Foreign Investment and Infrastructure Financing: Railways During the First Age of Globalisation

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Author's Declaration

I, Tehreem Husain, declare that all material presented in this thesis is entirely my own work. Where information has been derived from other sources, I confirm that this has been indicated and that all sources and quotations are cited.

Abstract

The late nineteenth and early twentieth century is characterised as a time of rising international integration in goods and financial markets. Sovereign and railway securities were the top-most avenues of British capital flows during 1880-1913. Railways were risky ventures characterised by high capital intensity and significant sunk costs, and were therefore structured as emergent Build-Operate-Transfer schemes, with both public and private shades in ownership and management. Focusing on infrastructure finance as the key theme, the thesis draws on literature from finance and economic history to explore foreign investment in railway securities from fifteen countries. The thesis takes an investor's perspective, analysing the relationship between railway and government securities through the lens of country creditworthiness. In doing so, it explores three research questions. First, was the government guarantee a signal of government credibly committing to meet their obligations? Second, what were the determinants of yield spreads on railway securities and were there any commonalities with determinants on sovereign securities? Third, what was the dynamic relationship between returns on government and railway securities and how did they behave during times of crisis? Qualitative and quantitative methods point to two key results. First, the guarantee was a credible signal of government commitment and was the mechanism through which sovereign creditworthiness had a spillover effect on railways. Second, railways and sovereigns exhibited a time-varying relationship. However, crisis episodes such as the Barings crisis of 1890 significantly influenced the nexus between railways and sovereigns. Overall, a key result of the thesis is that investors took both sovereign and railway securities into account when forming perceptions of country creditworthiness. Current literature on the roots of creditworthiness during 1880-1913, rely exclusively on sovereign securities. This thesis expands the debate by looking at both sovereign and railway securities in understanding how market sentiment was shaped.

Impact Statement

This thesis informs policy-making on infrastructure and contributes to different strands of academic literature. The thesis explores railway financing during 1880-1913, where railways were structured as emergent Build-Operate-Transfer schemes, a form of public-private partnership. In that vein, the thesis provides a historical perspective on public-private partnerships and contributes to understanding the critical role infrastructure policies can play in shaping investor perceptions and attracting investments for railway projects globally.

The thesis also contributes to the wider literature on project finance. Countries raised railway financing to either/and showcase country capacity to host large-scale projects, ensure the success of current projects or to achieve socio-economic or strategic aims. Railway projects were capital-intensive in nature and significant volumes of funding could only be raised by offering investors various incentives on their investment. In this regard, sovereign guarantees on railways were pivotal in attracting investment. On the one hand, sovereign guarantees enhanced confidence of private sponsors by reducing the riskiness of their investment and were crucial in ensuring companies creditworthiness to attract foreign financing. On the other, governments also used guarantees on railway projects as a credible signal of their commitment to support railway projects. Moreover, the thesis suggests that the sovereign guarantee was a mechanism through which sovereign creditworthiness has a spillover effect on railway securities. So far, the role of guarantees in the wider literature in economic and financial history has been largely ignored. This thesis fills this gap.

Related to the above, the thesis also provides a historical precedent to understanding project bonds, popularly used to raise financing during 1880-1913. Post global financial crisis of 2007-8, stricter regulatory standards on banks resulted in an inability to fund infrastructure projects using traditional debt alone. Consequently, there is a search for more innovative ways of funding.

The academic impact of the thesis has several dimensions. One concerns the debate on the roots of creditworthiness during 1880-1913. So far, this debate has focused exclusively on sovereign securities. The thesis argues that railway securities were 'quasi-sovereign' in nature as governments provided various incentives such as guarantees, land grants,

subsidies etc. to attract foreign capital. In this way, the thesis expands the debate on country risk during 1880-1913 by investigating both sovereign and railway securities in a unified framework. Overall, understanding how market perceptions of the risk profile of infrastructure securities are formed is beneficial in providing a perspective to improve the funding conditions of public sector enterprises and in reducing the cost of public investments today.

Related to this, a key contribution of the thesis is understanding how sovereign creditworthiness changes over time. Episodes of monetary and fiscal stress can influence investor perceptions on country risk. The thesis studies investor perceptions on investment in railway and government securities during the Barings crisis of 1890. While it employs quantitative techniques to understand investor risk aversion during the episode, it supplements the analysis through investment advice given during 1880-1913. Results show that investors were implementing principles of portfolio much before its formal study by Markowitz in 1952.

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"And what railway companies now do, limited companies of high standing, when they are thoroughly embarked in business and are sure of sound credit, will be certain to do likewise. Several of the best of them already are issuing debentures and are getting their money. The Government is exposed within the country to a permanent and industrial competition which it did not use to feel, but which it is beginning to feel acutely. Instead of being nearly the only borrower of indisputable credit, it is now only one among an augmenting crowd of such borrowers."[1]

"The Southern Mahratta terms offer a permanent security to investors, which is equal to the security of the Government of India, with the addition of a quarter of the net receipts of the line."[2]

"If an investor wishes for an absolutely safe security, then he should invest in the debenture and preference issues of the leading railways, applying to them the same principle that he would apply to all leading gilt-edged stocks."[3]

[1] The Low Value Of Government Securities. (1864, September 10). Economist, 1134+.

[2] 1884. Report from the Select Committee on East India Railway Communication;together with the Proceedings of the Committee, Minutes of Evidence, and Appendix, (HC 284, 1884). [Online]. London:The Stationery Office.

[3] Thorpe (1901)

Chapter 1

Introduction

The late nineteenth and early twentieth century, popularly known as the first era of financial globalisation (1880-1913), is characterised as a time of rising international integration in goods and financial markets (Bordo & Meissner, 2011; Mauro, Sussman, & Yafeh, 2006). During that time, global trade volumes increased, and international capital mobility witnessed unprecedented growth (Janelle & Beuthe, 1997). Britain, specifically London, was the financial capital of the world investing an average of 5 percent of GDP overseas during 1873-1913 and this number reached the 10 percent mark just before the outbreak of the Great War (Fishlow, 1985). Besides Britain, France and Germany were also major capital exporting countries and by 1914, Britain, France and Germany together accounted for 76 percent of total global foreign investment (Tunçer, 2015).[1]

This rising financial integration during that time was marked by ground-breaking advances in transportation technology. Coffman and Neal (2014), explore the origins of modern infrastructure finance, and argue that the Long Nineteenth Century (1789-1914) witnessed a succession of technological innovations that disrupted existing networks of canals, steamships and roads. More specifically, advances in transportation technology, especially railways, were considered as "the principal single determinant of the levels of investment, national income and employment in the nineteenth century" (Atack, Bateman,

[1] Britain's share was 43 percent compared to 20 percent share by France and 13 percent by Germany.

Haines, & Margo, 2010; Twomey, 2000).[2]

Railway construction during that time was not justified on socio-economic benefits alone but also to achieve strategic aims. For instance, the vast Russian empire required rail links capable of moving the Tsarist army quickly and competently. Similarly, the 'strategic' railways on the North-West frontier of India were vital for imperial defence in British India (Otte & Neilson, 2012). Interestingly, the development of rail infrastructure drew large-scale external finance irrespective of the socio-economic and geopolitical motives of the financiers and the borrowing countries. Considering the flow of huge volumes of international capital for public works, especially railways, this dissertation acknowledges the conceptual framework elaborated by Janeway (2012) on innovation economies and presents a case of railway financing during 1880-1913 as a set of continuous, reciprocal and interdependent relationship between the government, market economy and financial capitalism. In essence, the thesis takes an investor's perspective and explores the drivers and patterns of investment flows. It argues that financial capitalists (investors) formed perceptions of a country's creditworthiness taking both sovereign and railway securities into account. Looking at railway securities to form perceptions on country creditworthiness is a relatively under-appreciated perspective in the existing literature, which projects performance of sovereign securities as the sole driver of sovereign risk during 1880-1913.

1.1 Railways during the First Era of Globalisation

Railways revolutionised the world. They were argued as "historically the most powerful single initiator of take-offs" having "three major impacts on economic growth during the take-off period". This was to lower transport costs and bring new areas and products into the market, develop a major new export sector and promote the development of the modern coal, iron and engineering industries (Channon, 2001; Jacks, Meissner, & Novy, 2010; Mitchell, 1964; Mokyr & Strotz, 1998). Similarly, O'Rourke and Williamson (1999) reiterate that "...the decline in transportation costs after mid-nineteenth century was

[2]Appendix Chapter 2 Table 1 highlights the railway opening dates in different British possessions around the world.

enormous, and it ushered a new era of globalisation". This led to increased opportunities for trade, particularly in land intensive commodity exports (L. Fisher, 1959; O'rourke & Williamson, 2002). The historical experience corroborates with a wide body of contemporary literature which argues that public infrastructure investment raises output in both the short and the long run (Ganelli & Tervala, 2016). It was the dawn of the railway age where countries raced to build networks in their countries, and capital exporting nations directed their investments in railways abroad.

Britain, as the leading capital exporting nation, directed capital towards the development of railways besides a wide array of public works, land development schemes, construction and mining (Feis, 1930; Paish, 1909). Evidence of this is shown in Table 1.1 which illustrates an overall picture of portfolio distribution by sectors of economic activity in global centres of finance and political power during 1880-1913.

Table 1.1: Portfolio Distribution by Centres of Economic Activity

	Germany	Britain	France
Total Government Loans	48.6	32.2	1.4
Railways	33.1	32.4	45
Public Utilities	3.5	6.5	16.3
Finance	9.6	7.8	22.6
Raw Material	3.7	11.8	11.2
Industrial and Other	1.5	9.3	4

Note: Values in percentage of total market value of portfolios. For France, I have taken the average of the portfolio allocations. Source: R. Esteves (2011) and R. Esteves (2012)

Britain was the leader in terms of volume of capital exports and had a diversified portfolio of flows in terms of geography and industries (Stone, 1999). With colonies across all continents, 47 percent of its capital was directed within the empire. Outside the empire, the US was the largest recipient of British capital (around 20 percent). Almost 32.2 percent of British investment was directed towards sovereign securities, whereas an equal proportion was invested in railway securities.[3] Besides Britain, other leading capital exporters such as

[3]Some of the investment shown under government loans, might explicitly be for railway purposes. Such was the case of a number of Latin American countries (Argentina, Brazil, Chile, Colombia, Honduras,

Germany and France also concentrated their investments in sovereigns and railways. Table 1.1 shows that on average almost 64 percent of investment was directed across sovereign and railway issues in all three global financial capitals during 1880-1913.

Table 1.2: Composition of Victorian Investors' Financial portfolios in England and Wales from 1870-1902 (percent over time)

	1870-78	1879-1886	1887-1894	1895-1902
Government securities				
U.K.	31.9	23.4	5.9	21.4
Empire	14.4	2.3	5.9	8.8
Foreign	4.3	10	3.1	3.3
Total	50.6	35.7	14.3	33.4
Municipal securities				
U.K.	0.2	0.7	5.7	5.6
Non U.K.	0	0	0	0.1
Railway securities				
U.K	19.4	26.1	42	19.2
Empire	2.6	2.9	6	5.4
Foreign	1.6	3.2	6.9	7.8
Total Railways	23.6	32.3	55	32.5

Source: Sotiropoulos and Rutterford (2018), p.20

Furthermore, in terms of railways, media sources such as the Investor's Monthly Manual and detailed data sources on the London Stock Exchange such as the Stock Exchange Official Intelligence, geographically categorised investment in railway securities. For instance, investment in railway securities was categorised as four classes; Indian railways, Railways in British Possessions (other than India), American Railways and Foreign Railways. Table 1.2 builds on Table 1.1 and illustrates the geographical and sectoral composition of Victorian investors' financial portfolios in England and Wales from 1870-1902. Portfolio compositions exhibit variation over time where the share of government bonds declined

Peru), European nations (Greece, Finland, Italy, Portugal and Switzerland); colony (Australia). Russia, Mexico and China also raised loans for the construction of railways (detailed in Appendix Chapter 2 Table 3). A significant proportion of colonial debt was held in the form of railway debentures. Source: Fenn (1889); Investor's Monthly Manual (various editions).

from 1870-78 to 1895-1902 (50.6 percent to 33.4 percent). On the other hand, the share of railways in investor portfolios increased from 23.6 percent to 32.5 percent by 1902. Overall, while investors diversified their portfolios over time, investments in railways and sovereign securities commanded a sizable share.

Taking both Table 1.1 and Table 1.2 together, one can argue that not only did investors diversify their portfolios geographically but also across different asset classes. Contemporary literature has shown that investors consider infrastructure as a distinct asset class, and therefore, build their portfolios with a separate investment allocation to infrastructure (Della Croce, 2012). This can also be argued for railways due to their characteristic features. Railways are long-term capital-intensive projects, have high sunk costs and exhibit high asset specificity, being tied to the region where the investment is made (Kasper, 2015). Moreover, investments in railways are lumpy in nature, and produce limited or no cash flows in the early stages of the asset (Helm, 2010). Hence, it is the very nature of the asset, that renders private capital markets alone insufficient to finance such ventures, with the consequence that it is best delivered with the participation of both public and private parties (Cardinale, Coffman, & Scazzieri, 2017).

1.2 Conceptual Background

With the above mentioned characteristics in mind, what drove investment in railway securities? By definition, capital flows are the difference between domestic investment and savings, which makes it important to look at both investment-based (demand side) and saving-based (supply-side) determinants of capital flows. Given that foreign capital gained supreme importance in this era, its supply became a crucial factor towards the financing and construction of railway infrastructure worldwide. Perez (2003) argues that railways were one of the five waves of technological revolution since the eighteenth century, where each wave presented investors 'new opportunities of seizing profits'. Governments capitalised on investors' search for yield by offering lucrative yet safe returns on railway investments. Investors earned handsome (guaranteed) returns and also received a portion of profits. Railway securities offered higher overall returns relative to the same amount invested in

government funds and therefore attracted a substantial volume of investment (Whitehead, 1849).[4] Overall, overseas investments (including government and railway securities) offered a higher realised rate of return on relative to domestic assets during 1880-1913, and were the highest during 1897-1909 (Edelstein, 1976).[5]

On the other hand, capital-importing countries faced with inadequate funds, resulted in a substantial demand for foreign capital for financing public works. This demand was met through borrowing for financing infrastructure, and private capital markets such as the London Stock Exchange were deep enough to finance such ventures. However, new technologies entailed information asymmetries making it difficult for investors to evaluate risk (Coffman, Leonard, & Neal, 2013). In order to overcome several information asymmetries between buyers (investors) and issuers (borrowing governments and corporations), markets developed a variety of techniques including offering guaranteed returns, investment safety via sinking funds, defining collateral clauses and ensuring marketability of securities (Kemmerer, 1916; Neumann, 2003).

Railway securities attracted investment in four ways.[6] First, long-dated railway securities provided a fixed, unalterable dividend or the provision of guaranteed minimum interest with a certain participation in profits. In the case of India, the imperial government provided a limited but generous guarantee to private companies for every mile they built.[7] Similar to the case of India, the governments of Canada and the Ottoman Empire

[4] Whitehead (1849) wrote a thin 84 paged pamphlet discussing the merits of investment in guaranteed railway securities in the case of Britain. He argued that government backed railway securities had important features which made them as good as if not better than government securities.

[5] Mortimer (1762) in his book, 'Every Man His Own Broker' (1769) gives a definition of the term 'security'. He attaches the concept of limited liability to the term 'stock' which he explains as the capital which a certain number of proprietors have agreed to use in proportion to the sum or share contributed by each. He defines government securities as public debt and not stocks as government securities are granted by the parliament for meeting public expenses and are borrowed from the public through various acts of parliament under the condition that they would be redeemed by the parliament.

[6] In this dissertation the term securities includes all instruments such as stocks, shares, debentures, ordinary shares and preference shares. Shares are considered equity instruments whereas bonds are considered debt instruments. The earliest source the thesis comes across using this categorisation is by Mortimer (1762), but Campbell and Taksler (2003) also discuss it at length in their paper and appendix.

[7] The initial guaranteed companies during the 1860s were the East Indian; Eastern Bengal; Calcutta and South Eastern; Oude and Rohilkhund; Sind, Punjab and Delhi; Great Indian Peninsula; Bombay, Baroda and Central India; Madras and Great Southern of India. Source: (Bogart & Chaudhary, 2012).

also offered 'kilometric guarantees' to attract investment in railways. Second, investments in railway securities, similar to government securities, were protected through the acts of parliament. Their 'safe' nature was promoted not only by the government guarantee but also contained lottery clauses, in which a sinking fund was used to retire a percentage of the certificates outstanding (Cardinale et al., 2017).[8] Railway securities could thus be closely mapped to Tobin (1958) definition of government securities as obligations to pay stated cash amounts in the future and free from default risk. Third, similar to sovereigns, railway securities were collateralised by revenues or custom duties. These provided mechanisms of creditor action (Tunçer, 2015). Fourth, railway securities were designed to ensure marketability. Simply defined, non-marketable assets can be made marketable through floating shares on the stock market or privatisation of government owned firms (Stapleton & Subrahmanyam, 1979).

Marketability of railway securities served as a key driver attracting investment. Marketability encapsulates the concepts of transferability, negotiability and convertibility.[9] This was broadly true for the universe of railway securities listed on the London Stock Exchange, but specific examples can illustrate the concept more meaningfully. In terms of transferability, railway debentures of the Madras Railway Company, were transferable by endorsement without stamp and renewable at the option of the holder.[10] Railway securities were also negotiable since they guaranteed the payment of a specific amount of

[8]For the construction of railway connecting Quebec and Halifax, one of the covenants regarding the guarantee of interest by British Treasury was that the government of Canada would annually pay at one percent per annum on the entire amount of principal money in a sinking fund. Besides Canadian, Indian, Italian and Ottoman railways also had arrangements for sinking funds, Source: (1867). Canada railway loan. A bill for authorizing a guarantee of interest on a loan to be raised by Canada towards the construction of a railway connecting Quebec and Halifax. HC 99. [Online]. London: The Stationery Office; (1880). Railway and Mining Share List, The Economist, 038 (1928), p.928.

[9]There exists substantial debate on the effect of marketability on asset prices exists. Longstaff (1995) using option-pricing theory shows that lack of marketability results in potentially large discounts on security prices even if the period of illiquidity is very short. On the other hand, Stapleton and Subrahmanyam (1979) have shown that for a range of utility functions, the degree of marketability has no effect on the market price of risk or on the level of prices. Generally speaking, stock marketability can also be evaluated by measuring market value, earnings per share and return to investors (Seiford & Zhu, 1999).

[10]Debentures of the Madras Railway company were renewable for a second term of five years at the same rate of interest upon notice given by the holder twelve months prior to the expiry of the first term. The Position of Indian Securities. (1861, February 2). Economist, 114+.

money, either on demand, or at a set time, whose payer is usually named on the document. This feature was also discussed in popular media sources such as the Economist which discussing the Italian Company of Meridional Railways wrote that the direct guarantee given by the government was advantageous to the company as it increased the negotiability of the railway security and would ultimately be beneficial for its issuing price.[11] Lastly, railway debentures such as that of Italian railways, amongst others, were also convertible into stock. Greater marketability was ensured through restricting raising of capital by debentures as far as possible, especially debentures which are not convertible into stock.[12] Railway securities were designed to ensure that all three aspects of marketability were met.[13] To summarise, governments took the above mentioned four initiatives (provision of guarantee, safety of investment through legislative frameworks and collateral clauses and marketability) to reduce informational asymmetries and attract financing for railway projects built for economic or strategic aims.

Government's role to make the project viable through the issuance of sovereign guarantees for railway projects was not the only means that intricately linked railway and government securities. As an industry, railways had varying shades of public and private ownership and management. Railways fell into four categories; state owned and operated, privately owned but state operated, state owned but privately operated and privately owned and operated. The thesis argues that the variation in the shades of ownership and management makes railway securities *quasi-sovereign* in nature. In contemporary literature *quasi-sovereign* debts refer to debts of quasi-sovereign states that have ceded some but not all prerogatives to a central government (Gelpern, 2011). In the historic literature, Clarke (1878) argues that railway debt is *quasi-sovereign* in nature. This is attributed to two reasons. First, railway operations, for example that in India, were conducted by companies that were fully or partially British owned and managed. Secondly, other companies are only

[11] Source: The Italian Company Of Meridional Railways. (1865, July 8). Economist, 842+.

[12] France. (1902, August 23). Economist, 1327+.

[13] Bills enabling the Secretary of State for India provide insight into how each of these aspects of the marketability (transferability, negotiability and convertibility) of railway instruments was met. Source: (1901). East India loan (Great Indian Peninsula Railway debentures). A bill to enable the Secretary of State in council of India to raise money in the United Kingdom for the purpose of paying off or redeeming debentures of the Great Indian Peninsula Railway Company. (HC 279). [Online]. London: The Stationery Office.

nominally foreign, as they were domiciled in London, had a foreign guarantee with their dividends also payable in London. The quasi-sovereign nature of railways, had implications on their financing as well. When railways were publicly operated, the lending was directed via government borrowing. When railways were privately owned, their construction was accompanied by significant public expenditure. This resulted in a strong complementarity between private and public sector investments in this period (Della Paolera & Taylor, 2013).

1.3 Outline of the Argument

The key argument the thesis makes is that investors form perceptions of country creditworthiness taking both sovereign and railway securities into account. Current literature on the roots of creditworthiness during 1880-1913, relies exclusively on studying sovereign securities alone, this thesis expands the debate by looking at both sovereign and railway securities in understanding how market sentiment was shaped. Overall, on a micro-level, studying sovereign and railway securities under a unified framework has implications for understanding investors' portfolio choice during 1880-1913. On a broader level, investor perceptions on country creditworthiness (taking both railway and sovereign securities into account) has implications on country's continued access to funds both for short-term budgetary concerns as well as long-term development financing (Feder & Uy, 1985).

It is in this background that the thesis draws on the extensive literature on portfolio theory, which provides a framework of analysis of individual choice of securities and the determination of their market prices, and explores the nexus between sovereign and *quasi-sovereign* railway securities. Focusing on infrastructure financing as the key theme, the thesis draws on literature from finance and economic history to explore foreign investment in *quasi-sovereign* railway securities listed on the London Stock Exchange from fifteen capital-rich and capital-poor countries. These are comprised of Austria, Argentina, Belgium, Brazil, France, Italy, Portugal, Russia, Spain, Sweden, Canada, India, Australia, New Zealand and Turkey. Taken together these countries comprise 47.1 percent of total British investment in railways (Stone, 1999). The selection of these countries makes the

sample representative as they lie on various points on the political risk spectrum with the sample set categorised into Dominions (Canada, Australia, New Zealand),[14], colony (British India), sovereign nations heavily dependent on foreign inflows for economic development (Argentina, Brazil, Italy, Portugal, Spain, Russia and Turkey), and sovereign capital-rich countries (Austria, Belgium, France and Sweden). Foreign investment in railway securities is analysed vis-à-vis investment in sovereigns, to understand the relationship between these two important avenues of investment during the first era of globalisation.

The thesis recognises that American railways were a top avenue of British Investment, but America is not added to the country set for three reasons. First, America was a sizeable market, merits a study on its own, and its inclusion would likely overshadow the rest of the sample. Secondly, there existed considerable differences in market structure between America and the rest of the sample. This is in the form of dominance of private ownership and management of American railways in contrast to the current sample set where the state played a substantial role (Dinhobl & Roth, 2017). Third, America also differs from the rest of the sample in regards to the form of state support available to railways. Governments offered guarantees on payment of principal and interest on railway debt to the fifteen capital-rich and capital-poor countries comprising the sample, whereas American railways were largely given state support in the form of land grants (Van Oss, 1893).[15]

This thesis uses multiple data sources and a variety of empirical techniques to test the relationship between sovereign and railway securities. Data on bond prices and bond characteristics is taken from two different publications. These include the Investor's Monthly Manual (1869-1929) and the Stock Exchange Official Yearbook. The IMM, a monthly supplement produced by the Economist contained detailed information on the available

[14]Dominions were areas where Europeans settled. Fieldhouse (1961) saw a marked legal difference between 'colonial' and 'dominion' status. In a colony, the authority of the Imperial parliament is real and over-riding and is defined by the Colonial Laws Validity Act. In a dominion, after its adoption with the Statute of Westminster, the authority is virtually eliminated. The difference between colonial and sovereign borrowing costs has elicited a wide body of literature where colonial borrowing costs are arguably less because of their colonial status and the elimination of default risk (Ferguson and Schularick (2006); Accominotti, Flandreau, and Rezzik (2011))

[15]Appendix Chapter 2 Table 2 shows that the inclusion of America does not qualitatively change the results.

bonds, details on price (latest, high and low during the month), coupon payment dates and some information on bond underwriters. The Investor's Monthly Manual is available in digitised form on the International Centre for Finance website administered by Yale University.[16] Primarily, the thesis uses data from the Investor's Monthly Manual for prices of government and railway securities. Railway level information is collected from Pech (1911), International Historical Statistics by Mitchell and Statistical Abstracts of Foreign Countries and Colonies. Macroeconomic variables are taken from the Global Finance database. These databases are complemented with official publications and reports and articles from the financial press.

1.4 Contribution and Thesis Structure

The thesis has three main contributions. First, this thesis fills a gap in the current literature on how investor perceptions of country creditworthiness were formed during 1880-1913, by looking at both sovereign and railway securities together. So far, the literature on the roots of creditworthiness has focused exclusively on sovereign securities, By looking at both sovereign and railway securities, the thesis improves current understanding on how market sentiment on country creditworthiness was shaped. Second, empirical analysis in the thesis points to the beneficial impact of sovereign securities in terms of market completion and price discovery for railway securities. So far, literature on sovereign debt during 1880-1913 has paid little attention to the role that sovereign securities played in the market for *quasi-sovereign* or corporate securities. Third, the thesis sheds light on investor portfolio strategies in the past. This is through exploring a long time period of 33 years which gives evidence of investor strategies in response to global shocks as well as including a range of capital-rich and capital-poor countries where country fundamentals played a key role in guiding the relationship between the two most important avenues of investment in that era. The next chapter sets a background for the thesis, giving an overview of railways during the first era of globalisation, outlining their key characteristics including their ownership

[16]The Investor's Monthly Manual, a record of The London Exchange was digitised by the Yale International Center of Finance. The link is as follows: https://som.yale.edu/centers/international-center-for-finance/data/historical-financial-research-data/london-stock-exchange.

and management structure, the market microstructure under which they operated, and the type of railway securities listed on the London Stock Exchange.

Under this argument, the thesis is broadly divided into four substantive chapters. Chapter 2 sets a background for the thesis, giving an overview of railways during the first era of globalisation. It outlines the key characteristics of railways as an infrastructure class, details their ownership and management structure, outlines the role of intermediaries in railway finance and illustrates a typology of railway securities listed on the London Stock Exchange. Chapter 3 focuses on the theme of credibility of government promises, taking the case of the government guarantee, and explores the role that government guarantees played in attracting foreign investment in railways. The argument is structured under the light that lenders assess creditworthiness by paying close attention to borrowers' potential in meeting their commitments (Daniels, Morgan, & Larrymore, 2020). The chapter uses railway contracts, foreign council reports and bond prospectuses, analysing the credibility of government promises to undertake a qualitative analysis and asks a key question. Did the presence of government guarantees serve as a credible signal for government commitment towards railway projects during 1880-1913? The chapter argues that the provision of government guarantees was important in boosting investor confidence and that the guarantee played an important role in governments credibly signalling their commitment towards railway obligations. The chapter undertakes a case study of the 'Romero arrangement' in Argentina in the aftermath of the Barings crisis of 1890, to analyse the guarantee under crisis times. The chapter argues that although a number of railway companies went into default, only guaranteed railway companies were part of government efforts towards consolidation of Argentinian finances.

Chapter 4 explores country creditworthiness through studying the determinants of yield spreads on railway securities. Yield spreads on railway securities, defined as the difference between yield on railway securities and yield on UK government securities, measure markets' perception of default risk of railway companies (Flandreau & Zumer, 2004; Kavussanos & Tsouknidis, 2014). Those yield spreads are influenced by a large number of determinants, broadly categorised into credit, liquidity and market risks (Ferrucci, 2003). Annual data on yield spreads on railway and sovereign securities from the Investor's Monthly Manual

is complemented from data on macroeconomic variables from the Making Global Finance database. In addition to this, industry-specific data is used from the International Historical Statistics and Statistical Abstracts on Foreign Countries and colonies. In investigating the determinants of yield spreads on railway securities, the chapter explores how they relate to the determinants of yield spreads on sovereign securities. A key result of the chapter, predictably, is that yield spreads on sovereign securities emerges as the key determinant explaining yield spreads on railway securities. This points to the beneficial role of sovereign securities in market completion. Benchmark securities play an important role by allowing heterogeneously informed investors to hedge against major income risks and adverse selection (Dittmar & Yuan, 2008; Shiller, 1993). Moreover, the government guarantee emerges as the mechanism through which sovereign creditworthiness has a spillover impact on railway securities. Another key finding is that, yield spreads on sovereign securities exhibits a relationship of *substitution* in capital-rich countries whereas a relationship of *complementarity* in capital-poor countries, indicating the differing levels of financial development in both sets of countries. Overall, the chapter gives a deeper understanding into the nature and dynamics of both these important classes of securities during the era.

It is important to note that perceptions on country creditworthiness can exhibit volatility during periods of financial stress. Literature on asset pricing has shown that strong correlations between markets is directly linked to high volatility during crisis episodes (Junior & Franca, 2012). Chapter 5 explores this idea through investigating the time-varying co-movement, using higher frequency monthly returns on sovereign and railway securities in 15 countries during 1880-1913.[17] The chapter employs the theoretical framework of Modern Portfolio theory which posits that assets should not be selected only on unique characteristics of the security alone, but rather how each security exhibits co-movement with all other securities (Elton & Gruber, 1997). Exploiting the Barings episode as a natural event, the chapter analyses potential structural breaks in the relationship between returns on railway and government securities, investor risk aversion and 'flight to quality' behaviour and how quickly the equilibrium relationship between the two securities was restored. The chapter also indicates that the direction of causality runs from sovereigns

[17] Co-movement is defined later in the chapter and implies a shared or common movement manifested through strong correlations between asset returns (Baur, 2003).

to railway securities, implying that sovereign securities played a beneficial role in price discovery by improving the price informativeness of quasi-sovereign railway securities. The chapter supplements the empirical analysis through studying narrative analysis from historical investment guides and finds that investors were applying the fundamental tenets of Modern Portfolio Theory much before its formal exposition by Markowitz in 1952. Finally, Chapter 6 concludes the thesis. It highlights some of the key findings of the thesis and their broader implications for our understanding on sovereign debt, infrastructure finance and country creditworthiness.

Chapter 2

Railways During the First Era of Globalisation

Large-scale, permanent, continuous markets for government debt had existed in Britain, France, the Netherlands and the Italian city-states for centuries, but these polities denominated their debt in their own currencies. Sovereign bond markets in the modern sense date from the early nineteenth century and became progressively deeper over the years. Although debt securities issued by early modern sovereigns were usually marketed to their own subjects, to reduce reliance on traditional banking syndicates, by the nineteenth century, few European states, with the noted exceptions of Britain and France, were able to mobilise large-scale resources with domestic borrowing (Coffman et al., 2013; Neal, 1991). Following the advent of Rothschild's Prussian Loan, borrowing from foreign creditors through loans denominated in sterling were also being traded on the London Stock Exchange (Cardoso & Lains, 2010; Neal et al., 1998).

It is important to understand the various purposes for which sovereign loans were raised on global stock exchanges. Sovereign loans raised on global stock exchanges as reported in official documents, such as country statistical abstracts, comprised of three broad categories; municipal loans, loans for financial and credit companies and loans for railway and industrial companies (Clarke, 1878). A sizable proportion of government debt

comprised of debt raised by railway companies.[1]. Railways, were the biggest industry to raise external finance on global stock exchanges during 1880-1913 (Goetzmann & Ukhov, 2006). Railway projects were organised as Build-Operate-Transfer (BOT) projects, a key form of Public Private Partnership (PPP) projects. Public-private partnerships are used by governments to procure and implement public infrastructure or services using the resources and expertise of the private sector (World Bank, 2020).[2]. One way in which public-private partnerships are structured is in the form of BOT projects where a concessionaire retains a concession for a long-term fixed period (usually thirty to forty years) for the development and operation of an infrastructure facility. The private infrastructure company (the railway company) builds, finances and operates a new infrastructure facility for a specific period and ownership of the facility reverts back at no cost to the public party (government, ministry, or public agency) (Devapriya, 2006; Xenidis & Angelides, 2005). This was also the practice in the past where the 'Railways' section in the Stock Exchange Yearbooks details long-dated concession contracts awarded to railway companies, the nature of guarantees involved and the ultimate transfer of the railway to the government. The enmeshed responsibilities of the public and private sector in railways during 1880-1913 is also highlighted in Appendix Chapter 2 Table 1.

An efficient and frequently used method for financing infrastructure PPP projects is through project finance schemes where lenders provide long-term financing on expected cash flows of infrastructure assets (Z. Lu, Peña-Mora, Wang, Liu, & Wu, 2019; Yescombe, 2002). This was also the practice in the past where railway prospectuses from 1880-1913 detailed the revenue earning potential of the project, based on which lenders financed the enterprise (Barings prospectus, 1890). BOT uses project finance to develop large-scale infrastructure projects and facilities of public interest (Xenidis & Angelides, 2005). Project financing has historically been used to finance infrastructure. One of the earliest applications of project finance dates back to 1299, when the English Crown enlisted a

[1]In the case of India, government debt comprised of sterling bills and securities of guaranteed railway companies. Moreover, the India Office could raise money required by the guaranteed railway companies either through the issue of government loans or through flotation of railway company debentures (Sunderland, 2013)

[2]Retrieved from: https://ppp.worldbank.org/public-private-partnership/about-us/about-public-private-partnerships

leading Florentine merchant bank to aid in the development of Devon silver mines. The bank received a one-year lease for the total output of the mines in exchange for paying all operating costs without recourse to the Crown if the value or amount of the extracted ore was less than expected (Esty, 2003). Project financing techniques were also employed in trading expeditions in the 17th and 18th century. Investors provided funds to the Dutch East India Company and the British East India Company for voyages to Asia after which they were repaid according to the share of the cargo once sold (Kensinger & Martin, 1988). It can be argued that the roots of modern day project financing techniques can be found in this period.

Structuring railway projects as Public Private Partnerships is one way in which the relationship between railways and sovereigns was influenced through various forms of ownership and management. Another channel through which railways and sovereigns were intricately bounds was through the presence of intermediaries. Intermediaries' market power played a significant role in overcoming information asymmetries, and for the overall development of sovereign debt during the first era of globalisation. Given the dearth of information about sovereign borrowers, investors relied on intermediaries' reputation to guide their investments (Flandreau & Flores, 2009). Various issues of the Stock Exchange Yearbooks reveal that reputable underwriters such as Rothschild and Barings, were also responsible for underwriting railway issues for a number of countries. This chapter aims to provide a broad overview of infrastructure assets in general, and railways in particular. It focuses on the relationship between railways and sovereigns through the lens of ownership and management and through the presence of common intermediaries. Understanding the nexus between public and private parties contextualises the key argument of the thesis that investors took both sovereign and railway securities into account while forming perceptions on country creditworthiness. On the other hand, the overview also indicates and acknowledges certain dimensions, on which railway securities exhibited dissimilarities relative to sovereign securities, mainly in terms of the nature of railway instruments listed on the London Stock Exchange during 1880-1913.

This chapter is divided as follows. Section 2.1 explores the characteristic nature of infrastructure assets. Section 2.2 analyses the hybrid forms of ownership and management

of railway companies during the first era of globalisation. Section 2.3 explores the relationship between sovereigns and railways through the presence of common underwriters. Section 2.4 looks into the various types of railway instruments used for raising financing during 1880-1913. Section 2.5 concludes.

2.1 Infrastructure Asset Characteristics

Railways like other large infrastructure projects are capital-intensive, characterised by high sunk costs and are tied to the region in which the investment is made (Kasper, 2015). In addition to this, infrastructure assets have high asset specificity, are characterised by long lives and therefore generate substantial financing requirements, a bulk of the investment being required up front (Sawant, 2010). A sizable magnitude of investment is also required as economies of scale are critical to the success of the project.[3] Investments in infrastructure are lumpy in nature and revenues are only generated after the completion of that asset. Moreover, they may not generate positive cash flows in the early phases and may take a long time to break even (Helm, 2010). It is due to these characteristics of infrastructure projects that it is best delivered with the participation of both public and private parties when risks are shared between those two parties.

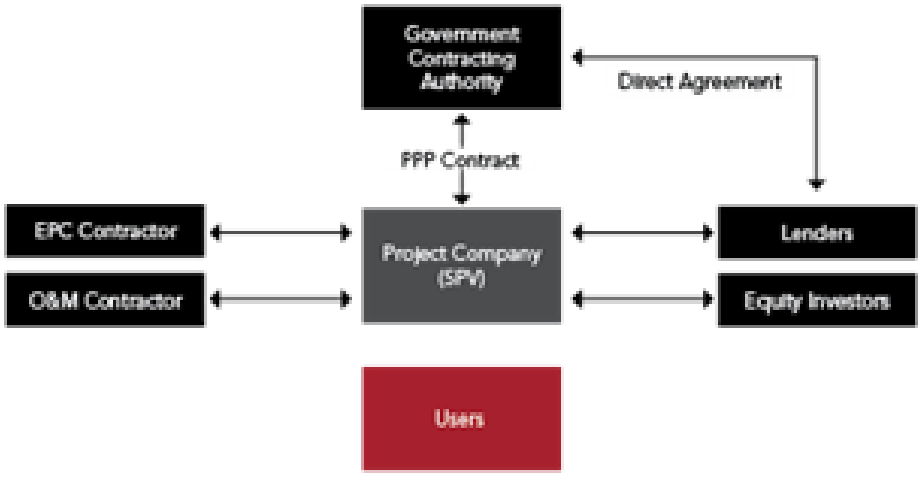
Project Finance

A frequently used and efficient method of financing infrastructure PPP projects is through project finance schemes where lenders provide long-term financing on expected cash flows of infrastructure assets (Z. Lu et al., 2019). Project finance, raised for new projects, is provided for a 'ring-fenced' project (legally and economically self-contained) through the creation of a special purpose vehicle (usually a company) whose only business is the project. Lenders look towards the earnings of that economic unit as the source of funds from which a loan will be repaid and to the assets of the economic unit as a collateral for the loan. Lenders of project finance also pay close attention to the project company's contracts, licenses, or ownership rights to natural resources. This is so as the

[3]Economies of scale means that as the level of production increases, the marginal cost of producing an extra unit of output drops.

project company's physical assets are likely to be worth much less than the debt if they are sold off after a default. Another key characteristic of project finance is that projects have a finite life, based on the length of the contract or licenses and therefore project finance debt must be fully repaid by the end of this life (Yescombe, 2002)(Figure 2.1).

Figure 2.1: Project Finance Structure



Despite project finance being used to finance many infrastructure projects since the 1970s, private finance has historically been used to finance large-scale public infrastructure projects. It can be argued that railways during the first era of globalisation were emergent forms of project finance. Similar to project finance arrangements today where detailed contracts are designed to appropriately allocate construction, operations and revenue risks between various parties, project finance for railways was organised under a concession agreement between the government and the private sector which gave the railway company rights to construct the lines and earn revenues by providing a service to the general public (Yescombe, 2002). To summarise, project finance encompasses a wide range of financial, legal and regulatory mechanisms that have developed around such single-asset project

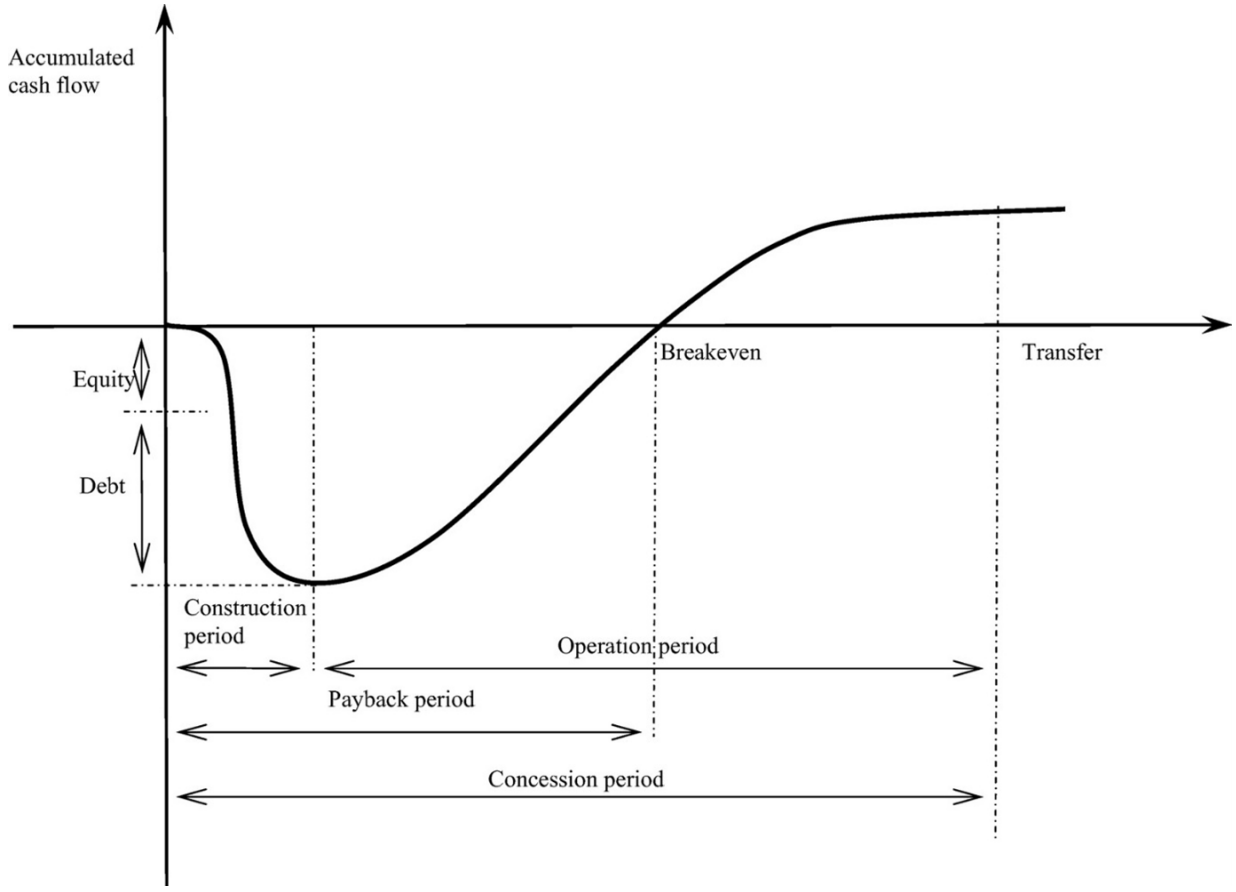
companies and their financing (Boardman & Vining, 2012).

Railway projects were organised as Build-Operate-Transfer (BOT) projects, a key form of PPP projects. BOT uses project finance to develop large-scale infrastructure projects and facilities of public interest (Xenidis & Angelides, 2005). In the BOT approach, a concessionaire retains a concession for a long-term fixed period (usually thirty to forty years) for the development and operation of an infrastructure facility. The private infrastructure company builds, finances and operates a new infrastructure facility for a specific period and ownership of the facility reverts back the facility at no cost to the public party (government, ministry, or public agency) (Devapriya, 2006; Xenidis & Angelides, 2005). The concessionaire arranges a large amount of capital (equity and debt) to build the facilities associated with the project. The huge construction cost associated with the project is intended to be recovered through project revenues in the future period of operations (Zhang, 2009). This is illustrated in Figure 2.2 which exhibits the typical cash flow profile of a BOT project.

Infrastructure assets are characterised by long lives, which makes the exposure of these assets to fixed and sunk costs particularly important (Helm, 2010).[4] Government support is crucial in the initial stages where the infrastructure project is characterised by negative cash flows. Various forms of government support are offered to make the project more acceptable and financeable to private investors by protecting them from risks they have little control over or are not willing to bear (Z. Lu et al., 2019). It is the very nature of the asset, which makes private capital markets alone insufficient to finance such ventures, with the consequence that it is best delivered with the participation of both public and private parties (Cardinale et al., 2017). The characteristic nature of infrastructure assets is also exhibited in hybrid forms of ownership and management.

[4]Infrastructure poses multiple market failures. The failures are related to the properties of public goods, sunk costs, market power and externalities. Since infrastructure assets are part of networks or systems, once they are in place, the marginal costs of another consumer is zero. Hence, economic welfare is organised by providing the good to as many people as possible, with incentives reflecting marginal and not average costs. This gives rise to the issue of recovering fixed and sunk costs without creating distortions to consumption.

Figure 2.2: Cash Flows of Build-Operate-Transfer Projects



2.2 Railways Ownership and Management

The contractual relationship between the government and private investors as described above is also reflected in varying forms of ownership and management of railway enterprises. This variation in the shades of ownership and management makes railways *quasi-sovereign* in nature. This is also illustrated in Table 1 which dissects railway network on a spectrum of ownership and management.

