky research significantly contributed to Apple's success (Mazzucato, 2015, Chapter 5) as well as top elite universities' research results.[14]

An example of how Apple currently plans multiple small[15] innovation circuits at the same time is the apps development process. Since 2008, it consists of an open platform with a form of outsourcing called "crowdsourcing" because it is performed by a community attracted by an open call (Brabham, 2008). Apple provides developers a Software Development Kit where it is explained the type of apps that can be made publicly available. Guidelines include technical information, privacy policies, religion and sex matters to be considered, trademarks, etc. Apple controls the whole innovation process including the programming software to be used (iOS), the approval process, the distribution mechanisms, suggests pricing categories (in general predefined low prices) and the rewards scheme (Apple retains 30% of every purchased app plus in-app advertising). Hence, Apple decides which apps will be sold and when without paying any direct remuneration to developers who actually afford all the associated production costs (Bergvall-Kareborn & Howcroft, 2013).

While Apple minimizes its risks and significantly avoids software development costs, developers carry all this burden and even have to adapt their apps to Apple's new products or features ensuring compatibility. As a result, Apple profits from the productivity of its crowdsourced labor force. Freelance developers can be conceived as small capitals participating in Apple's innovation circuits, considering that those consistently successful in creating highly purchased apps can eventually become technological capital enterprises. Indeed, some developers interviewed by Bergvall-Kareborn and Howcroft (2013) worked on outsourced applications that are owned by companies that can be conceived as technological capital enterprises.

14 Retrieved from https://www.aau.edu/university-research-made-your-smartphone-smart on January 24, 2018.

15 In the sense that they will most certainly not reconfigure Apple's GVC, but are still innovation processes planned by Apple.

MeLLmo Inc., the makers of Roambi Analytics, is an example of Apple's exclusive developer. Together with Box and DocuSign, these are enterprises participating in Apple's innovation circuits that could potentially be technological capital enterprises.[16] DocuSign is an exception among technological capital companies in Apple's innovation circuits because it went public this year. As we said, start-ups are an archetypical example of this type of enterprise, although we may also find research universities and well established companies. Going public is a sign of the latter. Still, so far, profits have been negative for DocuSign as shown in their public balance sheet and income statement for 2017 and 2018.[17]

When technological capital companies participate in innovation circuits organized by different leaders, the impact of being drop by them after developing a mid or long term business relationship is a sign of their subordinated position. For instance, when Apple announced that it would stop working with Imagination Technologies, this company's stocks plunged.[18]

Apple also choses Universities to develop stages of its innovation circuits. For instance, by the end of 2017 Stanford University School of Medicine and Apple launched a joint heart study on Apple Watch.[19] Another example of an ongoing innovation circuit involves Aarhus University in Denmark. In 2016 Apple agreed to install a mega data center next to this university's Foulum research center with the aim of doing joint research on sustainable energy and computer science.[20]

The variety and relevance[21] of actors participating in Apple's innovation circuits is portrayed in Figure 3, which maps Apple's network of published

16 Retrieved from https://www.apple.com/business/partners/ on January 6, 2018

17 Retrieved from https://quotes.wsj.com/DOCU/financials/annual/income-statement on August 28, 2018.

18 Retrieved from https://www.forbes.com/sites/laurengensler/2017/04/03/apple-drops-imagination-technology-stock-craters/#8ea1aa5599d3 on September 2, 2018

19 Retrieved from https://med.stanford.edu/news/all-news/2017/11/stanford-medicine-to-collaborate-on-apple-heart-study.html on January 17, 2018.

20 Retrieved from http://dca.au.dk/en/current-news/news/show/artikel/aarhus-university-welcomes-apple-as-close-neighbour-to-its-foulum-research-centre/ January 11, 2018)

21 The frequency of co-authorship with Apple is represented by node's sizes.

papers since 2005, using CorText platform.[22] We used a raw metrics for this network map which means that we considered the raw numbers of co-occurrences between every possible pair of nodes (Wu & Leahy, 1993). Nodes are defined as different institutions or organizations (universities, enterprises, etc.). Since Apple is authoring every publication, the network map shows a star form with Apple in the middle. In this figure we show the 150 most relevant nodes, which means that Apple actually published with more institutions but not as often as with the 149 institutions depicted in Figure 3 together with Apple.