The varying shades of ownership and management of railways as witnessed in 1913 is seen in Table 2.1, with Appendix Table 1 exhibiting it in more detail. Railways fell into four categories; state owned and operated, privately owned but state operated, state owned

Table 2.1: Railways Ownership and Management in 1913

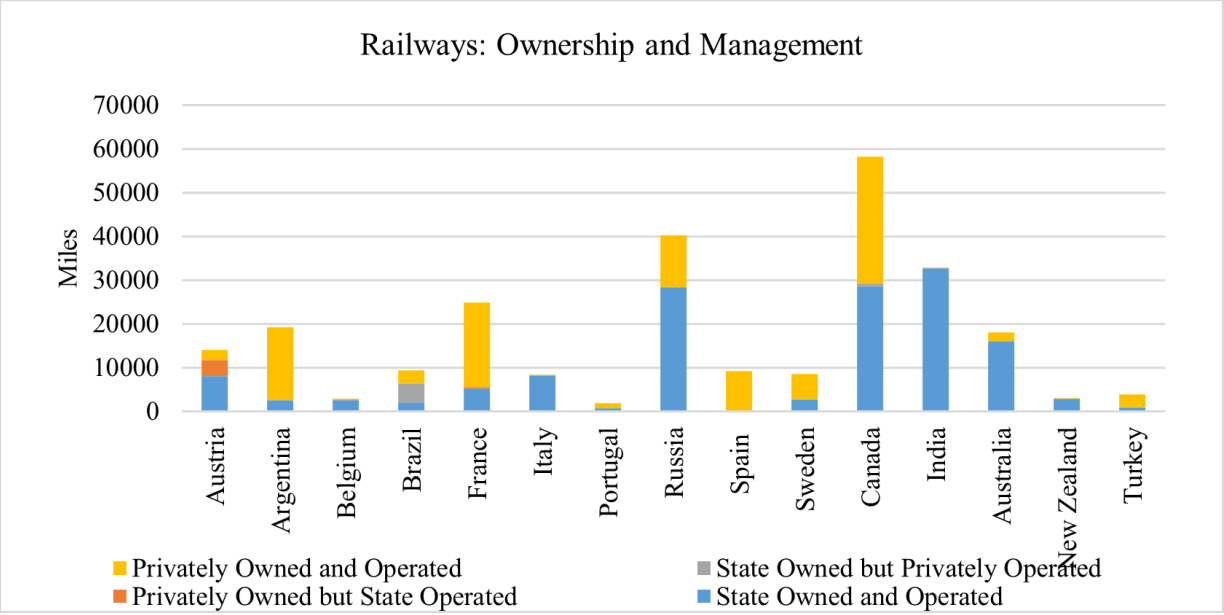
Country	State Owned & Operated (miles)	Privately Owned but State Operated (miles)	State Owned but Privately Operated (miles)	Privately Owned & Operated (miles)
Austria	8074	3593		2409
Argentina	2495			16734
Belgium	2530	151		218
Brazil	2000		4405	3020
France	5268	229		19445
Italy	8275			56
Portugal	696			1115
Russia	28400			11800
Spain				9194
Sweden	2745			5839
Canada	28453		825	28,833
India	32699			140
Australia	16079			1934
New Zealand	2808			29
Turkey	909			2946

Source: (1913). State Railways (British Possessions and Foreign Countries, HC287. [Online]. London: The Stationery Office; (1911). Statistical Abstract for British India.

but privately operated and privately owned and operated. The majority of the countries forming part of my sample belonged to the first category state owned and operated (141,431 miles). Taking the example of British India, which forms an important country under this category, railway ownership and management can be broken down into four phases. In the first phase up to 1869, private British companies constructed and managed the railways under a public guarantee. In the second phase, the Government of India entered the field constructing and managing state railways. The third phase during the 1880s saw more hybrid forms of public-private partnerships with Government of India as the majority owner and private companies in charge of construction and operation. Long-dated contracts (99 years) were drawn with private companies, at the end of which railway ownership would

be reverted to the government (Marshman, 1863). Finally, the Government of India began taking over all railway operations since 1924 (Bogart & Chaudhary, 2012). The next biggest category was privately owned and operated (103,712 miles). Argentina, Brazil, France, Portugal and Sweden fall in this category where private ownership and operation of railway lines dominates state ownership and operation. Figure 2.3 also illustrates this. the public-private nature of ownership and management.

Figure 2.3: Railways Ownership and Management



Placing the different combinations of ownership and management on to a spectrum with 'state owned and operated' on one end and 'privately owned and operated' on the other end (Figure 2.3), the country set analysed in this thesis exhibits a variety of different ownership and management arrangements. Establishing why a particular country exhibited a certain arrangement is a question in its own right, but historical evidence indicates more hybrid forms of public-private partnerships across all countries. This could be attributed to due to public-private partnerships offering optimal risk allocation arrangements between the public and private parties. In countries such as India 'state owned and operated railways' was the predominant arrangement, but private ownership was greatly encouraged. This

was reiterated in the Economist dated April 23, 1881 which discussing Indian railways wrote:

> "...It has been found that the work of developing the means of communication, if it is to be carried on with the requisite rapidity and comprehensiveness, is beyond the power of the government, and very wisely, therefore, it has been decided to encourage private enterprise to step in and supplement the efforts of the state. The grant to the Rothschilds of a railway concession is the first step that has been taken in that direction...."[5]

In contrast, Canada had a roughly equal proportion of 'privately owned and operated' and 'state owned and operated' railways. However, similar to India, private enterprise was encouraged to make the railways economically profitable. The Economist dated September 23, 1899 emphasising on the importance of private ownership wrote:

> "The Dominion government owns and operates the Intercolonial...and also the Price Edward Island Railway... The capital account of these two lines is now $65,000,000. The Intercolonial never paid operating expenses till last year (1898-9); the Island road has never paid them, and probably never will. They are political rather than commercial routes, but probably could be made to pay if in private hands".[6]

Despite private enterprise being encouraged in railways in Canada, the case of other self-governing dominions such as Australia, New Zealand and South Africa is completely different. In the case of Australia, New Zealand and South Africa, state ownership and operation of railways was predominant, with private railways comprising a small share in overall network. This could possibly be linked to railway performance. The case of railway construction in New South Wales can illustrate this point. Railway construction in New South Wales was originally proposed by private companies but financial difficulties faced

[5] "The Indian Budget." Economist, 23 Apr. 1881, pp. 501+.
[6] "Canadian Railway Subsidies." Economist, 23 Sept. 1899, pp. 1356+

by railway companies in 1854 resulted in government acquisition. Thereafter, construction and operation of main lines was undertaken by the state. To summarise, incentives of risk allocation and financial performance influenced the varying degrees of ownership and management exhibited in different countries during 1880-1913. The next section looks into the role of underwriters and how formed yet another link between railways and the government.

2.3 Railways, Government and Underwriters

The close contractual relationship between railways and the government was also reflected in their financing. Intermediaries' market power has played a significant role in overcoming information asymmetries, and for the overall development of sovereign debt during the first era of globalisation. Given the dearth of information about sovereign borrowers, investors relied on intermediaries' reputation to guide their investments (Flandreau & Flores, 2009). Borrowers accessing global capital markets through the agency of a reputed underwriter were prepared to pay a higher price. Borrowers were willing to pay higher prices as underwriter's reputation and market knowledge ensured the success of the issue. A key historical example is that of the Southern Maharatta Railway Company in India. In a correspondence by the Government of India with the Secretary of State for India, on the formation of the company, the government was of the view that "The position occupied by Messrs. Rothschild afforded an almost certain guarantee that, in the event of the project being launched under their auspices, the capital would be readily subscribed".[7] Leading banks thus owned a brand that could grant market access to borrowers on favourable terms (Flandreau & Flores, 2009).

Interestingly, besides Rothschild several other underwriters were involved in underwriting both railway and government securities during 1880-1913. This is evident in the case of House of Barings whose market comprised of underwriting and sovereign and railway

[7]East India (Southern Maharatta Railway). Copy or extracts of correspondence which has passed between the Secretary of State for India and the Government of India and the promoters with reference to the formation of the Southern Mahratta Railway Company, including a letter from the Viceroy of India in Council in the Railway Department to the Secretary of State, dated 21st October 1881.

securities for numerous countries. Barings were involved in sovereign issues of Austria, Argentina, Belgium, Italy, Portugal, Russia and Canada. They also underwrote issues for railways in Argentina (Western Railway of Santa Fe, Western Railways of Buenos Ayres, Great Southern Railway of Buenos Ayres), Canada (Atlantic and North Western Railway, Canadian Pacific Railway, Canadian Intercolonial Railway), India (Southern Maharatta Railway, Bengal and North Western Railway, Bengal Central Railway), Russia (Moscow Koursk Railway and Grand Russian Railway). A snapshot of underwriters involved with sovereign and railway issues during is illustrated in Table 2.2.

Table 2.2 illustrates the nexus between sovereign and railway securities through shared underwriters. The table suggests that some reputable underwriters such as the House of Barings are involved in underwriting sovereign and railway securities, but there are instances where underwriters are involved in underwriting either sovereign or railways but not both (for example London and Westminster Bank is involved in underwriting railways but not sovereigns). The question of underwriter incentives in underwriting either sovereign or railways or both merits a study in its own right and is not covered in this dissertation. It would be worth exploring in a future study of the incentives that underwriters have in underwriting either sovereign or railways or both.

Having explained the relationship between railway and government securities through the characteristic nature of infrastructure assets, hybrid forms of ownership and management and the interplay of common underwriters for both sovereign and railway securities, the next section describes the characteristics of a veriety of railway instruments listed on the London Stock Exchange during 1880-1913.

2.4 A Typology of Railway Securities

Understanding the variety of railway instruments listed on the London Stock Exchange during 1880-1913 is also instructive towards understanding the nexus between railway and sovereign securities. Instruments listed on the can primarily be listed into five different types. Table 2.3 shows the security composition of British capital exports from 1865-1914. The table shows that railway securities were distributed into four types; debentures,

Table 2.2: Underwriters for Government and Railways 1892

Country	Government	Railways
Austria	Barings	Rothschild
Argentina	Railway Loan (Messrs Murietta & Co), Barings, Stern Brothers, Messrs Louis Cohen & Sons, Morton Rose & Co, Messrs Heinemann and Co, Messrs A.Ruffer and Sons,	Messrs J.S.Morgan and Co, Messrs J.E. and M.Clark and Co, Messrs Murietta & Co, Morton Rose and Co, Barings, Messrs James Capel and Co,
Belgium	Barings	
Brazil	Rothschild, Messrs Morton Rose and Co., Messrs Louis Cohen and Sons, Messrs C. de Murietta and Co, Henry Schroder and Co,	Glyn Mills Currie and Co, Morton Rose and Co, Messrs Louis Cohen and Sons, Messrs Knowles and Foster, Messrs Murietta & Co, Messrs Smith Payne and Smith,
France	Rothschild	Rothschild, Comptoir National d'Escompte, Thomas Bonar and Co.
Italy	Barings, Maremmana Railway (Messrs Hambro and Sons),	Messrs Louis Cohen and Co, Barings, Hambro and Sons.
Portugal	Barings	Morton Rose and Co, Glyn Mills & Currie,
Russia	Rothschild, Messrs Thomas Bonar, Barings, Henry Schroeder and Co, Messrs Hambro	Barings, Messrs Hambro and Sons, Messrs Thomas Bonar & Co,
Spain	Rothschild	Messrs C. de Murietta and Co (1889), Samuel Dobree and Son, Messrs A. Ruffer and Sons, London Joint Stock Bank,
Sweden	Messrs C.J.Hambro and Sons, Rothschild,	Messrs Sheppards, Pellys, Scott and co
Canada	Barings, Glyn Mills Currie and Co, Bank of Montreal, Clydesdale Bank, Messrs Morton Rose and Co, London and Westminster Bank, Union Bank of London, London and County Banking Co, Messrs Coates Son and Co, Messrs Bosanquet Salt and Co	Messrs A. and W. Ricardo, Barings, Messrs John G. Meiggs and Son, Morton Rose and Co, Speyer Brothers, Bank of Montreal, Barings, Imperial Bank, Clydesdale Bank, Messrs Blake Boissevain and Co, Messrs Boyle and Co, Melville Evans and Co, Glyn Mills Currie and Co, Messrs Sheppards Pellys, Scott and Co, Messrs Armstrong and Co.
India	Bank of England	Bank of England,
Australia	Commercial Bank of Australia, Union Bank of Australia, National Bank of Australasia, London and Westminster Bank, Bank of England, Federal Bank of Australia, Queensland National Bank, English Scottish and Australian Chartered Bank, Consolidated Bank, Crown Agents for the Colonies.	National Bank of Australasia,
New Zealand	National Bank of New Zealand, Union Bank of Australia, Colonial Bank of New Zealand, Crown Agents, Bank of England,	London and Westminster Bank
Turkey	Imperial Ottoman Bank, Bank of England, Rothschild, Messrs Dent Palmer and Co	Imperial Ottoman Bank

Source: (1892). Stock Exchange Year Book.

ordinary shares, preference shares and notes. Debentures were the most popular railway instrument from 1865-1914 and overtook ordinary shares from 1870-4. Table 2.3 can further be expanded by detailing railway instruments based on their purpose of issue, by type of security provided and by the terms of payment. Interestingly, in contrast to sovereign securities, a greater variety of instruments were used for raising financing for railways. It is important to state that these categories are detailed here as another form of nexus between government and railway securities and are not used in the regression frameworks undertaken in Chapter 4 and 5.

Table 2.3: Security Composition of British capital exports-Railways 1865-1914 (percentage distribution of capital called)

	1865-9	1870-4	1875-9	1880-4	1885-9	1890-4	1900-4	1905-9	1910-14	1865-1914
Debentures	42	78	84	72	64	69	63	71	71	69
Ordinary Shares	53	19	13	22	21	15	21	19	10	18
Preference Shares	5	3	3	6	15	16	8	8	6	8
Notes	0	0	0	0	0	0	9	2	13	5
	100	100	100	100	100	100	101	100	100	100

Source: Stone (1999), page 396

Bond Classification

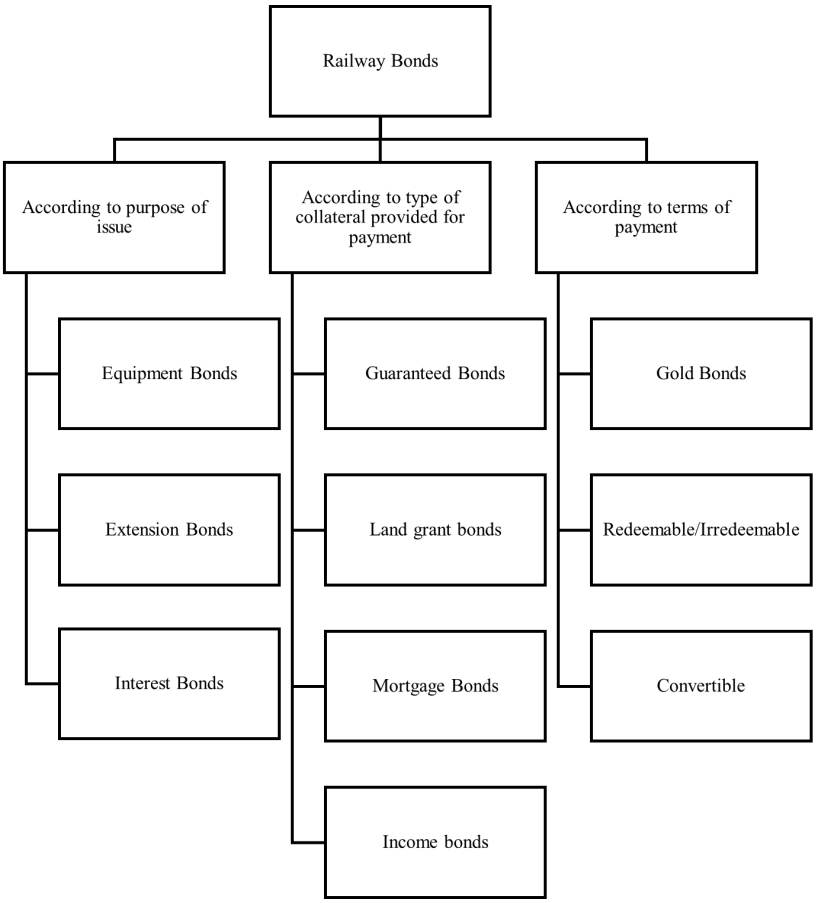
The thesis uses the classification by Cleveland (1907) to categorise railway securities into three broad classifications. This is illustrated in Figure 2.4.

It is important to note that specifically for railway securities, these categories are not mutually exclusive.[8] These are:

- Classification according to purpose of issue (equipment bonds, extension bonds, Interest Bonds).
- Classification of bonds according to the type of collateral provided for payment (guaranteed bonds; land grant bonds; sinking fund bonds; first, second or third mortgage bonds, general mortgage bonds, consolidated Mortgage bonds, income bonds.

[8]For example in the case of guaranteed bonds, they can be guaranteed extension bonds.

Figure 2.4: Railways Ownership and Management



- Classification of bonds according to terms of payments and retirement of issues (gold bonds, redeemable, irredeemable, convertible, joint etc.

Classification According to Purpose of Issue

Railway securities were issued for various purposes. The data from the Investor's Monthly Manual reveals that three different types of securities were issued for specific purposes. These are comprised of equipment bonds, extension bonds and interest bonds. Each will be looked in turn.

Equipment Bonds

Equipment bonds are the issues of a company, trustee, intermediate between the equipment manufacturer and the railway company. During 1880-1913, these bonds appeared in several series as listed in the Investor's Monthly Manual. Equipment bonds were used when the manufacturer of the rolling stock wanted to use the cash to carry out further transactions. The title to the rolling stock is transferred to the trustee, who issues to the railway a lease or other contract for partial payments. Serial notes and bonds were issued and sold, and provisions were made for the periodical payment of the notes from the revenue stream that the railway generates. Equipment bonds were usually floated for Canadian, American railway securities.[9]

Extension Bonds

Extension bonds, as the name suggests, were used for financing extension in railway networks from one point to another. At times, these bonds were also used in case of extensions in the time of payment. In the case of railway securities listed on the London Stock Exchange, extension bonds were used in terms of raising financing for undertaking extensions to the railway network. Extension bonds were issued for several railways in Argentina, Brazil, Canada and Turkey.[10]

Interest Bonds

Interest bonds were issued for the purpose of deferring interest payments due and protecting the property or corporation from the consequences of a default. The new contracts amount to an extension of interest payments without operating as an innovation of an old contract. Countries issuing interest bonds include America and Australia.[11]

[9]For Canada an example of equipment bonds were the "Grand Trunk Railway Company of Canada 6% 1st Charge Equipment Bond" issued in January 1869; for America an example is the "Detroit Grand Haven and Milwaukee Railroad 6% Equipment Mortgage Bond" issued in August 1879.

[10]Ottoman Railway of Anatolia and Ottoman Smyrna-Aidin Railway (Tireh Extension issued in March 1884, Seraikeny Extension issued in February 1888 and Sokia Extension issued in May 1894).

[11]Such was the case of "Tasmanian Main Line Funded Interest Certificates" for Australia issued in February 1878 and "New York Pennsylvania & Ohio Railroad Deferred Interest Warrants" for America issued in February 1888.

Classification of Bonds according to the type of collateral provided for payment

Railway securities can also be classified based on how they were secured. The secured railway securities can be categorised into the type of collateral/security provided. This could be on the basis of personal security or those which are secured by liens on specific property.

Guaranteed Bonds

A key instrument under this category were guaranteed bonds. Guaranteed bonds are those the security of which is a written guarantee, either attached to the credit instrument or produced in separate writing and enforceable according to the specific terms of the instrument. Governments offered a variety of different guarantees to attract investment in railways. These are discussed in greater detail in the following chapter.

Land Grant Bonds

Land grant bonds are issues of railways, which were secured through mortgages on the land on which the railway was constructed granted as a subsidy by either state or federal governments or both. This was a popular category of railway instrument which was issued by Argentina, Australia, Brazil, Canada, Spain, India, Italy, New Zealand and Sweden. These bonds were predominantly issued by America where the proportion of mortgage bonds relative to the global issuance of such type of bonds was a share of 62 percent.

2.5 Conclusion

This chapter provides an overview of railways during 1880-1913. It contributes to the theme of the thesis, i.e. to explore the nexus between government and railway securities, in three ways. First, it outlines the varying degrees of public and private ownership and management of railways. Long-term infrastructure assets such as railways are inherently risky, and optimal risk allocation warrants the involvement of both public and private parties in terms of ownership and management. This was also the case for railway financing during 1880-1913. Placing railways on a spectrum of ownership and management where

'state owned and operated' railways existed at one end, whereas 'privately owned and operated' railways existed at the other end of the spectrum, reveals that countries experimented with a variety of different arrangements between these two extremes. However, historical literature reveals that the involvement of both public and private parties was encouraged. Concomitant with the public and private character of railways, financing models relied on emergent forms of Project Finance. In this vein, the chapter provides a historical perspective on the modern day use of Project Finance and public-private partnerships to finance infrastructure assets.

Second, the chapter also explores the nexus between sovereign and railway securities through shared underwriters involved in underwriting both government and railway securities. Reputable underwriters involved in underwriting sovereigns were also involved in underwriting railways. However, variations exist where underwriters involved with sovereign issues were not involved with railways or vice versa. Future research can explore underwriter incentives and preference structures to underwrite one but not the other.

Third, the chapter provides an overview of the variety of railway instruments listed on the London Stock Exchange during 1880-1913. Amongst the many different types of railway instruments listed on the London Stock Exchange, railway securities carrying a government guarantee were popularly used to attract investment during the first era of globalisation. This illustrates yet another way in which sovereign and railway securities were bound in an intricate relationship. Government guarantees for railways are explored in detail in the following chapter which argues that governments offered the guarantee to raise financing for railway projects and signal their commitment towards meeting railway obligations.

Chapter 3

Guarantee as a Commitment Device: Railways During the First Era of Globalisation

The McKinsey Global Institute estimates that infrastructure investments worth $3.7 trillion need to be met to keep pace with projected GDP growth (Woetzel, Garemo, Mischke, Kamra, & Palter, 2017). Constrained public-sector budgets, increased public debt to GDP ratios and at times the inability of the public sector to deliver efficient spending has resulted in annual global infrastructure investment shortfalls to the tune of US $350 billion. Consequently, it is increasingly being acknowledged that alternative sources of financing are needed to support the large up-front investments required for infrastructure development. In this regard, Public-Private-Partnership (PPP) schemes have gained remarkable popularity as a means of infrastructure investment (Asao, Miyamoto, Kato, & Diaz, 2013). PPP schemes are a long-term contract between a private party and government entity, for providing a government asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance (Yong, 2010). Globally, 133 projects worth US$21.9 billion are structured as PPP projects, evident of the importance of investment commitments by private sector participants in infrastructure projects (Bank, 2020).

The characteristic nature of infrastructure projects such as tangibility, high capital intensity and asset specificity makes PPP schemes the suitable delivery model at various stages of the infrastructure lifecycle (construction, operation and management) (Sawant, 2010). High location specificity gives rise to the logic of irreversibility, where assets are financed on the strength of revenue streams generated by the assets with little or no expected residual value. Large capital-intensive assets are financed with non-recourse or limited recourse lending.[1] These features (high asset specificity, sunk costs and limited recourse lending) result in infrastructure financing infrastructure projects being inherently risky (Caprio et al., 2012).[2] In this regard, PPP schemes are structured with varying distribution of responsibilities and configurations of risk allocation between public and private entities.

A key PPP arrangement is the Build-Operate-Transfer model (BOT), defined as a 'kind of specialised concession in which a private firm or consortium finances and develops a new infrastructure project according to performance standards set by the government (Asao et al., 2013). Private participation in a BOT project is conditioned upon the mitigation of risks that may adversely impact the project's profitability (Chiara, Garvin, & Vecer, 2007). Build-Operate-Transfer schemes have been used to finance infrastructure investment not only in present times but also in the past. Railways, structured as emergent BOT schemes, were only second to sovereigns in attracting foreign investment. Stretched government budgets, limited expertise in large scale engineering projects and shallow domestic capital markets led to governments raising financing railways on global stock exchanges (Eichengreen, 1995). Railway contracts during 1880-1913, detail private sector parties being awarded a concession contract for the construction, operation and management of railways for a specified number of years after which the ownership of the enterprise is transferred back to the government.

Given the numerous risks at each stage of the project, and the fact that standard risk

[1]Limited or non-recourse lending is defined as a debt in which the creditor has limited claims on the loan if the borrower defaults. Limited recourse debt allows the lender to only collect on assets that are named in the original loan contractual arrangement (Srivastava, 2017)

[2]Sunk costs refer to irrevocable investment in a course of action, and are irrelevant by classical economic and normative decision theory because they cannot be changed by future action.

allocation techniques might not work, private sector participation was attracted through the use of incentives or subsidies to attract investment. These incentives took the form of government guarantees, minimum returns on investment or revenue, and restriction on competition etc.[3] Government guarantees, are defined as an arrangement in which a government entity undertakes payment of debt or performance of an obligation in the event of a default by a primary creditor, and are important in making infrastructure projects bankable. Government guarantees are used when debt providers are unwilling to lend to project companies due to concerns over credit risk and potential loan losses. Governments also use guarantees to boost investor confidence, signal its commitment and increase the amount of financing available (Albertazzi, Bijsterbosch, Grodzicki, Metzler, & Marques, 2020; Z. Lu et al., 2019).

The nineteenth century provides a historical case where government guarantees were integral to the process of infrastructure development (Eichengreen, 1995). Reading railway contracts during 1880-1913 reveals that there is a degree of imprecision with regard to the direct beneficiary of these guarantees where both railway companies and stock and bond holders appear as beneficiaries of the guarantee. Various guarantee types were used to attract investment. These comprise of interest-rate guarantees and dividend guarantees offered by companies to investors, and kilometric guarantees and guaranteed net profits offered by governments to companies. Interest guarantees were popularly used during 1880-1913, covering 45 percent of British railway investment in British possessions and more than a third of British investment in foreign railways (Stone, 1999). British Indian and Russian governments fall under this category offering interest-rate guarantees to investors of railway securities of their respective country. Overall, government guarantees were an integral component behind attracting foreign investment for railways during 1880-1913.

It can be argued that the government guarantee lent creditworthiness to railway projects as governments used it as a signal to exhibit their commitment to the project. This corroborates with contemporary literature on sovereign debt and country risk which argues that lenders assess creditworthiness by paying close attention to borrowers' potential in meeting

[3]An frequently used guarantee for toll road projects is a minimum revenue guarantee, where the government secures a minimum amount of revenue in order to improve the creditworthiness of a BOT arrangement (Huang & Chou, 2006).

their commitments (Daniels et al., 2020). Taking the period from 1880-1913, this chapter explores whether the government guarantee was a credible signal of government commitment to meet its obligations on infrastructure projects. This is important as governments during 1880-1913 could only raise a substantial volume of foreign financing for railway projects if the government lent creditworthiness to the project by credibly signalling its commitment. This signal was read by investors as ensuring the safety and lucrative nature of their investment. Through a careful study of railway concession contracts, bond prospectuses and foreign counsel reports from India, France, Belgium and Argentina, the chapter argues that contractual clauses were designed to limit government incentive to renege and hence ensured government's commitment to meet its obligations. The chapter contextualises the government guarantee in the broader institutional framework under which it operated and argues that the institutional design played a crucial role in ensuring the guarantee as a credible signal of government commitment. The chapter analyses the 'institutional design', through exploring legal arrangements and the role of underwriters in railway financing. These important historical references give an insight into how these institutions served as appropriate regulatory and oversight mechanisms ensuring that the government played its role as a credible partner to the BOT arrangement. In this way, the chapter also contributes to the credible commitment hypothesis by (North & Weingast, 1989) which argues that the institutional framework is important for governments to credibly commit to upholding property rights. The chapter uses the case of the Romero arrangement in January 1894 to argue that while a number of railway issues went into default, only guaranteed issues were part of the debt consolidation arrangement by the Argentinian government (Shepherd, 1933).

This chapter is structured as follows. Section 3.1 explores the need for government intervention in the form of a guarantee. Section 3.2 summarises the research question and methodology. Section 3.3 looks into the 'credible commitment' hypothesis and how the guarantee enhanced credible commitment. Section 3.4 explores the Romero Arrangement in Argentina in the aftermath of the Barings Crisis of 1890 and argues that only guaranteed railway companies were part of the debt consolidation efforts by the government. Section 3.5 concludes.

3.1 The Need for Government Intervention

The appropriate role of the government is a complex and controversial question and has elicited substantial debate (Wallis & Dollery, 1999). One approach to understanding this has been developed by welfare economists in the form of a theory of market failure. The market failure paradigm examines the operation of the economy and prescribes government intervention when markets 'fail' on the grounds of economic efficiency or equity. Public goods such as railways share the properties of non-rivalry and non-excludability.[4] These features of public goods result in private entrepreneurs unable to make ensure that only paying consumers will access their goods, resulting in either the good being not supplied or supplied in insufficient quantity (Martimort, De Donder, & De Villemeur, 2005). Hence, this provides a rationale for government intervention. Moreover, as discussed in the previous section, public goods in the form of infrastructure assets are capital-intensive and entail large sunk costs, therefore being a risky investment, and meriting a need for government intervention.

One popular form of government intervention during 1880-1913 was through the provision of guarantees. As mentioned above, it is important to note that the exact recipient of the guarantee remains unclear with both railway companies and railway bondholders appearing as beneficiaries during that period. This is evident in the case of Indian railways where the Report to the Secretary of State for India in Council on Railways in India (1859) stated that "railways are constructed in India under what is popularly termed as the 'guarantee' system, i.e through the instrumentality of companies who receive from the government the guarantee of a certain rate of interest upon the capital expended".[5] On the other hand, investors of railway securities received a guaranteed return on their investment. Overall, government support in the form of guarantees is offered due to three reasons. First, guarantees are offered to protect investors against business risks. Following the principle

[4]Non-rivalry implies that it does not cost anything for an additional individual to enjoy the benefits of the good. Non-excludability implies that it is difficult or impossible to exclude individuals from the enjoyment of the public good.

[5]Railway Department. 1860. Report to the Secretary of State for India in Council on Railways in India, to the End of the Year 1859. By Juland Danvers, Esq., Secretary, Railway Department, India Office. (HL 33). [Online]. London: The Stationery Office.

that "risk should rest with the entity best placed to manage it", government support in the form of guarantees can help manage exchange risk, insolvency risk and policy risk, all of which can have serious repercussions on the viability of a project (J. Z. Lu, Chao, & Sheppard, 2019). Insolvency risk, defined as an unpredictable variation in the value of the project arises when there is uncertainty on the firm's ability to pay its debts. Government intervention in the form of a guarantee can act as a contingent liability for the government and comes into effect when firms face default-like conditions. Besides insolvency risks, government guarantees are also offered to insure investors against exchange and policy risks and therefore attract lenders' interest in financing the project. Second, guarantees improve creditors' perceptions on borrowers' creditworthiness, thus improving market access and reducing borrowing costs. Literature on the financial performance of PPP projects shows that the provision of guarantees can help improve project creditworthiness (Wibowo et al., 2012). Third, government guarantees are crucial in the case of missing markets where it is always not possible to form a market price for all possible risks and products (Irwin, 2007).

Guarantees can be explicit (fully articulated) or implicit (derived from unstated understandings) and contractual (legally enforceable) or non-contractual (promises) (Heald & Hodges, 2018). Guarantees are tailored to the circumstances of the project. Project based guarantees are provided in the context of specific investment projects where governments wish to attract private financing. They are designed to provide risk mitigation with respect to key risks that can impede the viability of the project. In contemporary times, multilateral agencies such as the World Bank offer loan guarantees (covering default of debt-service payments) or payment guarantees (covering payment defaults of non-loan-related government obligations) to private entities where such payment obligations require credit enhancement. Payment obligations include agreed compensations to private entities or a foreign public entity for losses caused by non-performance of government or public sector entities as stipulated in the contract. The next section looks into the nature of government guarantees offered in the past.[6]

[6]Retrieved from https://www.worldbank.org/en/programs/guarantees-program

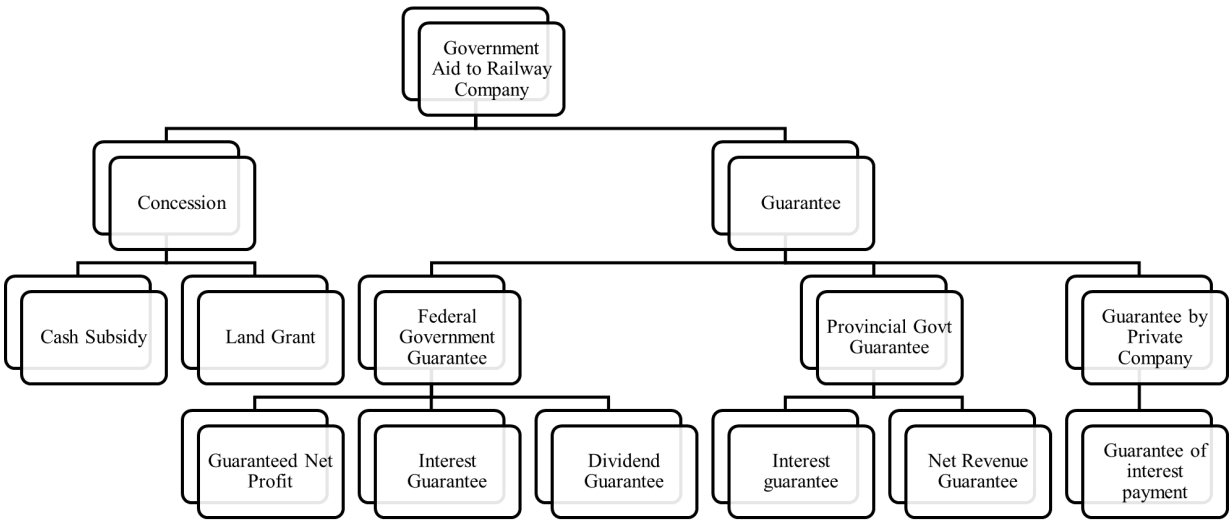
3.1.1 Government Guarantees for Railway Companies (1880-1913)

Since the early 19th century, globally, government guarantees have been used to finance bridges, canals and railways. The first railway guarantees were granted in the United States in 1833 where Maryland authorised the Baltimore and Susquehanna Railroad to borrow $350,000 and agreed to guarantee the payment of up to 5 percent interest for forty years (Irwin, 2007). This was the starting point of debt guarantees which continues today. The first European government to offer guarantees was Poland, where the Polish government offered guaranteed dividends for the construction of a railway from Warsaw to the Austro-Hungarian border in 1838 (Haywood, 1966). In South America, the Argentinian government offered 6-7 percent guaranteed return on capital invested in railways. These guarantees helped the country to attract investment from foreign capital markets and reflected a view that Argentina had to compete for such funds by offering incentives similar to those offered by other countries (Irwin, 2007). Figure 3.1 illustrates the various forms of government aid to companies which exhibits concessions and guarantees used to attract investment in railway securities during 1880-1913. It is important to note that these categories are not mutually exclusive, with some government guarantees offered under concession contracts to companies.

In contemporary terms, concessions are defined as any arrangement in which a firm obtains from the government the right to provide a particular service under conditions of significant market power (Kerf et al., 1998). In a concession model, investors do not own the underlying assets; they get the rights to operate the assets and recoup their investments from user fees. Concession contracts are usually for 15 to 30 years, after which the assets devolve back to the state. Concession models are used when there are legal or political problems for private ownership of assets (Sawant, 2010).

During 1880-1913, concessions could be provided by the federal or provincial government. Such was the case of the Buenos Ayres and Valparaiso Transandine Railway Company which was awarded a concession by the Argentine government with an interest-rate guarantee for 20 years at 7 percent per annum. This in in contrast to the Buenos Ayres Northern Company which was granted a concession by the provincial government of Buenos

Figure 3.1: Types of Government Guarantee



Notes:Author's own illustration derived from various Stock Exchange Yearbook issues.

Ayres.[7] As the above examples show these concessions were long dated, ranging between 25-90 years, included details on the length and nature of the government guarantee (if it was provided) and other incentives in the form of land grants, cash subsidies, exemptions from taxation and monopoly clauses (restricting potential competition).[8] Reading through foreign counsel reports on French railways reveals the long-term nature of the concession (exhibited in Table 3.1). Moreover, various editions of the Stock Exchange Yearbook reveal the types of government aid offered to railway companies. A case in point is the Rio Claro Sao Paolo Railway of Brazil where the main line of the railway was granted a concession for 50 years, during which time no other railway could be constructed in the same direction within 30 kilometres on each side of it.[9]

[7](Stock Exchange Yearbook 1888, p.65)

[8]For most Indian Railways the concession contracts were between 25-50 years. For some Argentinian Railways these concession contracts could be for 90 years. In the case of Brazil, the concession contract for The Rio Claro Sao Paolo Railway was for 50 years (Source: Stock Exchange Yearbook 1890, p.239).

[9]Stock Exchange Yearbook, 1890

Table 3.1: Date of Expiry of Concessions for French Railways

Name of Railway	Date of Expiry of Concession
Northern	31-Dec-50
Eastern	26-Nov-54
Orleans	31-Dec-56
P.L.M	31-Dec-58
Southern	31-Dec-60
Ceinture de Paris	11-Dec-52
Grande-Ceinture	31-Dec-58

Source: (1910). Continental Railway Investigations. Reports to the Board of Trade on Railways in Belgium, France and Italy.

In terms of guarantees, the various types of guarantees offered to railway companies during 1880-1913 are illustrated in Table 3.2. These could broadly be described as interest guarantees or minimum revenue guarantees. Interest guarantees, defined as the government guaranteeing the interest and sinking fund obligations was the dominant form of guarantees offered to railway companies by the government, covering 45 percent of British investment in British possessions and more than a third of British investment in foreign railways (Stone, 1999). It is important to note that in addition to guaranteeing the principal and sinking fund obligations in the event of any contingency, the government paid the companies a guaranteed return sum as a proportion of their share capital. Figure 3.2 shows the interest payments for Indian guaranteed railways. The figure illustrates that from 1880-1900, a regular sum was paid, after which it declined and became insignificant as railways started to generate higher returns (above 4 percent on average) in the late nineteenth century. Moreover, guarantee payments also declined as by 1900 more than 80 percent of the Indian railways came under the ownership of the government (Bogart & Chaudhary, 2012).

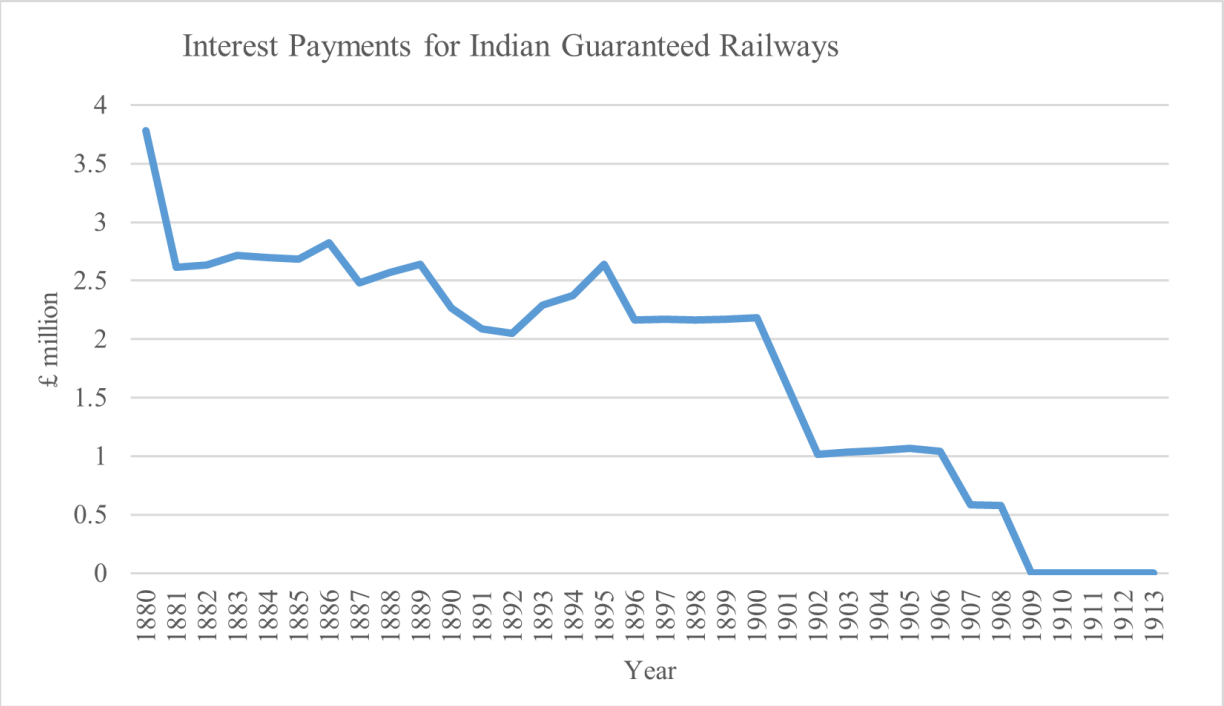
It is important to note that in the initial stages of operation, a regular sum under guarantee payments was crucial for railways globally. This was so as a guaranteed cash flow could cover the sunk costs that BOT projects face in the early phases of the project. Second, the guaranteed sum was crucial in attracting investment as it indicated government's commitment to make the project successful. Taking the case of Canadian railways, the Economist dated March 27, 1880 emphasised

Table 3.2: Types of Guarantee

Country	Date of Convention/Contract	Type of Guarantee
Austria	1889	Interest Guarantee. Payment for bond servicing and 5 percent dividend guarantee.
Argentina	29th July, 1858	Mostly interest guarantee between 5-7 percent per annum was provided for various Argentinian railways
Belgium	20th February, 1866	Interest guarantee. The Government guaranteed to the Concessionaire for a term of fifty years as a minimum interest, the sum of 275,000 Francs per annum
Brazil	Imperial Law of 1852	Interest guarantee. Guarantee of 5 percent on the capital expended with various privileges to facilitate the construction and subsequent working of the line.
France	17 July, 1883	Guarantee of revenue. The guaranteed revenue consists of the dividend fixed by the Convention for the share capital, contributions to sinking fund of the share capital, and the interest and contribution to the sinking fund on the debenture capital
Italy	July 24, 1877	Kilometric guarantee. By the Law of 24th July, 1877, the subsidy was increased to a figure varying from 8000 to 9000 lire per kilometer.
Portugal		Interest Guarantee. A guarantee of 6 percent on certain terms. Also, subsidy on land.
Russia		Interest Guarantee. The State was involved in guaranteeing interest of lines operated by companies.
Spain	1908	Interest Guarantee. State guarantees interest at the rate of 5 percent per annum on the construction of strategic and secondary lines.
Sweden	1897	Interest Guarantee. A majority of the State Loans issued at the London Stock Exchange was for the construction of railways. Payments to sinking fund guaranteed.
Canada	1867	Interest Guarantee. Interest guaranteed of 4 percent
India	Aug 21, 1860	Interest Guarantee. Different Railways had varying rates of guaranteed interest.
Australia	1855	Interest Guarantee. Owing to financial difficulties of provincial governments, government took over their liabilities.
New Zealand	Aug 1, 1870	Interest Guarantee. Payments into sinking fund.
Turkey	July 1866	Kilometric and Interest guarantee. On the construction and extension of lines, the guarantee was for gross receipts of about £1200 per mile. For Smyrna-Aidin railway, 6 percent interest rate was guaranteed on the whole capital.

Sources: (1859). Return of Contracts with any Company for Making Railways, Public Roads, Canals, Works for Irrigation, or other Public Works in India. (HC 259). [Online]. London: The Stationery Office. (XIX.635); (1867) Canada Railway Loan: Bill for authorising a Guarantee of Interest on a Loan to be raised by Canada towards the Construction of a Railway connecting Quebec and Halifax. (HC 73). [Online]. London: The Stationery Office ; (1910). Continental Railway Investigations. Reports to the Board of Trade on Railways in Belgium, France and Italy. (HC Cd.5106). [Online]. London: The Stationery Office.. (1863). Foreign Trade, &c: Abstract of Reports of the Trade, &c. of Various Countries and Places, for the Years 1859, 1860: received by the Board of Trade (through the Foreign Office) from Her Majesty's Consuls.–No.11. (HC 24). [Online]. London: The Stationery Office.: (1904). No. 617 Miscellaneous Series. Diplomatic and Consular Reports. Brazil. Report on the Railway Systems of Brazil.96(XCVI.81); (1877). Return of all Outstanding Loans raised by British Colonies or Dependencies and by Foreign Governments which the Commissioners of her Majesty's Treasury have been authorised to guarantee. (HC 274). [Online]. London: The Stationery Office. ; (1896). Turkey. No.4. (1896). Report by Major Law on Railways in Asiatic Turkey. (C. 8019). [Online]. London: The Stationery Office.

Figure 3.2: Railways Ownership and Management



Source: Statistical Abstract of India, various editions Note: The data for this graph has been taken from the 'detailed statement of heads of expenditure in India and England'. This statement shows interest payments for guaranteed companies. I have used the exchange rate of £=15 Rs for the entire period.

> "When railways are required for a vast and thinly peopled country like Canada- railways which shall act the part of pioneers to cultivation and national development- they must receive the support of the State during which the development of the traffic is small."[10]

Besides Canadian railways, guarantees were offered on a number of railways globally. A Foreign Counsel report published in 1910 for railways in Belgium, France and Italy show that an annual sum of Fr150,000 was guaranteed to the 'Entre Sambre et Meuse' Railway of Belgium.[11] Government commitment to the project through offering the guarantee was

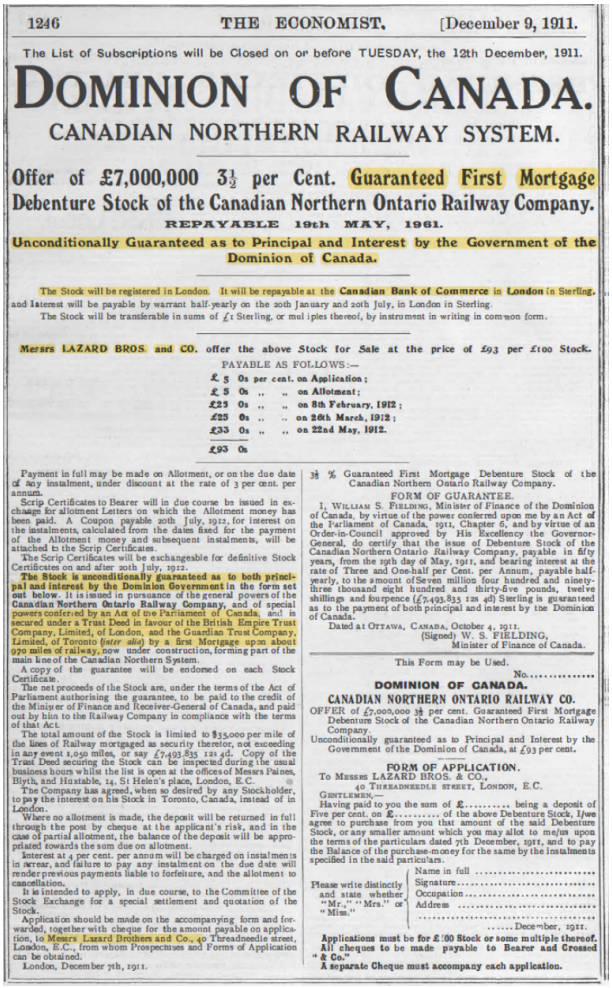
[10] A Short Inquiry Into The Profitable Nature Of Our Investments - Colonial And Foreign Railways. (1880, March 27). Economist, 353+.