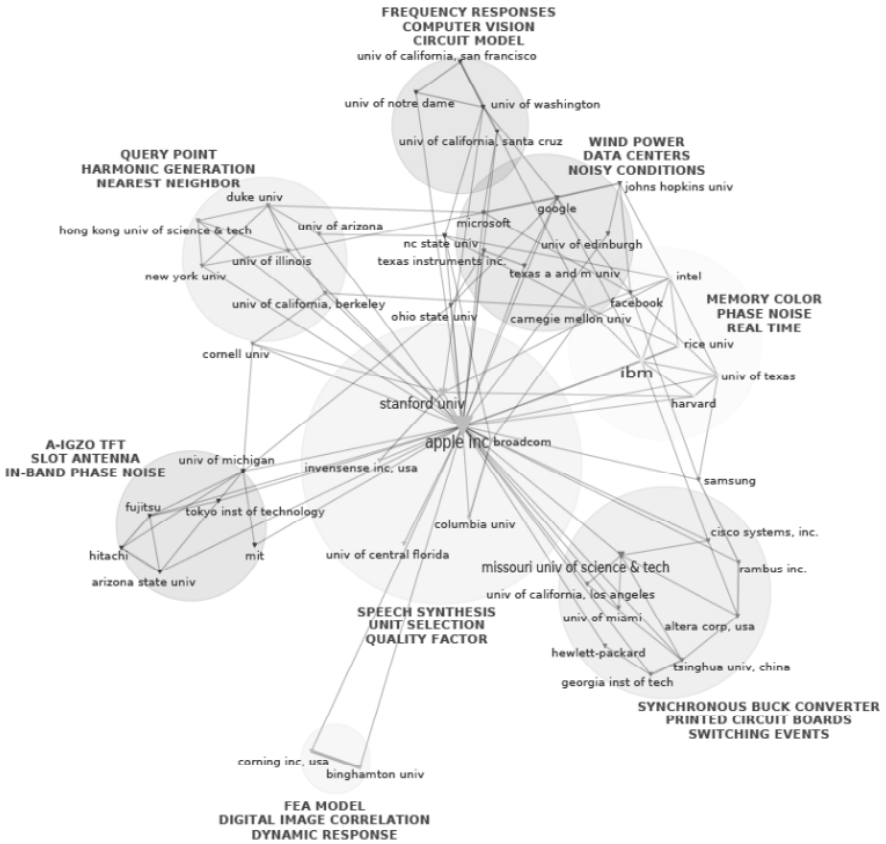
Figure 3. Apple's publications co-authorship raw network mapping (2005-2017)

Source: Author's analysis based on Scopus data extraction

22 Cortext is an open platform for performing bibliometric and semantic analysis. It can be accessed online at: https://www.cortext.net/

In order to concentrate on most important links, Figure 4 presents the same network (Apple's academic publications) but using a chi2 measure for determining nodes proximity and prioritizing the top 50 nodes, meaning that we consider Apple's top 49 partners. This map is completed by a semantic analysis of publication's abstracts. Keywords for each cluster were constructed through analyzing phrases occurrences in all the abstracts of each cluster.

Figure 4. Apple's publications co-authorship chi2 network mapping (2005-2017) with lexical analysis



Source: Author's analysis based on Scopus data extraction

When focusing on Apple's major co-authors (Figure 4), we observe that Apple strategically picks its partners among top research universities (Stanford University, California University, MIT, Tsinghua University,

etc.) in core countries and other leader corporations. Contrary to the 150 top co-authors, there are no start-ups among its top 49 co-authors. This makes sense if we consider that start-ups tend to focus on a particular innovation, thus the number of papers that can be published related to it are fewer than what Apple can publish with, for instance, a top research university. As expected, considering both Apple's history and home base, there is a predominance of American partners, in particular, top research universities among which Stanford and Missouri University of Science and Technology stand out.

Looking at keywords, we see that each depicted cluster may correspond to different innovation circuits, while distinct clusters may participate in the same innovation circuit. For instance, Phase Noise is a regular topic in two distinct clusters. Moreover, the cluster with Japanese multinationals, a Japanese and American leading universities, including the MIT, has been working on different innovation circuits. A-IGZO TFT is a type of screen that Apple introduced last year, while papers on Slot Antenna were probably intermediate results of the "Micro-Slot" patent granted by the USPTO in 2013 (patent number 8373610, for "Microslot antennas for electronic devices").

There are two corporations that belong to Apple's main cluster which participate both in Apple's innovation circuits by providing improved chips (Broadcom) and motion tracking sensor (InvenSense) for the IPhone. These companies contribute to reconfigure the IPhone value chain by systematically providing new features in their products in order to contribute to achieve next IPhone generations. They work close with Apple, as we can depict in Figure 3, which may imply that Apple steers their research in line with their future requirements. Broadcom chips currently include the provision of wireless charging, Wi-Fi, Bluetooth and GPS capabilities for the new models. Furthermore, Apple and Broadcom have been working together in innovation circuits for analog interface and wireless charging.[23] Regarding InvenSense, it was acquired by the Japanese semiconductor company TDK in December 2016 at a significantly low price, considering that it has historically offered higher performance motion processor, probably the reason why it became Apple's partner. The low

23 Retrieved from https://www.cnbc.com/2018/06/05/broadcom-will-generate-10-in-revenue-from-every-new-iphone-jp-morgan-estimates.html on August 30, 2018.

price sale is an expected result considering its innovation lag. InvenSense lost the innovation race with the French company STMicro who won part of the former's market share. As we have already argued, technological capital companies sell innovation (or stages of the innovation process). They remain in Leaders' innovation circuits as long as they keep performing while Leaders reap part of their innovation rents.