[11] (1910). Continental Railway Investigations. Reports to the Board of Trade on Railways in Belgium,

also advertised in the popular financial press. Figure 3.3 exhibits a call for subscriptions for the Canadian Northern Ontario Railway Company published in 1911. Key elements of the advertisement are highlighted and discussed in the next section.

France and Italy. (HC Cd.5106). [Online]. London: The Stationery Office.

Figure 3.3: Call for Subscriptions for Canadian Northern Railways 1911



1246 THE ECONOMIST. [December 9, 1911.

The List of Subscriptions will be Closed on or before TUESDAY, the 12th December, 1911.

DOMINION OF CANADA.

CANADIAN NORTHERN RAILWAY SYSTEM.

Offer of £7,000,000 3½ per Cent. Guaranteed First Mortgage Debenture Stock of the Canadian Northern Ontario Railway Company.

REPAYABLE 19th MAY, 1961.

Unconditionally Guaranteed as to Principal and Interest by the Government of the Dominion of Canada.

The Stock will be registered in London. It will be repayable at the **Canadian Bank of Commerce** in **London** in Sterling, and Interest will be payable by warrant half-yearly on the 20th January and 20th July, in London in Sterling.

The Stock will be transferable in sums of £1 Sterling, or multiples thereof, by instrument in writing in common form.

Messrs LAZARD BROS. and CO. offer the above Stock for Sale at the price of £93 per £100 Stock.

PAYABLE AS FOLLOWS:—

£ 5	0s	per cent.	on Application;
£ 5	0s	,,	,, on Allotment;
£25	0s	,,	,, on 8th February, 1912;
£25	0s	,,	,, on 20th March, 1912;
£33	0s	,,	,, on 22nd May, 1912.
£93	0s		

Payment in full may be made on Allotment, or on the due date of any instalment, under discount at the rate of 3 per cent. per annum.

Scrip Certificates to Bearer will in due course be issued in exchange for allotment Letters on which the Allotment money has been paid. A Coupon payable 20th July, 1912, for interest on the instalments, calculated from the dates fixed for the payment of the Allotment money and subsequent instalments, will be attached to the Scrip Certificates.

The Scrip Certificates will be exchangeable for definitive Stock Certificates on and after 20th July, 1912.

The Stock is unconditionally guaranteed as to both principal and interest by the Dominion Government in the form set out below. It is issued in pursuance of the general powers of the **Canadian Northern Ontario Railway Company,** and of special powers conferred by an Act of the Parliament of Canada, and is secured under a Trust Deed in favour of the British Empire Trust Company, Limited, of London, and the Guardian Trust Company, Limited, of Toronto (*inter alia*) by a first Mortgage upon about 970 miles of railway, now under construction, forming part of the main line of the Canadian Northern System.

A copy of the guarantee will be endorsed on each Stock Certificate.

The net proceeds of the Stock are, under the terms of the Act of Parliament authorising the guarantee, to be paid to the credit of the Minister of Finance and Receiver-General of Canada, and paid out by him to the Railway Company in compliance with the terms of that Act.

The total amount of the Stock is limited to $35,000 per mile of the lines of Railway mortgaged as security thereior, not exceeding in any event 1,050 miles, or say £7,493,835 12s 4d. Copy of the Trust Deed securing the Stock can be inspected during the usual business hours whilst the list is open at the offices of Messrs Paines, Blyth, and Huxtable, 14, St Helen's place, London, E.C.

The Company has agreed, when so desired by any Stockholder, to pay the interest on his Stock in Toronto, Canada, instead of in London.

Where no allotment is made, the deposit will be returned in full through the post by cheque at the applicant's risk, and in the case of partial allotment, the balance of the deposit will be appropriated towards the sum due on allotment.

Interest at 4 per cent. per annum will be charged on instalments in arrear, and failure to pay any instalment on the due date will render previous payments liable to forfeiture, and the allotment to cancellation.

It is intended to apply, in due course, to the Committee of the Stock Exchange for a special settlement and quotation of the Stock.

Application should be made on the accompanying form and forwarded, together with cheque for the amount payable on application, to Messrs Lazard Brothers and Co., 40 Threadneedle street, London, E.C., from whom Prospectuses and Forms of Application can be obtained.

London, December 7th, 1911.

3½ % Guaranteed First Mortgage Debenture Stock of the Canadian Northern Ontario Railway Company.

FORM OF GUARANTEE.

I, WILLIAM S. FIELDING, Minister of Finance of the Dominion of Canada, by virtue of the power conferred upon me by an Act of the Parliament of Canada, 1911, Chapter 6, and by virtue of an Order-in-Council approved by His Excellency the Governor-General, do certify that the issue of Debenture Stock of the Canadian Northern Ontario Railway Company, payable in fifty years, from the 19th day of May, 1911, and bearing interest at the rate of Three and One-half per Cent. per Annum, payable half-yearly, to the amount of Seven million four hundred and ninety-three thousand eight hundred and thirty-five pounds, twelve shillings and fourpence (£7,493,835 12s 4d) Sterling is guaranteed as to the payment of both principal and interest by the Dominion of Canada.

Dated at OTTAWA, CANADA, October 4, 1911.

(Signed) W. S. FIELDING,
Minister of Finance of Canada.

This Form may be Used.

No.....

DOMINION OF CANADA.

CANADIAN NORTHERN ONTARIO RAILWAY CO.

OFFER of £7,000,000 3½ per cent. Guaranteed First Mortgage Debenture Stock of the Canadian Northern Ontario Railway Company.

Unconditionally guaranteed as to Principal and Interest by the Government of the Dominion of Canada, at £93 per cent.

FORM OF APPLICATION.

To MESSRS LAZARD BROS. & CO.,
40 THREADNEEDLE STREET, LONDON, E.C.

GENTLEMEN,—

Having paid to you the sum of £..... being a deposit of Five per cent. on £..... of the above Debenture Stock, I/we agree to purchase from you that amount of the said Debenture Stock, or any smaller amount which you may allot to me/us upon the terms of the particulars dated 7th December, 1911, and to pay the Balance of the purchase-money for the same by the instalments specified in the said particulars.

Please write distinctly and state whether "Mr.," "Mrs." or "Miss."

Name in full .....
Signature.....
Occupation.....
Address .....
.....
.....December, 1911.

Applications must be for £100 Stock or some multiple thereof. All cheques to be made payable to Bearer and Crossed "& Co."

A separate Cheque must accompany each application.

Source: (1911). Dominion of Canada, The Economist, 073 (3563), p.1246.

Anatomy of a railway advertisement of call for subscriptions

The above prospectus published in the Economist on Dec 9, 1911 gives an insight into the factors considered crucial for investment in railway securities. It is worth noting that the guaranteed status of the security was one of the first lines mentioned in the advertisement. The highlighted portions at the top of the advertisement are discussed in detail in the text that follows:

- "Guaranteed First Mortgage Debenture Stock"
- "Unconditionally Guaranteed as to Principal and Interest by the Government of Dominion of Canada"
- "Registered in London"
- "Repayable at the Canadian Bank of Commerce in Sterling"
- "Messrs Lazard Brothers and Co. offer the above Stock"
- "It is issued in pursuance of the general powers of the Canadian Northern Ontario Railway Company, and of special powers conferred by an Act of the Parliament of Canada"
- "It is secured under a Trust Deed in favour of the British Empire Trust Company of London and the Guardian Trust Company of Toronto by a first mortgage upon about 970 miles of railway".

The above advertisement of the Canadian Northern Ontario Company shows that several key pieces of information were important to be exhibited to potential investors. The highlighted text can be broadly categorised under three major themes; safety of investment, well-defined creditor rights and elements of market microstructure. Investment safety was demonstrated through protection from insolvency and exchange risk. Insolvency risk was covered by the government offering an 'unconditional guarantee of principal and interest by the Government of the Dominion of Canada' whereas exchange risk was covered as the debenture stock was repayable at the Canadian Bank of Commerce in sterling.

Investment security was also exhibited due to well-defined creditor rights as the investment was a 'first mortgage debenture stock'. A first charge on a security gives lenders priority in repayment in the event of a default. It is important to note that investment safety through the provision of the government guarantee and well-defined creditor rights did not work in isolation but under a carefully designed market microstructure. Two important elements of the market microstructure were the legal framework and intermediaries. Each is discussed in turn.

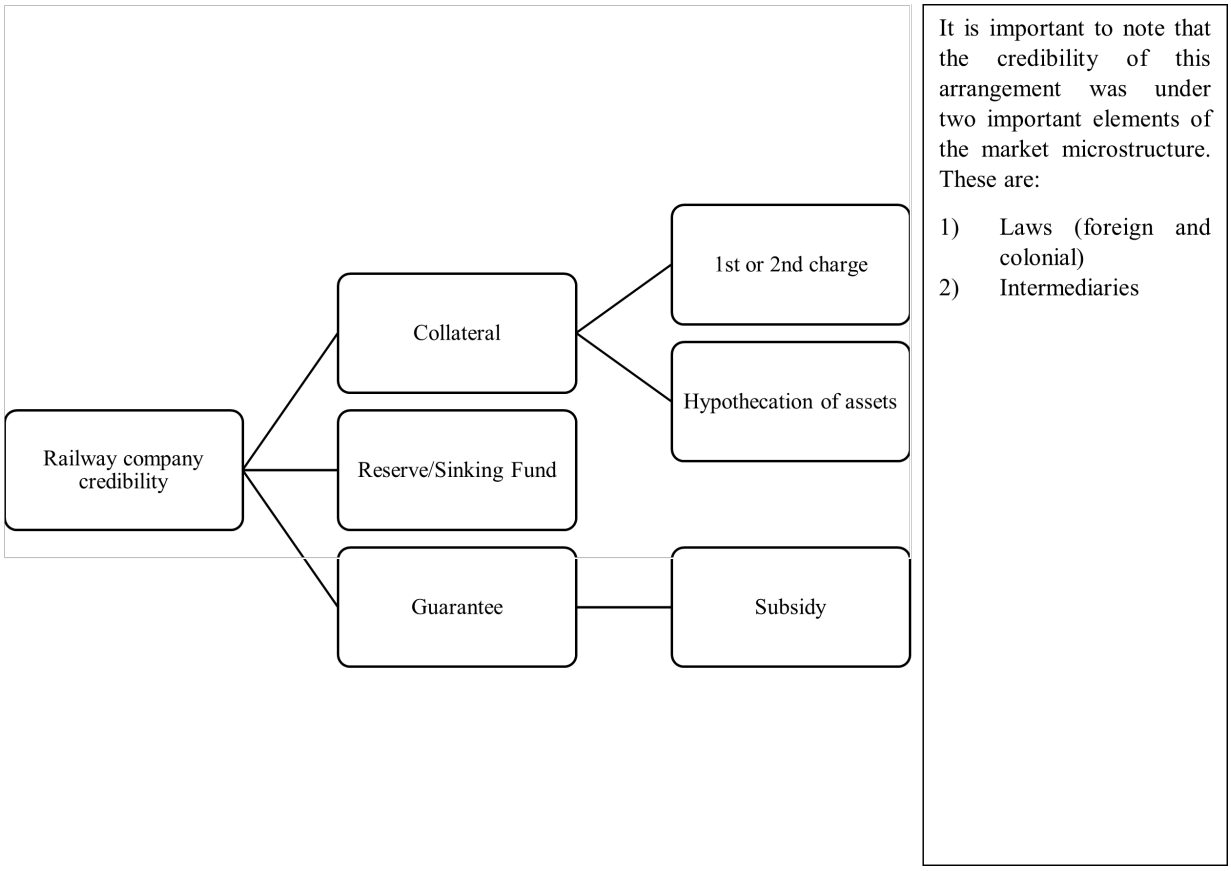
First, the legal framework played an important role in assuring investors of the safety of their investment. In terms of the legal framework, the security was registered in London with special powers conferred by an Act of the Parliament of Canada. Moreover, legal titles were well defined through the presence of Trust Deeds which ensured credible commitment on part of the government.[12] Second, an important element exhibited in the advertisement is the name of the intermediary involved in listing the security. Underwriter market power and prestige guided investors to associate their names with safer products and built investor confidence in financing railway projects globally (Flandreau & Flores, 2009). Interestingly, the advertisement template is not specific to the Canadian Northern Railway, but is generic to railway securities. Appendix Chapter 3 Figure 1 analyses another advertisement for the debenture stock of Buenos Ayres and Pacific Railway published in the Economist dated Jan 9, 1886. Themes identified above can be applicable to that as well, where the statement 'Argentine Government Seven Per Cent Guarantee (For 20 Years)' precedes the name of the railway company.

To summarise, in exploring advertisements of railway securities to accentuate the importance of the guarantee, a common theme that emerges is how the guarantee and other supporting elements, including the market microstructure lent creditworthiness to the project, and assured investors of government's credible commitment to the success of the enterprise. The next section illustrates the research question and the methodology adopted in addressing the question.

[12] A trust deed is a document used in transactions related to infrastructure. It comes into play when one party has taken a loan from another party to purchase a property. The trust deed represents an agreement between the borrower and a lender to have the property held in trust by a neutral and third independent party until the loan is paid off (Jessop, 1976)

3.2 Research Question and Methodology

Figure 3.4: Research Question and Methodology



Note: Author's illustration based on reading various issues of the Stock Exchange Yearbook and media sources such as the Economist Historical Archive.

Having built a background on the need for government guarantees and the nature of guarantees offered in the past, it is important at this point, to reiterate the research question. Given that governments were heavily reliant on foreign financing for railway projects during 1880-1913, did the government guarantee on railways serve as a credible signal for government commitment? Figure 3.4 illustrates the key elements assuring investors of

both the safety and lucrative nature of their investment. Credibility of the railway company rested on certain key elements such as 1) the presence of collateral (first or second charge/hypothecation of assets); 2) the presence of reserve/sinking funds; and the 3) the government guarantee. These commitment devices operated in a carefully designed market microstructure comprised of two crucial elements; an appropriate legislative environment and the presence of intermediaries.

In this regard, taking the perspective of railways, the chapter provides another example of North and Weingast (1989) 'credible commitment' hypothesis which argues that economic growth and the development of markets is not simply driven by the rules governing economic exchange but the institutions governing how those rules are enforced. The next section briefly outlines the 'credible commitment' hypothesis. This sets the background using a variety of different sources (such as railway debt contracts, Foreign Counsel reports, and Reports of the council of Foreign Bondholders) in later sections to argue that the guarantee was an important element signalling government commitment and thus attracting investment for railways.

3.3 Credible Commitment

A vast and rich literature has looked into sovereigns credibly committing to repaying their debts. Institutional change arising from the Glorious Revolution of 1688/89 created for the first time, a 'credible commitment' that the government would not default on its debt in the future (Coffman et al., 2013). This was a crucial watershed moment in the development of a capital market separating the experience of Western Europe from the rest of the world, where the arbitrary behaviour of government with respect to credible commitment over property rights was shackled (North, 1993). In their seminal paper, Kydland and Prescott (1977) demonstrated that initial optimal plans would turn out to be sub-optimal if planners changed policies in response to new behaviour by private agents. The resulting 'time inconsistency' of public policy would lead private decision-makers to respond by restricting investment in light of resulting uncertainty. Hence, credible commitment mechanisms have to be in place to keep political authorities from making time-inconsistent policy decisions.

In this sense, a commitment can be made imperative in the sense that performance is coerced or discretion is disabled (Shepsle, 2019).

Commitments can be made credible through both formal and informal institutions. Institutions are the humanly devised constraints that structure human interaction and reduce the uncertainty arising from that interaction (North, 1993). The creation of the Bank of England in 1694, the expansion of its rights in 1697 and its rechartering in 1708 have been cited as important contributors to the credibility of the English debt (North & Weingast, 1989). The literature offers two explanations regarding how the Bank of England protected the credibility of sovereign debt. The Bank obtained a *dejure* monopoly in its core business of banking in 1697, and increasingly a *defacto* monopoly on floating new sovereign debt, beginning 1694-1711. The Bank's status as monopoly lender increased the penalty it could impose on a defaulting government. Second, the Bank could block the statutes that would be needed to revise or repudiate debt. The Bank of England Directors also played a crucial role in engineering a system of credibility, pushing the Bank's Charter and its monopoly, and bargaining for debt consolidation and generally promoting the interests of public creditors (Cox, 2016).

More generally, formal institutions encompass well-functioning courts, enforcement of law, and protect firms from any potential expropriation of private property by the state. On the other hand, informal institutions are personalised relationships ("deals") between the agents of the state and the business sector that are repeated over time (Hallward-Driemeier & Pritchett, 2015). If these deals are "ordered" – that is, if deals negotiated between the state and business are reliably honoured – then informal institutions can provide the credible commitment necessary for investment to take place, even when formal institutions are missing or poorly functioning (Kar, Pritchett, Raihan, & Sen, 2013).

Signalling credible commitment is even more important in the case of infrastructure. This is so as infrastructure assets are long-lived, are associated with high sunk costs and once completed, the difference between the marginal and average costs is typically very large. This leads to a problem for investors, where politicians and regulators might be tempted ex post to drive prices to marginal costs, having promised ex ante to honour the sunk costs (Helm, 2010). Literature on infrastructure finance reveals three broad explana-

tions behind government incentives to renege; government reneging on their commitments due to economic uncertainty, the logic of obsolescing bargain and political competition and change (Ramamurti, 2003).

Limiting government incentives to renege on their promises lies in bargaining a long-term contract between the government and private investors. Investors will only invest if the government credibly commits to making sure they get their sunk costs back (Dasgupta & Sengupta, 1993). Applying this to the first era of globalisation, designing credible political and regulatory commitments for the recovery of sunk costs-or overcoming the inherent time inconsistency problem was key to attracting the substantial volume of foreign investment for railways during 1880-1913. In this regard, the government guarantee, acted as a credible commitment device. The government guarantee served as an example of investors given credible assurances that sensible binding obligations ("the rules of the game") will be honoured (Dailami & Klein, 1998).

The credibility of the government guarantee was ensured through contractual clauses designed to limit government incentives to renege. The chapter applies the framework used by Ramamurti (2003) to analyse railway concession contracts from India, Belgium, France and Argentina, during 1880-1913 and explores how contractual provisions were drafted to limit government incentives to renege on infrastructure deals. The selection of these countries is based on the availability of railway concession contracts during 1880-1913. The chapter explores how specific contractual provisions were outlined to deal with economic uncertainty, the logic of the obsolescing bargain and political competition for India, Belgium and France but were either missing or not clearly defined in the case of Argentina. Understanding railway contractual details gives insight into how government incentives to renege were shaped. These are discussed as follows and summarised in Table 3.3 and 3.4.

3.3.1 Government Incentives to Renege

Economic Uncertainty

Governments seeking private investment in infrastructure enter into long-term contracts

Table 3.3: Incentives for the Government to Renege due to Economic Uncertainty

Economic uncertainty (writing clever and comprehensive contracts)				
Tactics/Examples	India	Belgium	France	Argentina
Include contingency clauses for uncertainties and skew them in investor's favour	Followed. The Company was liable to protect the railway from injury, flooding or tempests.	Followed. In the case of any 'force majeure', the concessionaire shall give notice to the Department of Public Works and bear the risk without any cost to the State.	Followed. Provisions were kept for any untoward incidents such as any accident, loss, damage or fire.	Followed. For National Railways (railways owned by the state), the privileges would subside if there is interruption of a service. In case of force majeure, Executive Power can take control of railways and offer compensation to the companies.
High penalty costs for reneging	Followed. In the event of default, the interest of the said railway company in land, railway, telegraph and works would be terminated.	Followed. If the contract is not abided, the Concessionaire will be deprived of all his rights.	Followed. In case, the railway company does not repay the advances made by the State will be repaid to the company by an annual payment. Should this payment not be made the Company will have the right to exact interest at the rate at which the loan was issued.	Mixed evidence. National railway concessions will be lapsed if contracts are not drawn within the stipulated time. [Non conformity of the company in terms of inspectors would be manged by technical arbitrators]
Obtaining provincial and government guarantees	Followed. Interest or dividend guarantee was present.	Followed. Belgian railways were guaranteed by the government.	Followed. Guarantee of interest was provided by the government.	Followed. Provincial and imperial guarantees were provided for railways.
Provide for international arbitration	Followed. Colonial Validity Law Act made any law repugnant to the provisions of the Act of Parliament, null and void.		Followed. In the case of disagreement between the ministry of Public Works and the engineers of the State, it would be settled through arbitration (umpires and the Seine Court of Justice.)	Not followed. There is no mention of international arbitration in the railway law of 1900.

Source: (1910). Report to the Board of Trade on Railways in Belgium, France, and Italy by Messrs. Chute, C. H. Pearson, and N. S. Reyntiens (Railways: Belgium, France, and Italy) (Cd. 5106).[Online]. London: The Stationery Office.; (1871). Return of Contracts with any Company for Construction of Railways in India. (HC 51). London: The Stationery Office.; Christian, E.T. (1900), The Argentine Railway Law as Applied to National and Other Railways, Krieger: Buenos Aires.

with private parties, spelling out each side's obligations and rules for contract enforcement (Ramamurti, 2003). A principle function of a long-term contract is to facilitate trade between parties making relationship-specific investments. A relationship-specific investment is defined as an investment which once executed will have a lower value in alternative uses than in the use originally intended to support a specific trading relationship (Joskow, 2003). However, long-term contracts are by nature incomplete and prone to uncertainty, as it is nearly impossible to deal appropriately with potential contingencies during the course of the trading relationship (Hart, 1989). The greater the uncertainty, the greater the likelihood that unanticipated scenarios arise necessitating contract renegotiation. One reason behind uncertainty is due to changing economic conditions, for example changes in input or output prices, or changing demand (Ramamurti, 2003). Such uncertainties are managed through the use of contracts allocating risk appropriately. During 1880-1913, railway concession contracts for India, Belgium and France had special clauses anticipating contingencies and how to effectively deal with them. An important means of dealing with economic uncertainty during that time was the provision of guarantees. The guarantee exhibited government commitment in making the project successful, lent creditworthiness to the enterprise and hence played a crucial role in attracting foreign capital. This is also

evident from the Report of the Select Committee on East Indian Railways 1884 which elaborated on the importance of the guarantee in times of uncertainty, "When the prospect is not so well assured, the Bengal Central terms offer a greater inducement to the investor, by guaranteeing interest on capital".

The media also emphasised the importance of the guarantee in the success of the project and accentuated guarantor's creditworthiness as a crucial element behind attracting foreign investment. The Economist dated June 13, 1891 wrote that

> "To determine between a sound and an unsound company is oftentimes a difficulty, but as a rule, it may be assumed in those cases where debentures of a limited liability company are insured or guaranteed by a first-class guarantee office, that the company itself is in a sound position, for in no case would a guarantee office issue a policy of insurance without having first taken measures to satisfy itself that it was quite safe to do so.[13]

Besides government guarantees, another key element to deal with economic uncertainty and reduce government incentives to renege was to keep specific provisions for dispute arbitration. This is because implementing a judicial system impartially enforcing such rules is crucial for credible commitment (North, 1993). This was also evident in railway contracts which kept provisions for arbitration. Such is the case of French railways where the concession contracts had specific clauses mentioning the role of arbitrators, neutral umpire and the Seine Court of Justice to deal with disagreements between the government and the railway company. In contrast to France, in Argentina, contractual clauses to deal with disputes was absent in the Railway Law of 1907.

The Obsolescing Bargain

Besides economic uncertainty, another reason for governments' incentive to renege is due to the logic of 'obsolescing bargain'. Vernon (1971) provides an explanation on government incentives to renege through the 'obsolescing bargain' theory, and argues that deals appearing attractive to governments ex ante might become less attractive ex post.

[13]Investor. (1891, June 13). Guaranteed Mortgage Debentures. Economist, 766.

Table 3.4: Incentives for the government to renege due to Obsolescing Bargain

Tactics/Examples	India	Belgium	France	Argentina
Undertake investments in several stages than all at once	Followed. The company was formed with an original capital of £4 million, with the power of extension to £14 million and ultimately to £20 million. Moreover, the East India Company proposed to construct an experimental line first.	No such clause was present.	The State had the responsibility to set prices for the Western railway but it should not be less than that charged by other companies for the same kind of goods.	No such clause is mentioned.
Make project dependent on foreign raw materials or on export markets	The Coal for the railway was taken from various cities from India. A large part of the coal was also imported from Britain	If the concessionaire suspends the operation of the line, the Department of Public Works has the right to take over. If the concessionaire is not in a position to take over, he shall be deprived of all rights.		Followed. Railways under British ownership imported equipment to fabricate wagons and locomotives at workshops in Buenos Aires and Rosario.
Do not pursue strategies based on the principle that high ex ante risk justifies higher ex post returns				Companies were allowed to reduce rates for freight carriers. The reduction in charge should be done with the approval of the Railway Directory.

Source: (1910). Report to the Board of Trade on Railways in Belgium, France, and Italy by Messrs. Chute, C. H. Pearson, and N. S. Reyntiens (Railways: Belgium, France, and Italy). (Cd. 5106). [Online]. London: The Stationery Office.,; (1871). Return of Contracts with any Company for Construction of Railways in India. (HC 51). [Online]. London: The Stationery Office.; Christian, E.T. (1900), The Argentine Railway Law as Applied to National and Other Railways, Krieger: Buenos Aires.

Investors perceiving high industry, country, technical or commercial risks ex ante expect higher returns ex post (Wells & Gleason, 1995). Governments are willing to concede to investor expectations ex ante due to the volume of investments and foreign exchange associated with infrastructure projects, and the risk of investment pulling out if risks are not shared appropriately. However, government incentives to renege increase when once investors have sunk their capital, their bargaining power declines, and the private returns that seemed justifiable to the government ex ante appear excessive and unnecessary ex post (Ramamurti, 2003). Contractual provisions that maintain bargaining power in the hands of investors are an effective way to deal with obsolescing bargain. There are two ways in which this was followed during 1880-1913. One way of maintaining bargaining power in the hands of investors was to undertake investments in several stages rather than all at once. Such was the case of Indian railways where experimental lines were constructed

before extending the network to other regions. In contrast to India, this stipulation was missing in the case of Argentinian railways.

Another contractual provision to deal with 'obsolescing bargain' is through linking the project to upstream or downstream investments. This is undertaken so that government reneging on its commitments would have detrimental consequences on the project as it would be without key imported inputs or lose access to export markets or customers (Ramamurti, 2003). In the case of French railways, the Convention of 1883 modified by the 'arrangements' of 1886, and approved by Ministerial Decree, limited government incentives to expropriate by keeping in check government pricing strategy. Article 16 of the Convention of 1883 stated that 'price of transport be not **less** than that charged by the company for the same transport from the junction of Paris to vice versa'. In this way investors had the advantage in their bargaining relationship with the host government.

Political Change and Competition

A final reason for governments reneging is due to political reasons (Ramamurti, 2003). Government incentive to renege due to political change and competition was well managed in the case of colonies due to the overarching role of the imperial government. In the case of sovereign governments such as Belgium, government incentives to renege on infrastructure deals was managed as infrastructure contracts were won through competitive bidding. However, no such stipulation was present in the case of Argentina reflecting a degree of untransparency in railway contracts. The next section details how two important elements of the market microstructure, the legislative framework and intermediaries played a role in ensuring the credibility of the government guarantee on railway projects.

3.3.2 Elements of the Market Microstructure: Legislative Framework

It is important to note that besides contractual provisions, elements of the market microstructure in the form of appropriate legislation and intermediaries played a key role in ensuring the credibility of government commitment towards railway financing. The government's obligations to provide support can be defined in law, decrees, statutes licenses,

concessions, contracts or other legally binding documents (Dailami & Klein, 1998). In contemporary times, countries benefit by joining international commitment institutions such as bilateral investment treaties but the effects of those international institutions on Foreign Direct Investment flows are modified by the strength of domestic commitment institutions (Moon, 2014). The first era of globalisation gives us a good example where commitment was ensured both through international and domestic institutions.

Appropriate legislative structures were present to protect investor interests and ensure credible commitment on part of the government. Many of the colonial railway companies were passed through Acts of Parliament and had their headquarters in London.[14] The geographic location was important because the collection of revenues was outside the jurisdiction of the government (Vizcarra, 2009). This is also reiterated by the 1892 Report of the Council of the Corporation of Foreign Bondholders which discussing Argentinian loans wrote: "The remaining provincial loans (Tucuman) are not held in England and are not therefore of direct interest to English bondholders, except as showing the general economic condition of the Republic".[15]

Moreover, the jurisdiction was also important because the law of the imperial power superseded colonial law (Vizcarra, 2009). A case in point is that of the "Colonial Laws Validity" Bill passed in 1865 which ordained that any colonial law repugnant to the provisions of any Act of Parliament would remain void and inoperative. Despite colonial legislatures having full powers to legislate, the power and procedure of such legislation should strictly adhere to the manner required by the Acts of Parliament, Letters Patent, Order in Council or Colonial Law for the time in force for the said colony.[16] This was also applicable to railway financing. In the case of Canada, Treasury Commissioners could not give any guarantee under the 'Railway Guarantee Act' of 1867, until an Act of the Canadian Parliament had been passed satisfying the Treasury of the progress of railway

[14](1884). Report from the Select Committee on East India Railway Communication; together with the Proceedings of the Committee, Minutes of Evidence, and Appendix. (HL 225). [Online]. London: The Stationery Office.

[15](1892). Report of the Council of the Corporation of Foreign Bondholders, page 37

[16](1865). Colonial Laws Validity. A Bill Intituled An Act to remove Doubts as to the Validity of Colonial Laws. (HL 158). [Online]. London: The Stationery Office.

construction and the need for raising additional expenditure for construction.[17] Another case in point is Indian railways where the Secretary of State in Council of India was given powers to raise money in the United Kingdom, as and when necessary, for the discharge and redemption of debentures for the various railway companies under the authority of Parliament.[18]

Besides assuring investors of the safety of their investment through appropriate legal frameworks, investor security was also assured through the hypothecation of assets. In the case of India, the entire revenues of the country were mortgaged to the railway. A specific case is raising financing for the Great Indian Peninsular Railway where the East India Loan (Great Indian Peninsula Railway Debentures) Act of 1901 ordained that all bonds, debentures and bills issued under this Act and the principal and the interest shall be charged on and payable out of the revenues of India, in like manner as other liabilities incurred on account of government of India.[19] To summarise, the market microstructure in the form of appropriate legislation played a key role in ensuring the credibility of government commitment towards railways.

3.3.3 Elements of the Market Microstructure: The Role of Intermediaries

Another key element of the market microstructure is the role of intermediaries. Sovereign contracts are not subject to third party enforcement. Lenders have to orchestrate a credible threat to levy a sufficiently large penalty in case of a government default, to ensure government commitment on its obligations (Tunçer, 2015). Theoretically, a sovereign can commit to honour his financial obligations in two ways. First, is by building reputation.

[17] Canada. (1867). An act for authorizing a guarantee of interest on a loan to be raised by Canada towards the construction of a railway connecting Quebec and Halifax.(HL 73). [Online]. London: The Stationery Office.

[18] (1880). East India Loan (East Indian Railway Debentures). A Bill Intituled An Act to enable the Secretary of State in Council of India to raise money in the United Kingdom for the purpose of paying off or redeeming Debentures of the East Indian Railway Company, 3(36), III

[19] (1901). East India Loan (Great Indian Peninsula Railway Debentures). A Bill Intituled An Act to enable the Secretary of State in Council of India to raise Money in the United Kingdom for the Purpose of Paying off or redeeming Debentures of the Great Indian Peninsula Railway Company.

Reputation effects imply that a default is penalised either through a future credit boycott or higher interest rates on future loans reflecting a default risk premium. Alternatively, the government can commit by orchestrating an increased penalty for default over and above the threat of credit restrictions (Vizcarra, 2009). A common way governments tried to establish their credibility in the international capital market was to trust debt servicing to a firm with an excellent reputation within the British financial community.

Most governments contracted with a reputable merchant house to manage foreign debt servicing. Leading investment houses specialised in recommending only the highest quality foreign bonds. These comprised of railways backed by state government credit or bonds that had an established reputation. Luring overseas investors required intermediation from specialised institutions that had grown in the London market; issue houses, private banks, bill brokers and financial investment companies. To signal their commitment, they bought the same bonds for their own portfolios (Eichengreen, 1995). The employment of a respected British merchant house was important as an organisation which had invested heavily to build its reputation in London would not forsake its reputation for any temporary gains (Vizcarra, 2009).

Having detailed the market microstructure under which the guarantee operated, it is now useful to examine the specific case of the January 1894 'Romero arrangement' in Argentina, post Barings crisis of 1890. The chapter studies the event to argue that although a number of railway companies went into financial difficulties, government efforts were targeted only towards guaranteed railway companies as part of consolidation of Argentinian finances.

3.4 The Romero Arrangement

By the early twentieth century, Argentina had the most extensive and integrated railway systems in the world, a great part of which was British owned (Lewis, 2015). The election of Julio Roca as president, heralded an era of construction of railways and other public works and a resurgence of foreign trade and foreign flows from Europe (Mitchener & Weidenmier, 2008). During the decade from 1881 to 1890, Argentine national, provincial and

municipal government and the government guaranteed mortgage banks borrowed approximately $500 million in Europe, chiefly in England (Shepherd, 1933). Borrowing for public works particularly railways in the province of Buenos Aires, many of them with the help of government guarantees, stimulated short-run economic activity but posed long-term financing challenges (Ford, 1956). It could take several years before substantial revenue from these development projects could be realised, potentially impeding the country's ability to service its debts and creating a maturity mismatch problem. Moreover, Argentina also faced a currency mismatch problem as it issued bonds in sterling or gold on European capital markets whereas it operated a paper standard at home (Mitchener & Weidenmier, 2008).

Rising fiscal deficits led to Argentina selling 'Central Norte and Andino' railways to British capitalists and halting its borrowing to finance new railway projects. This measure was unable to restore fiscal discipline and the country began issuing additional debt through state banks (Mitchener & Weidenmier, 2008). The Argentinian economy worsened towards 1890 with 40 percent of the borrowing going towards debt servicing and 60 percent of the imports going towards the purchase of consumption goods. So long as foreign funds continued to flow, debt servicing and import consumption could be met. However, once the flow of borrowings ceased, debt service charges and import payments were to be met with export proceeds alone. Expenses on import consumption and debt servicing was much larger than exports and the balance of payments adjustment involved either a fall in imports, suspension of debt-service charges or a combination of the two (Ford, 1956). Argentina defaulted on nearly £48 million of debt in 1890, constituting 60 percent of the world's defaulted debt in the 1890s. Amidst the crisis, Baring Brothers responsible for underwriting most of Argentina's foreign debt issues, could not escape the country's problems. The Investment Bank was unable to sell the Buenos Aires Water Supply and Drainage debt and notified the Bank of England of its financial problems in 1890. The Argentine government and the House of Baring failed to reach an agreement resulting in Nathan Rothschild to form a committee of leading financiers to structure the country's debt obligations (Mitchener & Weidenmier, 2008).

The Argentinian government defaulted on 14 loans, and a plan known as the Rothschild-

Romero arrangement agreed in 1893, was deemed of key importance for the stability of Argentinian finances. The total amount of debt which was to be unified in the Rothschild-Romero arrangement was $394.8 million. This was divided into national debt comprising $222.5 million, provincial debt with interest arrears of $137.3 million and railway guarantees equal to $35 million.[20] The plan proposed to consolidate this amount into $350 million of 4 percent bonds with 1 percent amortisation. The Rothschild-Romero arrangement also reduced interest servicing to a sum of £1565,000 till July 1898, after which full payment of interest and sinking fund should be made up to 1901. The arrangement proved successful and Argentina resumed full interest payments on the national debt one year in advance of the date set by the agreement. Moreover, adjustments of the defaulted provincial and municipal loans and of the mortgage bank bonds, or cedulas, were arranged during the ten years from 1897 to 1906 (Shepherd, 1933).

A closer look at the debt included under the Romero arrangement reveals that the country had defaulted on 14 loans, of which two specifically related to railways.[21] One of them was the Northern Central Railway Extension issued multiple times through 1887-9. These were five percent government mortgage bonds, issued by Messrs Murietta and Co and secured on the railway extensions for the construction of which the loan was raised. The bonds were redeemable by 1 percent accumulative sinking fund. The other was the six percent Railway loan, to enable the government to undertake extensions of the Central, Northern and Andine railways and issued by Messrs Murietta and Co in London and Messrs L. and R Cahen d'Anvers and Co. in Paris at 91 percent. This loan also had a sinking fund. A greater part of this loan was converted into five percent debenture stock of the Cordoba Central Railway Company in 1889. The value of the remaining bonds was to be deposited in the Bank of England by Messrs Murietta and Co and temporarily invested in English or Argentine sterling securities. These funds were only to be withdrawn as and when required for redemption of capital.[22]

It is important to note that a large part of the Argentinian railway network was financed through government guarantees. In 1892, the Argentinian railway network comprised of

[20]The Proposed Argentine Debt Unification. (1895, November 16). Economist, 1495+
[21]The Report of the Council of Foreign Bond Holders, 1894
[22]Report of the Council of Foreign Bondholders, 1894

11260 km operated by guaranteed railway companies while 5175 km was run by non-guaranteed railways. Therefore, resolving the railway guarantees was of utmost importance to the government as its unsettled question was impinging on the national credit of the country. This is also reiterated in the Economist dated March 1895, "He (the Argentinian Finance Minister) is credited with the intention of settling the railway guarantee question by hook or crook, "to restore Argentine credit in Europe".[23]

Politically, settling the "guarantee question" was important. The government decreed on Mar 12, 1894 that in view of the representations made to them by the railway companies, since the non-payment of guarantees to the companies would result in them stopping railway traffic, they would provide assistance to the railway companies. In the early part of last year, the government decided to make quarterly allotments out of a total sum of £400,000 to each of the guaranteed railways, on account of arrears of guarantees up to 31 Dec 1893. By the advice of the Argentinian Finance Minster the government showed an inclination to commute the railway guarantees by issuing bonds of which the interest would amount to £400,000 per annum for the completed sections, the incomplete sections to be left for a future arrangement. Table 3.5 illustrates that only guaranteed railway companies were part of debt consolidation efforts under the arrangement. The table also exhibits the allotment made during 1894 to each railway, and the amount still due for arrears.

A Bill for the final solution of the railway guarantee question was presented to the Congress in 1895. In the Argentinian president's address to the Congress he explained government's inability to service the railway guarantees:

> "The gross earnings reached 66 million dol. paper and the expenses 39 million dol. Paper, leaving a profit of somewhat 2 percent on the invested capital, which cannot be considered satisfactory for the railway companies, even taking into consideration the depreciation of the paper currency, in which the tariffs are paid and the economical crisis through which the nation is passing. It is in these cases that, in the last three years has prevented the government from carrying on regularly the services of the guarantees, though desirous of doing

[23]Argentina. (1895, March 16). Economist, 352+.

Table 3.5: Settling the Railway Guarantees

Railway	Length of Guarantee in years	Paid on Account 1894	Up to 31 Dec 1893	Due for 1894	Total Arrears
Argentine Great Western	20	49496	253659	71146	325405
Argentine North Eastern	20	19060	94193	117728	211921
Bahia Blanca and North Western	20	16587	104418	40781	145199
Buenos Ayres and Pacific	20	56627	172976	191825	364801
Buenos Ayres and Valparaiso	20	16693	94513	51670	146183
Cordoba Central	15	59639	355491	208333	563824
East Argentine	40	20444	150203	67875	218078
Villa Maria and Rufino	11	18407	120918	48609	169527
Total		256953	1346371	798567	2144938

Source: (1895). Twenty-Second Annual General Report of the Council of the Corporation of Foreign Bondholders for the year 1894, p.28, London: Council House. Note: All these railways were guaranteed by the Imperial or Federal government. All values are in £.

so."[24]

Argentinian consular reports from 1890-1900 accentuate the importance of regularly servicing railway guarantees. This was for two reasons. First, railway guarantees formed a share of nearly 50 percent of the extraordinary expenditure, making its redemption crucial. Second and more importantly, servicing the guarantee was linked to upholding Argentinian credit in the global financial markets. This was expressed in a consular report on Argentinian affairs dated 1900, where it was realised that expenditure related to settling the railway guarantees was burdensome, but exception had to be made for special laws authorising credit operations for the redemption of the guarantees as such "expenditure was beneficial to the country or necessary for the protection of its interests".[25] In contrast to assistance provided to government guaranteed railways, it is important to note that non-guaranteed railways did not meet with the same preference by the government. The next section takes the case of non-guaranteed railways in Argentina and New Zealand

[24](1895). Foreign Office. 1895. Annual Series. No. 1495. Diplomatic and Consular Reports on Trade and Finance. Argentine Republic. Report for the year 1894 on the general and financial condition of the Argentine Republic. Reference to previous report, Annual Series No. 1147. (C.7581-35). [Online]. London: The Stationery Office.

[25](1900). No. 2497 Annual Series. Diplomatic and consular reports. Africa. Report for the year ending March 31, 1900, on the trade and general condition of the British Central Africa Protectorate. Reference to previous report, Annual Series No. 2327. (Cd. 1-134). [Online]. London: The Stationery Office.

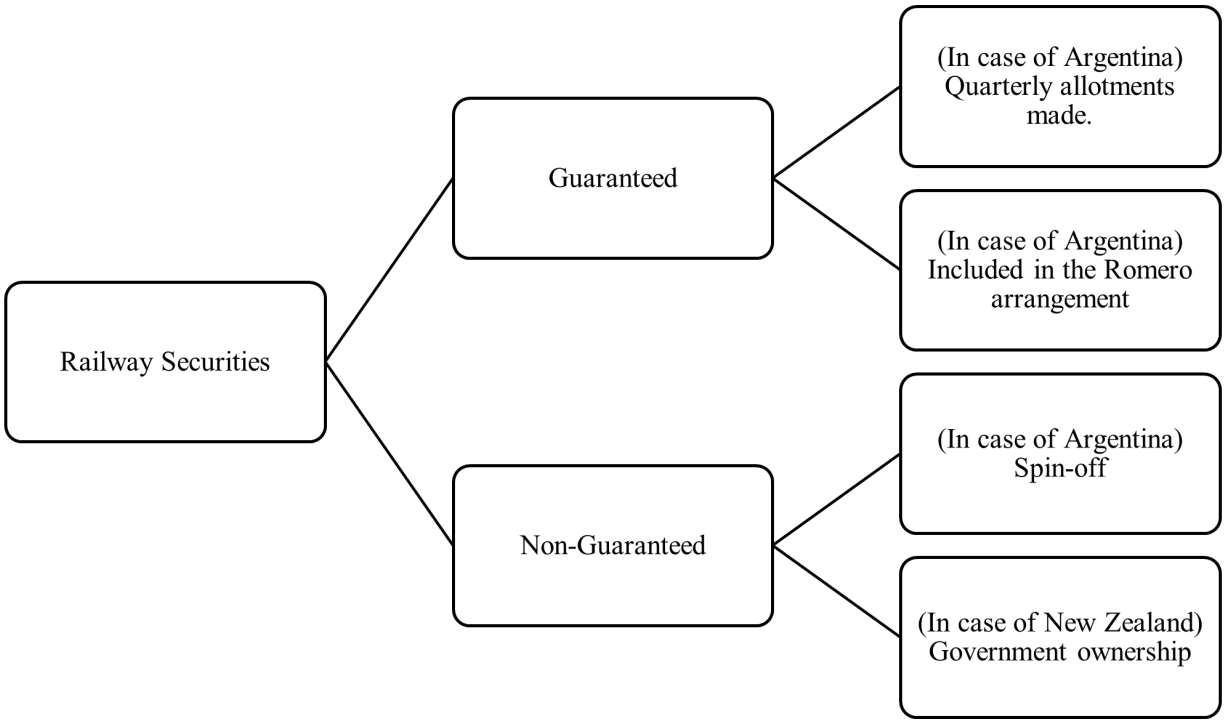
where different resolution mechanisms were adopted when railways either faced default-like conditions or defaulted.

3.4.1 Non-guaranteed Railways

In Argentina, six big non-guaranteed railway companies were Buenos Ayres Great Southern, Buenos Ayres and Rosario, Central Argentine, Buenos Ayres Western, North-West Argentine and Buenos Ayres and Ensenada Railway. Various editions of the Stock Exchange Yearbook give insight into the mechanisms employed to deal with non-guaranteed railways when they entered default or default-like conditions. This is illustrated in Figure 3.5 which illustrates the resolution mechanisms when non-guaranteed Argentinian railways and the New Zealand midland railway, entered default or default-like situation. Resolution mechanisms involved corporate spin-offs (in the case of Argentinian railways) or acquisition by the government (in the case of New Zealand Midland railway). A corporate spin-off is defined as the creation of a new stand-alone business by selling or distributing the shares from the existing business. It does not involve any cash transactions and is a distribution of the shares of a firm's subsidiary to the shareholders of a firm (Krishnaswami & Subramaniam, 1999). Amongst other reasons, spin-offs can be conducted if a company runs into financial troubles and looks to raise capital by selling its attractive assets.

The Buenos Ayres Western, a non-guaranteed railway presents a case of a corporate spin-off when it encountered financial difficulties. The Buenos Ayres Western was registered on May 17, 1890 at the London Stock Exchange. It was instituted to acquire a system of railways constructed and owned by the province of Buenos Ayres (Stock Exchange Yearbook, 1891). In 1890-1, with the onset of the economic crisis in Argentina and subsequent recessionary environment, the railway entered financial difficulties, and was unable to meet the interest payments and distribute dividends. The Stock Exchange Yearbook for 1891 describing the failure of interest and dividend payment stated that "the directors were unable to complete the 4 percent issue on satisfactory terms". Consequently, net earnings were used for meeting urgent capital requirements. No dividends were distributed for the year but it was decided that dividend certificates can be converted into an equal amount of the company's 4 percent debenture stock (Stock Exchange Yearbook, 1891). In later

Figure 3.5: Resolution Mechanisms for Railway Securities in case of Argentina and New Zealand in 1895



Note: Author's illustration based on reading various issues of the Stock Exchange Yearbook and media sources such as the Economist Historical Archive.

years, the Buenos Ayres Western underwent a corporate spin-off and its network was sold to various railway companies such as the Central Argentine Railway, the Buenos Ayres Great Southern railway, the Buenos Ayres and Ensenada Port Railway Company.

The Central Argentine Railway, a non-guaranteed railway (which bought parts of the Buenos Ayres Western railway), its interest charges were made up of three items; interest on debenture stock, lease of the Buenos Ayres Northern line, and the annuity payable for the lines acquired from the Buenos Ayres Western. It was mandatory to meet all these interest charges or default on any one could potentially result in receivership for that section, and the system could not be worked as one line (Stock Exchange Yearbook, 1895). When the Central Argentine Railway entered financial difficulties in 1891, it was unable to distribute

dividends and could only pay rentals and debenture charges. It received no government assistance and drew down its reserves to meet capital charges (Stock Exchange Yearbook, 1891). Another case is that of and the Buenos Ayres and Ensenada Port Railway Company which in the face of also faced financial difficulties and could not distribute dividends in 1892, resulting in dividends in arrears of 8 percent in 1895 (Stock Exchange Yearbook, 1895).

Finally, besides spin-offs, when non-guaranteed railways were embroiled in financial troubles, they were dealt through acquisitions by the government. The New Zealand Midland railway provides a case in point. The New Zealand Midland railway was registered in 1886 for the purpose of constructing a railway under contract with the New Zealand government. Under the contract the company was entitled to a land grant of 2 million acres. Debenture interest was regularly met until 1894 but the company defaulted in April 1895. The government seized the line and the matter was referred to arbitration. It was subsequently decided that coupons from April 1895 to April 1897 should be funded into debentures of the same class (Stock Exchange Yearbook, 1900). To summarise, in contrast to guaranteed railways where governments stepped in to provide investors compensation in the event of a default, corporate resolution mechanisms such as spinoffs and acquisitions were undertaken for non-guaranteed railways.

3.5 Conclusion

During the first era of globalisation, railways were structured as emergent BOT (Build-Operate-Transfer) schemes, designed around the participation of both public and private entities and used project finance for raising investment. While government participation was crucial to attract foreign investment, however, its overarching role (as financier, customer, supplier, competitor and regulator) exposed private investors to the risk of it reneging on its commitments. In that sense, government's role in the infrastructure domain cannot only be characterised as deal maker but also holds the risk of being a deal breaker.

This chapter explores the role that government guarantees played in attracting foreign investment in railways. In doing so, it explored whether government guarantees on railway

projects during 1880-1913 served as a signal of government credibly committing to meet its obligations.

Undertaking a qualitative analysis and investigating railway contracts, foreign counsel reports and bond prospectuses, the chapter argues that the guarantee played an important role in ensuring credible commitment by the government. The chapter argues that the provision of government guarantees was important in boosting investor confidence and the government signalling its commitment. More importantly, the market microstructure under which the guarantee operated was crucial in forming investor perceptions of the guarantee as a credible signal of government's commitment.

The credibility of the government guarantee was also exhibited when guaranteed railway companies entered into financial difficulties. The chapter takes the case of the 'Romero arrangement' in the aftermath of the Barings crisis of 1890 and argues that although a number of railway companies went into default, only guaranteed railway companies were part of government efforts towards consolidation of Argentinian finances. The chapter explores a variety of different historical sources to argue that in the aftermath of a financial crisis, the government guarantee acted as a commitment device in settling investor claims on railway securities. The next chapter studies yield spreads of railway securities of 15 capital-rich and capital-poor countries listed on the London Stock Exchange from 1880 to 1913 (first era of globalisation). Chapter 4 uses a variety of different sources to build a database on macroeconomic, firm-specific and industry-specific variables to explore the determinants of yield spreads on railway securities. Given the close and obvious connection between sovereign and railway securities, the chapter uses quantitative techniques to investigate the mechanism through which creditworthiness of sovereign securities has a spillover impact on railway securities, specifically focusing on the government guarantee for railways. In that sense, Chapter 4 augments the analysis of this chapter which argues that the government guarantee was a credible signal of government commitment to attract financing for railway projects on global stock exchanges.

Chapter 4

Understanding Determinants and Common Factors of Railway and Sovereign Securities

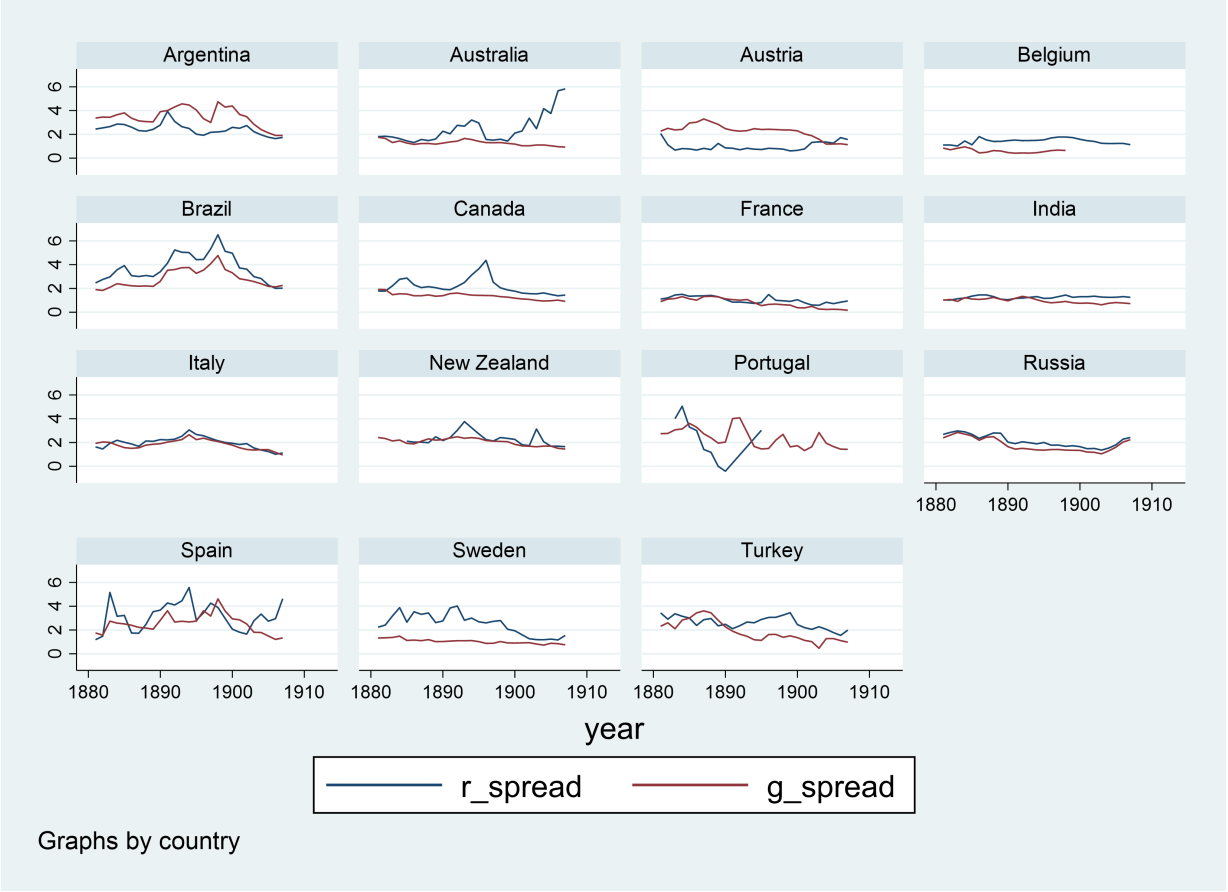
This chapter aims to investigate the determinants of railway spreads, defined as the difference between the total return on the railway security and the comparable government security (taken in this chapter as the UK consol) during the first era of globalisation (1880-1913).[1] Yield spreads on railway securities, are a benchmark measure of its credit risk and indicates the cost of financing for firms. Yield spreads can be defined as the excess interest rate that would be obtained if the firm does not default and the investors hold the bond to maturity and reflect investors' perception of the risk of investment in the security.

Yield spreads are not a modern concept but was also in vogue with investors during

[1]Government securities are debt instruments of a sovereign government. For the historical case, they comprise of consols, annuities, local loans, guaranteed stocks, exchequer bonds and Treasury bills. Capital flows for financing railways were usually directed towards an instrument called 'debentures' which is a security yielding a fixed rate of interest. 'Debenture Debt' means and includes money raised by a railway company on mortgage, bond, debenture stock, mortgage preference stock. These represented the loan capital of the railway company under the authority of the act of parliament. For the case of this chapter, 'bond' means the debenture debt used to raise funds for financing railways. Source: House of Commons Papers (1913), 41(146), XLI.143; (1867)., Railway Debenture Holders, A bill for affording better security to the holders of railway debentures, (Bills and Acts 20), [Online]. London: The Stationery Office.

1880-1913, where investors analysed the premium securities of various asset classes offered relative to the comparable government security. Such was the case of British railway securities. The Economist dated July 14, 1894 while discussing British railway securities wrote: "demand for the prior stocks of prosperous home railways, and in this way a return of 3.25% or in some cases even more was obtainable in lieu of only 2.75% yielded by consols. The additional yield was a very important inducement to trustees and others to divert their investment funds into these stocks, for an extra risk incurred by doing so was a consideration hardly taken into account."

Figure 4.1: Yield Spreads on Railway and Government Securities



Notes: Authors Calculations. Using all the railway securities listed on the London Stock Exchange for a particular country, an average annual return is calculated. This is then subtracted from a comparable government security (the UK consol) for calculating the yield spread.

In the well-integrated financial world during 1880-1913, the very nature of the railway security, described in detail in Chapter 2 and 3, is arguably quasi-sovereign in character making it imperative to study sovereign and railway spreads together. Visualising the world of securities listed on the London Stock Exchange during 1880-1913 on a spectrum, where sovereign securities lay at one end and corporate securities lay at the other end of the spectrum, railways lie in the middle of this spectrum, having both sovereign and corporate characteristics. Working with these definitions, the close and obvious relationship between

railways and government is also exhibited in yield spreads on railway and government securities (as illustrated in Figure 4.1. Figure 4.1 provides a key motivation for this chapter which attempts to explore three questions. First, what factors determine yield spreads on railway securities? Second, how do those factors relate to the determinants of yield spreads on sovereign securities? This question is motivated by a rich body of literature on sovereign spreads which argues that investor decisions on bank loans, foreign direct investment and portfolio investment depends crucially on how they perceive the risks associated with the home country of the borrower or project (Durbin & Ng, 2005). Third, given the obvious relationship between government and railway securities, what is the mechanism through which creditworthiness of sovereign securities has a spillover effect on the creditworthiness of railway securities?

The chapter uses a number of data sources to compile a database comprising of macroeconomic and railway specific factors on 15 capital-rich and capital-poor countries. The chapter gives evidence of three key results. First, results indicate that the key factors explaining yield spreads on railway securities include yield spreads on sovereign securities (over the benchmark UK government security), country fiscal factors, and railway security-specific factors capturing liquidity. For the overall sample, Both interest servicing on debt (debt burden) and yield spreads on government securities have a strong positive impact on yield spreads on railway securities. These results are robust to various model specifications, estimation techniques and definitions of key variables. Second, results indicate that interest servicing as a proportion of revenue, an indicator of debt burden, is the key common factor which explains both yield spreads on government and railway securities. Identification of common factors is important in indicating how shocks are propagated in the underlying variables (Bai & Ng, 2006). This has important implications for understanding portfolio diversification during the first era of globalisation. Third, the government guarantee appears as the mechanism through which creditworthiness of sovereign securities has a spillover effect on the creditworthiness of railway securities. Results suggest that in contrast to non-guaranteed railway securities, railway securities carrying a government guarantee have lower spreads, indicating that guaranteed railway securities were perceived as 'low-risk' in the eyes of the investor. Taking into account country, year, firm and instrument type effects guaranteed securities exhibit a risk reduction of 2.2 basis points relative to non-guaranteed

securities.

The chapter makes two important contributions. First, while previous research has focused extensively on the determinants of sovereign securities alone during the first era of globalisation, there has been little research on *quasi-sovereign* railway securities. This study aims to fill this gap. By analysing the determinants of railway securities, the chapter broadens the debate on understanding what factors influenced country creditworthiness during the first era of globalisation. Currently, the roots of creditworthiness has exclusively focused on the factors influencing yield spreads on sovereign securities alone. Second, exploring the mechanism linking railway and government securities is important as in the financially integrated world of the first era of globalisation, with both sterling denominated sovereign and railway securities, one can expect credit and non-credit related shocks to affect all types of bonds alike (Martell, 2008).

This chapter is divided as follows. Section 4.1 explores contemporary literature on the determinants of yield spreads on sovereign and corporate securities. Section 4.2 delves into the historical narratives discussing the determinants of yield spreads on railway securities. This is important in understanding what factors influenced investor perceptions of investment in railway securities historically. Section 4.3 outlines the variable construction and data sources. Section 4.4 illustrates the model. Section 4.5 discusses the empirical results. Section 4.6 introduces firm and instrument specific controls to the existing model. Section 4.7 illustrates techniques applied to check the robustness of the results. Section 4.8 details how the chapter deals with issues of endogeneity. Section 4.9 concludes.

4.1 Literature Review

Determinants of sovereign and corporate securities has elicited a wide body of literature. The literature review includes both contemporary and historic sources and identifies some broad themes for determinants of sovereign and corporate spreads. Each of these key themes is discussed in the next section.

4.1.1 Key Themes Identified in Sovereign Bond Spreads

There is a vast body of literature on the determinants of sovereign yield spreads which can be divided into six broad themes. These are long run and short run determinants, macroeconomic related factors, role of financial variables, effect of business cycle conditions, political and fiscal risk factors and the role of behavioural factors on sovereign yield spreads. A broad overview is given based on which variables are chosen for the regression analysis conducted later in the chapter.

Economic policies play a crucial role in determining sovereign spreads. Investors closely monitor policy developments, and reward policymakers through lower borrowing costs and a greater supply of funds (Flandreau & Zumer, 2004; Sachs & Williamson, 1985). Investors also pay close attention to country debt management policies. High debt to GDP ratios and concomitant debt service obligations, reduce government borrowing capacity, debt rollover and hence increase the risk of default (Belhocine & Dell'Erba, 2013; Ho, 2016; Lemmen & Goodhart, 1999; Min, 1998; Poghosyan, 2014)). Besides debt, other key macroeconomic fundamentals influencing sovereign spreads are trade-related variables. Improved terms of trade are associated with lower yield spreads (Maltritz, 2012; Martinez, Terceno, & Teruel, 2013; Min, 1998). Besides trade and debt, other key explanatory macroeconomic factors are the ratio of non-gold foreign exchange reserves to imports, the ratio of current account to GDP, growth and inflation and quality of economic policies and institutions (Gelos, Sahay, & Sandleris, 2011; Haque, Kumar, Mark, & Mathieson, 1996).

Variables capturing domestic and global monetary conditions have also been identified both in contemporary and historical literature as a key determinant of yield spreads on sovereign securities. Bordo and Rockoff (1996) argue that that during the period from 1870-1914, adherence to the gold standard served as a 'good housekeeping seal of approval' with countries on the gold standard charged lower than those that had a mixed record of adherence. Obstfeld and Taylor (2003) studying the London bond market from 1870s-1930s argue that before 1914, gold standard adherence signalled credibility and shaved up to 30 basis points from country borrowing spreads. However, this changed over time and in the 1920s, resuming pre-war gold parities was insufficient to secure declines in spreads. Contemporary studies on determinants of sovereign spreads also give credence to the role

of monetary policy. For the contemporary case, Arora and Cerisola (2001) quantify the impact of changes in US monetary policy on sovereign spreads in emerging markets. The authors find that while country-specific fundamentals are important in explaining fluctuations in country risk, the stance and predictability of US monetary policy are important in stabilising capital flows and capital market conditions in emerging markets.

Economic policies are also influenced by country's inherent political systems and institutional environment. Economic history literature has produced wide-ranging debates on the importance of political status in determining sovereign spreads. Countries at different positions on the political risk spectrum (sovereign, quasi-sovereign states and colonies) face differing borrowing costs (Clarke, 1878). Obstfeld and Taylor (2003) studying sovereign spreads between 1870-1930 argue that public debt and British Empire membership were important determinants of spreads after World War 1 but not before. Ferguson and Schularick (2006) exploring determinants of country risk during 1880-1913 challenge this view and argue that colonial status mattered for investors before 1914. The authors show that British colonies were able to borrow in London at significantly lower rates of interest than non-colonies because of their political status. The authors further emphasise that political status mattered more than either gold standard adherence or sustainability of fiscal policies. Accominotti et al. (2011) challenging Ferguson and Schularick (2006) show that measuring 'colonial effect' without an analysis of the financial consequences of political subjection can be misleading. Colonial status resulted in removing default risk. The authors argue that a proper understanding of the empire effect is only possible through exploring how colonial status removed default risk and the impact it had for colonial borrowing costs.

Contemporary studies have also explored the role of political systems in explaining sovereign spreads. Baldacci, Gupta, and Mati (2011) using a sample of emerging market sovereign bond spreads, argue that lower levels of political risk are associated with tighter spreads. Moreover, efforts at fiscal consolidation result in narrowing credit spreads especially in countries that experienced previous default. Eichler (2014) investigates the role of political variables in affecting sovereign spreads and finds that political systems play an important role in affecting yield spreads. Countries with parliamentary systems and low quality governance face higher sovereign yield spreads, while the degree of democracy and

elections play no significant role. Similar to Eichler (2014), Tunçer and Weller (2022) test the role of democracy on sovereign spreads. The authors test the democratic advantage hypothesis that democratic governments have historically borrowed more cheaply than autocratic governments during 1870-1913 and argue that democracies during 1880-1913 were associated with higher country risk. Lastly, an associated body of literature looks at the effect of institutional environment on sovereign bond spreads. Eichengreen and Mody (2001) investigate the impact of collective action clauses on sovereign spreads and find that in the presence of collective action clauses, the probability of bank-run liquidity crises decreases, resulting in reducing spreads.

A large body of literature discusses the behaviour of sovereign spreads at various points in the business cycle. Fama and French (1989) note that credit spreads widen when economic conditions are weak. Comelli (2012)'s findings corroborate with Fama and French (1989) as he finds that during crisis times, good macroeconomic indicators are helpful in containing spreads but less so in non-crisis times. These findings suggest that credit spreads may contain a priced risk factor from business cycle. Litzenberger (1992) argues that investors expect the risk premium related to the business cycle to increase simultaneously with business and economic conditions, making credit spreads sensitive to changes in business and economic conditions, and hence affecting the probability of default. Guo (2013) notes that bond yield spreads respond differently in response to the business cycle, with a tendency to narrow during expansion and widen during economic contractions.

Business cycle conditions are affected not only by domestic economic fundamentals but also global financial conditions. A sizable body of literature looks at the impact global financing conditions have on sovereign spreads. Mauro, Sussman, and Yafeh (2002) comparing contemporary data to the historical case during 1870-1913 argue that sharp changes in spreads tended to be mostly due to global events whereas they were primarily related to country-specific events during 1870-1913. Longstaff, Pan, Pedersen, and Singleton (2011) and Maltritz (2012) also emphasise on the importance of global financing conditions such as US interest rates in influencing sovereign yield spreads. Global or European Monetary Union wide factors are also argued to transmit external shocks to country risk and are the main drivers of changes in sovereign CDS spreads. In an increasingly interconnected world,

contagion from global financial market significantly affects the price of sovereign credit risk (Blommestein, Eijffinger, & Qian, 2016; González-Rozada & Yeyati, 2008; Kamin & Von Kleist, 1999; McGuire & Schrijvers, 2003).

Besides macroeconomic fundamentals and business cycle conditions determining bond spreads, variables that capture investors' behavioural characteristics, such as investors' risk aversion, and overall market sentiment are also important in explaining sovereign yield spreads (Arru, Iacovoni, Monteforte, & Pericoli, 2013; Özatay, Özmen, & Şahinbeyoğlu, 2009). Investor perceptions captured through news, consumer sentiments, confidence and views of upcoming economic activity are all crucial in explaining bond spreads (Aristei & Martelli, 2014; Georgoutsos & Migiakis, 2013). A sub-strand within this body of literature, is the role of risk aversion in affecting sovereign yield spreads. Garcia-Herrero, Ortiz, and Cowan (2006) studying Latin American sovereign yield spreads, argue that global risk aversion is positively and significantly related to movements in sovereign spreads. Investor attitudes towards risk tend to be a key factor in explaining spreads and portfolio flows. However, risk aversion is not constant over time and changes with the course of economic events or at different points in the business cycle. In this vein, Bernoth and Erdogan (2012) study the determinants of sovereign yield spreads across 10 EMU countries between 1999-2010, and note the changing importance of behavioural factors during different phases of the business cycle.

Lastly, bond specific characteristics are important in explaining sovereign yield spreads. Amira (2004) studying the determinants of sovereign Eurobond spread at issuance from 1991-2000 argues that yield spreads increase with maturity, issue size and gross fees and decreases with credit rating and the number of managers. Afonso and Jalles (2019) also study bond-specific determinants of sovereign yield spreads and argue that bid-ask spreads have positive impacts on sovereign yield spreads.

The chapter complements the literature on the determinants of yield spreads of sovereign securities with that on the determinants of yield spreads of corporate securities to motivate the inclusion of both sovereign and industry related variables in the empirical framework discussed in section 4.4.

4.1.2 Key Themes Identified in Corporate Bond Spreads

Determinants of yield spreads on corporate securities has attracted substantial attention with research focusing on firm-specific factors (such as liquidity, solvency and managerial efficiency); bond-specific characteristics (callable vs non-callable bonds, term structure, bid-ask spread); macroeconomic fundamentals (industry stock prices, interest rates, industrial production growth and inflation) and more importantly, the influence of sovereign risk on corporate spreads.

Some of the earliest studies on the determinants of corporate bonds was done through the development of empirical models pioneered by Lawrence Fisher. L. Fisher (1959) presented four important hypotheses. First, that the average risk premium on a firm's bonds depends on the firm's default probabilities and second on their marketability. Second, default risk can be estimated as a function of three variables-the coefficient of variation of a firm's net income, the length of time the firm has been operating without incurring a loss and the ratio of the market value of equity to the par value of the firm's debt. Third, the marketability of the firm can be estimated by the market value of outstanding publicly traded bonds. Fourth, the average risk premium can be estimated as a linear function of the logarithm of the above mentioned variables (default risk, coefficient of variation of a firm's net income, and market value of outstanding publicly traded bonds). Merton (1974)'s famous theoretical paper sets foundation for the theory of risk structure of interest rates. It also corroborates with L. Fisher (1959) result that the corporate default premium is a function of only three variables. These are firm value volatility, the time to maturity of the debt contract and the leverage.

A vast body of literature has found firm-specific factors to be highly explanatory in determining corporate bond spreads. Cavallo and Valenzuela (2010) find that corporate bond spreads are determined by firm-specific variables, country-specific sovereign risk, bond characteristics, macroeconomic conditions and global factors. Using variance decomposition analysis, the authors show that firm-level performance indicators account for a large share in the variance in corporate spreads. Applying this to the case of historical railways, performance indicators in the form of the freight carried was contingent on the economic development of adjoining regions. These in turn depended on unknowns such as the soil

fertility, reliability of rainfall and the extent of mineral reserves (Eichengreen, 1995).

Liquidity is a key determinant of corporate spreads with an improvement of liquidity causing a significant reduction in yield spreads both in studies concerning the historical period (Alquist, 2010) as well as for the contemporary era (Covitz & Downing, 2007; Hund & Lesmond, 2008; Min, Lee, Nam, Park, & Nam, 2003). For the historical period between 1880 and 1910, Chavaz and Flandreau (2017) explore the importance of liquidity and credit for government bonds. The authors argue that differences in underlying asymmetries, led to heterogeneous pricing of colonial and sovereign debt where sovereign spreads mainly reflected credit risks whereas colonial spreads mainly reflected liquidity risks. Coffman et al. (2013) illustrate that liquid secondary markets not only acted as a catalyst for the reduction of interest rates (and hence reduced spreads) but also made a marked increase in the volume of debt issues possible. The authors also emphasise on the existence, smooth operation and depth of secondary markets for strong primary markets for financial assets. Chen, Liao, and Tsai (2011) highlight internal liquidity risk as a key determinant of corporate credit spreads. The authors find that corporate internal liquidity risk significantly impacts bond yield spreads even after controlling for other well-known determinants of bond yields. Besides liquidity, other firm-specific determinants include leverage, volatility of returns on the firm's value maturity and risk-free interest rates.

Similar to the case of sovereign bonds, macroeconomic factors are also known to have explanatory power for the determinants of corporate spreads. Bondt (2005) examines the macroeconomic determinants of corporate debt securities in the euro area. He finds that financing costs (approximated by the cost of debt securities), financing needs (captured through mergers and acquisitions) and gross domestic product are significant in explaining determinants of corporate spreads in the short and long run. Thakur, Kannadhasan, and Goyal (2018) also find the importance of macroeconomic variables in determining credit spreads in the Indian bond market. They find that interest rates variables relating to stock market performance and inflation are key in explaining the level of corporate credit spreads in Indian bond market. Li, Li, and Si (2020)) investigate the role of macroeconomic factors in explaining corporate bond spreads in China and find that corresponding industry stock prices, interest rates and industrial production growth rate negatively drive the

industry credit spread. While stock market volatility and inflation rate positively affects the credit spreads at each industry level. A key finding of the paper is that there are substantial asymmetric effects of macroeconomic determinants on credit spreads with the positive changes in determinants exhibiting larger impacts than negative changes for most industries.

Various studies have found that the behaviour of variables in different economic conditions influence corporate spreads. A case in point is stock market volatility. Merton (1974) shows that a firm with more volatile equity is more likely to reach the boundary conditions for default. He concludes that investors should require additional compensation in the form of higher spreads. Campbell and Taksler (2003) in a study of US corporations, find that equity volatility explain a third of the variation in corporate bond yield spreads. (D. Shin & Kim, 2015) add to this and study the impact of the global financial crisis of 2007-08 on the Korean corporate bond market. Their findings reveal that selected liquidity variables explain a large variation in yield spreads before and during the crisis period, whereas the credit risk component has become a more influential determinant of yield spreads after the crisis.

Behavioural variables are also important in explaining explaining investors' investment decisions. These variables captured through information uncertainty and information asymmetry show that investors charge a high-risk premium on information asymmetry and uncertainty when controlling for other variables affecting corporate spreads. Bernoth and Erdogan (2012) argue that in times of uncertainty, investors become more risk averse and restructure portfolios accordingly. The flight to safety motive favours countries that have a low default risk.

Bond-specific variables are also key determinants of corporate spreads. Van Landschoot (2008) presents a systematic comparison between the determinants of euro and US dollar yield spread dynamics and shows that US dollar yield spreads are significantly more affected by changes in the level and slope of the default-free term structure and stock market return and volatility. On the other hand, euro yield spreads are strongly affected by the level and slope of US term structure of interest rates. For both regions, the effect of changes in the bid-ask spread is significant mainly during periods of high liquidity risk.

Lastly, sovereign risk is key in explaining yield spreads on corporate securities. Firms and government operate in the same macroeconomic environment and are hence subject to the same economy-wide conditions (Durbin & Ng, 2005). Sovereign credit ratings have a spillover impact on corporate bond ratings, with a deterioration in sovereign ratings (due to for example debt servicing difficulties) being transferred to domestic private borrowers (Cheikh, Hmiden, Zaied, & Boubaker, 2021). When the sovereign has a credit rating that is not at the high end of the scale, credit ratings for firms for that country would also tend to suffer regardless of their financial soundness (Borensztein, Cowan, & Valenzuela, 2007). R. Esteves and Tovar Jalles (2016) investigate the impact of sovereign risk, captured through sovereign defaults, on the ability of the corporate sector in emerging nations to finance itself abroad. Taking a historical case covering a majority of corporates that received foreign capital during 1880-1913, the authors find that sovereign defaults resulted in credit rationing that was very large and persisted long beyond the default settlement. This had negative implications not only for their growth but also on the private sector's ability to finance itself abroad.

Related to this strand of literature on sovereign risk in explaining corporate spreads, is the idea of 'sovereign ceiling', a long-standing policy of the credit industry. The 'sovereign ceiling' implies that private debtors cannot have a better credit than their sovereign. Research on investors applying the rule has shown mixed results. While some studies provide empirical evidence on the application of the rule (Cavallo & Valenzuela, 2010; Grandes, Panigo, & Pasquini, 2010) there are numerous studies which show that investors do not always apply the sovereign ceiling (Durbin & Ng, 2005; Garay, González, & Rosso, 2019; Grandes & Peter, 2007; Martell, 2008; Mohapatra, Nose, & Ratha, 2017). For the historical data, R. Esteves and Tovar Jalles (2016) study the impact of sovereign defaults during 1880-1913 on the ability of the corporate sector to finance itself abroad. The authors show that the sovereign ceiling rule is loosely applied. However, they argue for further research on the role of economic environment (especially around crisis times) on the likelihood of the rule being violated. Related to this, (Durbin & Ng, 2005) and (Ferri, Liu, & Majnoni, 2001) explore why the sovereign ceiling might be violated. This can be summed in three reasons. First, sovereign ceilings might be violated if a firm has a lower default risk than the government. Secondly, firm-specific variables are critical to understanding if sovereign

ceilings are strictly adhered to. Specifically, if a domestic firm's revenues are principally in foreign currency, has a close relationship either with a foreign firm or has substantial overseas assets the rule can be violated. Lastly, if close ties exist between the firm and its government (if the government sees telecom as a 'strategic' sector, it might allow a country's telecom bonds to be repaid even if the country is in default).

With the above background on the determinants of sovereign and corporate spreads, what is the relationship that has been identified between the risk-free rate and the credit spread on corporate securities? For the historical case, both sovereign and corporate securities exhibited a close connection. This is evident from some Indian railway securities which were considered identical to the nature of government annuities, especially where the government has exercised its option of purchasing the railways.[2] The relationship between sovereign and corporate-like securities became even stronger in the case where railway securities carried a government guarantee. Thorpe (1901: 190)) wrote that "Brazilian guaranteed railways must be looked at merely from the point of view of Brazilian credit".

Duffee (1998); Longstaff and Schwartz (1995); Merton (1974) postulate postulate an inverse relationship between the risk free rate and the credit spread. Theoretical models argue that as the risk free rate increases, the corporate rate increases less than proportionately and the credit spread tightens. Empirical literature such as (Davies, 2008) and Bevan and Garzarelli (2000) find a positive relation between the two variables, with increases in the risk free rate inducing a widening of the credit spread. Bernoth and Erdogan (2012) have argued for a time-varying relationship between government bond yields and credit spreads. The authors argue that sharp increases in government bond yields over time cannot purely be attributed due to macroeconomic fundamentals but also to the fact that general pricing of risk has increased over time, with financial markets reacting more strongly to different risk variables. Lastly, Martell (2008) studies the determinants of changes in credit spreads for US dollar denominated domestic and foreign sovereign bonds using fundamentals specified by structural models to separate spreads into credit

[2]In the time period of this study, starting from 1884 when the Eastern Bengal Railways was purchased by the State, the process continued till 1910 when a majority of the Indian railways come under state control. Source: (1906). Railways (Foreign Countries and British Possessions)., (HC 331). [Online]. London: Stationary Office, page 184

and non-credit components. The non-default portions of spreads have a component that is common for each type of spread. Using a vector autoregressive model, the author finds that domestic spreads are related to the lagged component of sovereign spreads and that proxies for liquidity are related to the common components.

To conclude, literature review on the determinants of sovereign and corporate securities has revealed certain common themes. Specifically macroeconomic related factors, bond-specific characteristics and variables capturing the effect of business cycle conditions have significant explanatory power in determining yield spreads on sovereign and corporate securities. For the case of macroeconomic factors, interest rate variables, cost of debt securities and inflation are seen to significantly influence both sovereign and corporate spreads. For bond-specific variables, liquidity is seen to have a significant influence on the spreads of both sovereign and corporate securities. The variables identified through the literature review would then be used in the model to analyse the determinants of yield spreads on sovereign and corporate securities during the first era of globalisation. While this section provides a broader overview of the literature on the determinants of sovereign and corporate spreads, the next section uses historical records to understand what information investors might consider more meaningful for investment in railways.

4.2 Historical Background and Determinants of Sovereign and Corporate Spreads: A Review

This section explores possible determinants driving investor perceptions regarding investment in railways during 1880-1913. Investors used several media sources to stay abreast on news and price movements of securities and general economic conditions of the respective issuing country.

Interest Servicing on Railway Securities

In the British, Colonial and Foreign Railways section of the Investor's Monthly Manual, the periodical regularly published a column titled 'Memoranda' and highlighted key

features of the economy hosting the railway. Specific details mentioned in this column related to the country's size of population, area, government revenue and expenditure, trade and key agricultural produce. Government revenue and expenditure was further explained by highlighting outlay on public works. Amongst this, expenditure payments for interest servicing comprised a significant proportion of total government expenditure on railways. This is illustrative in the case of India where interest payments comprised a share of more than 90 percent of railway expenditure in 1911.[3] The periodical also detailed the length of railway networks open in the country. This gave key information to investors on the extent of country growth and development.

A similar format was in place in other foreign manuals such as 'The Manual of Statistics (1897). The Stock Exchange Handbook' that published details of securities listed on the New York Stock Exchange. The manual reported railway earnings, and interest payments on railway securities.[4] For some countries, interest servicing on debt acquired for railway purposes comprised a significant share in overall debt servicing. Such was the case of Australia. The Financial Times dated August 10, 1928 stated

> "The Australian Government Railways represent the most important factor in the public finances of the Common wealth. The capital cost of the railways (more than £300 million) is nearly half of the total public debt of the States, and the annual interest payable on the railway debt is 42 percent of the total interest for which the States are liable."

Besides Australia, interest payments on railway debt formed a significant proportion of government expenditure for other colonies. Popular media sources played a key role in influencing investor perceptions on debt servicing history of railway companies. The Investor's Monthly Manual dated Dec 1885 (p.574) writing about the performance of Canadian railway securities warned "the results of the company's operations for the first half of the year

[3](1911). State Railways (British Possessions and Foreign Countries). (HC 331). [Online]. London: The Stationery Office.

[4]Sources: Fraser,J. (1903). English Railways: Statistically Considered. Effingham Wilson (London). Nicoll, C. (1897). The Manual of Statistics, Stock Exchange Handbook. New York

were peculiarly disappointing, there being a deficiency in meeting the debenture interest, and when these were made known the market collapsed heavily".

Another case in point is that of the *Les Chemins de Fer Sud de l'Espagne*, a Spanish railway company listed on the Paris Stock Exchange and largely held by French investors. The company had suspended payment of interest in April 1898 on its bonds while continuing to pay dividends. The French government took strict action of this practice and decided that in case the Spanish government did not take any action towards this or the company did not resume paying interest regularly on its contractual obligations, no new Spanish securities of any description would be granted the permission of being listed on the bourse (Max, 1933). Besides interest servicing, historical periodicals also emphasised industry-specific variables in explaining yield spreads on railway securities.

Industry-Specific Variables

Two key railway industry specific variables emphasised in historical literature are railway traffic returns on both passengers (number of passengers conveyed) and freight (amount of freight carried). Weekly traffic statements on British railways were published alongside the Daily Stock Exchange Official List, highlighting the importance of the indicator. Popular media sources also highlighted the importance of freight traffic by linking it to railway profitability. The Financial Times dated Mar 12, 1907 discussing Mexican railways wrote, "The support for Mexican railway ordinary shares was renewed upon the publication of an excellent traffic return." Both freight carried and passengers conveyed capture the revenue earning potential of the industry and hence have importance in influencing investor perceptions on the creditworthiness of the railway security (Thorpe, 1901).

To summarise, financial press (newspapers and stock manuals detailing prices of securities listed on global stock exchanges) during 1880-1913, illustrated overall country economic performance through key macroeconomic variables (interest servicing amongst others), and illustrated how its key industry, railways, fared through highlighting freight carried or passengers conveyed. This played a crucial role in building investor perceptions on the performance of the sovereign and the railway industry. The variables categorised as industry-specific and economic variables are also identified in contemporary literature on the determinants of sovereign and corporate spreads in the previous sections and in-

cluded in the regression framework discussed in section 5.6. The next section looks into the variable construction and data sources employed for empirical analysis in the chapter.

4.3 Variable Construction and Data Sources

Data Cleaning

The chapter constructs a dataset comprising a number of macroeconomic, monetary and industry-specific variables across fifteen different capital-rich and capital-poor economies. In tradition with Flandreau and Zumer (2004), capital-rich or capital-exporting countries from the sample comprise of Austria, Belgium, France and Sweden. Capital-poor countries (capital-importers) are those reliant on foreign capital through borrowing on the international capital markets. These comprise of Argentina, Brazil, Italy, Spain, Portugal, Russia, Canada, India, New Zealand Australia and Turkey. These are also listed in Appendix Table 32. This dataset covers 214 different railway securities during 1880-1913. The details of railway securities from the respective countries is are illustrated in Appendix Table 4, 5 and 6. The choice for selecting these countries is based on data availability on my key dependent variable, yield spreads on railway securities and a broad range of available macroeconomic and industry-specific indicators for these nations.[5]

The key source of data is the Investor's Monthly Manual for sovereign and railway security prices (used to calculate yield spreads) and outstanding/subscribed amount (which is used to calculate market capitalisation). The chapter uses the Making Global Finance database (2004) and Global Finance database used by Accominotti et al. (2011), an extension of Flandreau and Zumer (2004), for country series on key macroeconomic variables. The macroeconomic variables include interest servicing, government revenues, budget deficits, public debt and exports. Various issues of the *Statistical Abstract for Foreign Countries, Statistical Abstract for the several colonial and other possessions of the United Kingdom, Manuel des Societes Anonymes Fonctionnant en Turquie (1906)* and *Interna-*

[5]Data on government and railway securities listed on the London Stock Exchange from 1880-1913 spans more than 50 countries but for most of these countries the data series is broken and does not appear in the records for many years.

tional Historical Statistics by Mitchell (2013) have also been used for a range of other railway specific and country-specific information. As mentioned above, the key reason behind extracting macroeconomic and industry-specific information from these sources is due to it being published in detail and at regular frequencies.

The key variable of interest are yields on railway and government securities, extracted from the Investor's Monthly Manual. The Investor's Monthly Manual (IMM) available for the period between 1869 and 1929 has been digitised by the International Centre of Finance (ICF) at Yale. The IMM was a monthly periodical that reported on market conditions and gave detailed information on prices, dividends, market capitalisation (Rogers, Campbell, & Turner, 2020). A variable is generated which uses the name of the security to encapsulate all the railway securities in the sample.[6] This was then cross-checked with the hard copies of the Investor's Monthly Manual to see if any company which was categorised under 'Miscellaneous Companies' has been erroneously recognised as railway securities. There were a few cases where some 'railway wagon' and 'railway carriage' companies categorised under 'miscellaneous companies' in the IMM hardcopies was recognised as railway securities. These were subsequently removed. The sample is then restricted on two fronts; 1) using railway securities only for the 15 countries in my sample and 2) using the data from 1880-1913. This leaves me with 373,424 monthly observations for railway securities during 1880-1913. Besides this, the type of security is also coded. ICF has coded the securities into six different types; common stock, corporate bond, government bond, preferred stock, right issues and warrants. After the process of cleaning, railway securities fell into five different types of instruments; common stock, corporate bond, preferred stock, right issues and warrants. Out of these, the highest proportion of railway securities fell into 'corporate bonds' (57.8 percent) and 'preferred stock' (21.7 percent). A corporate bond is any security with an interest rate or the word 'debenture' in its name. A preferred stock is any security with the word 'preferred' in its name (Bogart & Chaudhary, 2019). A similar procedure is applied for government securities. Using the security type of security, the dataset also includes government securities(195,796 observations).

[6]The name of the company gives clue as to whether it is a railway security or not. For example, 'Caledonian Railway Co.' would mean that it is a railway instrument.

4.3.1 Calculating Railway and Government Returns

The chapter follows the methodology used by Bogart and Chaudhary (2019) to calculate yield spreads on railway and government securities. The total returns to any security is constructed as the sum of capital gains and dividend yield. First, on any year t, the capital gain is the increase in the average value of the security in that year relative to the previous year. This is given as follows:

This is given as follows:

$$Capital\ Gains_{it} = (P_t - P_{t-1})/P_{t-1} \tag{4.1}$$

In Equation 4.1 P_t is the price of security i in year t.

The dividend yield is calculated as follows:

$$Dividend\ Yield_{it} = (Interest\ Rate_{it}/Latest\ Price_{it}) * par\ value_{it} \tag{4.2}$$

To calculate the dividend yield (Equation 4.2), essentially the coupon rate mentioned on the security is divided with the latest price and multiplied with the par value. The par value of most railway securities was usually 100. The calculation of the current yield on dividends matched almost exactly with the column given in the IMM labelled as 'Last yrs. Divs. yld. Investor at latest price. PerCent'. This stated yield had visibility for investors who might have used it to form their investment choices. This stated yield has been used in a number of studies on sovereign and railway securities during the first era of globalisation. Examples of this are by Suzuki (1991) studying foreign government loan issues on the London capital market with special reference to Japan. Bogart and Chaudhary (2019) have also used this yield when analysing returns on Indian railway securities listed on the London Stock Exchange from 1880-1929. For this chapter, the end of year yields are used for both railway and government securities.

The total return on railway and government securities is defined as follows.

$$railreturn_{it} = (Capital\ Gains_{it} + Dividend\ Yield_{it}) \tag{4.3}$$

$$govreturn_{it} = (Capital\ Gains_{it} + Coupon\ Yield_{it}) \tag{4.4}$$

In calculating the railway returns (Equation 4.3) the entire set of railway securities (indexed by i) issued by each country, rather than one unique bond per country are taken. The reason for doing this is as picking a benchmark security entails erasing relevant information. Benchmark bonds tend to be the most-liquid ones and are perhaps not representative of the average outlook of a given borrower (Alquist & Chabot, 2011). Similar to returns on railway securities, returns on government securities are calculated as shown in Equation 4.4. Similar to railway securities, the entire set of government securities is taken. For robustness purposes, following Mauro et al. (2006), the chapter also uses the return on representative government bonds.

4.3.2 Calculating Yield Spreads on Railway and Government Securities

Using the dummy variables created for recognising railway and government securities, the data was then collapsed to form yearly averages of the key railway variables such as railway returns, outstanding amount and prices of the universe of railway securities listed on the London Stock Exchange for the selected countries.[7] This essentially means that in order to make the series on yield spreads on railway and government securities comparable to the rest of the data series, it was averaged on an annual basis. This was so as the rest of the data variables most of which were extracted from the Making Finance (2004) and Global Finance database (2010) appear on an annual frequency. Using the methodology adopted by Flandreau and Zumer (2004) to calculate spreads, the yield spread on railway securities is calculated by subtracting the return on the railway security from the long-term yield on

[7]This was collapsed at a country level so railway returns, prices and capitalisation reflect an average number for country X in year Z. In a later section of the chapter, the data is collapsed taking firms and instruments into account.

British government gold bonds. This was used for two reasons. First, using the yield on UK government gold bonds was appropriate as it was a long-term bond similar in maturity to the long-term nature of the railway security. Second, with fifteen countries as part of the sample, this rate was also appropriate in terms of comparability. It is important to note that the chapter recognises that yield to maturity is a more accurate indicator and has been used in historical studies R. P. Esteves and Tunçer (2016) and others. However, maturity data on railway securities from the Investor's Monthly Manual contains a large number of missing values. Available data series suggests that average maturity of railway securities was long-term justifying the use of rate on long-term government UK gold bonds as the reference rate. Using Equation 4.3 this is expressed in the following equation:

$$railspread_{it} = railreturn_{it} - ukgovgold_{t} \tag{4.5}$$

Equation 4.5 shows the yield spread on railway securities of country i at time t is calculated by deducting the yield on UK government gold at time t from the return on railway securities of country i at time t.

Similarly, government spreads is calculated as follows:

$$govtspread_{it} = govreturn_{it} - ukgovgold_{t} \tag{4.6}$$

Equation 4.6 shows the yield spread on government securities of country i at time t is calculated by deducting the the yield on UK government gold at time t from the return on government securities of country i at time t. Yield spreads on government securities could also have been calculated by taking the yield on government security of country i at time t rather than an international base rate (the yield on the long-term UK government bond). Using the yield on country government security and not the international long-term rate to calculate spreads does not make any qualitative difference to the results. Regression results along with other definitions are presented in the results and robustness section of this chapter.

4.3.3 Calculating Market Capitalisation of Railway Securities

The chapter follows the methodology used by Bogart and Chaudhary (2019) to calculate market capitalisation of railway securities. Market capitalisation of a security is the number of shares multiplied by their market price. Market capitalisation is calculated using capital subscribed and capital amount per share. To calculate market capitalisation, the capital subscribed is divided by the capital amount per share to get the number of shares. These number of shares are then multiplied by the latest price to get market capitalisation (Equation 4.7). Annual market capitalisation of railway securities is constructed using the using the average annualised latest price. An alternate method to calculate market capitalisation is using the average latest annual price. There is no qualitative change in the results when either is used in the regression.

$$Market\ Cap_{it} = (Cap\ Outstanding_{it} * Latest\ Price_{it}) / Capital\ Amount\ per\ Share_{it} \quad (4.7)$$

To clearly outline the potential significance of various factors in explaining railway yields, the chapter follows the methodology of R. Esteves and Tovar Jalles (2016) and divide the variables into three distinct blocks. These are investment climate and monetary stability, bond specific characteristics and industry-specific characteristics.[8] This approach allowed the chapter to (a) to capture micro (corporate level and instrument level) and macro (investment-monetary environment) environments, and (b) to create categories of variables for conducting Principal Components Analysis (PCA) , implemented in later sections as a robustness technique. PCA was also used as a technique to address multicollinearity in the data. Table 4.1 exhibits the summary statistics. All variable definitions and their data sources (Table 8) and correlation matrix (Table 9) are given in the appendix.

General discussion on key independent variables is as follows:

[8]Following R. Esteves and Tovar Jalles (2016), data was collected on a category called as 'Long-run macroeconomic prospects'. This block primarily contained data on arable land on food crops, number of children in primary and secondary schools. This was not added to the regression equations as the data had a high percentage (over 30 percent) of missing values which would potentially distort the results.