Finally, another interesting result observed in Figure 4 is that Google, Facebook and Microsoft belong to the same cluster. This means that they tend to publish altogether with Apple. Co-publishing with other leaders could be a token of technological cooperation between them. As we pointed out earlier in this paper, we believe there are new forms of cooperation and competition that surpass traditional price competition in a context of GVCs. We are referring to technological cooperation and technological competition. Leaders, at the same time, cooperate at certain stages of their respective innovation circuits, while their main form of competition is technological. Another example of technological cooperation is the new Artificial Intelligence initiative called 'Partnership of AI to benefit people and society" integrated by Microsoft, Google, Amazon, IBM, Facebook and, recently, Apple.[24]

It must be said that Apple also acquired promising start-ups, such as Siri, and later Emotient, an Artificial Intelligence start-up. Indeed, recognizing Apple's capacity to plan partly outsourced innovation circuits that may result in all sorts of innovations (from marginal or small innovations like apps to transformative innovations like the iPhone) does not mean to neglect the core internal R&D function that leaders should preserve in order to stay at the top.

5.3. A possible explanation for Apple's profit rate evolution

By developing planning relations with the developers, start-ups, universities and public science and technology bodies that participate in

24 Retrieved from https://www.partnershiponai.org/2016/09/industry-leaders-establish-partnership-on-ai-best-practices/ on January 4, 2018 and from https://www.partnershiponai.org/2017/01/partnership-ai-update/ on January 29, 2018

Apple's innovation circuits, all the former will be reinforcing Apple's dominance. Indeed, Apple's profit rate increase between 2004 and 2011 could be partly explained by this innovation circuits' strategy. However, Figure 2 shows that Apple's profit rate is falling since 2011, with the exception of a rebound in 2015. Which factors could contribute to explain this evolution?

In order to stay at the top, we have said that a leader must keep on innovating, reinforcing entry barriers and generating rents. We have also argued that leaders compete but not mainly for prices but for innovations. Thus, their innovation's monopoly needs to be systematically renewed in order to keep a leader position. In this monopolistic competition for innovations Apple, Samsung and Huawei are currently the undisputed leaders of the smartphones' market (WIPO, 2017), each of them leading a GVC and multiple innovation circuits. Still, this position is never granted; it is always contested by other players and between the incumbent leaders themselves. Furthermore, as we previously explained, once a leader different mechanisms are put in place to enhance that power, ranging from lobby to tax avoidance or evasion, including bribing and other illegal actions. The aforementioned plea driven by the European Union competition commission against Apple, together with the intention to tax big digital companies selling in Europe are factors to be considered in the bargain between governments and leaders.

Anyway, Apple continued launching new IPhone models and other products after 2011. However, we may think that those were not breakthrough innovations, thus the impact on consumers and sales was not as outstanding as former innovations, while other leaders, in particular Huawei and Samsung, may have been stepping ahead in technological competition. In fact, in 2016 Apple's net sales decreased. Besides general macroeconomic conditions, the company considers that the main explanation for its first fall in years was 'a lower rate of iPhone upgrades during 2016 compared to 2015' (Apple Inc, 2017, p. 23).

If our argument is accurate, it would mean that Apple's latest innovations had a smaller economic impact (smaller rents), leading to a reduction in its rate of profit. Increasingly investing in R&D is a necessary but not a sufficient condition to win the innovation race, especially when other leaders are following the same strategy. Technological competition between leaders is a never-ending race. As we have previously explained,

entry barriers' porosity can be overcame with a constant flow of science-based innovations. As explained in WIPO's report, which of the leaders in the smartphones' market has the biggest market-share still depends on consumer preferences for each leader's innovations (Center on Law and Information Policy at the Fordham University School of Law, 2012). Apple is aware of this challenge:

> The Company's future financial condition and operating results depend on the Company's ability to continue to develop and offer new innovative products and services in each of the markets in which it competes. (Apple Inc, 2017, p. 5)
> The Company continues to believe that focused investments in R&D are critical to its future growth and competitive position in the marketplace, and to the development of new and updated products and services that are central to the Company's core business strategy. (Apple Inc, 2017, p. 27)

Hence, although it is still a long way to go, if Apple starts systematically losing the innovation race, meaning that other companies (potentially Huawei or Samsung) innovate at a faster speed, and if Apple doesn't manage to keep its entry barriers high enough by applying to other non-market sources of power (such as lobbying) these barriers will become porous and may eventually impact on its leader position. In the smartphones' market, it is possible to conceive Nokia as an example of the latter.