Table 4.1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
r_spread	383	2.16	1.06	-0.41	6.52
g_spread	395	1.83	0.94	0.17	4.77
Interest Servicing/Gov Revenue	501	0.25	0.11	0.05	0.52
Budget Deficits/Gov Revenue	502	-0.06	0.16	-0.85	0.22
Exports/Population	471	0.05	0.07	0.00	0.39
Passengers Carried/Population	428	6.58	8.2	0.28	40.2
Freight Carried/Population	426	2.75	2.51	0.06	11.6
Agriculture Output/Population	335	0.36	0.28	0.00	1.53
Number Educated/Population	349	0.11	0.07	0.00	0.21
Railway Market Capitalisation/Public Debt	406	14.36	1.54	11.66	17.45
Railway Log Miles	475	9.45	0.92	7.33	11.10
Railway Net Income	384	400.19	221.68	104.78	1051.39

- Investment Climate and Monetary Stability: Three key variables included in this category, are interest servicing over government revenue (interest servicing divided by government revenues), budget deficits over total revenue (budget deficits divided by government revenue) and total exports per capita (total exports divided by population). Numerous studies on the determinants of corporate spreads have given importance to indicators capturing solvency (Covitz & Downing, 2007; Min et al., 2003). Interest servicing on debt acquired to finance the government and railways was deemed crucial. Flandreau and Zumer (2004) also find a large, positive effect of interest servicing as a proportion of tax revenues on interest spreads on sovereign securities. The relationship between yield spreads on government and railway securities and the debt burden is illustrated in Appendix Figure 2. Other structural variables monitored by investors include exports, population and fiscal deficit. Again, through the debt-servicing channel, high fiscal deficits are associated with increasing spreads, whereas exports per capita are likely to reduce spreads. These variables (interest servicing, government revenue, budget deficits, country exports and population) are primarily taken from the Global Finance database (2010). Broadly, these variables affect the demand for investment in the railway infrastructure and level of attractiveness a country has for investors.

- Industry-specific characteristics: Industry fixed effects control for unobservable heterogeneity in industry risk. Literature on the determinants of corporate bond spreads has also given importance to industry and firm specific characteristics (Cavallo & Valenzuela, 2010; Garay et al., 2019; Kalimipalli & Nayak, 2012). Variables used from both these sources comprise of freight carried, passenger traffic conveyed, length of country railway network and railway income and expenditure. The variables used in the regression framework comprise of passenger traffic conveyed over population (passenger traffic conveyed divided by population), freight traffic carried over population (freight traffic carried divided by population) and log of length of railway networks in country. Freight carried and passengers conveyed are derived from several editions of the *Statistical Abstract for Foreign Countries* (for sovereign countries), *Statistical Abstract for the several colonial and other possessions of the United Kingdom* (for colonies) and data on Turkey is extracted from *Manuel des Societes Anonymes Fonctionnant en Turquie (1906)*. Length of railway networks obtained from International Historical Statistics by Ltd (2013). Higher the freight carried, or higher the passenger population conveyed indicates favourable business conditions and is hypothesised to lead to smaller spreads. Length of railway networks, arguably an indicator of economic the development during 1880-1913, was mentioned alongside country-specific macroeconomic information such as revenues and deficits in the *Investor's Monthly Manual* and the *Stock Exchange Official Yearbook*. These two key publications would likely be influential in affecting investor perceptions on country creditworthiness. Other industry-specific variables include railway profitability captured through the difference of income and expenditure. Higher profitability is hypothesised to reduce corporate credit spreads, as investors perceive the industry to be on a sound footing.

- Bond-specific characteristics: Liquidity represented by bond-specific characteristics is considered a key determinant of corporate spreads (Cavallo & Valenzuela, 2010; Covitz & Downing, 2007; Kalimipalli & Nayak, 2012). Liquidity is captured through bond specific characteristics such as market capitalisation, and prices (opening price, highest and latest price at which bond is traded). Bond specific prices capturing the

bid-ask spreads are considered important in explaining determinants of corporate spreads (Van Landschoot, 2008). Bond risk premiums should be higher for illiquid bonds that cannot be easily sold or exchanged for cash (Amihud & Mendelson, 1991). Based on this, we would expect a negative relationship between bond liquidity and spread changes.

4.4 Model

Based on the rich debate on modelling sovereign spreads and their determinants and other similar studies (Accominotti et al., 2011; Flandreau & Zumer, 2004) following standard specification of the model has been used to explore the determinants of railway spreads. Theoretically, Equation 4.8 shows that the yield spreads on railway securities is the left-hand side variable of an implicit equation that investors used to price risks as a function of a number of variables. The simplest form of the model is as follows:

$$Y_{it} = \alpha_i + \gamma_t + \beta X_{it} + \epsilon_{it} \tag{4.8}$$

where Y_it is the yield spread on railway securities (difference between the railway return in country i at time t and the UK government yield) for each country and year in the sample. On the right-hand side, we have four components: (1) the set of α_i are country fixed effects absorbing time-invariant differences across nations, (2) the set of γ_t are year fixed effects. Year fixed effects control for factors changing each year that are common to all countries for a given year, (3) β's represent estimated coefficients of X_it a vector of covariates, and (4) ϵ_{it} which denotes a set of robust errors clustered at the country level. The set of variables X_it includes the spread of government securities (over the long-term UK government gold bond yield). This is the key variable of interest helping us determine the relationship between the two largest sectors, government and railways. Other variables capture heterogeneity are linked to the investment climate, industry-specific characteristics, and the bond-specific characteristics as outlined in the previous section. We hypothesise

that these variables determine the railway spread through a contraction of supply (investor perception about the government and the industry may lead to less supply of funds) or through depressing the demand for finance by domestic firms.[9]

Routine data checks are conducted to find the error structure and investigate if heteroscedasticity and autocorrelation is present in the data. These are all detailed in the Appendix Chapter 2 page 210-213. All variables are winsorised before entering the regression equation to assure that there are no outliers driving the results. Panel fixed effects model is chosen as it is best suited to measure changes in the determinants of yield spreads on railway securities within countries across time. The choice for using fixed effects model is also motivated from results from the Hausman test which suggests that relative to a random effects model fixed effects model is the better choice. Appendix Table 8 details the variables, their construction, the expected sign and the data sources used in their construction. Appendix Table 9 exhibits the correlation matrix of the variables used in the regressions.

4.5 Empirical Results

This section presents the results of estimation of equation 4.8 using pooled OLS and FE panel methods. Table 4.2 exhibits the estimation results for different model specifications. The analysis begins with the baseline regression with yield spread on railway securities as the dependent variable and a host of macroeconomic and railway specific explanatory variables. The results are further dis-aggregated into capital-rich and capital-poor countries to document the relationship between yield spreads on government and railway securities in the separate sets of countries. This is in tradition with Flandreau and Zumer (2004) who have argued that capital does not freely move from one country to another, termed by nineteenth century economists as 'the disinclination for capital to migrate' or in contemporary

[9] Flandreau and Zumer (2004) and R. Esteves and Tovar Jalles (2016) have included default memory effect as another determinant, however in case of railways it is not much relevant as railway companies were mostly guaranteed by the government and defaults were sparse limited to 4 out of 15 countries in our sample. These were limited to one to three years in default (eg. Argentina (1890-93), Brazil (1898), Turkey (1876-81) except for the case of Portugal (1892-1901).

times as the 'home bias'.

Table 4.2: Fixed Effect Estimations

Variables	(1) Overall	(2) Cap Rich	(3) Cap Poor	(4) Overall	(5) Cap Rich	(6) Cap Poor	(7) Overall
g_spread	0.556***	-1.206*	0.648***	0.267*	-0.709**	0.406***	
	(0.186)	(0.38)	(0.187)	(0.135)	(0.217)	(0.117)	
Interest servicing/Gov Revenue				0.049***	0.028	0.056***	0.054***
				(0.013)	(0.024)	(0.012)	(0.015)
Railway Market Capitalisation/Public Debt				-0.156	-11.829***	-0.132	-0.178
				(0.142)	(1.06)	(0.166)	(0.144)
Exports/Population				-6.34	5.350**	-3.982	-3.5
				(5.308)	(1.467)	(5.398)	(3.587)
Log Railway Miles				0.214	-3.105*	0.018	0.174
				(0.39)	(1.184)	(0.41)	(0.284)
Passengers Carried/Population				0.073***	-0.224	0.091***	0.073***
				(0.023)	(0.127)	(0.01)	(0.021)
Freight carried/Population				-0.253*	0.01	-0.121***	-0.247*
				(0.136)	(0.111)	(0.035)	(0.136)
Gold dummy				0.158*	-0.825**	0.166	0.148
				(0.085)	(0.237)	(0.152)	(0.091)
Constant	0.904*	3.336**	0.702	-1.289	33.345*	-0.577	-0.624
	(0.467)	(0.577)	(0.497)	(3.463)	(11.225)	(3.72)	(2.745)
Observations	374	99	275	306	99	207	315
R-squared	0.238	0.483	0.312	0.368	0.745	0.483	0.343
Number of countries	15	4	11	13	4	9	13
Country Effect	YES	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES	YES
VIF	1.25	1.19	1.48	4.5	23.24	9.15	4.21

Note: Dependent variable (r_spread) is the yield spread on railway securities at annual frequency. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. The data is winsorised at the 1% level to remove any outliers.

Table 4.2 points to some important findings. It outlines the overarching importance of country i's government spreads with the UK government in explaining yield spreads on railway securities. Investors' perception of country risk has important implications for foreign investment in emerging markets. This is witnessed both in estimates from pooled OLS and fixed effects regressions. Estimates for the overall sample using fixed effects regressions (column 1) shows that on average a 100 basis points rise in government spreads leads to a 56 basis points rise in railway spreads. Yield spreads on government securities remains significant across all specifications. It is important to note that benchmark securities play an important role in completing the market by allowing heterogeneously informed investors to hedge against major income risks and adverse selection (Dittmar & Yuan, 2008; Shiller, 1993). This is specifically so for capital-poor countries, especially those at the early stage of their development since these markets are characterised by severe incompleteness and intense information asymmetry (Yuan, 2005). Interestingly, yield spreads on government

securities exist in a relationship of *substitution* (as exhibited by the negative sign of the coefficient) in capital-rich countries whereas they exist in a relationship of *complementarity* in capital-poor countries. This points to the role of country heterogeneity in influencing the relationship between yield spreads on sovereign and railway securities. Relative to a relationship of complementarity, a relation of substitution offers investors more portfolio hedging opportunities. Moreover, this result also points towards differing levels of financial development in the two sets of countries.

Besides yield spreads on government securities, Table 4.2 also emphasises the crucial importance of the debt burden (interest servicing to revenue ratio). As mentioned in the previous section, a significant proportion of country debt was for financing expenditure on public works. Hence interest servicing was an important variable in influencing investor perceptions on country macroeconomic stability. It appears with the correct sign (higher the interest servicing, greater the investor perception of riskiness and hence greater the spread) and remains significant across a variety of specifications. On average for the overall sample using fixed effects, a 10 percent rise in the debt burden results in a rise of 50 to 55 basis points of railway spreads.[10] This result is in line with Flandreau and Zumer (2004) who find that a 10 percent rise in debt burden increases interest spreads on government securities by 70 to 80 basis points. Interestingly, debt burden is not significant in the case of capital-rich countries. This shows that investors perceived capital-rich countries to be on sound macroeconomic footing and therefore did not deem this important for their investment decision. Capital-poor countries relied almost exclusively on foreign investors for investment in railways. Investment in capital-poor countries was considered riskier, and therefore, investors needed a higher compensation for the risk that they undertook, other things being equal (Flandreau & Zumer, 2004). The findings also corroborate with contemporary studies, which find that fiscal fundamentals and risk-aversion are important drivers of sub-sovereign spreads (Beck, Ferrucci, Hantzsche, & Rau-Goehring, 2016). Other variables in the 'investment climate and monetary stability' block such as exports per capita appear with the correct sign in the overall sample and for capital-poor countries but are insignificant.

[10]The variable 'interest servicing/government revenue' is defined in percentage terms when used in the regression and converted to basis points for this statement.

Bond-specific variables such as the railway market capitalisation as a proportion of total debt are significant for capital-rich countries in explaining railway yield spreads. Longstaff et al. (2011) find that liquidity risk is priced in corporate bond returns. Market capitalisation can be proxied for marketability of railway stocks. Hypothetically speaking, a greater market capitalisation would indicate higher marketability of the underlying security and hence a lower spread. More bond-specific variables such as maturity could be added as another control variable. However, data on maturity of railway securities is very sparse in the Investor's Monthly Manual making it difficult to be added to the regression framework. Besides bond-specific variables, industry specific variables such as freight carried as a proportion of population is highly significant in the overall sample. Similarly, passengers carried as a proportion of population are significant in the overall sample but appears in the coefficient with an incorrect sign. Through capturing the main sources of railway revenue-passengers carried and freight transported, industry-specific variables try to capture the financial health of railways.

Finally, results suggest the presence of multicollinearity indicated by the high VIF for capital-rich countries. One way to deal with multicollinearity is the use of Principal Components Analysis techniques. I have implemented this and detailed in the robustness section of this chapter. I now undertake empirical analysis using yield spreads on government securities as the dependent variable to investigate the presence of any common determinants explaining both yield spreads on sovereigns and railway securities.

Table 4.3: Determinants of Yield Spreads on Government and Railway Securities

	(1) g_spread Pooled OLS	(2) g_spread FE	(3) r_spread FE
Interest servicing/Gov Revenue	0.044***	0.025**	0.059***
	(0.009)	(0.01)	(0.016)
Railway Market Capitalisation/Public Debt			-0.202
			(0.142)
Budget Deficits/Gov Revenue		-0.237	0.698*
		(0.374)	(0.333)
Exports/Population		2.904	-3.439
		(4.908)	(3.501)
Log Railway Miles		0.590*	0.096
		(0.283)	(0.255)
Passengers Carried/Population			0.073***
			(0.02)
Freight Carried/Population			-0.252*
			(0.131)
Gold dummy			0.158
			(0.097)
Constant	0.617*	-4.185	0.024
	(0.331)	(2.685)	(2.474)
Observations	392	363	315
R-squared	0.317	0.436	0.354
Number of countries		14	13
Country Effect	YES	YES	YES
Year Effect	YES	YES	YES

Note: Dependent variable (g_spread) is the yield spread on government securities at annual frequency. Dependent variable (r_spread) is the yield spread on railway securities at annual frequency. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4.3 exhibits the determinants of government securities. The dependent variable in column 1 and 2 is the yield spreads on government securities of country i. The table shows that in both the pooled OLS and the fixed effects regressions, interest servicing as a proportion of revenues, an indicator of debt burden appears to be positive and highly significant in explaining government spreads. Column 3 of Table 4.3 takes yield spread on railway securities as the dependent variable and a host of other controls but does not include the yield spreads on government securities. This is to investigate whether the debt burden affects railway spreads directly, or if it affects railway spreads through the government spread variable. The results show that interest burden is positive and strongly significant in explaining railway spreads. With the debt burden explaining both yield spreads on railway securities in Table 4.2 and government securities in Table 4.3, the chapter terms the debt burden as the common determinant explaining the yield spreads of both government and railway securities. Literature on sovereign spreads has also found common factors (latent or observable) as determinants of sovereign spreads. For instance, Geyer, Kossmeier, and Pichler (2004) study sovereign spreads in the Eurozone and find that the dynamics of sovereign spreads in the Eurozone may be driven by common latent factors.

4.6 Adding Firm and Instrument Effects

In the previous section the data was constructed to capture country and time fixed effects. Using the IMM data, the chapter now expands the data on two fronts. First, by coding all the securities that are part of the sample. This is done by using the 'name' of the security as mentioned in the IMM. These securities represent the firms issuing them on the London Stock Exchange. In total, 214 securities are part of the sample. Second, the chapter adds the type of the security (ordinary share, corporate bond, preferred shares etc). Railway securities largely fall into the corporate bond category. Adding these two fixed effects, in total, the chapter now controls for four fixed effects; time, country, firm and instrument type.

The specific models are illustrated as follows.

Adding Firm Effects

$$Y_{jit} = \alpha_i + \gamma_t + \beta X_{jit} + +\epsilon_{jit} \tag{4.9}$$

where Y_{jit} presents yield spreads for firm j in country i at time t, and the β represent estimated coefficients of the vector of covariates as discussed above in Eq.4.9. ϵ_{jit} denotes a set of robust errors clustered on the country level. More covariates are added to the existing model. First and more importantly, a binary variable *gua* is included which captures whether the railway security carried a government guarantee. Using the same variable used to recognise railway securities, a dummy variable 'guaranteed' is created which takes the value of 1 if the name of the security has the word 'guaranteed' in it. Different combinations of the word were tried to ensure that no security is missed out. Using the Stata command 'collapse' To match the frequency of the yields on railway and government securities as created above, I collapse the variable 'guaranteed' for railway securities by country, year and firm. The chapter also constructs an interaction-term *interest servicing/Gov Revenue*gua* which essentially captures investor perception on investment in railway securities and whether investment in railway securities carrying a government guarantee was deemed relatively safer. On a broader level, it also explores whether the guarantee was the mechanism through which sovereign creditworthiness had a spillover effect on yield spread of railway securities.

Second, using the IMM, a variable 'railinterest' (coupon rate offered on railway securities) is included as a covariate in the equation. The inclusion of this variable captures more bond-specific information. It can be hypothesised that securities having higher coupon rates pay higher yields. In addition to this, other firm-specific variables such as as 'firmage' are added. This is taken from various editions of the Stock Exchange Yearbook. The variable refers to the time in years when the issue was first registered on the London Stock Exchange.

Table 4.4 shows results of fixed effects estimations based on main specification in Equation 4.9. With firm effects added to the dataset, the firm is chosen as the panel variable and fixed effects regressions are conducting capturing firm, country and year effects. Specifica-

Table 4.4: Fixed Effects Regression with Country, Year and Firm Effects

	(1) Overall	(2) Cap-Rich	(3) Cap-Poor	(4) Overall	(5) Cap-Rich	(6) Cap-Poor	(7) Overall
g_spread	0.605**	-0.871*	0.617**	0.314***	-0.605*	0.332***	
	(0.223)	(0.295)	(0.225)	(0.053)	(0.25)	(0.058)	
Repgovtspread							0.388***
							(0.057)
Guarantee				0.012**	3.380***	0.014**	1.284***
				(0.523)	(12.005)	(0.562)	(0.401)
Interest servicing/Gov Revenue				0.034***	-0.064	0.039***	0.039***
				(0.005)	(0.038)	(0.006)	(0.008)
Interest servicing/Gov Revenue*Guarantee				-0.028*	-12.474***	-0.033**	-0.029**
				(0.014)	(0.443)	(0.014)	(0.011)
Gold dummy				0.237*	0.155	0.198	0.289*
				(0.113)	(0.219)	(0.127)	(0.157)
Exports/Population				4.492		2.94	
				(2.691)		(2.359)	
Railway Market Capitalisation/Public Debt				-6.533***	-3.771	-6.295	-5.903***
				(1.25)	(1.76)	(3.632)	(1.823)
Log Railway Miles				-0.268	-2.009	-0.124	0.004
				(0.161)	(1.668)	(0.232)	(0.27)
Passengers Carried/Population				-0.005	-0.196	0.021	-0.015
				(0.026)	(0.091)	(0.015)	(0.041)
Freight Carried/Population				-0.234***		-0.221***	
				(0.045)		(0.05)	
Firm Age				0.050*	0.074	0.041	-0.056
				(0.028)	(0.068)	(0.036)	(0.041)
Railway Coupon Interest				0.244**	0.11	0.255*	0.283**
				(0.098)	(0.059)	(0.119)	(0.121)
Observations	2,477	250	2,227	1,521	197	1,324	1,496
R-squared	0.116	0.213	0.122	0.167	0.457	0.173	0.153
Number of firmcode	168	13	155	112	11	101	112
Country Effect	YES	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES	YES	YES	YES

Note. Dependent variable (r_spread) is the yield spread on railway securities at annual frequency. To adjust the units for presentation, the coefficient of the dummy variable 'gua' has been divided by 100 for interpretability. This has also been carried out by (Chordia, Roll, & Subrahmanyam, 2005). Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

tions 4-6 indicate that regardless of whether countries are capital-rich or capital-poor, an increase in debt-servicing when debt carries a government guarantee (interest servicing/Gov Revenue*gua) decreases yield spreads on railway securities. Taking into account country, year and firm effects, for the overall sample, results indicate that investors perceived the government guarantee to be credible. For the overall sample, guaranteed securities exhibit a risk reduction of 2.8 basis points relative to non-guaranteed securities. This is in line with a substantial literature on infrastructure finance which argues that government guarantees are offered to reduce investment risk incurred by the private investor (Brandao & Saraiva, 2008). More broadly, the government guarantee emerges as the mechanism through which sovereign creditworthiness influences the pricing of railway securities. The financial press clearly understood the guarantee as the mechanism influencing sovereign creditworthiness influences pricing of railway securities. For Russian railways, the Economist writes:

> "(For the Trans-Caucasian Railway) no information is volunteered, either to its capital or its earnings... the only fact it is thought worth to state being, that the principal and interest of the bonds are guaranteed by the Russian government. To all interests and purposes, therefore the loan is treated as a loan to the Russian government, and this is as it should be. It is the credit of the state that is pledged, and it is on that credit alone that intending investors must rely".[11]

Table 4.4 also shows that yield spreads on government securities remain positive and significant in the overall sample. A 10 percent increase in the yield spreads on government securities results in a 61 basis points increase in yield spreads on railway securities (specification 1). Baseline specifications also retain the relationship of *substitution* between railway and government securities for capital-rich countries and *complementarity* for capital-poor countries. Moreover, similar to previous results, debt servicing burden remains an important determinant for yield spreads on railway securities in the overall sample and in capital-poor countries but not for capital-rich countries. As a robustness check, I have also used yield spreads on representative government securities. This is explained in the robustness section of this chapter.

[11](1882). The Russian Railways and the State, The Economist, 040 (2043), p. 1301

Adding Instrument Type Effects

The third model specification aims to implement the model at the level of instrument type, and it takes the following form:

$$Y_{kjit} = \alpha_i + \gamma_t + \beta X_{kjit} + \epsilon_{kjit} \tag{4.10}$$

where Y_{kjit} presents yield spreads on instrument k issued by firm j in country i at time t, and β represent estimated coefficients of the X_{kjit}. ϵ_{jit} denotes a set of robust errors clustered on the country level as I am interested in the effects of country heterogeneity on yield spreads of railway securities. Similar to Equation 4.10 our vector of covariates adds the binary variable *gua*, the interaction term (intrev x gua) and other firm-specific variables such as firmage and railinterest (coupon rate offered on railway securities).

The chapter now adds instrument type effects. A variable 'firmtype' is created which concatenates firms with the type of security issued on the London Stock Exchange. These comprise of common stock, corporate bonds and preferred stock. Controlling for instrument type would account for any possible heterogeneity in the results due to differences across instruments. The variable 'firmtype' is included as the panel variable and fixed effects regressions are conducted taking into account country, year, firm and instrument type effect. Table 4.5 shows the results of fixed effects estimations based on main specification in Equation 4.10 and exhibits no qualitative change in the results compared to Table 4.4. Results indicate that investors perceived the government guarantee to be credible. This is evidenced through guaranteed securities exhibiting a risk reduction of 2.2 basis points relative to non-guaranteed securities. Government guarantee remains the mechanism through which sovereign creditworthiness has a spillover on yield spreads on railway securities.

The chapter now turns to test the robustness of the results. Robustness techniques are used to deal with two particular problems. First, results could potentially be distorted because of multicollinearity as indicated in Table 4.2. This is as a host of macroeconomic variables explaining both yield spreads on sovereign and railway securities are used in the same empirical framework. One way to tackle multicollinearity is the application of factor analysis (Kline, 2014). The goal of factor analysis is to decreasing dimensionality, by

Table 4.5: Fixed Effects Regression with Country, Year, Firm and Instrument Type Effects

Dep Variable	(1) r_spread Overall	(2) r_spread Cap Rich	(3) r_spread Cap Poor	(4) r_spread Overall	(5) L.r_spread Overall	(6) r_spread System GMM
g_spread	0.295***	-0.332*	0.285***		0.202*	0.252***
	(0.037)	(0.107)	(0.034)		(0.101)	(0.001)
Repgovtspread				0.333***		
				(0.05)		
L.r_spread						0.182***
						(0.001)
gua	0.005*	3.192***	0.006*	0.004*	0.005	
	(0.266)	(7.363)	(0.284)	(0.203)	(0.436)	
Interest servicing/Gov Revenue	0.033***	-0.013	0.038***	0.021***	0.024*	0.020***
	(0.005)	(0.024)	(0.005)	(0.004)	(0.012)	0
Interest servicing/Gov Revenue*Gua	-0.022*	-11.816***	-0.024*	-0.014*	-0.027*	
	(0.011)	(0.273)	(0.011)	(0.007)	(0.014)	
Gold Dummy	0.197*	0.578	0.193**	0.187**	0.151	0.196***
	(0.094)	(0.312)	(0.083)	(0.085)	(0.112)	(0.003)
Exports/Population	3.603	-1.766	0.669		5.26	-3.428***
	(4.39)	(10.299)	(3.228)		(3.9)	(0.024)
Railway Market Capitalisation/Public Debt	5.956**	-0.319	8.124***	0.282	-1.132	-1.250***
	(2.37)	(0.877)	(1.349)	(2.01)	(1.341)	(0.181)
Railway Log Miles	-0.432*	-2.961**	-0.273	0.197	0.159	-0.151***
	(0.217)	(0.627)	(0.266)	(0.216)	(0.269)	(0.004)
Passengers Carried/Population	-0.054*	-0.043	-0.025	-0.026	-0.02	0.006***
	(0.029)	(0.101)	(0.02)	(0.037)	(0.037)	(0.001)
Freight Carried/Population					-0.136**	0.012***
					(0.061)	(0.001)
Firm Age	0.055***	0.055	0.052***		0.021	
	(0.008)	(0.052)	(0.007)		(0.013)	
Rail Interest				0.420***	0.397***	
				(0.118)	(0.111)	
Hansen J p-value						1
AR(1)						0.0002
AR(2)						0.3929
Observations	2,364	363	2,001	2,068	1,740	2,342
R-squared	0.074	0.292	0.076	0.129	0.127	
Number of firmtype	190	21	169	172	149	196
Country Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
Firm Effect	YES	YES	YES	YES	YES	YES
Type Effect	YES	YES	YES	YES	YES	YES

Note: Dependent variable (r_spread) is the yield spread on railway securities at annual frequency. To adjust the units for presentation, the coefficient of the dummy variable 'gua' has been divided by 100 for interpretability. This has also been carried out by (Chordia et al., 2005). Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

reducing a large number of variables to a fewer number of factors. This leads to improved interpretability in explaining their relationship with the dependent variable. Second, the results can also be potentially confounded by endogeneity. The next section details a host of robustness techniques applied to check the stability of the relationships identified in the earlier sections.

4.7 Robustness Techniques

The chapter uses three robustness techniques. First, alternative definition of the dependent (railway yield) and the independent (government yield) variable are constructed. A case in point is using the spread on representative government bonds as the yield spread on government securities. The chapter follows Mauro et al. (2006) in selecting representative government securities. Details of representative government securities are given in Appendix Chapter 4 Table 7. Moreover, certain variables from the Jordà-Schularick-Taylor macrohistory (2017) database are used in the existing regression framework to test the robustness of the key results presented in the chapter.

Second, the chapter uses Principal Components regression. In a Principal Components regression, the principal components of the explanatory variables are used as regressors instead of using the explanatory variables directly in the regression (R. Liu, Kuang, Gong, & Hou, 2003). The technique is used to deal with the problem of multicollinearity, where two or more explanatory variables in the multiple regression model are highly linearly related.

Third, robustness techniques applies a number of tests on the dataset and checks for heteroscedasticity, cross-sectional dependence and serial correlation. Based on the results of the tests, alternate estimation techniques can be used which are used to deal with such problems and result in efficient estimators.

4.7.1 Using Alternative Definitions and Data Sources

The first robustness technique explores the determinants of railway spreads using the following different definitions of yield spreads on railway and government securities.

First, taking lead from Mauro et al. (2006) the chapter uses yields on representative government securities of country i at time t to calculate yield spreads on sovereign securities.[12] Based on reasons mentioned above, with a sample size consisting of 15 capital-rich

[12]Another definition that was tried was calculating the spread as the difference between the yields on railway securities of country i at time t and the representative government security of country i at time t. There was no qualitative change in the results.

and capital-poor countries, the long-term UK government gold bond is used as a benchmark security for calculating the yield spread on government securities. The chapter now introduces an alternative definition of yield spreads on representative government securities.

$$Repgovtspread_{it} = Repgovtreturn_{it} - ukgovgold_{t} \tag{4.11}$$

where $repgovspread_{it}$ is the yield spread on representative government securities for country i at time t.

Second, the chapter uses different variables on import and exports from the Jordà-Schularick-Taylor macrohistory (2017) database. The database has been compiled on a number of macroeconomic variables for selected countries. Data on the 15 capital-rich and capital-poor countries used in the analysis for this dataset are not part of the Jordà-Schularick-Taylor macrohistory (2017) database, regressions are conducted on a sub-sample comprising of Australia, Canada, Belgium, France, Italy, Portugal, Spain and Sweden. Seven relevant variables from the Jordà-Schularick-Taylor macrohistory (2017) database are used. These are imports, exports, short-term interest rate, long-term interest rates, debt to GDP ratio, government revenues and government expenditure.

Third, the chapter uses an alternative definition of yield spreads on railway and government securities by calculating the yield spread on railway and sovereign securities using the end December yields. This is done to reduce the possibility of noise when averaging across the year. The yield spread on railway securities is calculated as the difference between the end December return (using end-December yields) on railway securities of country i at time t and the UK government gold bonds at time t. Similarly, the yield spread on government securities is the end December yield on government securities of country i at time t and the UK government bond yields at time t. This is expressed as follows

$$rspread2_{it} = railreturn_{it(enddec)} - ukgovgold_{t} \tag{4.12}$$

$$gspread2_{it} = govreturn_{it(enddec)} - ukgovgold_t \tag{4.13}$$

Pooled and fixed effects estimations on the data sample constructed accounting for country and year effects as exhibited in Table 4.6 show that using alternative definitions makes no qualitative difference in the results. Yield spreads on government securities and debt servicing (interest servicing/Gov Revenue) remain significant across different specifications. In addition to Table 4.6, specification 7 in Table 4.4 (accounting for for firm, country and year fixed effects) and specification 4 in Table 4.5 (accounting for firm, country, year and type fixed effects) use the spread on representative government securities and show that there is no qualitative change in the results.

4.7.2 Principal Component Analysis

Factor Analysis (FA) and Principal Components Analysis (PCA) are both data reduction techniques. Factor analysis is used to model the interrelationships among different variables and is employed with the explicit goal to reduce the dimensionality of the data and achieve a simpler structure to improve interpretability. Factor analysis assumes that variance can be partitioned into two; common and unique, where the common variance is the amount of variance that is shared among a set of items. Variables that are highly correlated will share a lot of variance. Unique variance, further subdivided into specific variance and error variance is the proportion of variance that is unique to the variable and therefore not common (Shlens, 2014). In contrast to FA, PCA assumes that common variances take up all the variances. Principal Component Analysis is used when the number of variables in the regression are to be reduced while retaining as much of the original variance as possible (Conway & Huffcut, 2003). The chapter applies Principal components analysis to the group of variables categorised above to achieve data reduction and better interpretability of the estimates.[13]

[13]This argument is consistent with Gaskin and Happell (2014) who argued that the purpose of factor analysis is to describe variables in terms of a smaller number of underlying dimensions, whereas the goal

Table 4.6: Robustness Estimates (alternative definitions)

	(1) r_spread Pooled OLS	(2) r_spread2 Pooled OLS	(3) r_spread FE	(4) r_spread2 FE
g_spread2		0.444***		0.444**
		(0.098)		(0.181)
Interest servicing/Gov Revenue	0.043**	0.046***	0.037*	0.046**
	(0.021)	(0.013)	(0.021)	(0.019)
Railway Market Capitalisation/Public Debt		-0.282***		-0.282***
		(0.077)		(0.088)
Railway Log Miles		-0.225		-0.225
		(0.182)		(0.179)
Gold dummy		0.174		0.174
		(0.108)		(0.14)
Budget Deficits/Gov Revenue		-0.277		-0.277
		(0.385)		(0.671)
g_spread	0.416*		0.353*	
	(0.221)		(0.185)	
Debt/GDP (schularick)	-1.222		-0.712	
	(0.897)		(0.86)	
Trade (schularick)	1.429		-0.218	
	(4.476)		(4.594)	
Budget Deficits/Gov Revenue (schularick)	0.257		0.235	
	(0.744)		(0.651)	
Passengers Carried/Population	-0.057		-0.038	
	(0.06)		(0.059)	
Freight Carried/Population	-0.234***		-0.223**	
	(0.071)		(0.086)	
Log Railway Market Capitalisation	-0.609***			
	(0.178)			
Constant	9.657***	0.799	1.298*	2.039
	(3.012)	(1.669)	(0.661)	(1.978)
Observations	159	344	159	344
R-squared	0.734	0.648	0.456	0.294
Number of countries			8	14
Country Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Firm Effect	NO	NO	NO	NO
Type Effect	NO	NO	NO	NO

Notes: r_spread is defined as the difference in the return on railway securities of country i at time t and the benchmark yield on UK government gold bond at time t. : g_spread is defined as the difference in the return on sovereign securities of country i at time t and the yield on UK government securities at time t. r_spread2 is defined as the difference between the end December railway return of country i at time t and UK government gold bonds. g_spread2 is defined as the difference between the end December return on government security of country i at time t and UK government gold bonds. sdebtgdp is the debt to GDP ratio for selected countries using the Schularick (2017) database. strade is defined as total trade per capita. It is calculated as (exports+imports)/population using the Schularick (2017) database. sdefrev is the budget deficits to government revenue ratio using the Schularick (2017) database. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

PCA technique is applied in two steps: factor extraction and factor rotation. Factor extraction makes a choice about the type of model as well as the number of factors to extract. Factor rotation comes after factor extraction. Factor rotation methods are either orthogonal or oblique. Orthogonal rotation methods assumes that the factors in the analysis are uncorrelated. In contrast, oblique rotation methods assume that factors are correlated. The chapter applies the oblique rotation method. This is so as if the factor correlation matrix shows correlations of more than 0.32, there is enough variance to warrant oblique rotation.(Jackson, 2014).[14]

Following R. Esteves and Tovar Jalles (2016), the chapter distributes the variables into two categories, investment climate and monetary stability and bond-specific variables. This is in light of the results obtained from the pooled OLS and Fixed Effects regressions in Table 4.2 and 4.3 where variables categorised under these two blocks remained significant in explaining railway spreads.

Investment Climate and Monetary Stability: The following variables were considered: interest servicing, government revenue, budget deficits, public debt and exports.[15] Two principal components are retained which explain 96 percent of the variance.

Bond-specific characteristics: Bond specific characteristics encompass market capitalisation of railway securities and a host of price variables which includes annual opening price, highest price and latest price of railway securities.[16] Two principal components are retained.

Two components of each block of variables capturing investment climate and monetary

of principal components analysis is data reduction.

[14]The factor correlation matrix exhibited correlations of more than 0.32 in which oblique rotation methods are better.

[15]The Bartlett's test of sphericity is rejected at the 1% level of significance. The Bartlett's test of sphericity tests the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and therefore may be unsuitable for structure detection. Small values (less than 0.05) of the significance level indicate that a factor analysis would be useful with the data. The Kaiser-Meyer-Olkin measure of sampling adequacy, which shows how suited the data is for factor analysis. It returns a value of 0.737. If the KMO measure is less than 0.5, factor analysis would not be very useful (Dziuban & Shirkey, 1974)

[16]The Bartlett's test of sphericity is rejected at the 1% level of significance. The KMO measure of sampling adequacy is 0.758 which shows that factor analysis can be carried out.

stability and bond specific characteristics are used. PCA components are also extracted for variables categorised under the block of long-run macroeconomic prospects, but not added in the regression equation as they had a high proportion of missing values creating problems for conducting the analysis.[17] Appendix Table 10 and Table 11 details the results obtained from the PCA. The tables for each of the category of variables shows that the first two components explain more than 90 percent of the data. This is also visible through the screeplots (Appendix Figure 3) which can also be used to determine the number of factors to be retained in the PCA. The output tables also show strong evidence of the existence of a common factor in yield spreads on railway securities, as the first common component for all the panels explains more than 75 percent of the variation (shown by the proportion of the first eigenvalue). Table 4.7 exhibits the regression output with PCA extracted components.

Table 4.7 exhibits panel corrected standard error estimations with PCA components. The chapter uses two different definitions of yield spread on railway securities. One is the average spread on railway securities (r_spread) and the other is the spread using the end-December yield (r_spread2). Similar to the results obtained in Table 4.2 yield spreads on government securities and the block of variables capturing 'investment climate and monetary stability' which includes the common factor of debt burden are significant. This exhibits that variables classified under this category, were important to investors as it drove perceptions of macroeconomic stability. This corroborates with findings in contemporary literature on the relationship between sovereign and sub-sovereign yields where the spread of the sovereign security is the most important determinant of the spread of sub-sovereign securities (Bellot, Selva, & Menéndez, 2017). Bond specific factors also remain significant under a variety of specifications. They are correctly signed and show that an increase in factors that contribute towards increasing the marketability of railway securities leads to a fall in spreads. This corroborates with contemporary literature which shows that when market capitalisation (used as a proxy for liquidity) is large it is associated with tighter

[17] Arable land used for cultivating food crops and the number of children in primary and secondary schools had more than 30 percent of the data which was missing. Both are derived from International Historical Statistics by Mitchell (2004). Although there is not a complete consensus on the acceptable percentage of missing data for valid statistical inference, but Schafer (1999) states that a missing rate of 5% or less is inconsequential.

Table 4.7: Principal Components Regression

	(1) r_spread Overall	(2) r_spread Capital-Rich	(3) r_spread Capital-Poor	(4) r_spread2 Overall	(5) r_spread2 Capital-Rich	(6) r_spread2 Capital-Poor
g_spread	0.512***	-0.367*	0.311***			
	(0.106)	(0.219)	(0.12)			
pc1inv1	0.310**	0.155	1.263***	0.106*	-0.05	0.635*
	(0.144)	(0.145)	(0.389)	(0.059)	(0.131)	(0.328)
pc2inv1	-0.032	-0.003	-0.059**	-0.025	-0.074	-0.050*
	(0.02)	(0.036)	(0.029)	(0.043)	(0.047)	(0.026)
pc1bond1	0.044	-0.654***	0.15	-0.012	-0.646***	0.059
	(0.113)	(0.136)	(0.156)	(0.056)	(0.125)	(0.129)
pc2bond1	-0.652***	-0.663***	-0.791***	-0.544***	-0.654***	-0.327*
	(0.161)	(0.169)	(0.228)	(0.061)	(0.171)	(0.181)
Gold dummy	-0.264**		-0.067	-0.236**	0.175	-0.137
	(0.122)		(0.117)	(0.112)	(0.21)	(0.087)
g_spread2				0.383***	-0.349**	0.527***
				(0.058)	(0.177)	(0.078)
Constant	1.106***	1.698***	1.694***	1.287***	1.796***	1.312***
	(0.335)	(0.408)	(0.426)	(0.286)	(0.434)	(0.265)
Observations	371	99	272	369	98	271
R-squared	0.459	0.764	0.599	0.451	0.789	0.575
Number of country	15	4	11	15	4	11
Country Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES
Firm Effect	NO	NO	NO	NO	NO	NO
Type Effect	NO	NO	NO	NO	NO	NO
VIF	2.37	7.61	2.81	2.37	7.99	2.81

Notes: r_spread is defined as the difference in the return on railway securities of country i at time t and the benchmark yield on UK government gold bond at time t. : g_spread is defined as the difference in the return on sovereign securities of country i at time t and the yield on UK government securities at time t. r_spread2 is defined as the difference between the end December railway return of country i at time t and UK government gold bonds. g_spread2 is defined as the difference between the end December return on government security of country i at time t and UK government gold bonds.Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

spreads (Hong & Warga, 2000). Moreover, alternate definitions of yield spreads on railway securities (using the end December yield) also exhibit similar results. More importantly, using principal components analysis has enabled me to deal with multicollinearity as Table 4.7 hows that variance inflation factors are all under 10.

Appendix Table 12 and Figure 4 illustrate the average marginal effects from the PCA regression. The table illustrates the dissection of spreads into its various components. While yield spreads on government securities and debt burden have a positive and significant effect on yield spreads on railway securities, the second component of bond-specific variables capturing capitalisation and prices have a negative impact on spreads.

4.8 Dealing with Endogeneity

Given the nature of study, endogeneity is likely to be a concern. Endogeneity is the most important and pervasive issue confronting studies in finance. It is loosely defined as a correlation between the explanatory variables and the error term in a regression. Endogeneity can result from omitted variables, simultaneity and measurement error. Simultaneity bias, a common cause of endogeneity, occurs when y and one or more of the x's are determined in equilibrium, so that it can be argued that either x_k causes y or y causes x_k. Endogeneity can lead to biased and inconsistent parameter estimates making reliable inference difficult (Roberts & Whited, 2013).

In the context of this chapter, two variables yield spreads on government securities and interest burden are endogenous. Interest burden (interest servicing/Gov Revenue) is the common factor affecting both yield spreads on railway securities and government securities and might be correlated with the error term. It is possible that the interest burden is largely endogenous, reflecting changes in yield spreads on railway securities rather than anticipating them (appearing as an explanatory variable in the equation).

The other endogenous variable is yield spreads on government securities. This could be possible because of two reasons. First, yield spreads on government securities and variables capturing the macroeconomic environment such as budget deficits and exports both appear on the right hand side of the equation. It could be the case that lagged values of economic fundamentals might determine yield spreads on government securities thus leading to inconsistent parameter estimates. Second, the presence of serial correlation in the data might also possibly result in reverse causality in which yield spreads on railway securities are explaining yield spreads on government securities rather than the other way round. R. Esteves and Tovar Jalles (2016) also treat for potential endogeneity issues due to reverse causality in the context of impacts of sovereign defaults in the ability of the corporate sector in emerging economies to finance themselves abroad. The authors argue that reverse causality might be manifested in the form of external shocks to the country-specific availability of finance forcing country defaults (expressed as changes in country spreads) through a deterioration of economic activity in small open economies. Other

studies on yield spreads of sovereign securities have also exhibited endogeneity issues. Uribe and Yue (2006) explore the relationship between country interest rates and business cycles and show that country spreads are endogenous and move in response to lagged values of itself, exogenous country-spread shocks, current and past US interest rates and current and past values of a set of domestic endogenous variables.[18]

To deal with potential endogeneity, the chapter uses two different approaches. First, the same model is used as that for pooled and fixed effect estimations but makes one change and uses the lagged value of the dependent variable (yield spreads on railway securities). Using lagged variables is a common approach to deal with endogeneity (Bernoth & Erdogan, 2012). Results illustrated in column 5 of Table 4.5 show no qualitative change. Second, the chapter uses the Arellano-Bover/Blundell-Bond linear dynamic panel data estimation. The Arellano and Bond estimator can perform poorly if either the autoregressive parameters or the ratio of the variance of the panel-level effect to the variance of the idiosyncratic error are too large. Building on the work of Arellano and Bover (1995), Blundell and Bond (1998) developed a more efficient system GMM estimator. This method is also used by R. Esteves and Tovar Jalles (2016) on their historical dataset. It jointly estimates Equation 4.9 in first differences, using as instruments lagged levels of the dependent and independent variables, and in levels, using as instruments the first differences of the regressors. Column 6 of Table 4.5 shows no qualitative difference in the results.

4.9 Summary and Conclusions

This chapter explores the determinants of yield spreads on *quasi-sovereign* railway securities on 15 capital-rich and capital-poor countries listed on the London Stock Exchange from 1880 to 1913. This chapter contributes to the theme of country creditworthiness studied in the thesis by closely exploring the nexus between sovereign and quasi-sovereign railway securities, through investigating the determinants of yield spreads on railway and sovereign securities. Specifically, the chapter attempts to answer two questions. First, it explores the

[18]Here country spreads are defined by the authors as the difference between the country interest rate and the US interest rate.

determinants of yield spreads on railway securities and whether, if any, commonalities exist with determinants of yield spreads on sovereign securities. Second, considering the close relationship between the two, the chapter explores the mechanism through which creditworthiness of sovereign securities has a spillover effect on the creditworthiness of railway securities.

The chapter relies on data from a number of historical sources and applies pooled OLS, fixed effects regression on a host of factors representing macroeconomic, industry-specific and railway security-specific dimensions to obtain three results. First, results indicate that the key factors explaining yield spreads on railway securities include yield spread on sovereign securities (over the benchmark UK government security), debt-servicing capacity, and railway security-specific factors such as freight carried which capture industry performance. Railway securities exhibit a relationship of *substitution* in capital-rich countries whereas they exist in a relationship of complementarity in capital-poor countries, indicating the differing levels of financial development in the two sets of countries. These results appear robust to various model specifications, estimation techniques and definitions of key variables. Second, results indicate that interest servicing as a proportion of revenue, an indicator of debt burden, is a common factor explaining both yield spreads on government and railway securities. By implication, the presence of a common factor suggests that investors took both railway and government securities into account when forming perceptions of country creditworthiness. Third, the government guarantee appears as the mechanism through which creditworthiness of sovereign securities has a spillover effect on the creditworthiness of railway securities. Results suggest that in contrast to non-guaranteed railway securities, railway securities carrying a government guarantee have lower spreads, indicating that guaranteed railway securities were perceived as 'low-risk' in the eyes of the investor. Taking into account country, year, firm and instrument type effects guaranteed securities exhibit a risk reduction of 2.2 basis points relative to non-guaranteed securities.

This chapter contributes to the wider literature on financial globalisation in two ways. First, it improves understanding on the nature and dynamics on sovereign and *quasi-sovereign* railway securities, the two most important classes of securities during 1880-1913. Second, the empirical design of the chapter captures investor perceptions on the factors

considered crucial for investment in these asset classes. Thus, one can argue that investors priced government and railway securities on the global capital market and traded these securities at levels, which reflected the degree of trust that they inspired. While a large body of literature has looked at sovereign spreads, literature analysing railway securities has received little attention. This chapter aims to fill this gap.

The nexus between yield spreads on sovereign and railway securities and how creditworthiness changes over time is explored in the next chapter by studying the time-varying relationship between the two securities. Investigating country creditworthiness through the lens of the two most important securities at that time (government and railways), the chapter studies how the relationship behaves in crisis and non-crisis times.

Chapter 5

Time Varying Relationship between Returns on Government and Railway Securities: An Empirical Analysis

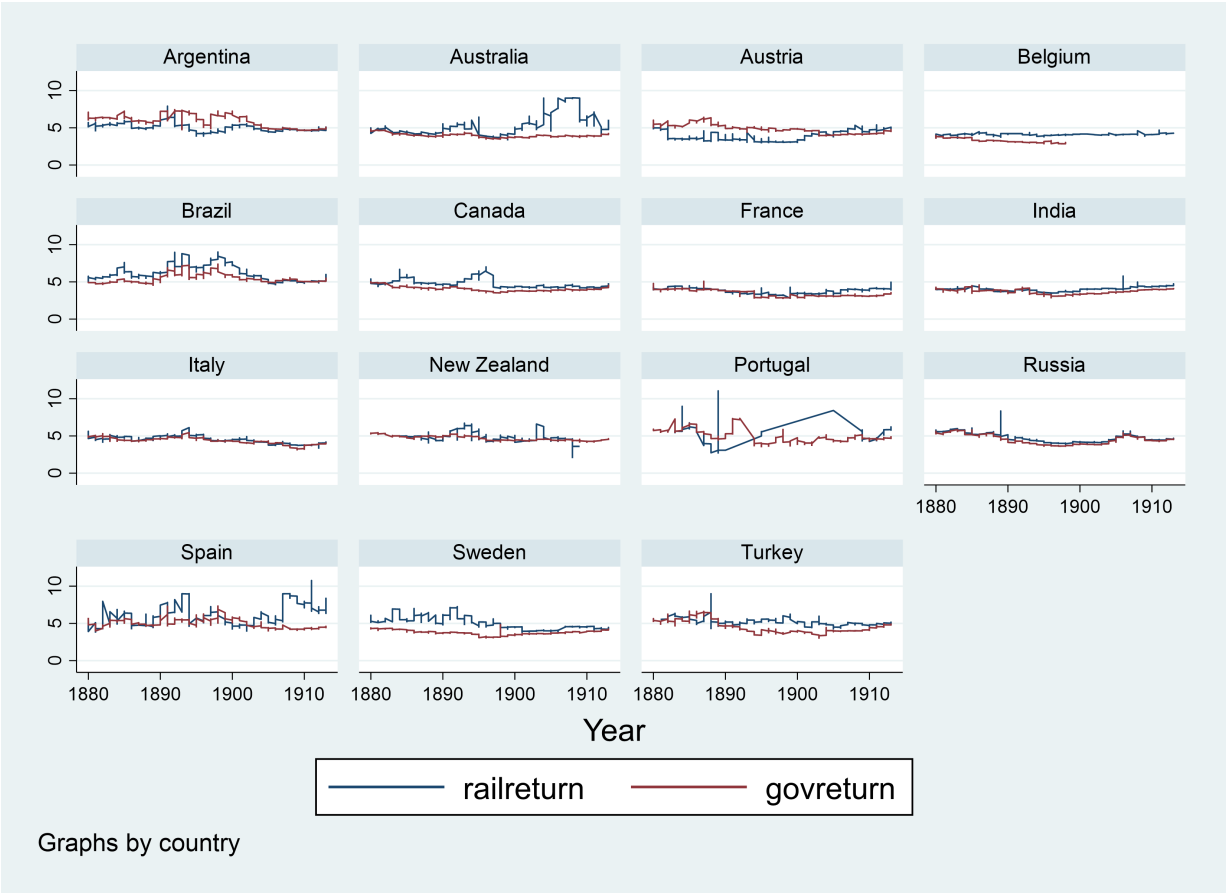
The period from 1880-1913, a comparable period of financial integration to today, was characterised by relatively free movement of capital and strong international trade and financial linkages (Bordo & Meissner, 2006; Goetzmann & Ukhov, 2006). International trade linkages generate both demand and supply side spillovers across countries. These trade and financial linkages can potentially result in a higher degree of business-cycle synchronisation and is exhibited in the form of strong correlations or co-movement between different asset classes (Jordà, Schularick, Taylor, & Ward, 2019; Kose, Prasad, & Terrones, 2003). While there exists substantial debate about the exact definition of 'co-movement', this chapter uses the definition of 'co-movement' implying a shared or common movement exhibited as strong correlations between asset returns (Baur, 2003).

While a substantial body of research has looked into the effects of financial integration on output and consumption co-movements across countries, less attention has been paid on the effects of financial integration on price co-movements (K. Shin & Sohn, 2006). In integrated and efficient capital markets, financial assets with similar risk characteristics

should yield similar expected returns, resulting in investors earning similar risk-adjusted returns on comparable exposures (Jobst, 2006). In the historical setting of the first era of globalisation, this can be applied to the two most important asset classes - government and railways securities as well. An asset class is a set of assets that bear some fundamental economic similarities to each other, and that have characteristics that make them distinct from other assets that are not part of that class (Greer, 1997).

The previous chapter argued that railway securities were *quasi-sovereign* in nature due to various degrees of government involvement in ownership and management. Moreover, railways were closely supported by the government through the provision of guarantees, subsidies etc. It can be argued that these features makes both railways and government securities belong to the same asset generating process. The close relationship between returns on railway and government securities is illustrated in Figure x. Jobst (2006) argues that market prices of different state-contingent claims when their value depends on the same asset-generating process exhibit a consistent and close pairwise association. This is also argued by Ross (1989b) that in an economic environment of financial integration, asset prices hold important information and thus, volatilities from different markets could affect each other. Both a close pairwise association and an enmeshed relationship in the form of a close degree of association in ownership and management between government and railway securities is exhibited for the historical period as well.

Figure 5.1: Monthly Returns on Government and Railway Securities



Note: The figure shows the monthly returns on railway and government securities calculated as a sum of capital gain and dividend yield. These are monthly average returns from 1880-1913 for a selection of 15 countries.

This chapter investigates the time-varying relationship between the returns on government and railway securities, in 15 capital-rich and capital-poor countries during 1880-1913. In contrast to the previous chapter, this chapter uses higher frequency monthly data and focuses exclusively on railway and government securities. It aims to explore three questions with respect to time-varying co-movement and diversification. First, is there a time-varying relationship between the two important avenues of investment during 1880-1913? Second,

how does the relationship between returns on government and railway securities behave during crisis episodes? The chapter uses the Barings crisis of 1890 as a historical episode to explore the relationship between returns on government and railway securities. The episode marks a watershed moment as the bank was heavily involved in underwriting sovereign securities and also dealt in railway securities of India, Argentina and Canada. Although the crisis originated in Argentina, news of the bank financial distress had contagion like effects in other economies as well (Mitchener & Weidenmier, 2008). Arguably, periods of economic tranquillity versus crisis can influence the relationship between returns on government and railway securities, with these two securities could potentially present heterogeneous behaviour at different time periods. This motivates the need to investigate the relationship using dynamic approaches. The chapter extends the analysis using more dynamic methods such as Pooled Mean Group, Dynamic OLS and Fully Modified OLS. Third, the chapter explores the causal direction between returns on government and railway securities. The direction of causality gives indication of the role of benchmark sovereign securities in market completion and price discovery for other securities listed on global stock exchanges during 1880-1913.

Econometric analysis gives evidence of three results. First, results point to a time-varying relationship and exhibits co-movement as indicated by the presence of cointegration.[1] The presence of cointegration is indicated in the overall sample as well as when it is disaggregated into capital-rich and capital-poor countries, implying a long-run causal relationship. Dis-aggregating the data into capital-rich and capital-poor countries reveals that similar to the results obtained in Chapter 4, country heterogeneity influences the nature of the relationship with government and railway securities exhibiting a *substitution* substitution relationship in capital-rich countries, and a *complementary* relationship in capital-poor countries. Second, the relationship exhibits time-varying nature, especially during crisis episodes. Results suggest that investors became risk averse and exhibited a potential 'flight to quality' behaviour during the Barings crisis of 1890. Third, applying granger causality methods reveals evidence of uni-directional causality with returns on gov-

[1]Cointegration first coined by Granger (1981) illustrates the phenomenon that non-stationary processes can have linear combinations that are stationary. Cointegration can be described as a technique to measure co-movement (Johansen, 2009).

ernment securities as a leading indicator signalling changes in returns on railway securities. The direction of casuality suggests the beneficial impact of benchmark sovereign securities for price discovery and market completion for railway securities.

The chapter uses the theoretical framework of Modern Portfolio Theory first developed by Markowitz (n.d.). A fundamental message of Modern Portfolio Theory is that assets should not be selected only on unique characteristics of the security alone, but rather how each security exhibits co-movement with all other securities (Elton & Gruber, 1997). Taking these co-movements into account, Markowitz (n.d.) argued that a portfolio can be constructed that had the same expected return and less risk than a portfolio constructed by ignoring these interactions between securities. A reading of historical investment guides and reports from the financial press reveals that investors took into account fundamental principles behind modern portfolio theory for their portfolio selection even before Markowitz first discussed it in 1952.

The chapter contributes to the wider literature on financial globalisation during 1880-1913 in two ways. First, this is the first study to investigate the long-run relationship between sovereign and railway securities, the two most important asset classes during 1880-1913. The chapter combines individual-country analysis by means of time series techniques with panel data approaches for completeness and robustness. Second, taking an investors' perspective, the chapter studies investors' decision function across countries and across time. In this way, the chapter contributes to understanding risk management prices, security pricing and portfolio diversification strategies employed by investors during the first era of globalisation. The analysis combines historical evidence obtained from investment commentaries and newspaper reports during that era with panel data econometric techniques.

The chapter is structured as follows. Section 5.1 looks at the stylised facts on returns on government and railway securities. Section 5.2 analyses the literature on the topic of co-movement and cointegration. Section 5.3 looks into the historical evidence with co-movement and cointegration. Section 5.4 details the data and variable construction. Section 5.6 elaborates the model. Section 5.7 details the estimation results. Section 5.8 discusses some robustness tests. Section 5.10 discusses results from granger causality tests

to give indications on the direction of causality between returns on government and railway securities. Section 5.11 concludes.

5.1 Stylised Facts

Visualising correlations between returns on government and railway securities cannot be taken as direct or causal evidence of their interrelationship during 1880-1913, but do exhibit certain indicative trends between the two securities over time. Moreover, they provide visual evidence of whether the research questions focusing on the themes of time-varying correlations between the two asset classes and implications need closer empirical examination. As reiterated above, this has implications for portfolio diversification how investors took into account country heterogeneity in their investment decisions.

It is important to note that Appendix Chapter 5 Table 16 exhibits cross-country correlations between returns on railway securities. The table shows that certain country pairs exhibit negative correlations providing investors good opportunities for portfolio diversification. When two investments present negative linear correlation, the total variance is at a minimum when each investment appears with a positive weight in a portfolio (Samuelson, 1967). Contemporary research has shown that equally weighted portfolios having low correlations with other countries in the portfolio can provide diversification benefits (Baele & Inghelbrecht, 2009; Kohers, Kohers, & Kohers, 2005). Applying this to the historical setting, the chapter analyses monthly correlations between returns on railway and government securities for the overall sample, across different country groups and across time.

Table 5.1 exhibits the correlations. Correlation between returns on government and railway securities was highest during the decade from 1890-1900. The table also exhibits country heterogeneity in the relationship between government and railway securities. This is underscored by the negative correlation coefficient for the overall period from 1880-1913 for capital-rich countries, indicating a relationship of substitution for capital-rich countries whereas a relationship of complementarity existed for capital-poor countries. Dis-aggregating the data into capital-rich and capital-poor countries is instructive as idiosyncratic behaviour in sub-samples is at times not reflected in the overall sample.

Table 5.1: Monthly Correlations Between Returns on Govt and Railway Securities

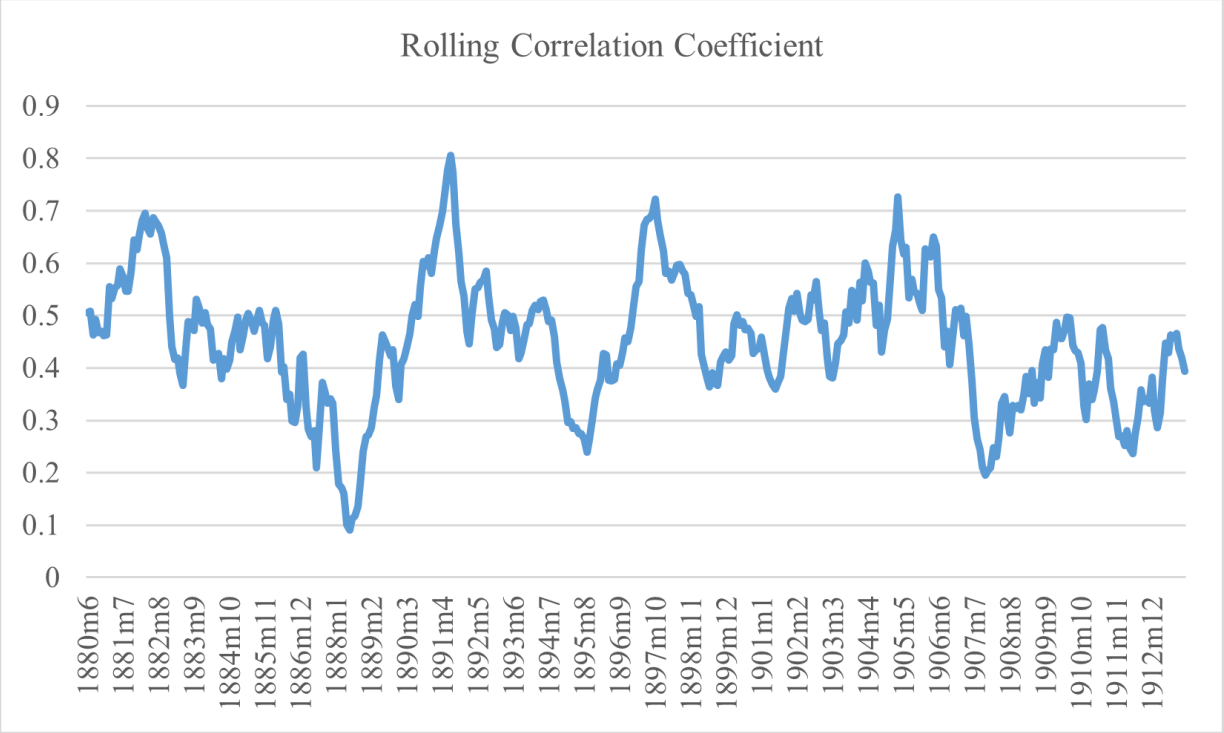
	1880-1890	1890-1900	1900-1913	1880-1913
All Countries	0.3628	0.4811	0.2242	0.3353
Capital-Rich	-0.2101	-0.2468	0.0771	-0.1107
Capital-Poor	0.3913	0.5249	0.184	0.3365

Notes: Correlations between railway and government securities depicted in the table are from 15 nations from a period of 1880-1913. These comprise of Austria, Argentina, Belgium, Brazil, France, Italy, Portugal, Russia, Spain, Sweden, Canada, India, New Zealand, Australia and Turkey. Based on Flandreau and Zumer (2004) these countries can be categorised into capital-rich and capital-poor countries. Capital-rich countries include Austria, France, Belgium and Sweden. The rest are classified as capital-poor.

The correlations exhibited in Table 5.1 is illustrated in Figure 5.2. Figure 5.2 illustrates the time-varying correlation between returns on railway and government securities using a time window of six months. This is calculated as follows. The chapter takes the entire dataset for monthly returns on railway and government securities (comprising of fifteen capital-rich and capital-poor countries). For a particular month, the chapter takes the overall sample and calculates the correlation coefficient between returns on railway and government securities. This is repeated for all the years (1880-1913). At the end of this exercise, a monthly correlation coefficient is obtained for for each month between the period 1880-1913. The chapter then takes a moving average of the series using a time window of six months, to remove any noise and plot the correlation against time. Figure 5.2 shows that for the overall sample, correlations between returns on government and railway securities exhibit time-varying behaviour. One explanation behind the volatility in the correlation coefficient could be explained due to changing local or global economic conditions. In a later section, the chapter explores this idea taking the historical case of the Barings crisis of 1890 and investigates the relationship between returns on government and railway securities in more detail.

To summarise, data from this section gives visual evidence that returns on government and railway securities exhibit time-varying correlation that could potentially be influenced

Figure 5.2: Six months Correlation Coefficient Between Returns on Government and Railway Securities



Note: This shows the correlation coefficient between returns on railway and government securities using a time window of six months to reduce noise.

by local and global events. Dissecting the sample indicates heterogeneity in investor perception about the interrelationship between government and railways in capital-rich and capital-poor countries. The next section outlines the literature on co-movement in asset returns, focusing on the body of literature analysing co-movement between government and railway securities.

5.2 Literature Review

Financial integration and cyclical co-movement amongst asset classes and stock exchanges has elicited much research. It is important to state at the outset that the chapter uses the definition of co-movement as elucidated by Baur (2003) where co-movement implies a shared or common movement manifested through strong correlations between asset returns. Literature studying the relationship between financial integration and cyclical co-movement between asset classes reveals three key themes. First, a large body of literature has looked at the relationship between asset classes listed on a single national market. Second, literature has focused on co-movement between asset classes listed on international stock exchanges, and third, the focus has been on co-movement between international stock exchanges themselves.

Despite substantial attention to understanding co-movement between different asset classes, for instance sovereign and corporate securities on global stock exchanges, less attention is paid to investigating the relationship between returns on sovereign and corporate securities of the same country (Bevilaqua, Hale, & Tallman, 2020). Before analysing the literature on co-movement between sovereign and corporate securities, understanding what co-movement entails and how it is measured is important.

5.2.1 Understanding Co-movement

Barberis, Shleifer, and Wurgler (2002) attribute co-movement to two reasons; fundamentals based, and category-based. Each is looked at in turn. Fundamentals-based co-movement is the subject of substantial research and is important in understanding the relationship between asset classes. Traditionally, in frictionless economies with rational investors, prices equal fundamental values and exhibit co-movement. Hence, in this ideal world scenario, any co-movement in prices is primarily attributed due to co-movement in fundamentals. Fundamental values are defined as the sum of an asset's rationally forecasted cash flows discounted at a rate appropriate for their risk. Applying the definition of fundamental values to understand correlated returns, the latter are explained either through correlated changes in rationally expected cash flows or due to correlated changes in discount rates.

The 'fundamentals' view of co-movement explains many instances of common factors in returns (Byrne, Fazio, & Fiess, 2013). Present value models in which discount rates depend only on macroeconomic variables argue that prices of different stocks move together either in response to common movements in earnings, or in response to common effects of changes in macroeconomic variables (Pindyck & Rotemberg, 1993). Fama and French (1992) found that two variables, market equity and ratio of book equity to market equity capture much of the variation of average stock returns. Fama and French (1995) augment this analysis by investigating whether the strong common factors detected in the returns of value and small stocks can be traced to common factors in the earnings of these stocks. Results show that common factors have strong linkages with profitability. Hence, fundamentals are a key source behind co-movement in asset prices.

Research has also focused that the strength of fundamentals-based co-movement is linked to the time horizon. Dewandaru, Masih, and Masih (2016) studying the relationship between Asia-Pacific equity markets find interdependence between these markets. The authors find evidence of low co-movements in the short-run and stronger co-movements in the longer term, suggesting a partial convergence across markets. Kiviaho, Nikkinen, Piljak, and Rothovius (2014) examine co-movement between European frontier stock markets with USA and developed markets in Europe. Results indicate that co-movement is stronger at lower frequencies (longer horizons) and increases during the turbulent period of the global financial crisis of 2007. Hence, in terms of co-movement between financial markets, longer horizons tend to show stronger co-movement.

Literature has also shown that the time horizon matters not only for co-movement between financial markets but also between two asset classes on a national stock exchange. Li, Chang, Miller, Balcilar, and Gupta (2015) examining the relationship between US stock markets and housing in the time and frequency domains show that co-movement and causality vary across frequencies and evolve over time. The results show that the two markets correlate with each other at low frequencies (in the longer term). C. Liu and Mei (1992) study excess return patterns on equity REITs over time on a national stock exchange. They also show evidence of time-varying co-movement where excess returns on REITs move very closely with those on small cap stocks and much less with those

of bonds. Hence, there is a wide body of evidence exhibiting time varying co-movement between financial markets and between asset classes listed on a single stock exchange.

Literature has also found evidence of high covariance of asset prices relative to the covariance of their fundamentals, which seems to defy rational expectations (Pindyck & Rotemberg, 1993). This 'excess covariance', or co-movement is taken as evidence of investor irrationality. More importantly, common macroeconomic factors or fundamentals-based co-movement cannot adequately explain co-movement alone and irrational factors should be included in understanding the relationship between asset returns (Zhou & Huang, 2020). In economies with frictions or with irrational investors, which also have limits on arbitrage, co-movement in prices is delinked from co-movement in fundamentals. This suggests an alternative view of co-movement based on 'sentiment' or 'frictions'. Co-movement in such economies might arise due to information spillovers across markets, portfolio rebalancing activity across stocks and bonds, financial constraints or from investor sentiment (Brenner, Pasquariello, & Subrahmanyam, 2009; Veldkamp, 2006). All these factors combined give rise to 'category-based' co-movement, which occurs when investors classify different securities in the same asset class and shift resources in and out of this class in correlated ways (Barberis & Shleifer, 2003). A related phenomenon is 'habitat-based' co-movement which arises when a group of investors restrict their trading to a given set of securities and move in and out of that set in tandem. After elaborating on the two key types of co-movement, it is important to understand how this phenomenon is measured.

5.2.2 Determining Co-movement

Literature on the measurement of co-movement has garnered much debate. Measuring co-movement only from the lens of correlation remains contentious, as the term 'correlation' remains vague and generic (Baur, 2003). It has also been argued that correlations only give information about short-run rather than long run dynamics between assets (Chou, Ng, & Pi, 1994). This problem is avoided by studying market co-movements through cointegration. In contrast to correlations, 'cointegration' focuses on long-run dynamics and provides a more robust measure of linkage between the two assets. Granger (1981) formalised this concept, defining such sets of variables as 'cointegrated' variables and since then tests and

techniques of working with cointegrated variables has developed. Cointegration is based on the fundamental concept that each individual component of a multivariate time series may be non-stationary, but certain linear combinations of these components are stationary. Cointegration studies the effects of these combinations and the relationships among the components (Lhabitant, 2017). Illustrating this concept through an example, the returns $R_{1,t}$ and $R_{2,t}$ on two assets are said to be cointegrated if a linear combination $aR_{1,t} + bR_{2,t}$ is stationary, i.e. it has constant mean, standard deviation and autocorrelation function for some a and b. In other words, the two series of returns never stray very far from one another; $R_{1,t}$ and $R_{2,t}$ are said to contain the same stochastic trend. A wide body of literature explores co-movement in asset returns by applying cointegration techniques, which has also been used in this chapter to investigate the relationship between returns on government and railway securities.

With the definition and measurement of co-movement laid out, the chapter now undertakes a literature review on the three broad themes identified in the literature on co-movement. These are co-movement between assets listed on a national stock exchange, cross-country co-movement and co-movement across stock exchanges.

5.2.3 Co-movement Between Asset Classes

Studies have also extensively focused on co-movement within and between asset classes and instrument types such as between short and long-term interest rates; Credit Default Swaps (CDS) and government bonds; and between stocks and bonds. Each is looked in turn.

Stock and Watson (1988) pioneered the study of cointegration, a technique popularly used to study co-movement. The authors explore co-movement between federal funds rate and three and twelve month Treasury bill rates by applying cointegration techniques. They find that the three interest rates appear to be cointegrated. Cointegration techniques have also been used to analyse the term structure of interest rates. The term structure of interest rates, commonly known as the yield curve depicts the interest rates of similar securities at different maturities. Hall, Anderson, and Granger (1992) analysing the term

structure of US Treasury Bill Yields, find that the term structure of US Treasury bill yields is well modelled as a cointegrated system. Mustafa and Rahman (1995) explore a possible long-run relationship between short-term and long-term interest rates within the standard cointegration framework. They obtain results in contrast of Stock and Watson (1988). Using 3-month Treasury bill rates and 10-year Treasury bond yields, the authors argue in support of the market segmentation hypothesis, which states that the two rates are determined independently by different market forces. However, they do not preclude the possibility of short-run dynamics between short and long-term interest rates. In contrast, Wallace and Warner (1993) find support for the existence of a Fisher effect on short and long-term interest rates and the expectations hypothesis of the term structure of interest rates. The expectations hypothesis asserts that short and long-term interest rates have a common stochastic trend and that they are related to each other. Evidence of cointegration between short and long-term interest rates therefore remains mixed.

A large body of literature has explored the relationship between CDS and government bonds. Andenmatten and Brill (2011) examine the empirical relationship between sovereign Credit Default Swap (CDS) premia and government bond spreads for Portugal, Italy, Ireland, Greece and Spain and find evidence of a long-run relationship between Credit Default Swap (CDS) premia and government bond spreads.[2] The results suggest that bond spreads react only sluggishly to long-term imbalances, as measured by the cointegrating relationship. In light of this, the authors conclude that, in most cases, CDS markets are leading markets if there is a long-run relationship between the CDS and government bond spread markets. Delis and Mylonidis (2011) investigate the dynamic interrelation between government bond spreads and their associated credit default swaps (CDS). Results show that CDS prices Granger-cause government bond spreads after the eruption of the 2007 sub-prime crisis. Feedback causality is detected during periods of financial and economic turmoil, indicating that high-risk aversion tends to perplex the transmission mechanism from CDS prices and government spreads. Bedendo and Colla (2015) use credit default

[2] A credit default swap (CDS) is a financial derivative or contract that allows an investor to 'swap' or offset his or her credit risk with that of another investor. For example if a lender is worried that a borrower is going to default on a loan, the lender could use a CDS to offset or swap that risk (Cao, Yu, & Zhong, 2010).

swap data to study the impact of sovereign risk on the credit risk of the non-financial corporate sector. They find evidence of co-movement between the two, with spillovers from the sovereign to corporate sector. The authors show that an increase in sovereign credit spreads is associated with a statistically and economically significant increase in corporate spreads which increases firms' borrowing costs. A deterioration in credit quality is likely to be more pronounced for firms that are likely to benefit from government aid. Stolbov (2016) examines causalities between sovereign and quasi-sovereign CDS prices (taking the case for Gazprom, VTB, Sberbank) for Russia. The sovereign and quasi-sovereign CDS prices exhibit a strong causal connectedness, with the impact of the quasi-sovereigns (in particular, that of banks) getting more pronounced in the longer run, i.e. over longer time horizons and at lower frequencies. High foreign exposure of the quasi-sovereigns, explicit/implicit public guarantees and the holdings of the Russian sovereign debt on their balances underlie the causalities.

Andersson, Krylova, and Vähämaa (2008) examined the impact of inflation, economic growth expectations and perceived stock market uncertainty on the time varying correlation between stock and bond returns. The results indicate that stock and bond prices move in the same direction during periods of high inflation expectations, while negative stock-bond return correlation seem to coincide with subdued inflation expectations. Consistent with the 'flight to quality' phenomenon, the results suggest that periods of elevated stock market uncertainty lead to a decoupling between stock and bond prices. Norden and Weber (2009) analyse the relationship between credit default swap (CDS), bond and stock markets during 2000-2002. Focusing on the intertemporal co-movement, the authors employ weekly, monthly and daily lead-lag relationships in a vector autoregressive model and the adjustment between markets caused by cointegration. Results suggest that stock returns lead CDS and bond spread changes. More importantly, the CDS market is more sensitive to the stock market than the bond market. The strength of the co-movement is dependent on credit quality and size of bond issue with a lower credit quality and larger bond issues resulting in stronger co-movements. To summarise, co-movement between asset classes is also significantly dependent on fundamentals. Besides co-movement between asset classes, a significant body of literature has also explored co-movement between stock exchanges, as discussed in the following section.

5.2.4 Co-movement Between Stock Exchanges

Cross-country co-movement has attracted substantial attention. For the historical period from 1880-1913, Mauro et al. (2006) find that co-movement of sovereign spreads amongst emerging markets was far higher during the 1990s than during the first era of globalisation. The authors argue that emerging markets were highly specialised in production and exports during 1880-1913, which led to a lower degree of co-movement in spreads than the contemporary era, where economies are well diversified and hence more alike each other. Goetzmann, Li, and Rouwenhorst (2001) show cross-country co-movement of equity has increased over the past decades, thus requiring investors to hold equities in an increasing number of countries for portfolio diversification.

Cross-country co-movement of asset returns has largely been attributed due to fundamentals. A large body of literature has explored the importance of domestic vs global fundamentals in understanding co-movement. Piljak (2013) examines dynamics of bond market co-movement of ten emerging and four frontier government bond markets with the US market. He explores the impact of macroeconomic factors and global bond market uncertainty on time varying co-movement. Results show that macroeconomic factors play an important role in explaining time variations in the bond return co-movement. Domestic macroeconomic factors have higher relative importance than global factors, with domestic monetary policy and inflationary environment identified as the most influential factors. Bunda, Hamann, and Lall (2009) empirically assess the co-movement in emerging market bond returns and disentangles the role of external and domestic factors during episodes of heightened market volatility. The conceptual framework they use in the paper allows them to identify the channels through which shocks originating in a particular emerging or mature market are transmitted across countries and markets. Beck et al. (2016) investigate the extent yield spreads on bonds issued by sub-sovereign entities within federations are driven by bailout expectations and investors' risk appetite as opposed to fundamental values related to default risk. The authors find that domestic factors such as the debt to GDP ratio is a significant determinant of spreads across regions. However, the positive link between fundamentals and spreads breaks down if sovereign debt or deficit levels lie above the federation median. Cross-country co-movement between asset returns largely due to

fundamentals - is explored through a variety of perspectives in asset-pricing literature.

The analysis of common stock market movements is important not only for understanding portfolio diversification but for understanding how the global financial system functions (Baur, 2003). Forero-Laverde (2019) explores the global cycle hypothesis by investigating whether the US stock market serves as an explanatory variable for the evolution of expansions and contractions in the UK stock market from 1922-2016. The author finds evidence of strong and contemporaneous co-movement between the US and UK stock markets. Using a VAR model to identify granger causality, results indicate that movements in the UK stock market, cause changes in the stock market index for advanced economies up to two years later. Most research has focused on international co-movement across government bond markets of developed economies. Over time, international investors have increasingly searched for alternative asset classes which are able to provide diversification benefits and high returns.

Implications of Co-movement

Two pivotal implication of co-movement are in the form of risk diversification or contagion. Each is discussed in turn. Correlations between stock market returns is an important indicator for international portfolio managers, who seek to minimise portfolio risk by diversifying across markets with low levels of correlation. Taking the case of correlations between stock markets, studies have exhibited time varying correlation where increased levels of correlation are indicative of increased integration between stock markets and therefore present reduced scope for diversification (Guidi & Ugur, 2014). This is also corroborated by DeFusco, Geppert, and Tsetsekos (1996) who examine long-run diversification potential of 13 emerging capital markets using cointegration tests. Results indicate the lack of cointegration; the apparent independence of these markets implies that diversification across these countries is effective. Thupayagale and Molalapata (2012) also add to this growing body of literature by evaluating co-movement and correlations in international fixed income markets through examining dynamic linkages between three emerging bond market yields with the US. Their results suggest that daily yields are not linked, implying long-run risk diversification.

Another strand of literature focuses on the impact co-movement, specifically between

national stock exchanges during crisis times has on contagion. Jiang, Yu, and Hashmi (2017) study the impact of the Asian financial crisis on six major stock markets during crisis and non-crisis periods. Results suggest that the crisis episode has reinforced the interdependent relationship between global stock markets.

To summarise, literature on the implications of co-movement are with respect to risk diversification and market contagion. It is important to note that the benefits of diversification is not a modern phenomenon but has been well known and practised in the investment community for much longer (Goetzmann & Ukhov, 2006). While this section elaborated on contemporary literature on these themes, the next section weaves it with references from historical sources to understand how investors thought about co-movement and diversification during the first age of globalisation.

5.3 Historical Evidence on Co-movement and Diversification

Historical investors had a good understanding of the concepts of correlation and co-movement and applied it to construct their portfolios. Investors had a wide range of sources guiding them on the optimal selection of securities helping them construct and diversify their portfolios. This comprised of investment periodicals, articles from the popular press and a wide range of sources detailing financial data. Investment periodicals and manuscripts detailed the stock exchange business, the main classes of securities and discussed at length investment strategies during periods of crisis and economic stability (I. Fisher, 1912; Thorpe, 1901). Popular media sources such as The Economist, Financial Times and The Times were used by investors to extract information on security prices and capitalisation, macroeconomic data and overall country economic prospects. Besides dealing with investment strategies, investment guides also focused on the important investment strategy such of portfolio diversification. In this regard, Lowenfeld (1909) is an example of an influential study on portfolio diversification with practical applications on managing portfolio risks both in the short and long-run (Goetzmann & Ukhov, 2006; Rutterford &

Sotiropoulos, 2016).

Together, these sources reveal that investors during the first era of globalisation were aware of the concepts of correlation and co-movement between asset classes and applied it to their investment choices. This section uses these sources to specifically explore how correlation and co-movement between asset classes was understood in the past. They are then analysed to see the implications they had on for investors' portfolio diversification strategies. Each of these is looked in turn in this section.

Correlation and Co-Movement in Historical Literature

Investment analysts during 1880-1913 gave investment recommendations for portfolio selection consistent with the fundamental tenets of modern portfolio theory (Rutterford & Sotiropoulos, 2016). This exhibits their understanding that correlations between different asset returns is crucial for optimal asset allocation decisions (D'Ecclesia & Kondi, 2018).

Investment guides also reflect analysts' understanding of strong correlations among stock returns and asset classes. Popular sources from the financial press such as the Economist regularly published an annual feature analysing the performance (recording changes in yields) of various securities listed on the London Stock Exchange. This feature comprehensively discussed performance of securities from various asset classes, contextualising them in the overall economic environment and comparing them to other securities belonging to the same asset class. In this way, the financial press during 1880-1913 described two types of co-movement; those within the same asset class and those between different asset classes.

This is evident from the Economist dated Jan 2, 1886 which comparing Canadian and American railways wrote that "Canadian railway securities have largely moved in sympathy with American issues, but the market has never at any time shown the same degree of buoyancy."

Besides annual publications such as the Stock Exchange Yearbook analysing the performance of the world of securities listed on the stock exchange, the Bankers' Gazette was another fortnightly feature published in the Economist providing a comprehensive snapshot of the banking industry and capital markets, analysing securities individually, and

in relation to other securities in the same asset class. For instance, The Economist dated January 29, 1887 wrote, "The market (British railways) has fluctuated chiefly in sympathy with foreign securities."

Besides understanding co-movement between securities belonging to the same asset class, historical sources also shed light on highlighting the movements between asset classes. This was a key source of information for investors constructing their portfolios. The Economist dated 1896 wrote "South American railways have, as a rule, given way slightly in sympathy with government stocks.[3]

The implications of this co-movement was important for portfolio optimisation, in understanding the factors affecting pricing of railway securities and for portfolio diversification. Wall (1902) in his book 'British Railway Finance; A Guide to Investors' mentions co-movement between different asset classes as a key determinant behind the pricing of railway securities. He wrote "we often read in newspaper articles of one market reacting upon another, or of one market sympathizing with another, and this is an influence that should be calculated upon".

It is interesting to note that investors were aware of the importance of investment jurisdiction in influencing co-movement between asset returns. Securities listed on the same platform were thought to be under control of a similar influence or trend. Taking the case of 'Natal 4.5 percent' Lowenfeld (1909) argued that although it is an African security, as the stock is entirely held in London, the investment demand which controls its fluctuations is heavily influenced by the state of British trade. Furthermore, he wrote that "all British stocks are under the control of the same identical influence". This 'common influence' had an impact on security prices and returns were 'dominantly influenced by the trading conditions of the particular country in which they were principally held and dealt in' and followed the country-specific business cycle (Rutterford & Sotiropoulos, 2016). The 'common influence' as discussed by Lowenfeld (1909) also had an impact on investors' portfolio diversification strategies.

Diversification

[3]The Stock Markets In 1885. (1886, January 2). Economist, 6+.; The Bankers' Gazette. (1887, July 23). Economist, 943+;The Bankers' Gazette. (1896, June 20). Economist, 805+.

Both these concepts of correlation and co-movement were analysed in relation to portfolio selection and diversification. Investment advice emphasised on selecting securities with certain characteristics such as safety of investment, regular return, marketability and growth potential. Chadwicks' Investment Circular (1870) argued that the greatest likelihood that all these four attributes were met were found only amongst commercial debentures of well-matured companies engaged in non-speculative business such as railways.

Securities were investigated on these four fronts and their performance was examined through a close reading of popular media sources or investment commentaries in the form of books or periodicals. Securities falling on these criteria were then analysed in relation to movements of securities within the same or different asset classes. Lowenfeld (1909) is a key example of a book paying close attention to correlation and co-movement between securities. The book offers a comprehensive study on the key principles and building blocks behind efficient portfolio selection and diversification. It offers graphical and quantitative analysis and illustrates a selection of some of the best securities traded on the London Stock Exchange offering lucrative investment returns and stability and regularity of income. The portfolio he uses comprises of both government and railway securities. The book exhibits detailed charts on the movement of returns and emphasises on the impact that correlation and co-movement can have on investment performance. The charts helped investors select optimal portfolios by picking securities with negative correlations (Rutterford & Sotiropoulos, 2016). While explaining diversification Lowenfeld (1909) writes: "The splitting up of a capital sum amongst a number of stocks fluctuating in sympathy with one common influence is not conducive to a distribution of investment risks' (p.95).

Besides geographical diversification, (Lowenfeld, 1909) also discusses diversification across securities. Furthermore, he emphasised that superior investment performance can be obtained by spreading capital in equal proportion geographically and carefully balancing back on a regular basis. Lowenfeld (1907) advised investors to divide their savings into equal amounts and choose securities in stock exchanges which are 'subject to entirely different markets and trade influences'.

A recent study by Edlinger and Parent (2014) has established that evidence of diver-

sification can also be drawn for French investors during 1880-1913. In the books of two famous French financial analysts, (Leroy-Beaulieu, 1906) in 1906 and (Alfred, 1913) in 1913, it is clear that "notions such as risk aversion and risk premium, international diversification and correlation, specific and systematic risks and arbitrage were common sense" (Edlinger & Parent, 2014). The above historical evidence for Britain and France exhibit that principles of modern portfolio theory had been applicable in Britain and France before the formalisation of modern portfolio theory by Markowitz in 1952.

Crisis and Co-movement

> "Not only here but almost universally, the year (1891) was one of financial prostration, the result of previous excesses. All lending nations have had heavy losses to bear, and been forced to economise."[4]

Investors also took into account country macroeconomic conditions and economic prospects to build their portfolios. Local and global economic conditions also had a huge influence on co-movement and diversification. Economic downturns were experienced in many countries following Baring Brothers Co coming under severe financial distress in 1890, leading to volatile capital flows and contagion like effects, where shocks in one country can lead to price movements in another country in excess of underlying fundamentals (Mitchener & Weidenmier, 2008). The Barings crisis orginated in Argentina, was transmitted back to London. Barings was the lead underwriter of involved in issuing sovereign debt for Canada, Argentina and Japan. Besides sovereign debt, it was also involved in railways for Argentina, India and Canada, issuing railway securities of leading Canadian railways such as the Canadian Pacific.

The Barings crisis of 1890 was not only felt on sovereign securities but was reverberated to railways as well. On average, Argentinian railway yields went up by 115 basis points in 1891. This corroborates to a substantial body of research which argues that financial market and asset volatilities increase substantially during crisis episodes implying that

[4]Year 1891. General Results Of Its Commercial And Financial History. Commercial History and Review of 1891. (1892, February 20). Economist, 1+.

market volatility and correlations move together over time (Kotkatvuori-Örnberg, Nikkinen, & Äijö, 2013). Correlations among different markets are higher during recessions than during expansion periods. In general, the stronger is the extent of co-movement between asset returns, the less diversified is a portfolio that blends those assets (Zimmer, 2015). Moreover, the issue becomes more complex if correlations between those assets change over time. Besides crisis episodes, the passage of legal acts such as the Trustee acts of 1892 and 1900, resulting uniform treatment of various government and railway stocks can also potentially influence movement of asset returns (Jessop, 1976).

To summarise, historical evidence shows evidence of the application of correlations and co-movement for portfolio selection and diversification. Moreover, the presence of shared underwriters of government and railway securities, can influence the time-varying relationship between the two most important classes of that era. Taking the case of returns on railway and government securities, this chapter focuses on the how the concepts of diversification and portfolio selection were implemented during 1880-1913. The next section describes the data and empirical strategy in analysing returns on railway and government securities.

5.4 Data and Econometric Methodology

In exploring the time-varying relationship between returns on railway and sovereign securities, the chapter uses the IMM to construct a dataset of monthly frequency measuring railway and government yields across fifteen different capital-rich and capital-poor countries. Similar to the previous chapter, following Flandreau and Zumer (2004), capital-rich countries comprise of Austria, Belgium, France and Sweden. Capital-poor countries comprise of Argentina, Brazil, Italy, Portugal, Russia, Spain, Canada, India, Australia, New Zealand and Turkey. The sample comprises of 214 different railway securities during 1880-1913. The details of each of these railway securities from the respective countries is illustrated in Appendix Chapter 4 Table 4, 5, 6. The choice for selecting these countries is due to railway and government securities of these countries being regularly listed and traded on the London Stock Exchange.

The chapter uses the same procedure for calculating returns on railway and government securities as outlined in the previous chapter. Railway securities are coded using their 'name' (as mentioned in the IMM) and government securities are coded using the 'type' as coded in the digitised IMM as government bond. Data on government securities consists of 375,046 observations from 1869-1929. Similar to railway securities, the chapter restricts the sample on the time dimension (1880-1913) and on the country dimension (15 capital-rich and capital-poor countries) and is left with 89,543 observations. Using the stata command 'collapse', the data is collapsed (yields on railway securities and prices of those securities) by country, year and month. A dataset is constructed comprising of fifteen countries where the main variable of interest is the yields on railway securities of monthly frequency from 1880-1913. The same exercise is repeated for calculating the returns on government securities. Since the analysis presented in this chapter focuses solely on returns on government and railway securities, bond-specific detail is not considered and therefore, that dimension is suppressed. The data is winsorised at the 1 percent variables so as to remove any possible outliers effecting the analysis. The chapter also constructs a variable which recognises all railway securities carrying a government guarantee. A dummy variable 'guaranteed' is created which takes the value of 1 if the name of the security has the word 'guaranteed' in it. The variable 'guaranteed' is created for railway securities by country, year and month.

Dealing with Missing Values

The Investor's Monthly Manual reports three types of prices, opening price (opening price at which the security is traded), high price (the highest price at which trade was executed) and latest price (at which last business is done in the particular security). The chapter calculates the total monthly return as a sum of capital gains and dividend yield for railway and government securities. However, this led to a large proportion of missing values (>10 percent). This is so as the 'latest price' component was used in calculating the return has a large number of missing values which led to a large number of missing values in the capital gains component of total return. On tabulating the missing values for each of these prices, the chapter found that the opening price had fewer missing values (7.9 percent missing values for railway securities and 7.3 percent missing values for government

securities). Despite railway high price having fewer missing values 4 percent missing values for railway securities and 3 percent missing values for government securities), the opening price was used to fill in the missing values in the latest price series for government and railway securities. This method was also adopted by Bogart and Chaudhary (2019) to fill in the missing values of their series. Moreover, relative to high prices, the use of opening prices can be justified so as to avoid any sharp spikes in the data series which upon imputation could potentially distort the results. The summary statistics of these prices are tabulated as follows which indicates the variation between them.

Table 5.2: Summary Statistics on Railway and Government Prices

Variable	Observations	Mean	Std. Dev.	Min	Max
		Railway Securities			
Opening Price	5,632	57.683	30.971	4	103.429
High Price	5,868	58.087	31.293	6	104.3
Latest Price	4,856	56.333	30.88	4	104
		Government Securities			
Opening Price	5,664	88.403	18.945	24	110.843
High Price	5,920	89.197	18.827	25	111.946
Latest Price	4,925	87.288	20.35	23.5	110.964

Source: IMM

Table 5.2 shows that there is very little difference in the mean and standard deviation of these prices. Thus the 'opening price' could be used as the price for calculating capital gains in the case where 'latest price' was missing. In calculating returns on railway securities using the original 'latest price', the missing values are 1256. When this was modified by imputing 'opening price' where 'latest price' is empty, the number of missing values is reduced to 239. Similarly, implementing the same procedure for government securities, the missing values are reduced from 1187 to 175. Overall, despite a large number of missing values have been imputed there is very little difference in the overall mean and standard deviation of the old series on total return on railway and government securities (using only latest prices) and the new series (using a mixture of latest and high prices). This is shown

in Table 5.3.

Table 5.3: Summary Statistics of Old and New Series on Returns of Railway and Government Securities

Variable	Obs	Mean	Std. Dev.	Min	Max
Old Railway Return	4,710	4.816	1.049	2.742	11.059
New Railway Return	5,712	4.833	1.065	2.162	11.059
Old Govt. Return	4,874	4.506	0.945	2.831	7.446
New Govt. Return	5,887	4.459	0.891	2.831	7.446

Note: The data source is from the IMM. The table shows the summary statistics of railway and government returns.

The chapter uses the new return on railway and government securities in the data analysis. These variables appear as railreturn and govreturn thereafter.

5.5 Econometric Methodology

The chapter follows the empirical methodology employed by Katsimbris and Miller (1993) and Ludwig (2014). Katsimbris and Miller (1993) examine interest rate linkages within the European Monetary System (EMS) and Ludwig (2014) estimates the long-run relationship of sovereign bonds of 26 EU member states from 1995 to 2012 with the risk free asset (taken as the 10 year German government bond). The methodology adopted in those papers is applied in this chapter for two reasons. First, both papers looks into the long run relationship between railway and (risk-free) sovereign securities, similar to one of the research questions explored in this chapter. Second, their chosen methodology works under an institutional arrangement of a common monetary framework similar to the time period analysed in the chapter (1880-1913) where numerous countries adhered to the classical gold standard.

Applying an appropriate methodology for time series data is crucial as a wrong specification or method can provide biased and unreliable results. (Shrestha & Bhatta, 2018) use seminal pieces of literature on time series analysis to comprehensively discuss the properties of time series data, present common data analysis methods and outline a methodological

framework for conducting time series data analysis (illustrated in Figure 5.3). The chapter follows the step-wise approach outlined by Shrestha and Bhatta (2018) for conducting empirical analysis.