6. FINAL REMARKS

There is a growing literature that focuses on power relations between firms, in particular GVC and GPN approaches. However, either they begin by assuming power relations in the market, or they explain market-power by the existence of entry barriers which have been considered porous, thus not sufficient proof for justifying long-term asymmetries. In order to fulfil this gap, we suggested that monopolizing innovation can actually be conceived as the source of a lasting power relation, leading to structural differences among enterprises allowing for the emergence of GVCs.

We then went one step further and explained that leaders do not only exercise market-power but also plan the working process of subordinated

enterprises. Planning outside the production unit is a capacity of the leader inside its GVC and innovation circuits. We explained how capital's differentiation is a dual process since the technological enhancement of leaders massively subordinated, at the same time, remaining enterprises. The wide gap between firms' innovative capacity leaves those non-innovative with no better option but to accept being subordinated in the market and planned. Furthermore, the leader will profit from that subordination by appropriating a portion of the value created in simple and small capital enterprises.

GVCs synthesize the structure of power relations between firms in a particular moment of time. Meanwhile, we suggested that innovation circuits are creative planning substructures whose results reconfigure GVCs throughout time. Innovation circuits are, thus, the renewing source of power as well as the responsible for GVCs long term dynamics and restructuring processes.

Overall, we believe this article contributed in four ways to GVC's analysis: 1) by providing a conceptual explanation for the emergence of leaders (innovation's monopoly), 2) by suggesting different types of subordinated enterprises (the simple, the small and the technological capital enterprises), 3) by conceiving the power relation between firms not only as a market-power relation but also as a planned production-power relation, and 4) by integrating innovation circuits with GVCs, which actually reinforces our first contribution. All in all, by contributing to the GVC framework we were able to give a theoretical explanation for Apple's higher profit rate when compared with the other enterprises in its value chain (Figure 1). We also pointed out some examples of Apple's planning capacity inside its GVC, and the concept of innovation circuits allowed us to discuss Apple's relations with other types of actors, such as technological capital enterprises and universities acting as such. Though further empirical research is required, and while innovation's centrality may not be equal in every GVC, we believe that the long-term differentiating effect of monopolizing innovation inside a branch cannot be neglected as a conceptual explanation for the emergence of GVCs, hence of structural power asymmetries between firms.

Still, we have left many open questions, some of which are mentioned next, drawing a future research agenda. The complex set of relations

among leaders, which are planning different portions of total social capital, has not been sufficiently addressed. A future research will focus on the latter by introducing the possibilities of what we have briefly referred as technological cooperation (or collusion). Furthermore, the subordination of different types of enterprises underlies that legal binds between enterprises do not necessarily determine independent, private or autonomous production units. Indeed, the configuration of GVCs and innovation circuits means that leaders have the capacity to plan and organize portions of social capital that are not legally bound to them. In fact, we may even say that the production unit (now the GVC) is split from capital's legal ownership. This track needs to be further developed. Last but not least, further work needs to be done to integrate intellectual or innovation monopolies with financialisation. This has been explored by Serfati (2008) but, in the aftermaths of the 2008 crisis, the emergence of patent monetization companies could be a tip of an iceberg connecting innovation and financialisation that should be looked at.

To conclude, the four theoretical contributions to GVC and other related approaches developed in this article need to be further reworked empirically and theoretically to provide policy recommendations. So far we may only be able to point out some preliminary advice . Changing the current power ratio inside GVCs demands a global effort. For instance, only if every country is committed to having a significantly higher minimum wage, whose threshold is globally determined, peripheral countrieswhere simple and small capitals working in GVCs tend to be located—may be able to significantly increase their workers wealth. By doing so, they will also be reducing the value that is appropriated by leaders. The Asia Floor Wage organization is fighting for this at an Asian level [25] but this is not enough, since for instance African countries could become the new super-cheap labor suppliers. Our suggestion would instead be to foster this initiative at a global level. We may also raise questions on the feasibility of upgrading in the GVC, which has been a common recommendation for developing countries, because leaders' planning capacity simultaneously reduces the upgrading capacity of the rest of the GVC. Instead, national states of the periphery may be able to plan public value chains and innovation circuits, which may even have a global-south scope as long as states from those countries manage to share the leading role.

25 Retrieved from http://asia.floorwage.org/ on February 26, 2018.

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