The starting point is conducting unit root tests determining the stationarity of the variable. If the variable is stationary, the ordinary least squares (OLS) or vector autoregressive (VAR) models can be employed. Both these methods will give unbiased results and can be used for short-run analysis but will be inappropriate when using it to analyse the long-term equilibrium relationship.[5]

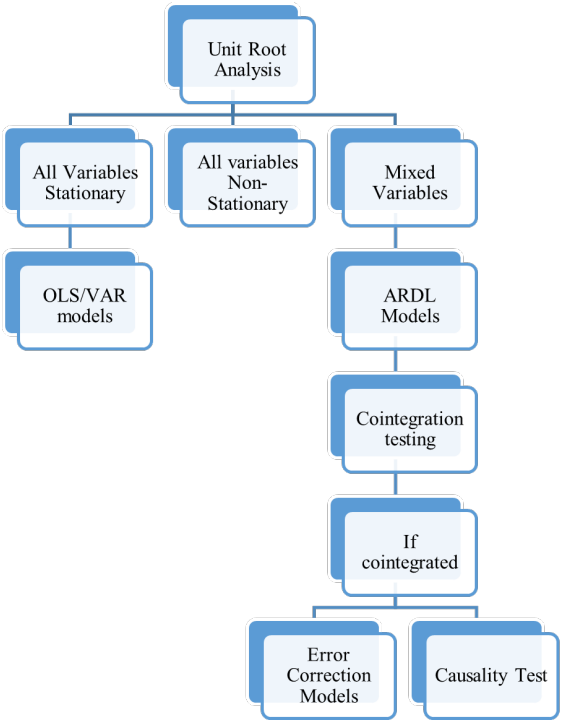
If the variables of interest are non-stationary, OLS or VAR models may become inappropriate to analyse the relationship. If a variable is non-stationary, it can be made stationary by taking first differences (Shrestha & Bhatta, 2018). If a time series is stationary after taking the first difference, then the series is said to be integrated of order one and denoted by I(1). Similarly, if a series is made stationary by differencing it twice, it is said to be integrated of order 2 and written as I(2).

Granger (1988) argues that a vector of variables, all of which achieve stationarity after differencing, may have linear combinations which are stationary without differencing. Engle and Granger (1987) formalise the idea of variables sharing an equilibrium relationship in terms of 'cointegration' of time series. More specifically, if two or more variables are linked in a way that they form a long-term equilibrium relationship, these variables are said to be cointegrated. The authors formalise the idea of cointegration and provide tests and an estimation procedure to evaluate the existence of equilibrium relationships, as implied by economic theory, within a dynamic specification framework (Dolado, Jenkinson, & Sosvilla-Rivero, 1990). Following the empirical methodology outlined in Figure 5.3 after checking for the stationarity of two variables, the next step then is to check whether the variables exhibit cointegration.

The final step is to estimate the relationship. If all the variables are I(1) and there

[5]Engle and Granger (1987) take the case of the consumption-income relationship and note that if the concept of equilibrium is to have any meaning or relevance, the processes underlying the relationship should be such that disequilibrium errors should tend to fluctuate around their mean value, or show some systematic tendency to become smaller over time. Equivalently, a minimal condition for equilibrium is that the variables should not drift too far apart.

Figure 5.3: Empirical Strategy



Note: This shows the empirical strategy followed in the chapter.

exists a cointegration relationship, then Error Correction Model (ECM) can be derived. Consider the following bivariate relationship:

$$Y_t = \mu + \beta_1 X_t + \epsilon_t \tag{5.1}$$

Based on the theorem of Engle and Granger (1987), the link between cointegration and Error Correction Model (ECM) is as follows.

$$\epsilon_t = Y_t - \mu - \beta_1 X_t \tag{5.2}$$

The error correction models for Y_t and X_t are as follows:

$$\triangle Y_t = \mu_Y + \alpha_Y \epsilon_{t-1} + \sum_{h=1}^{l} a_{1h} \triangle Y_{t-h} + \sum_{h=1}^{l} b_{1h} \triangle X_{t-h} + u_{Yt} \tag{5.3}$$

$$\triangle X_t = \mu_X + \alpha_X \epsilon_{t-1} + \sum_{h=1}^{l} a_{2h} \triangle Y_{t-h} + \sum_{h=1}^{l} b_{2h} \triangle X_{t-h} + u_{Xt} \tag{5.4}$$

where u_{Yt} and u_{Xt} are stationary white noise processes with lag length l. The model can also be extended for a multivariate case. The coefficients in the cointegration equation give the long-run estimated relationship among the variables and coefficients on the ECM describe how deviations from the long-run relationship affect the changes on them in next period. The parameters α_Y and α_X measure the speed of adjustment of X_t and Y_t respectively towards the long-run equilibrium. The Error Correction Model by Engle and Granger (1987) thus integrates the short-run dynamics with the long-run equilibrium without losing long-run information and avoids problems such as spurious relationship resulting from non-stationary time series data.

An improvement of Engle and Granger (1987) test was by Johansen (1991) which tests several I(1) time series. The test permits more than one cointegrating relationship and therefore in terms of performance is better than the Engle and Granger (1987) test. One limitation of the Johansen cointegration test is that it cannot be applied directly if variables of interest are of mixed order of integration or all of them are not non-stationary, as this method requires all the variables to be I(1). An ARDL (Autoregressive Distributed Lag Models) is an OLS based model which is applicable for both non-stationary time series as well as for time series with a mixed order of integration.

5.6 Model

Figure 5.3 highlights the empirical strategy followed following tests for stationarity and cointegration. For the purpose of model construction, if some variables are stationary and others are non-stationary, autoregressive distributed lag (ARDL) models can be used. ARDL is a dynamic model in which the effect of a regressor x on y occurs over time rather than all at once. A generalised ARDL regression model is illustrated as follows:

$$y_t = \beta_0 + \beta_1 y_{t-1} + ... + \beta_p y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + ... + \alpha_q x_{t-q} + \epsilon_t \tag{5.5}$$

A particularly important form of ARDL model is the error correction model (ECM). The dynamic error correction model can be derived from ARDL through a simple linear transformation (Shrestha & Bhatta, 2018). Error correction models (ECM) give two key insights. First, it outlines the dynamic co-movement among variables and second, it gives information on the adjustment process towards long-run equilibrium. A key advantage of using ECM is that it integrates short-run dynamics with long-run equilibrium without losing long-run information, and avoids estimating spurious relationships resulting from non-stationary time data (Maysami & Koh, 2000).

A generalised autoregressive distributed lag model (ARDL) model for the variables under discussion in this chapter is illustrated as follows:

$$railreturn_{it} = \sum_{j=1}^{p} \alpha_{ij} railreturn_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} govreturn_{i,t-j} + \mu_{it} + \epsilon_{it} \tag{5.6}$$

The error correction version of the ARDL model is given by:

$$\triangle railreturn_{it} = \phi_i(railreturn_{i,t-1} - \beta_i govreturn_{i,t}) + \sum_{j=1}^{p-1} \alpha_{ij} \triangle railreturn_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij} \triangle govreturn_{i,t-j} + \mu_i + \epsilon_{it} \tag{5.7}$$

where the β_i are our vector of interest, which measures the long run impact of the returns on government securities on returns on railway securities. ϕ_i represents the respective error correction term for each country. The remaining parameters are the short run coefficients. The disturbances ϵit are independently distributed across time and countries, with zero mean and constant variance within each country. This chapter uses the error correction model for estimation as it gives insight into the co-movement between returns on government and railway securities and their adjustment to the long-run equilibrium.

The chapter applies the pooled mean group (PMG) technique for estimating my results. The pooled mean group estimator (PMG) employs the ECM framework by allowing the short run parameters to vary from country to country but forces the long run parameters to be homogeneous (Pesaran, Shin, Smith, et al., 1996; Pesaran & Smith, 1995). This technique is best suited for this chapter as the dataset is a heterogeneous group of 15 capital-rich and capital-poor countries. This also corroborates with Pesaran, Shin, and Smith (1999) who have argued that for a panel data model with heterogeneous slope coefficients, the model is best estimated by the pooled mean group estimator. For this estimator, the variables can be a mixture of I(1) and I(0) and for the model to be read as an error correction mechanism, the variables have to be cointegrated (Asumadu-Sarkodie & Owusu, 2016).

As a robustness check, besides the use of error correction models, the chapter also uses single equation methods like Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) to examine the long-run relationship between yield spreads on railway and government securities. The next section will present the stationarity tests of the variables, the existence of cointegration and finally the panel estimator.

5.6.1 Unit roots and Structural breaks

A time series data is stationary is its value tends to revert to its long run average value and properties of the data series are not affected by the change in time only (Shrestha & Bhatta, 2018). On the contrary, a non-stationary series does not converge to its long-term average value and its mean, variance and co-variance also change over time. If the time series is non-stationary, it is said to have a unit root. Mathematically the series Y_t is stationary if:

$$E(y_t) = E(y_{t-s}) = \mu \tag{5.8}$$

for some s> 0

$$Var(y_t) = Var(y_{t-s}) = \sigma y^2 \tag{5.9}$$

$$Cov(y_t, y_{t-s}) = \upsilon_s \tag{5.10}$$

where E(y_t) is Expected value of y at period t. Var is variance (the variation of y_t from E(y_t). Cov is the covariance or the joint distribution of (y_t) and (y_{t-s}). Lastly, y_{t-s} is the lag of y up to period *t-s*.

Although the above discusses stationarity in a time series setting, the same concept is applied to panel data. Before estimating regression models, stationarity tests are conducted. This is so as estimating regression models with nonstationary variables leads to unreliable results (Nguyen & Kakinaka, 2019). Unit roots are applied on the data series to check if they are stationary. Non-stationary variables can be made stationary by taking first differences (Shrestha & Bhatta, 2018).

In the panel setting, to check the stationarity of the variables, and to check the robustness of the results, the chapter applies the Fisher-ADF and Fisher-PP tests (Choi, 2001).[6] Majority of the tests Levin, Lin, and Chu (2002), Breitung and Das (2005) assume that the dataset is a balanced panel, but the IM-Pesaran-Shin and the Fisher type tests allow for unbalanced panels (Pesaran, 2012). All the tests use the null hypothesis of a unit root with the alternate hypothesis that at least some panels are stationary.[7]

Table 5.4: Fisher's Unitroot Test (Augmented Dickey Fuller test)

	Overall Sample		Cap-Rich		Cap-Poor	
	Statistic	p-value	Statistic	p-value	Statistic	p-value
			Rail Return			
Inverse chi-squared (30)	114.0746	0	41.2638	0	72.8107	0
Inverse normal	-6.7156	0	-3.8831	0	-5.5005	0
Inverse logit t(79)	-7.904	0	-5.6048	0	-5.9162	0
Modified inv.chi-squared	10.854	0	8.316	0	7.66	0
			Gov Return			
Inverse chi-squared (30)	56.4872	0.0024	13.245	0.1037	43.2423	0.0044
Inverse normal	-3.5993	0.0002	-1.7063	0.044	-3.1742	0.0008
Inverse logit t(79)	-3.4652	0.0004	-1.6027	0.061	-3.1021	0.0015
Modified inv.chi-squared	3.4195	0.0003	1.3112	0.0949	3.2024	0.0007

Notes: Fisher's unit root Test takes the null hypothesis that all panels contain unit roots against the alternative that atleast one panel is stationary.

Table 5.4 presents the results of the panel unit root tests on variables. These tests are carried out on the overall sample and on a dis-aggregated basis on capital-rich and capital-poor countries. For the overall sample, results from the Fisher's unit root test show that returns on railway securities is stationary. A key question that arises here is that since the data appears to be stationary, there is no need to check for cointegration. The

[6]The basic difference between the Augmented Dickey Fuller (ADF) test and the Phillips-Perron (PP) test is that the PP is a non-parametric test, meaning that it does not need to specify the form of serial correlation of $\triangle y_t$ under the null hypothesis. Thus, the calculation of the t-ratio becomes different. Furthermore, PP corrects the statistics to consider the autocorrelation and heteroscedasticity issues. The hypothesis testing procedure remains the same as that of ADF. The results of the Im-Pesaran-Shin (IPS) test is given in the appendix of this chapter. There is no qualitative difference in the IPS results compared to the Fisher tests and the results appear to be stationary.

[7]One drawback of the Harris and Tzavalis (1999) and Levin et al. (2002) test is that the rejection of the null hypothesis is not convincing evidence that all series are indeed stationary. Another drawback is that the Levin et al. (2002) test is more powerful on a less restrictive sample.

chapter follows (Franses & Boswijk, 1992) who argues that it is good econometric practice to check for cointegration even if the data appears to be stationary. Moreover, Pesaran (2012) has argued that the rejection of a panel unit root test should be interpreted as evidence that a statistically significant proportion of the units are stationary. However, he recommends that the test outcome should be augmented with an estimate of the proportion of cross-section units for which the individual unit roots are rejected. Accordingly, the chapter conducts individual unit root tests for the countries in the sample to explore if individual country results differ from the overall sample. Individual country results reveal the existence of a unit root at higher lags.[8] The chapter therefore proceeds to conduct tests of cointegration on the sample.

5.6.2 Cointegration tests

Two data series are said to be cointegrated if a linear combination of the variables (returns on railway and government securities) exists which makes them stationary. This implies that the variables are attracted to a long-run (equilibrium) relation and any deviation from this relation reflects short-run (temporary) disequilibrium. Three panel cointegration tests applied in this chapter are developed by Kao (1999),Pedroni (1999) and Westerlund (2006).

The panel cointegration test proposed by Kao (1999) is based on the Engle and Granger (1987) test and specifies cross-section specific intercepts and homogenous coefficients on the regressors in the first stage estimation. In the bivariate case described by Kao (1999)

$$y_{it} = \alpha_i + \beta x_{it} + \epsilon_{it} \tag{5.11}$$

for $y_{it} = y_{i,t-1} + \mu_{it}$ and $x_{it} = x_{i,t-1} + \epsilon_{it}$

For t=1,.....T ; i=1,.....N. More generally, the first stage regression requires α_i to be heterogeneous, β to be homogeneous across cross-sections and setting all the trend

[8]Out of 15 countries, 11 countries in the sample exhibited the presence of a unitroot.

coefficients to be zero. The null hypothesis of the Kao cointegration test is that there is no cointegration.

Pedroni (1999) and Pedroni (2004) test is also based on the Engle and Granger (1987) cointegration test and extends it for panel data. It is based on an examination of I(1) variables. If the variables are cointegrated, then the residuals should be I(0). On the other hand, if the variables are not cointegrated, then the residuals will be I(1). The Pedroni test proposes several tests for cointegration that allow for heterogeneous intercepts and trend coefficients across cross-sections. Allowing for heterogeneous trend coefficients across cross-sections makes it different from the Kao (1999) cointegration test which sets all the trend coefficients to be zero.

For the bivariate case

$$y_{it} = \alpha_i + \delta_i t + \beta_i x_{it} + \epsilon_{it} \tag{5.12}$$

For t=1,.....T ; i=1,.....N; where y and x are assumed to be integrated of order one. The parameters α_i and δ_i are individual and trend effects. The Pedroni test also takes the null hypothesis of no cointegration. The residuals ϵ_{it} will be I(1).

The chapter conducts the Kao (1999),Pedroni (2004) and Westerlund (2006) cointegration tests for the bivariate case consisting of returns on railway securities as the dependent variable and returns on government securities as the independent variable. The Kao cointegration test takes five different statistics, Modified Dickey-Fuller, Dickey-Fuller, Augmented Dickey-Fuller, Unadjusted modified Dickey-Fuller and Unadjusted Dickey-Fuller. The Pedroni test uses three different statistics, the modified Phillips-Perron, Phillips-Perron and the Augmented Dickey-Fuller statistic. More than one cointegration test was applied for robustness purposes. The results confirm the existence of cointegration. Table 5.5 shows the result of these cointegration tests which overwhelmingly indicate that the null hypothesis of no cointegration is rejected at the 1% and 5% levels. Both these tests were conducted for the overall sample, for capital-rich countries and for capital-poor countries. Results exhibit the presence of cointegration for the overall sample as well as for the dis-aggregated

Table 5.5: Cointegration Tests

	Kao Cointegration Test					
	Overall Sample		Cap-Rich		Cap-Poor	
	Statistic	p-value	Statistic	p-value	Statistic	p-value
Modified Dickey-Fuller t	-9.09	0.00	-12.18	0.00	-10.20	0.00
Dickey-Fuller t	-6.40	0.00	-6.26	0.00	-6.60	0.00
Augmented Dickey-Fuller t	-2.57	0.01	-4.09	0.00	-2.97	0.00
Unadjusted modified DF	-31.70	0.00	-20.72	0.00	-30.00	0.00
Unadjusted Dickey-Fuller t	-11.50	0.00	-7.22	0.00	-10.44	0.00
	Pedroni Cointegration Test					
	Overall Sample		Cap-Rich		Cap-Poor	
Modified Phillips-Perron t	-19.23	0.00	-14.76	0.00	-16.76	0.00
Phillips-Perron t	-9.85	0.00	-7.71	0.00	-8.21	0.00
Augmented Dickey-Fuller t	-13.85	0.00	-9.51	0.00	-11.24	0.00
	Westerlund Cointegration Test					
Variance Ratio	-3.49	0.00	-1.51	0.07	-3.54	0.00

Notes: Kao, Pedroni and Westerlund cointegration test take the null hypothesis of no cointegration against the alternative that all panels are cointegrated. This table shows the rejection of the null hypothesis implying the presence of cointegration.

sample. The next section discusses the estimation results using the error correction model.

5.7 Results

The chapter uses a variety of different estimation techniques for investigating the long-run relationship between returns of railway and government securities. Before undertaking the regressions, country-level autoregressive distributed lag regressions (ARDL) regressions are estimated to find the lag structure. Results show that the most common lag structure is the first lag of returns on railway securities whereas returns on government securities is to enter in levels.

After investigating the lag structure, various econometric techniques are applied to

explore the dynamic relationship between returns on government and railway securities. The estimations involve Dynamic Fixed Effects (DFE), Dynamic Ordinary Least Square (DOLS) and Fully Modified Ordinary Least Square (FMOLS) techniques. In dynamic panel data methods, two methods are adopted. At the one extreme, one can estimate separate equations for each group and examine the distribution of the estimated coefficients across groups. Of particular interest will be the mean of the estimates, called as the mean group estimator. This estimation does not take into account that certain parameters may be the same across groups. At the other extreme are the fixed and random estimators, where the intercepts are allowed to differ across groups whereas other coefficients and error variances are constrained to be the same. Pooled Mean Group is the intermediate estimator between these two extremes because it involves both pooling and averaging. This estimator allows the intercepts, short-run coefficients and error variances to differ across groups, but constrains the long-run coefficients to be the same (Pesaran et al., 1999). This chapter uses the Dynamic Fixed Effects Estimator which pools the data for each group and restricts both long and short-run coefficients to be equal across all groups (Weinhold et al., 1999). There are reasons to expect the long-run equilibrium relationships between variables to be the same such as common technologies influencing all groups in the same way.

Table 5.6: Dynamic Fixed Effects, Dynamic OLS and Fully Modified OLS estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dynamic Fixed Effects			Dynamic OLS (DOLS)			Fully Modified OLS (FMOLS)		
	Overall	Cap Rich	Cap Poor	Overall	Cap Rich	Cap Poor	Overall	Cap Rich	Cap Poor
gov return	0.354***	-0.391**	0.434***	0.440**	-1.422***	0.559***	0.398***	-1.478***	0.530***
	(0.098)	(0.186)	(0.11)	(0.184)	(0.268)	(0.198)	(0.12)	(0.204)	(0.132)
Differenced gov return	0.155***	0.03	0.179***						
	(0.029)	(0.052)	(0.035)						
Adjustment coefficient	-0.077***	-0.074***	-0.083***						
	(0.005)	(0.01)	(0.006)						
Constant	0.253***	0.426***	0.255***	3.297	5.8	2.342	1.712**	12.623***	1.551
	(0.037)	(0.075)	(0.046)	(79.036)	(7.821)	(46.629)	(0.766)	(1.168)	(0.981)
Observations				5,515	1,427	4,073	5,533	1,441	4,091
R-squared				0.555	0.771	0.51	0.042	0.088	0.033
Country Effect				YES	YES	YES	YES	YES	YES
Time Effect				YES	YES	YES	YES	YES	YES

Note: The dependent variable is the return on railway securities calculated as a sum of capital gain and dividend yield. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 5.6 exhibits the results. Econometric estimations point to two main results. First, results indicate the presence of a long-run relationship between returns on railway

and sovereign securities and its adjustment from the short-run to the long-run. Second, results also indicate that investors perceive and manage the risk and return balance in their portfolios. Each is looked at in turn.

Results also point towards a long-run relationship between returns on government and railway securities. For the overall sample using dynamic fixed effects estimation, a 100 basis points increase in return on government securities results in a 35 basis points increase in return on railway securities. Table 5.6 also points towards the adjustment of the relationship from the short to long-run. This was not an unfamiliar concept to investors in the past. Lowenfeld (1909) also hinted on security prices returning to their 'equilibrium' falling any disruption due to speculative practices or economic events. He writes

> ...in the long-run artificial methods of preventing prices from going to their proper level are ineffective...it is only a question of time when a stock will come to its proper selling price" ((Lowenfeld, 1909), p.261)

The dynamic fixed effects estimations evaluate both the short-run coefficients and their adjustment of the long-term relationship in a single framework. The error correction term in Table 5.6 estimates how this disequilibrium causes the variables to adjust towards equilibrium in order to keep the long-run relationship intact (Afonso & Jalles, 2012). The error correction term for the overall sample (-0.077) and for the dis-aggregated sample in terms of capital-rich and capital-poor countries has the expected sign and is significant at the 1 percent level. This result shows that there is a quick adjustment dynamic from short-run to long-run in asset prices in the countries analysed in the article.

Second, the chapter dis-aggregates the overall sample based on country heterogeneity using the typology of capital-rich vs capital-poor countries (Flandreau & Zumer, 2004). When the sample is disaggregated into capital-rich and capital-poor countries, Table 5.6 shows that returns on railway securities are in a substitution relationship with returns on government securities in capital-rich countries whereas they are in a complementary relationship in capital-poor countries. This is consistent across all estimations (specifications 1-9). In comparison to a relationship of complementarity, a relationship of substitution

between returns on railway and government securities offers more diversification opportunities for investors.

This is also evident from (Lowenfeld, 1909) where he writes

> "Whether capital is used in active participation in a business, or by lending to others there is always a risk involved and some portion may be lost in the long run. For this reason, it is self-evident that it would be highly unwise to place the whole of one's possession in any one concern. . . ." ((Lowenfeld, 1909), p.66).

From the results obtained in Table 5.6 it can be argued that investors did not execute naïve diversification and carefully considered relevant country characteristics before attempting to achieve diversification (Gupta & Donleavy, 2009).

The chapter now explores the time-varying relationship between returns on government and railway securities by dis-aggregating the sample on the basis of railway securities carrying a government guarantee. The chapter explores what effect if any, does a government guarantee on railway securities have on the long-run relationship between sovereign and railway securities. A dummy variable is created which takes the value of one if the railway security carrying a government guarantee was listed on stock exchange for that month. The chapter splits the sample into issues carrying a guarantee versus those without it. Results exhibited in Table 5.7 reveal that the relationship between returns on government and railway securities is stronger when railway securities carry a government guarantee. This reiterates that guarantee was the mechanism through which government and railway securities were intricately bound. The next section outlines robustness checks to test the stability of the relationship.

5.8 Robustness Checks

The chapter applies two robustness techniques to estimate the long-run relationship between returns on government and railway securities. First, the chapter uses alternative

Table 5.7: Dynamic Fixed Effects Estimation on railway securities carrying a government guarantee

	(1) Overall	(2) Guaranteed	(3) Not Guaranteed
gov return	0.354***	0.818***	0.001
	(0.098)	(0.086)	(0.158)
Differenced gov return	0.155***	0.164***	0.153***
	(0.029)	(0.025)	(0.049)
Adjustment coefficient	-0.077***	-0.069***	-0.091***
	(0.005)	(0.007)	(0.008)
Constant	0.253***	0.079***	0.445***
	(0.037)	(0.029)	(0.071)

Note: The dependent variable is the return on railway securities calculated as a sum of capital gain and dividend yield. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

estimation techniques such as the Dynamic OLS and the Fully Modified OLS. FMOLS and DOLS estimators, first proposed by Pedroni (2001) simultaneously deal with the problem of endogeneity and serial correlation. Ordinary least square estimators are asymptotically biased and can introduce undesirable endogeneity and serial correlation (Nguyen & Kakinaka, 2019). To mitigate such problems, Pedroni (2001) introduced a group-means fully modified OLS (FMOLS) estimator that incorporates a semi-parametric correction to the OLS estimator to eliminate endogeneity and serial correlation. Table 5.6 exhibits estimation results when using Dynamic OLS techniques (DOLS) and Fully Modified OLS (FMOLS) techniques (specifications 4-9). Results show that there is no qualitative change in the results.

Testing the relationship in the presence of structural breaks

Second, the chapter estimates the relationship while taking into account structural breaks. The Barings Crisis of 1890 is the nineteenth century's most famous sovereign debt default episode (Mitchener & Weidenmier, 2008). Episodes of financial crisis can result in structural breaks, defined as a sudden jump or fall in an economic time series (Ludwig,

2014). Structural breaks are not only attributed to financial crisis but are also caused by changes in regime, policy direction and external shocks. Structural breaks caused by financial crisis can potentially have contagion effects and can spill-over to other sectors in the same country and to other countries through various channels, most notably through trade. The Barings crisis of 1890 had severe macroeconomic implications for the Argentine economy. This was felt for railways as well. The Economist dated Feb 21, 1891 wrote:

> "The collapse of Barings, and the consequent shrinkage in value of all securities in the Argentine Republic, has perhaps nowhere been more widely felt than by the railway companies working in that country. Investors in these securities have seen them drop 20, 30, and 40 percent and even more, with no prospect of a recovery".[9]

The chapter argues that this crisis episode can potentially result in a structural break which can potentially influence the long-run relationship between returns on government and railway securities. A wide body of literature has argued that the stability and strength of the cointegration relationship should be tested by taking into account known and unknown structural breaks (Carrion-i Silvestre & Sansó, 2006). For this chapter, it is important to take into account structural breaks for two reasons. First, it could potentially cause a possible break in the cointegration relationship and second, it could impact the long-run relationship (Afonso & Jalles, 2012).

The chapter uses the Gregory and Hansen (1996) residual-based test to detect structural breaks in the presence of cointegration. The test uses the null hypothesis of no cointegration against the alternative hypothesis of cointegration with a single shift at an unknown point in time. The test does not impose a known structural date but endogenously does so through analysing data. The detected structural breaks can be taken into account by including country-specific dummy variables that are specified according to the estimated break dates. Following Belke, Dobnik, and Dreger (2011) dummy variables are created for the structural break dates in trend identified by the Gregory and Hansen (1996) procedure. This dummy variable 'strucbreak' takes the value of 1 at the estimated structural break

[9] Argentine Railways. (1891, February 21). Economist, 237+. https

Table 5.8: Estimated Structural Break Dates

Country	Trend	Regimetrend
Austria	1901m11	1901m5
Argentina	1892m1	1892m6
Brazil	1902m11	1902m4
France	1888m9	1890m4
Italy	1903m4	1896m5
Russia	1888m5	1888m11
Spain	1906m11	1906m12
Canada	No structural break	No structural break
India	1888m2	1888m2
Australia	No structural break	1906m5
New Zealand	1888m7	1898m8
Turkey	1886m11	1890m12

Notes: The chapter tests for two types of break. The column heading 'trend' refers to a break in the constant and the trend. The column 'regimetrend' refers to a break in the constant and a slope or a break in the constant, the slope and trend.

date and 0 otherwise. One possible limitation of the Gregory and Hansen (1996) procedure is that it has a strict requirement of having no missing data in the variable being tested. Due to this requirement, this procedure was not carried out on Belgium, Portugal and Sweden.

Table 5.8 shows the possible structural break dates with breaks detected in trend and regime. Structural breaks in trend specify a break in the constant and trend, whereas structural breaks in regime trend specify a break in the constant, the slope and the trend (Gregory & Hansen, 1996). The table shows that a structural break in the relationship between returns on railway and government securities occurred in many countries on or near the 1890s.

The chapter uses Dynamic Fixed Effects, Fully Modified OLS and Dynamic OLS techniques, for the sample of 12 countries for the calculation of structural break. The estimations evaluate the long-run relationship between returns on government and railway securities by excluding the date where the structural break was found, or where the vari-

Table 5.9: Estimating the Relationship Accounting for Structural Break on the Overall Sample

	(1) Dynamic Fixed Effects	(2) Dynamic OLS	(3) Fully Modified OLS
gov return	0.322***	0.492***	0.462***
	(0.115)	(0.183)	(0.126)
Adjustment Coefficient	-0.061***		
	(0.005)		
Differenced gov return	0.132***		
	(0.026)		
Constant	0.208***	7.442	1.358*
	(0.036)	(89.204)	(0.805)
Observations	.	4,723	4,741
R-squared		0.582	0.039
Country Effect		YES	YES
Time Effect		YES	YES

Note: The dependent variable is the return on railway securities calculated as a sum of capital gain and dividend yield. Standard errors in parantheses *** p<0.01, ** p<0.05, * p<0.1

able 'strucbreak' equalled 0. Table 5.9 shows that there is no qualitative difference in the results while accounting for possible structural breaks, indicating the strength of the cointegrating relationship between returns on government and railway securities.

While it is important to note that the above results indicate that structural breaks in the data do not influence the long-run relationship between government and railway securities, it is worthwhile to explore how the time-varying nature of the relationship changes during the crisis episode. The next section explores the time-varying relationship between returns on government and railway securities during the decade of 1890s, a period of financial distress for the global economy. This is done in two ways, by studying the relationship during the crisis years and by applying rolling regression techniques. Results indicate that investors were aware of the time-varying nature of this relationship and employed strategies to balance their portfolios to achieving the best return. Each of these is looked in turn.

5.9 Relationship between Government and Railway Securities during the crisis episode

The previous sections exhibited that returns on government and railway securities indicate a significant and positively correlated relationship for the overall sample, but this can be altered during times of economic and financial exigency. This can potentially be caused by investors reassessing their risk preferences, becoming more risk averse, and/or shifting their wealth to less risky asset classes, which is frequently termed a 'flight to quality' phenomenon (Opitz & Szimayer, 2018; Vayanos, 2004). This is also mentioned in the Economist:

> "British investors, both public and private, evidently came to the conclusion that it was better to be content to receive a low rate of interest and preserve the capital, than to receive a high rate of interest and lose the capital or any large part of it. Acting on this salutary principle, they no longer looked abroad for their investments or trusted the so called 'trust companies' to do so for them but steadily gave their attention to home investments and those of the first class."[10]

The Economist further reiterated "a large inflation of prices of second-rate securities led to the speculative mania of 1890-1. During the whole of this time the price of first-class securities had been gradually declining...".[11]

To test the 'flight to quality' relationship in an econometric framework, the chapter constructs a series of monthly yields on UK consol from the NBER microhistory database from 1880-1913.[12] This series is extracted from the Statistical Abstract for the United

[10](1894). The Price of Consols. The Economist, 052 (2651) London: England. p.730

[11]Ibid. This article published on June 16, 1894 also charts the prices of consols over time and argues that historical panics of 1847, 1857 and 1866, resulted in low prices which were restored once the economy came out of recession.

[12]The NBER microhistory database covers all aspects of pre-World War 1 and interwar economies. The chapter took the series m130141b on yield of three percent consols from 1852-1888 and m13041c on the yield of consols from 1888-1938 to cover the data period under analysis for this chapter. Source: https://data.nber.org/databases/macrohistory/contents/uk.html

Kingdom and captures the yield on the three percent consols. To further test whether there was a flight to quality during this time, the chapter defines a variable 'crisis' which takes the value of one from the years 1890-1894 (both inclusive). This period is chosen because historically, this was the period of unsettled status of guarantee payments related to railway securities. This is so as post-Barings crisis of 1891, the Argentinian government faced severe financial difficulties resulting in non-payment of railway guarantees, having contagion like effects in other countries where Barings was a lead underwriter. On Feb 2, 1895 the Argentinian Minister of Finance announced that the question of railway guarantees will be settled by creating special interest bonds for the total sum claimable until the expiration of the guarantees (about eight million sterling).[13] Besides Argentina, other economies in Latin America such as Brazil where the crisis reverberated also announced during the early 1890s that previously unpaid guarantees would now be paid.[14] Similarly, the Spanish government also drafted a bill to assist railway companies.[15]

FMOLS regression is undertaken to test the relationship between returns on railway and government securities in and outside of crisis. Based on the historical evidence mentioned above and empirical investigations, the chapter defines the crisis period between 1890-4. This is further elaborated in Appendix Table 18 which shows that there is a change in the long-run relationship between the period 1890-94 after which it reverts to its equilibrium relationship.[16] The dependent variable is the return on railway securities whereas the two independent variables are the return on government securities of that country and the yield on the UK consol. Yield on the UK consol is taken to proxy the 'flight to quality' phenomenon.

Table 5.10 exhibits the results of the FMOLS regression. During crisis times, return on government securities is positive and significant for the overall sample and for capital poor countries but not for capital rich nations (specifications 1-3). This is so as in contrast

[13](1893). Argentine Railway Guarantees, The Economist, 051 (2597), p.663
[14](1890). Brazilian Railway Guarantees, The Economist, 048 (2433), p.456
[15](1894). The Treasury and the Bank of Spain, The Economist, 052 (2652), p.764
[16]Before applying FMOLS techniques, the chapter checked the data series on yields on three percent consols for stationarity and cointegration. The series is stationary but is cointegrated with returns on railway securities. Following these tests the chapter applied FMOLS techniques to check the long term relationship with returns on railway securities.

Table 5.10: FMOLS Regressions to test relationship in Crisis and Non-crisis Times

	(1)	(2)	(3)	(4)	(5)	(6)
		In crisis			Without crisis	
	Overall	Cap Rich	Cap Poor	Overall	Cap Rich	Cap Poor
gov return	0.390***	0.148	0.360***	0.324**	-1.403***	0.461***
	(0.044)	(0.14)	(0.121)	(0.138)	(0.17)	(0.159)
ukconsol	2.965***	3.250***	3.166**	0.213	0.742	0.307
	(0.504)	(0.726)	(1.545)	(1.366)	(1.067)	(1.694)
Constant	-7.157***	-6.592***	-6.073	1.576	9.993***	1.049
	(1.423)	(2.069)	(4.365)	(4.214)	(3.307)	(5.246)
Observations	846	238	607	4,686	1,202	3,483
R-squared	0.658	0.83	0.746	0.036	0.035	0.032
Country Effect	YES	YES	YES	YES	YES	YES
Time Effect	YES	YES	YES	YES	YES	YES

Note: The dependent variable is the return on railway securities calculated as a sum of capital gain and dividend yield. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

to capital-rich countries, capital-poor countries, specifically colonies, were largely thought to be an extension of the metropolis (Flandreau, 2006). During crisis times investors considered both government securities as well as the benchmark security (the UK consol) in capital-poor countries as 'safe'. On the other hand, the insignificant yield on government securities in capital-rich countries also reflects higher financial development relative to capital-poor countries as investors more actively balance their portfolios and give more importance to first-class securities (such as the UK consol) in light of changing economic circumstances. Overall, the positive and significant coefficient of the variable 'ukconsol' indicates that the 'flight to quality' phenomenon appears in the overall sample as well as in the dis-aggregated sample into capital rich and capital poor countries (specifications 1-3).

In non-crisis times, the equilibrium relationship is attained. Returns on government securities are positive and significant in explaining the return on railway securities. Moreover, it appears to be in a substitution relationship in capital rich countries and complementary relationship in capital poor countries (specification 4-6). The yield on the UK consol carries no significance in explaining the return on railway securities. The next section explores the time-varying nature of the relationship through rolling regression techniques.

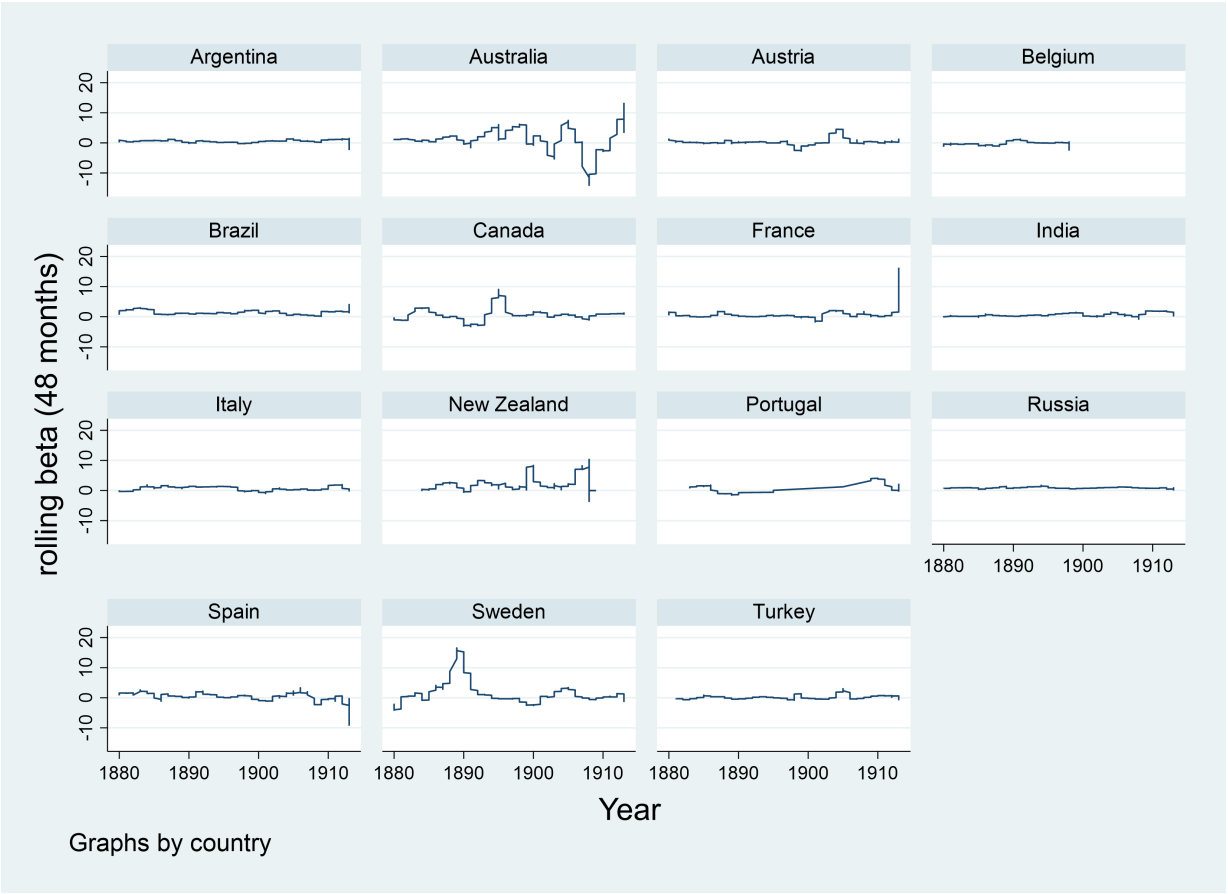
5.9.1 Rolling Window Regressions

Lowenfeld (1909) points to the 'time varying movements' of securities and explains how investors used pricing and market information from information sources such as the Economist to carefully adjust their portfolios across time. He writes:

> "Supposing, then, that the Investor, from a study of the Money Market Article, has been able to watch the different markets of the world, he should now be in a position, if he applies his knowledge rightly, to so adjust and re-adjust his investments from time to time as to always remain in the best market." ((Lowenfeld, 1909), p.351)

Contemporary literature in financial econometrics use rolling window methods to study the potential dynamic relationships between different financial markets (Zhu, Chen, Hau, & Chen, 2021). Rolling windows explore time variations in the level of diversification benefits derived from different securities in a portfolio (Haglund, 2010). Rolling-window estimators, also known as fixed-window estimators, are based on a changing sub-sample of fixed length that moves sequentially from the beginning to the end of the sample by adding one observation at the end of the sample while dropping one at the start. A window size of l means that each rolling sub-sample includes l observations. The selection of window size has no strict criterion. Figure 5.4 depicts rolling coefficients (by a bi-variate regression with returns on railway securities as the dependent variable whereas return on government securities as the independent variable) using a popularly used rolling window of 48 months (Aye, 2015).

Figure 5.4: Rolling beta



Note: The figure shows the rolling beta coefficients using a time window of 48 months.

Figure 5.4 illustrates two important points. First, as pointed out in historical literature that securities were subject to 'controlling influences', the graph exhibits co-movement between railway and government securities. Second, the relationship between railway and government securities can best be described as time varying. Although largely, the disaggregated sample of capital-rich and capital-poor countries adhere to the substitution and complementarity relationship respectively, there are certain points in time where this relationship was broken, potentially due to crisis episodes. The graph also depicts volatility in rolling betas with respect to Australia and New Zealand in the post 1890 period. This

is so as this was a period of economic depression with real GDP falling by 17 percent in 1892 and 1893. The over-extension of the 1880s property boom and its unravelling led to a collapse of private investment in the pastoral industry and urban development and a sharp pullback in public infrastructure investment (Fitz-Gibbon, Gizycki, et al., 2001). A fall in capital inflow from Britain, adverse movements in trade and drought in 1895 accentuated and prolonged the depression. Depressed economic conditions could potentially explain the volatility in the rolling estimates for Australia and New Zealand.

5.10 Direction of Causality

The final step is to determine the direction of causality of the dynamic relationship between returns on government and railway securities. This helps identify which variable acts as a determining factor for another variable. Granger causality in a Vector Autoregression Model implies a correlation between the current values of one variable and the past values of another variable. If there are two variables X and Y, if the lagged values of X and Y can predict X, then Y will granger cause X. On the other hand, if X influences Y, then X granger causes Y. This is known as unidirectional causality because one variable granger causes another variable. In certain cases if both variables X and Y are found to be influenced by the other's lagged values, this is known as bidirectional causality. Table 5.11 provides evidence of significant unidirectional causality from returns on government to railway securities. This indicates that changes to returns on sovereign securities granger cause returns on railway securities. The result implies the beneficial presence of sovereign securities. This is so as the information flow from sovereign to corporate securities indicates that the price informativeness of railway securities improves with the presence of benchmark sovereign securities. Hence, the result implies that (benchmark) sovereign securities promote price discovery. Moreover, this result is also supported by the finding in the earlier chapter that the government guarantee is the mechanism through which sovereign securities have a spillover effect on railway securities.

Table 5.11: Granger Causality between Returns on Government and Railway Securities

Equation\Excluded	chi2	df	Prob>chi2
	rail return		
govreturn	2.992	1	0.084
ALL	2.992	1	0.084
	gov return		
railreturn	2.214	1	0.137
ALL	2.214	1	0.137

Table notes

5.11 Summary and Conclusions

This chapter investigates the time-varying relationship between railway and government securities, the topmost avenues of investment during the first era of globalisation. In doing so, it explores whether the concepts of correlation and co-movement described in detail in historical investment periodicals can be explored through modern time series techniques. The paper employs dynamic fixed effects, DOLS and FMOLS model on fifteen capital-rich and capital-poor countries during 1880-1913 and gives three important results. First, results indicate the existence of a long-run relationship between returns on railway and government securities. Estimates on the overall sample suggest that a 100 basis points increase in the return on government securities results in a 35 basis points increase in the return on railway securities. The long-run relationship withstands various robustness checks and is stronger in the case of railway securities carrying a government guarantee. Moreover, investigating the adjustment parameter (the error correction term) from the short to the long run reveals adjustment in all the countries in the sample. Second, investors were not naïve and took account of country heterogeneity when applying their investment strategies. Relationship between returns on railway and government securities is that of substitution in capital-rich countries, whereas it is complementary in capital-poor countries. Third, the relationship between returns on railway and government securities illustrates a time-varying nature due to increased investor risk aversion and a possible flight to quality during crisis periods. This is evident through slicing the data into 48 month windows and

applying rolling regressions.

Chapter 6

Summary and Conclusions

The thesis explores the drivers and patterns of investment flows in *quasi-sovereign* railway securities from fifteen capital-rich and capital-poor countries. Taking an investor's perspective, the thesis investigates the nexus between sovereign and railway securities. The thesis fits into the domain of historical infrastructure finance and contributes to literature dealing with international financial markets, financial globalisation and portfolio choice. The key argument the thesis makes is that investors form perceptions of country creditworthiness taking both sovereign and railway securities into account. In doing so, it expands existing research on the roots of country creditworthiness during 1880-1913, which has so far exclusively relied on studying sovereign securities. By looking at both sovereign and railway securities, the thesis improves current understanding on how market sentiment on country creditworthiness was shaped.

Understanding sovereign and railway securities in a unified framework has implications for our understanding on sovereign debt, country creditworthiness and infrastructure finance. First, the thesis uses the framework of Modern Portfolio Theory to explore investors' portfolio choice during 1880-1913. Through various quantitative techniques, the thesis shows the beneficial presence of sovereign securities in terms of completing the market and in promoting price discovery. Second, investor perceptions on country creditworthiness (taking both railway and sovereign securities into account) has implications for the short run in terms of country's continued access to funds both for budgetary concerns as

well as more long-term concerns with respect to development financing. Third, studying infrastructure securities in the past, the thesis aims to inform policy-making on project bonds and enhances our understanding on how market perceptions on the risk profile of infrastructure securities are formed. This is beneficial in providing a perspective on improve the funding conditions of public sector enterprises and in reducing the cost of public investments today.

The thesis investigates the period 1880-1913, characterised as a time of rising international integration in goods and financial markets where Britain, specifically London, was the financial capital of the world. Besides Britain, European centres of power such as France and Germany were also large capital exporting countries and accounting for 76 percent of total global foreign investment (Tunçer, 2015). Britain was the leader in terms of volume of capital exports and had a diversified portfolio in terms of geographies and industries. Geographically, this capital was largely directed towards its empire. In terms of industrial sectors, sovereign and railway securities attracted the highest proportion of British investment. Railways were argued to be "the principal single determinant of the levels of investment, national income and employment in the nineteenth century" (Atack et al., 2010).

As an industry, railways are characterised by certain distinctive features. Railway projects are highly capital intensive, exhibit asset-specificity and require substantial upfront investments. Railways are also characterised by enormous sunk costs and take a long time to breakeven (Helm, 2010; Kasper, 2015; Sawant, 2010). It is due to the characteristic nature of railway projects that makes government intervention necessary for the viability of the project. Governments were heavily involved in attracting funds to construct railway projects. This was done through two ways. First, governments played a crucial role in the viability of railway projects through the issuance of sovereign guarantees. Second, as an industry, railways were structured as emergent Build-Operate-Transfer (BOT) schemes and exhibited varying shades of public and private ownership and management. These features, as the thesis argues, made railway securities quasi-sovereign in nature. This had implications on their financing as well. When railways were publicly operated, the lending was directed via government borrowing. On the other hand when railway were privately

owned, construction of railways was accompanied by significant public expenditure: related infrastructure, guarantees etc. This resulted in a strong complementarity between private and public sector investments in this period (Della Paolera & Taylor, 2013).

This close complementarity between public and private investments exhibited either in the form of governments providing guarantees on railway investment or through ownership and management of railway BOT projects, is investigated throughout the thesis using both qualitative and quantitative methods. The thesis sheds exclusive focus on the government guarantee for railway securities, a theme which runs throughout it. Investments in railway construction were profitable due to handsome guaranteed returns coupled with a portion of profits, and overall, paid a higher overall return relative to the same amount invested in government securities. Borrowers offered higher returns on railway investments than sovereign instruments to attract investments in long-term, capital intensive mega-projects of that time. This was more so for capital-poor countries which had either non-existent or shallow capital markets, and relied exclusively on global stock exchanges to raise financing. In this way, government guarantees on railway project served as a signalling device for borrowing governments and corporations. The thesis argues that the provision of government guarantees was important in reducing information asymmetries regarding borrower and project quality and therefore worked to boost investor confidence in their investment in the project. More importantly, the guarantee played an important role in signalling credible commitment. Investigating various railway contracts, foreign counsel reports and bond prospectuses reveals that the provision of guarantee was a crucial clause, with the borrower now bound by a legal framework to meet its commitments. While on the one hand it was important for borrowers to attract investors through exhibiting their credible commitment towards the project, on the other hand, it was also important for investors to believe that the guarantee was in fact credible. The thesis shows that under a market microstructure of reputed intermediaries floating railway securities on global stock exchanges and legal frameworks where colonies were bound by imperial law, investors perceived the guarantee to be credible.

Investor perceptions on the credibility of the government guarantee is also exhibited through two other ways. First, official publications, articles from the popular press and re-

ports of the Council of Foreign Bondholders reveals that guaranteed railway securities held an elevated status during crisis episodes. An example of this is from the 'Romero arrangement' in the aftermath of the Barings crisis of 1890, which exhibited that only guaranteed railway companies were part of government efforts towards consolidation of Argentinian finances. Second, besides qualitative evidence the thesis also provides quantitative evidence that irrespective of whether countries were capital-rich or capital-poor, investor perceived their investment to be less risky when the railway security carried a government guarantee. In this way, the government guarantee illustrates the nexus between sovereign and railway securities as it appears as the mechanism through which sovereign creditworthiness has a spillover effect on railway securities.

The thesis also explores the nexus between government and railway securities through a risk-return framework. Sovereign securities are benchmark securities, representing claims on the government of origin, with their value depending only on factors systematic to the country. In contrast, corporate securities depend not only on these systematic factors, but also bear idiosyncratic risk specific to the issuing company. The thesis calculates yield spreads on railway securities, an indicator of its risk premium over the long-term benchmark UK government bond. The thesis explores the determinants which contribute towards risk adjusted returns on railway securities. Accounting for various effects (country, time, firm and instrument) and under a variety of robustness checks, the benchmark yield spread on sovereign security, perhaps not surprisingly, emerges as a key determinant explaining yield spreads on railway securities. Benchmark securities play an important role in market completion and allow heterogeneously informed investors to hedge against major income risks and adverse selection (Dittmar & Yuan, 2008; Shiller, 1993). This is specifically so for capital-poor countries, especially those at the early stage of their development, since these markets are characterised by severe incompleteness and intense information asymmetry (Yuan, 2005).

Despite the obvious result that yield spreads on benchmark securities explain yield spreads on railway securities, interestingly, country heterogeneity influences this relationship. The yield spread on the sovereign security exhibits a relationship of *substitution* in capital-rich countries whereas a relationship of *complementarity* in capital-poor countries.

This has two implications. First, it exhibits the relative levels of financial development in both sets of countries. Second, it has implications for investors' portfolio choice as a relationship of *substitution* offers more hedging opportunities relative to a relationship of *complementarity*. In addition to this, besides systematic factors, industry-specific variables such as railway freight carried, debt ratio and firm age appear significant idiosyncratic risk factors to explain yield spreads on railway securities. It is important to note that considering the close interconnection between government and railways, hypothetically, there is a high likelihood that common determinants explain yield spreads on both railway and government securities. Empirical analysis reveals that interest servicing as a proportion of government revenue, (indicating country debt burden) is the common determinant which explains yield spreads on both railway securities and sovereigns. This finding corroborates to a rich literature on country creditworthiness which elucidates that investors assess country creditworthiness and pay close attention to borrowers' potential to meet their commitments (Daniels et al., 2020). Overall, the finding that common determinants exist which explain yield spreads on railway and government securities, gives credence to the key argument of the thesis that investors form perceptions of country creditworthiness taking both sovereign and railway securities into account.

The thesis covers a time span of 33 years, allowing it to investigate the nexus between railway and government securities in different states of the world, during both crisis and tranquil periods. As mentioned above, this period was characterised by high financial integration, and in an environment of financial integration, asset prices hold important information and hence volatilities in different asset classes could affect each other (Ross, 1989a). A wide body of literature has also argued that periods of high financial integration can potentially result in asset price co-movements. More specifically, assets with state-contingent claims, exhibit a consistent and close pairwise association since their value depends on the same asset generating process (Jobst, 2006). The thesis takes the case of railway and government securities for this thesis, and argues that government securities and quasi-sovereign railway securities, belonged to the same asset generating process, and hence, experience time-varying co-movement. The thesis investigates time-varying co-movement between higher frequency monthly returns on railway and government securities. Results suggest that returns on government and railway securities exhibit time-varying

co-movement. Country heterogeneity plays a crucial role in influencing co-movement especially during crisis episodes such as the Barings episode of 1890, where investors exhibit 'flight to quality', and reflect risk averse behaviour in their investment decisions.

Empirical investigations suggest that the direction of causality runs from returns on sovereigns to railway securities, which implies the beneficial presence of sovereign securities. This is so as the information flow from sovereign to corporate securities indicates that the price informativeness of railway securities improves with the presence of benchmark sovereign securities. Hence, (benchmark) sovereign securities promote price discovery. Moreover, this result is also supported by the finding that the government guarantee is the mechanism through which sovereign securities have a spillover effect on railway securities.

Overall, the thesis applies the theoretical framework of Modern Portfolio Theory to historical infrastructure finance, which argues that asset selection should be based on two characteristics; 1) on the unique characteristics of the security and 2) how each security exhibits co-movement with all other securities. Econometric results indicate co-movement between returns on railway and government securities are supplemented with narratives given in notable investment chronicles in the past. In this way, the thesis sheds light on investor portfolio strategies and argues that historical investors were just as aware of the concepts of correlation, diversification and co-movement as their contemporary counterparts.

This thesis uses multiple data sources to test the relationship between sovereign and railway securities. Data on bond prices and bond characteristics is taken from the Investor's Monthly Manual (1869-1930). The IMM, a monthly supplement produced by the Economist contained detailed information on the available bonds, details on price (latest, high and low during the month), coupon payment dates and information on bond underwriters (more so for sovereign issues). The thesis also uses railway level information from the Manuel Des Societes Anonymes Fonctionnant en Turquie (1906), International Historical Statistics by Mitchell and Statistical Abstracts of Foreign Countries and Colonies. Macroeconomic variables are taken from the Global Finance database. These databases are complemented with official publications and reports and articles from the financial press.

The thesis has two key limitations. First, an important stakeholder in railway financ-

ing were financial intermediaries, specifically underwriters floating railway securities on global stock exchanges. Given the dearth of information about sovereign borrowers, investors relied on intermediaries' reputation to guide their investments (Flandreau & Flores, 2009). By underwriting bonds for foreign governments, underwriters played a crucial role in helping sovereign borrowers access financial markets and thus contributed towards the development of a sustainable sovereign debt market in the early nineteenth century (Flandreau, Flores, Gaillard, & Nieto-Parra, 2010). A major portion of the thesis was written during the COVID-19 pandemic which resulted in closure of the archives leaving the role of underwriters unexplored. Second, there are data limitations, which if addressed could make the analysis richer. Specifically, data on maturity of railway securities could be collected from sources other than the Investor's Monthly Manual to add richer bond-specific information.

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APPENDICES

.1 Chapter 2

Table 1: Opening Date and Ownership Structure of Railway Companies

Possessions	Ownership	First Opening	1850	1860	1870	1880	1885	1890	1895	1900
Dominion of Canada	Govt	1855		194	200	1,420	1,184	1,214	1,379	1,543
	Private	1836	66	1861	2,417	5,471	8,966	12,042	14,598	16,114
British India	Govt & Private	1853		839	4,775	9,300	12,368	16,345	19,408	24,670
New Zealand	Govt	1863			46	1,287	1,613	1,842	2,014	2,212
	Private	Not stated					41	114	167	88
South Africa	Govt	1873				1,005	1,683	1,869	2,294	2,528
	Private	1860		2	6		135	177	188	404
Australia	Govt	1854		215	953	3,427	6,117	9,085	10,870	12,497
	Private	1876				205	266	439	731	734

The table presents records of railways companies owned by the government and the private sector, thus having both sovereign and corporate characteristics. Source of data include "Statistical Abstracts for the several colonial and other possessions of the UK in each year from 1888 TO 1902. Fortieth number. Page 254."

Table 2: Panel Corrected Standard Errors Regression with USA

Dep variable	(1) r_spread Overall	(2) r_spread Cap Rich	(3) r_spread Cap Poor	(4) r_spread Overall	(5) r_spread Cap Rich	(6) r_spread Cap Poor
g_spread	0.369***	-0.442**	0.485***	0.190*	-0.398**	0.364***
	(0.107)	(0.173)	(0.117)	(0.098)	(0.161)	(0.114)
Interest servicing/Gov Revenue				1.769*	-2.135	1.824*
				(0.931)	(2.622)	(0.998)
Railway Market Capitalisation/Public Debt				255.732***	24.766	298.236***
				(69.583)	(75.304)	(75.914)
Exports/Population				-0.036	-0.078*	4.654
				(0.028)	(0.044)	(5.954)
Log Railway Miles				0.176	-3.077***	-0.654
				(0.262)	(0.732)	(0.477)
Passengers Carried/Population				-0.038	-0.152**	-0.011
				(0.032)	(0.064)	(0.038)
Freight carried/Population				-0.252***		-0.124
				(0.072)		(0.083)
Gold dummy				0.214*	0.342	0.224*
				(0.114)	(0.304)	(0.126)
railinterest				0.373**		0.234
				(0.176)		(0.230)
Observations	398	125	273	329	124	205
R-squared	0.638	0.553	0.661	0.553	0.763	0.532
Number of cc	16	5	11	14	5	9
Country Effect	YES	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES	YES

Robust Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The dependent variable *r_spread* is the yield spread on railway securities. *g_spread* is the yield spread on government securities. *intrev* measures the debt servicing burden defined as interest servicing divided by government revenue. *debtratio* measures railway indebtedness defined as railway market capitalisation divided by public debt. *exppop* is a measure of exports per capita calculated by dividing exports by population. *logmiles* is a logarithm of the total railway network in the country.*passpop* is calculated as passengers carried divided by population. *freightpop* is the freight carried divided by population. *golddummy* is the dummy variable which captures the years the country was on a gold standard. *railinterest* captures the average interest rate offered on railway securities.

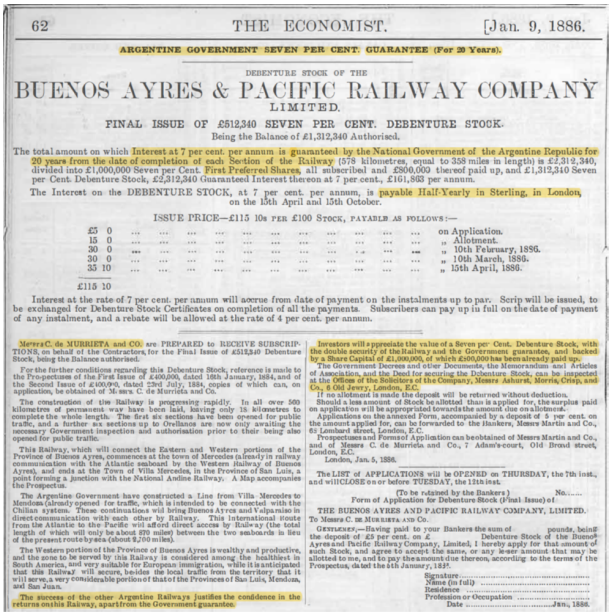
Table 3: Government Loans Raised Explicitly for Financing Railways

Name	mean(yield)
Argentina 4% Railway Guaranteed Restorat	5.16
Argentina 5% North Central Railway Exter	5.73
Argentina 5% Santa Fe and Reconquista Ra	5.77
Argentina 6% Railway Loan of 1881	6.14
Brazil 4% Railway Guaranteed Res. Bonds	4.82
Buenos Aires Province 4.50% Railway Exte	5
Chile 5% Coquimbo Railway Bond	5.18
China 5% Canton-Kowloon Railway Loan	5
China 5% Hukuang Railways Bond	5.23
China 5% Imperial Railway Loan	5.15
China 5% Shanghai-Hangchow Railway Bond	5.05
China 5% Shanghai-Nanking Railway Bond	4.95
China 5% Tientsien-Pukow Railway Bond	5.03
Colombia 6% Bond of 1863 Secured on 15%	
Entre Rios 6% Central Railway Mortgage B	6.45
Finland 4.50% Government Railway Bond	4.63
Greece 4% Railway Loan of 1902	4.62
Honduras 10% Railway Loan of 1867	
Honduras 10% Railway Loan of 1870	
India 4% East Indian Railway Bonds	3.88
Italy 5% Maremmana Railway Bonds of 1862	4.48
Mexico 5% National Railway Bond of Tehua	6.78
Peru 5% Pisco to Ayacucho Railway Loan	
Peru 6% Railway Loan of 1870	
Portugal 5% Minho and Douro Railway Bond	5.61
Russia 4% Consolidated Railway Series of	5.25
Russia 4% Consolidated Railway Series of	5.55
Russia 4% Nicholas Railway bonds of 1867	4.53
Russia 5% Consolidated Railway Series Bo	5.45
Russia 5% Consolidated Railway Series Bo	5.54
Russia 5% Consolidated Railway Series Bo	5.53
Russia 5% Consolidated Railway Series Bo	5.48
Santa Fe Province 5% Northern Col. Railw	5.2
Santa Fe Province 5% Western Central Rai	5.54
Sardinia 5% State Railway Loan of 1851	4.59
Switzerland 3.50% Federal Railway Bonds	3.67
Victoria Railway 4% Bonds of 1881	3.68
Victoria Railway 4% Inscribed Bonds of 1	3.67
Victoria Railway 4% bonds of 1874-1876	3.79
Victoria Railway 4% bonds of 1876	4.1
Victoria Railway 4% bonds of 1883	3.88
Victoria Railway 5% bonds of 1869 Redeem	4.16
Victoria Railway 6% bonds of 1859-1863 R	5.31
Victoria Railway 6% bonds of 1859-1863 R	5.03
Victoria Railway 6% bonds of 1865 Redeem	4.51
Victoria Railway 6%Bonds Redeemable 1959	4.1

Source: Investors Monthly Manual

.2 Chapter 3

Figure 1: An Advertisement for the Buenos Ayres and Pacific Railway Company



62 THE ECONOMIST. [Jan. 9, 1886.

ARGENTINE GOVERNMENT SEVEN PER CENT. GUARANTEE (For 20 Years).

DEBENTURE STOCK OF THE

BUENOS AYRES & PACIFIC RAILWAY COMPANY LIMITED.

FINAL ISSUE OF £512,340 SEVEN PER CENT. DEBENTURE STOCK.

Being the Balance of £1,312,340 Authorised.

The total amount on which Interest at 7 per cent. per annum is guaranteed by the National Government of the Argentine Republic for 20 years from the date of completion of each Section of the Railway (578 kilometres, equal to 358 miles in length) is £2,312,340, divided into £1,000,000 Seven per Cent. First Preferred Shares, all subscribed and £800,000 thereof paid up, and £1,312,340 Seven per Cent. Debenture Stock, £2,312,340 Guaranteed Interest thereon at 7 per cent., £161,863 per annum.

The Interest on the DEBENTURE STOCK, at 7 per cent. per annum, is payable Half-Yearly in Sterling, in London, on the 15th April and 15th October.

ISSUE PRICE—£115 10s PER £100 STOCK, PAYABLE AS FOLLOWS:—

£5	0	on Application.
15	0	„ Allotment.
30	0	„ 10th February, 1886.
30	0	„ 10th March, 1886.
35	10	„ 15th April, 1886.
£115	10	

Interest at the rate of 7 per cent. per annum will accrue from date of payment on the instalments up to par. Scrip will be issued, to be exchanged for Debenture Stock Certificates on completion of all the payments. Subscribers can pay up in full on the date of payment of any instalment, and a rebate will be allowed at the rate of 4 per cent. per annum.

Messrs C. de MURRIETA and CO. are PREPARED to RECEIVE SUBSCRIPTIONS, on behalf of the Contractors, for the Final Issue of £512,340 Debenture Stock, being the Balance authorised.

For the further conditions regarding this Debenture Stock, reference is made to the Pro-spectuses of the First Issue of £400,000, dated 16th January, 1884, and of the Second Issue of £100,000, dated 23rd July, 1884, copies of which can, on application, be obtained of Messrs. C. de Murrieta and Co.

The construction of the Railway is progressing rapidly. In all over 500 kilometres of permanent way have been laid, having only 78 kilometres to complete the whole length. The first six sections have been opened for public traffic, and a further six sections up to Ovellanos are now only awaiting the necessary Government inspection and authorisation prior to their being also opened for public traffic.

This Railway, which will connect the Eastern and Western portions of the Province of Buenos Ayres, commences at the town of Mercedes (already in railway communication with the Atlantic seaboard by the Western Railway of Buenos Ayres), and ends at the Town of Villa Mercedes, in the Province of San Luis, a point forming a junction with the National Andine Railway. A Map accompanies the Prospectus.

The Argentine Government have constructed a Line from Villa Mercedes to Mendoza (already opened for traffic, which is intended to be connected with the Chilian system. These continuations will bring Buenos Ayres and Valparaiso in direct communication with each other by Railway. This International Route from the Atlantic to the Pacific will afford direct access by Railway (the total length of which will only be about 870 miles) between the two seaboards in lieu of the present route by sea (about 8,700 miles).

The Western portion of the Province of Buenos Ayres is wealthy and productive, and the zone to be served by this Railway is considered among the healthiest in South America, and very suitable for European immigration, while it is anticipated that this Railway will secure, besides the local traffic from the territory that it will serve, a very considerable portion of that of the Provinces of San Luis, Mendoza, and San Juan.

The success of the other Argentine Railways justifies the confidence in the returns on this Railway, apart from the Government guarantee.

Investors will appreciate the value of a Seven per Cent. Debenture Stock, with the double security of the Railway and the Government guarantee, and backed by a Share Capital of £1,000,000, of which £800,000 has been already paid up.

The Government Decrees and other Documents, the Memorandum and Articles of Association, and the Deed for securing the Debenture Stock, can be inspected at the Offices of the Solicitors of the Company, Messrs Ashurst, Morris, Crisp, and Co., 6 Old Jewry, London, E.C.

If no allotment is made the deposit will be returned without deduction.

Should a less amount of Stock be allotted than is applied for, the surplus paid on application will be appropriated towards the amount due on allotment.

Applications on the annexed Form, accompanied by a deposit of 5 per cent. on the amount applied for, can be forwarded to the Bankers, Messrs Martin and Co., 68 Lombard street, London, E.C.

Prospectuses and Forms of Application can be obtained of Messrs Martin and Co., and of Messrs C. de Murrieta and Co., 7 Adam's-court, Old Broad street, London, E.C.

London, Jan. 5, 1886.

The LIST of APPLICATIONS will be OPENED on THURSDAY, the 7th inst., and will CLOSE on or before TUESDAY, the 12th inst.

(To be retained by the Bankers.) No.....

Form of Application for Debenture Stock (Final Issue) of

THE BUENOS AYRES AND PACIFIC RAILWAY COMPANY, LIMITED.

To Messrs C. de Murrieta and Co.

Gentlemen,—Having paid to your Bankers the sum of pounds, being the deposit of £5 per cent. on £ Debenture Stock of the Buenos Ayres and Pacific Railway Company, Limited, I hereby apply for that amount of such Stock, and agree to accept the same, or any lesser amount that may be allotted to me, and to pay the amount due thereon, according to the terms of the Prospectus, dated the 5th January, 1886.

Signature .....
Name (in full) .....
Residence .....
Profession or Occupation .....
Date .....1886.

Notes: Source: Buenos Ayres & Pacific Railway Company Limited. (1886, January 9). Economist, 62.

.3 Chapter 4

Figure 2: Scatterplot matrix of Yield Spreads on Railway and Government Securities and the Interest Burden

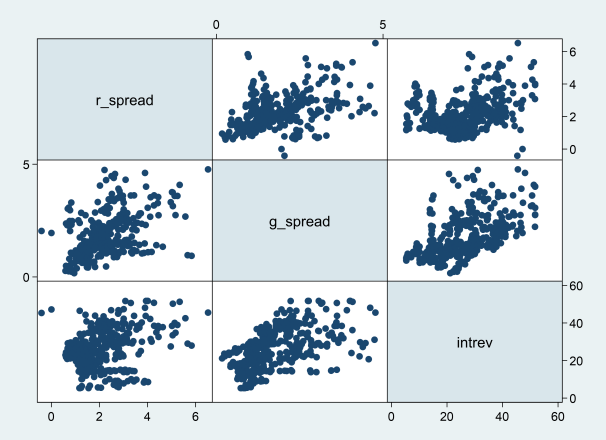


Table 4: Details on Railway Securities

Country	Railway Security Name
	Argentine North-Eastern Railway
	Argentine Transandine Railway
	Buenos Aires & Valley Transportation Railway
	Argentina 4% Railway Guaranteed
	Argentina 5% North Railway
	Argentina 5% North Central Railway
	Argentina 5% Santa Fe and Reconquista Railway
	Argentine Great Western Railway
	Buenos Aires & Ensenada Port Railway
	Buenos Aires, Ensenada & South Railway
	Buenos Aires & Pacific Railway
	Buenos Aires & Rosario Railway
	Buenos Aires Central Railway
	Buenos Aires Great Southern Railway
	Buenos Aires Midland Railway
	Buenos Aires Northern Railway
	Buenos Aires Province 4.50% Railway
	Buenos Aires Western Railway
	Central Argentine Railway
	Cordoba Central Railway Ltd. 4% 1st Debentures
	Cordova and North-Western Railway
	Cordoba and Rosario Railway
	East Argentine Railway
	Entre Rios 6% Central Railway
	Forestal Railway
	North West Argentine Railway
	Northern Railway of Buenos Aires
	Santa Fe & Cordoba Great Southern
	Santa Fe and Reconquista
	Santa Fe Province 5% Northern
	Santa Fe Province 5% Western
	Villa Maria & Rufino
Australia	Alexandra (Newport & South Wales) Dock & Railway
	Chillagoe Mining and Railway 6% Debentures
	Emu Bay and Mount Bischoff Railway
	Great Fingall Consolidated Railway
	Melbourne and Hobson's Bay United Railway
	Midland Railway Co. of Western Australia
	Mount Lyell Mining and Railway Co. Ltd.
	Victoria Railway 4% Bonds of 1881
	Tasmanian Main Line
	Sydney & Louisburg Coal and Railway Ltd.
Austria	South Austrian & Lombard-Venetian Railway
Belgium	Antwerp and Rotterdam Railway
	Belgian Eastern Junction Railway
	Namur and Liege Railway
	Sambre and Meuse Railway Ltd
Brazil	Alagoas Railway
	Araraquara Railway
	Bahia & San Francisco Railway Ltd. 6%
	Bahia Blanca & North West Railway 4.50%
	Brazil 4% Railway Guaranteed Res. Bonds
	Brazil Great Southern Railway
	Brazil North-Eastern Railway 6% 1st Debe
	Brazilian Imperial Central Bahia Railway
	Brazilian Street Railway
	Campos and Carangola Railway Ltd. 5% Deb
	Central Bahia Railway
	Conde d'Eu Railway
	Donna Theresa Christina Railway Ltd. 5.5%
	Espirito Santo and Caravellas Railway Co
	Great Western of Brazil Railway Co. 6% Debentures
	Imperial Brazilian Natal and Nova Cruz Railway
	Ituana Railway Co. 6% Debentures
	Leopoldina Railway
	Machae and Campos Railway 5% Debentures
	Madeira-Mamore Railway
	Minas and Rio Railway Co. Ltd. 6% Debentures
	Mogyana Railways Co. 5% Debenture Bonds
	Natal and Nova Cruz Railway Ltd. 5.50% Debentures
	Para Electric Railway
	Porto Alegre Railway
	Recife & San Francisco (Pernambuco) Rail
	Rio Claro Railway & Investment Co. 5% Debentures
	Rio Claro Sao Paulo Railway
	Rio de Janeiro & Northern Railway
	Sao Paulo & Rio de Janeiro Railway 6%
	Southern Brazilian Rio Grande do Sul Railway
	Southern Sao Paulo Railway 5% 1st Debentures
	Sorocabana Railway Co. 4.50% 1st Debentures

Table 5: Details on Railway Securities

Country	Railway Security Name
Canada	Alberta & Great Waterways Railway 5% Guaranteed
	Alberta Railway & Irrigation Co.
	Algoma Central & Hudson Bay Railway Co.
	Algoma Eastern Railway Co. 5% 1st-Mortgage
	Atlantic and St. Lawrence (Grand Trunk)
	British Columbia Electric Railway Co. Ltd
	Calgary & Edmonton Railway Co. 4% Debentures
	Canada Atlantic Railway Co. 4% Gold Bond
	Canada Central Railway Co. 5% 1st Mortgage Bonds
	Canada Southern Railroad 5% Guaranteed Bonds
	Canadian Northern Alberta Railway Co
	Canadian Northern Ontario Railway Co.
	Canadian Northern Pacific Railway Co. 4%
	Canadian Northern Quebec Railway Co.
	Canadian Northern Railway Co. Inc. 3% De
	Canadian Pacific Railroad 3.50% 50-year
	Cape Breton Coal Iron & Railway Co. Ltd.
	Caraquet Railway Co. 6% 1st Mortgage Bon
	Dominion Atlantic Railway Ltd.
	Edmonton Dunvegan & British Columbia Railway
	European and North American Railway 6%
	Grand Trunk Railway
	Great Western Railway of Canada
	International Bridge (Grand Trunk) Railway
	Levis (Quebec) and Kennebec Railway 7% M
	Manitoba & South-West Colonisation Railway
	Midland Railway of Canada 5% 1st Mortgag
	Montreal Street Railway Co. 4.50% Sterli
	Montreal and Champlain Railroad 5% 1st M
	Montreal and Sorel Railway
	Nakusp and Slocan Railway 4% Guaranteed
	New Brunswick Railway 4% Consolidated De
	Newfoundland Railway 6% 1st Mortgage
	Northern Railway Co. of Canada 4% Perpet
	Ontario and Quebec Railway 5% Perpetual Debentures
	Pacific Great Eastern Railway 4.50% Gura
	Qu'Appelle Long Lake and Saskatchewan Railway
	Quebec & Lake St John Railway 3%-5% Bond
	Quebec Central Railway
	St. John and Maine Railway 5% Debenture
	St. Laurence and Ottawa Railway 4% Bonds
	Temiscouata Railway St. Francis Branch
	Toronto Grey & Bruce of Canada Railway
	Toronto Railway Co. 4.50% Sterling Bonds
	Toronto Suburban Railway 4.50% Debenture
	Wellington Grey and Bruce of Canada Railway
	White Pass and Yukon Railway 6% Debentures
	Windsor & Annapolis Railway 4% Debenture
	Shuswap Railway
France	Eastern Railroad of France
	Northern of France Railway
	Orleans and Rouen Railway 3% Sterling Bonds
	Paris and Orleans Railway
	Southern Railway of France
	Western Railway of France
	West Flanders Railway
India	Assam Railways & Trading Co. Ltd
	Assam-Bengal Railway Co. Ltd
	Barsi Light Railway Ltd
	Bengal Dooars Railway Co. Ltd
	Bengal Central Railway Ltd
	Bengal Nagpur Railway Guaranteed Shares
	Bengal and North-Western Railway Co. Ltd
	Bombay Baroda and Central India Railway
	Burma Railways Co. Ltd. 2.50% Guaranteed
	Darjeeling Himalayan Railway Ltd. 3.5% D
	Delhi Umballa Kalka Railway Ltd.
	Eastern Bengal Railway Ltd
	East Indian Railway
	Great Indian Peninsula Railway 3% Guaran
	Indian Midland Railway Co. 4% Guaranteed
	Madras & Southern Mahratta Railway 3.50%
	Madras Railway Co
	Nilgiri Railway Ltd. 4% Debenture
	Nizam's Guaranteed State Railways

Table 6: Details on Railway Securities

Country	Railway Security Name
Italy	Italian Railways
	Italy Maremmana Railway
	Palermo Marsala & Trapani Railway
	Royal Sardinian Railway
	Sardinia 5% State Railway Loan of 1851
	Sicilian Railway Ltd. 6% 1st Mortgage Debentures
	South Italian Railway 3% Obligations
New Zealand	New Zealand Midland Railway
	Wellington & Manawatu Railway
Portugal	Beira Alta Railway Co. of Portugal 3% Obligations
	Beira Railway 4.50% Debenture
	Portugal 5% Minho and Douro Railway
Russia	Armavir Railway
	Black Sea-Kuban Railway 4.50% Guaranteed
	Dvinsk and Vitebsk Railway Ltd. 4% Bonds
	Grand Russian Railway 4% Nicholas Bonds
	Kahetian Railway Co. 4.50% Guaranteed Bo
	Kharkov-Azov Railway 5% Bonds (Guranteed)
	Kharkov-Krementschug Railway 5% Bonds (Guaranteed)
	Troitzk & Kokand Namangan Railways 4.50%
	Kursk Kharkov Azov Railway 5% Bond (Guaranteed)
	Moscow-Jaroslaw Railroad 5% Guaranteed Bonds
	Moscow-Kursk Railway 6% Bonds
	Moscow-Windau-Rybinsk Railway 4% Guaranteed
	Orel-Vitebsk (Provincial) Railroad 5% Guaranteed
	Provincial Orlov Railway
	Russia 4% Consolidated Railway Series
	Russia 4% Conversion Railroad Bonds
	Russia 4% Nicholas Railway bonds
	Russia 5% Consolidated Railway
	Tamboff Railway
	Wolmar Railway Co. 4.50% Guaranteed Bond
Spain	Alcoy & Gandia Railway
	Bilbao River and Cantabrian Rail
	Great Southern of Spain Railway
	Jerez to Algeciras-Gibraltar Railway 6%
	Northern of Spain Railways 3% Priority D
	Parcocha Iron Ore & Railway Ltd. 6% Debe
	Zafra and Huelva Railway 3% Bonds
Sweden	Bergslagernas Railway
	Nassjo og Oscarshamn Railway 5% 1st Mort
	Royal Swedish Railway Ltd. 3% Consolidat
	Swedish Central Railway Ltd.
Turkey	Metropolitan Railway Co. of Constantinople
	Ottoman Railway of Anatolia Railway 4.50
	Ottoman Smyrna & Cassaba Railway Co. 4%
	Ottoman Smyrna-Aidin Railway Co. 4% 1st

Table 7: Representative Government Bonds

Country	**Representative Government Security**
Austria	Austria 4% Gold Rentes
Argentina	Argentina 6% Public Works of 1871, Argentina 5% Bonds of 1886-1887
Belgium	Belgium 3% Bonds of 1874, Belgium 3% Rentes
Brazil	Brazil 4.50% Bonds of 1863, Brazil 4% Bonds of 1889
France	France 3% Rentes
Italy	Italy 5% Rentes of 1861, Italy 3.50% Rentes
Portugal	Portugal 3% Irredeemable New Loan of 1874, Portugal 3% Irredeemable Loan
Russia	Russia 5% Bonds of 1822
Spain	Spain 5% Quicksilver Mortgage of 1870, Spain 4% Sealed Bonds
Sweden	Sweden 4% Bonds of 1880 1st Issue
Canada	Canada 4.50% Bonds of 1880, Canada 4% Bonds of 1889
India	India 4.50% Bonds of 1872, India 3% Stock
Australia	New South Wales 4% Bond of 1875, Queensland 4% Bonds Redeemable 1924
New Zealand	New Zealand 5% Bond of 1864, New Zealand 6% Bond of 1866
Turkey	Turkey 4% Bonds of 1855

Table 8: Variable Description

Variable	Definition	Expected Sign	Data Source
r_spread	railreturn-ukgovgold		Investors Monthly Manual, Global Finance database
g_spread	govreturn-ukgovgold	+	Investors Monthly Manual, Global Finance database
Intrev	Interest Servicing/Government Revenue	+	Global Finance Database
Defrev	Budget Deficits/Government Revenue	+	Global Finance Database
Exppop	Exports/Population	-	Global Finance Database
golddummy	Years in which country was on a gold standard	-	Various sources
debtratio	Market capitalization/ Public Debt	-	Investors Monthly Manual, Global Finance database
logmiles	Log of Length of Railway Network	+	International Historical Statistics
Passpop	Passengers Carried by Railways/Population	-	Statistical Abstract for foreign countries, Statistical Abstract for the several colonial and other possessions of the United Kingdom, Statistical Abstract for the United Kingdom
Freightpop	Freight Carried by Railways/Population	-	Statistical Abstract for foreign countries, Statistical Abstract for the several colonial and other possessions of the United Kingdom, Statistical Abstract for the United Kingdom
Firmage	Current Year-Year in which firm was registered on the London Stock Exchange	-	Stock Exchange Yearbook
Railinterest	Coupon rate on railway security	+	Investors Monthly Manual
Agripop	Arable land/Population	-	International Historical Statistics
Edupop	Number of children in school/Population	-	International Historical Statistics

Table 9: Correlation Matrix

	railspread	govtspread	intrev	defrev	exppop	passpop	freightpop	agripop	edupop	debtratio	logmiles
railspread	1										
govtspread	0.4719*	1									
intrev	0.3304*	0.5325*	1								
defrev	-0.2029*	-0.4897*	-0.2019*	1							
exppop	-0.1499*	-0.2114*	-0.2969*	-0.0376	1						
passpop	0.0229	-0.3333*	-0.1863*	0.1183*	0.4401*	1					
freightpop	-0.1084	-0.3446*	-0.3980*	0.2215*	0.6253*	0.5951*	1				
agripop	0.1860*	0.2019*	0.0941	-0.1816*	0.1019	0.3270*	0.1684*	1			
edupop	0.2569*	-0.2175*	-0.0021	0.3383*	0.0707	0.4841*	0.5387*	0.1620*			
debtratio	-0.1620*	-0.2445*	-0.0808	0.1916*	-0.3523*	-0.099	0.0033	-0.0822	0.1602*	1	
logmiles	-0.2112*	-0.2848*	-0.3820*	0.2096*	-0.1632*	-0.0356	-0.0837	-0.0119	0.1129*	0.1846*	1

Table 10: Panel A: Principal Component-Investment Climate and Monetary Stability

Component	Eigenvalue	Difference	Proportion	Cumulative
Interest Servicing	3.73	2.73	0.75	0.75
Government Revenue	1	0.79	0.2	0.95
Budget Deficits	0.2	0.15	0.04	0.99
Public Debt	0.06	0.04	0.01	1
Exports	0.02	.	0	1

Table 11: Panel B: Principal Component-Bond-Specific Variables

Component	Eigenvalue	Difference	Proportion	Cumulative
Log Capitalisation	3.15	2.3	0.79	0.79
Opening price	0.85	0.85	0.21	1
High price	0	0	0	1
Latest price	0	.	0	1

Figure 3: Scree Plots

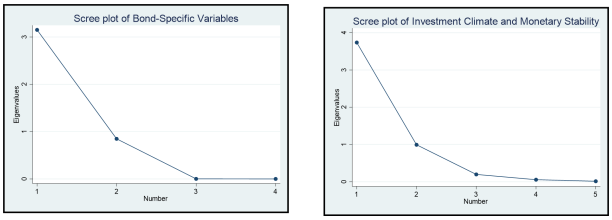
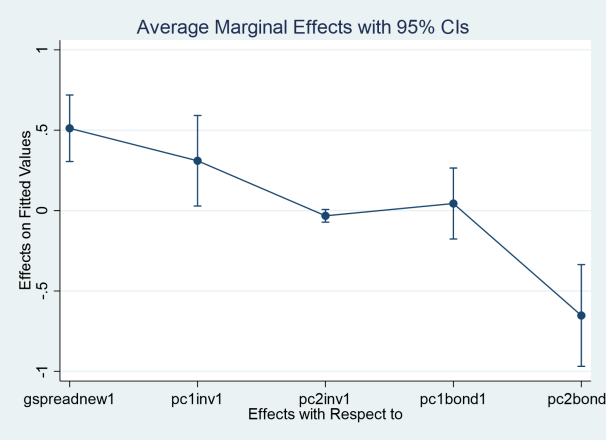


Table 12: Marginal Effects
Delta-method

	dy/dx	Std. Err.	z	P>z	[95% Conf.	Interval]
g_spread	0.51	0.11	4.85	0	0.31	0.72
pc1inv1	0.31	0.14	2.16	0.03	0.03	0.59
pc2inv1	-0.03	0.02	-1.61	0.11	-0.07	0.01
pc1bond1	0.04	0.11	0.39	0.7	-0.18	0.26
pc2bond1	-0.65	0.16	-4.04	0	-0.97	-0.34
golddummy	-0.26	0.12	-2.17	0.03	-0.5	-0.03

Figure 4: Average Marginal Effect



Identifying and Dealing with Issues in the Data

This section routine checks to understand panel data properties and error structure of the dataset. Panel data can be characterised by complex error structures. If not addressed properly they can generate inefficiency in coefficient estimation and biasedness in the estimation of standard errors (Reed & Ye, 2011). Both serial correlation (the relationship between the variable and a lagged version of itself over various time intervals) and cross-sectional dependence (where all units in the same cross-section are correlated) (Henningsen & Henningsen, 2019). Both of these are recognised as potential problems for panel data (Driscoll & Kraay, 1998). I follow the strategy by Hoechle (2007) to run a number of tests on my dataset to check the validity of my estimation techniques in the presence of heteroscedasticity, cross-sectional dependence between panels and serial correlation. The results are detailed here.

- Testing for Time-Fixed Effects: First, I test the dataset to see if time fixed effects are needed when running a fixed effects model. The null hypothesis of the test is that the dummy variables for all years are all equal to 0. If they are all jointly equal to zero, then time-fixed effects are not needed. I applied this test to my dataset and found that prob>F was <0.05. This meant that there are significant time fixed effects and therefore the FE model was an appropriate choice. This test thus supports the inclusion of year fixed effects in the regression equation.

Table 13: Testing for Time Fixed Effects

F(12, 12)	=	2.54
Prob > F	=	0.0598

- Testing for random effects: Breusch-Pagan Lagrange Multiplier (LM). The Lagrange-Multiplier test helps to decide between a random effects regression and a simple OLS regression. The null hypothesis in the LM test is that variances across entities is zero (Baltagi & Li, 1990). The results suggest that we reject the null hypothesis and conclude that there is evidence of significant differences across countries.

Breusch and Pagan Lagrangian multiplier test for random effects

$$r_{spread}[cc,t] = Xb + u[cc] + e[cc,t] \tag{1}$$

Table 14: Testing for random effects

	Var	sd = sqrt(Var)
r_spread	1.126471	1.061353
e	0.478647	0.6918428
u	0.534307	0.730963

Test: Var(u) = 0

2(01) = 1100.28

Prob > chibar2 = 0.0000

- Testing for cross-sectional dependence/contemporaneous correlation/Breusch-Pagan LM Test of Independence: Panel data can be subject to pervasive cross-sectional dependence whereby all units in the same cross-section are correlated. This is usually attributed to the effect of some unobserved common factors, common to all units and affecting all of them, perhaps in different ways (Henningsen & Henningsen, 2019). Cross sectional dependence is a problem in macro panels with long time series (over 20-30 years) (Baltagi, Feng, & Kao, 2012). This is not much of a problem in micro panels (few years and large number of cases). To test for cross-sectional dependence, I use Pesaran's test of cross-sectional dependence. The test has the null hypothesis of cross sectional independence with the alternate hypothesis that cross sections are dependent. The test results on my dataset show that the null hypothesis of cross sectional independence cannot be rejected and hence there is no cross sectional dependence.

  Pesaran's test of cross sectional independence = 0.745, Pr = 0.4560

- Testing for heteroscedasticity: A standard assumption of the regression model is for errors to be homoscedastic. This is when the variance of the disturbance term

is the same across observations and does not depend on the values of the explanatory variables (Yang, Tu, & Chen, 2019).To check whether the error term in my regression exhibits homoscedasticity, I apply the Modified Wald test for group-wise heteroscedasticity (Baum, 2001). The test has the null hypothesis of homoscedastic errors exhibiting constant variance. The test results reject the null hypothesis of constant variance and thus indicates the presence of heteroscedasticity. I use clustered standard errors at the country level to deal with this problem.

Modified Wald test for groupwise heteroskedasticity in Fixed Effects regression model

$$\sigma i^2 = \sigma^2 \tag{2}$$

χ^2 (15) = 13106.53

Prob>chi2 = 0.0000

- Testing for serial correlation: Serial correlation biases the standard errors and causes the results to be less efficient. Problems of serial correlation are most likely present in panels with long time series (over 20 to 30 years). Serial correlation causes the standard errors of the coefficients to be smaller than they actually are and results in a higher R-square. I apply the Wooldridge test for autocorrelation in panel data (Drukker, 2003). This test has the null hypothesis of no first-order autocorrelation. The test results reject the null hypothesis of no first-order autocorrelation and thus indicates the presence of serial correlation.

  Wooldridge test for autocorrelation in panel data

  H0: no first-order autocorrelation F(1,12) = 25.008, Prob > F = 0.0003

Based on the presence of heteroscedasticity and serial correlation present in my data, I use feasible generalised least squares (GLS) and linear regression with Panel Corrected Standard Errors where the parameters are estimated by either OLS or Prais-Winsten regression. Feasible generalised least squares allows estimation in the presence of AR(1)

autocorrelation within panels and cross-sectional correlation and heteroscedasticity across panels(Stata et al., 2015). I choose Feasible GLS which is asymptotically efficient and is the best overall performer on efficiency grounds (Reed & Ye, 2011).[1] As a robustness check, I also implement the Linear Regression with Panel-Corrected Standard Errors. I use a panel-specific AR(1) autocorrelation structure weighted by panel sizes and assume panel-level heteroscedastic errors. The results of both the regression techniques are illustrated in Table 15. Using both Feasible GLS and Prais-Winsten Regression, there is no qualitative change in the results.

[1]The authors show that for a given data set is T/N¿=1.5, Feasible Generalised Least Squares should be used as it was more efficient than 95% of the experiments the authors conducted on their dataset using Monte Carlo methods. For my dataset the ratio of T/N is 2.2 (33/15).

Table 15: GLS and Panel Corrected Standard Error Regressions

	(1) r_spread GLS Overall	(2) r_spread PCSE Overall
g_spread	0.302***	0.263***
	(0.066)	(0.088)
Interest servicing/Gov Revenue	0.018**	0.029***
	(0.007)	(0.009)
Railway Market Capitalisation/Public Debt	-0.109	-0.103
	(0.08)	(0.101)
Exports/Population	-1.409	-0.907
	(1.529)	(1.747)
Log Railway Miles	0.006	0.156
	(0.118)	(0.168)
Passengers Carried/Population	0.031	0.041*
	(0.023)	(0.025)
Freight carried/Population	-0.041	-0.029
	(0.06)	(0.079)
Gold dummy	0.142	-0.013
	(0.097)	(0.125)
Constant	0.844	-0.612
	(1.171)	(1.665)
Observations	306	306
R-squared		0.493
Number of cc	13	13

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

.4 Chapter 5

Table 16: Correlation Matrix between Returns on Railways of Different Countries in the Sample

	Austria	Argentina	Belgium	Brazil	France	Italy	Portugal	Russia	Spain	Sweden	Canada	India	NZ	Aus	Turkey
Austria	1														
Argentina	-0.3775	1													
Belgium	-0.5905	0.0901	1												
Brazil	-0.6523	0.2758	0.6968	1											
France	-0.2798	0.0873	0.017	-0.1485	1										
Italy	-0.6539	0.3911	0.5515	0.7304	0.1027	1									
Portugal	-0.5799	0.2682	-0.2228	0.3199	0.303	0.0197	1								
Russia	0.0671	0.1186	-0.4277	-0.4303	0.7434	-0.1028	0.346	1							
Spain	-0.2596	0.1012	0.0332	0.3481	-0.0941	0.4176	0.1276	-0.0347	1						
Sweden	-0.6046	0.6099	0.3467	0.362	0.5479	0.6079	0.4891	0.4725	0.2743	1					
Canada	-0.4749	0.0117	0.366	0.4305	0.387	0.7559	0.569	0.0897	0.2803	0.47	1				
India	-0.2737	-0.1927	0.4256	0.2441	-0.0874	-0.0404	0.2109	-0.3019	-0.0756	-0.0528	-0.0419	1			
NZ	-0.3329	0.3052	0.1784	0.5358	-0.2449	0.6253	0.0339	-0.1546	0.4959	0.3696	0.3659	-0.2219	1		
Aus	0.563	-0.451	-0.402	-0.4	-0.5555	-0.482	-0.0796	-0.2167	0.2015	-0.5823	-0.3598	0.0326	-0.2178	1	
Turkey	-0.3722	0.1101	0.1797	0.4057	0.5392	0.4461	0.6862	0.3558	0.0191	0.4685	0.4778	-0.15	0.2882	-0.7224	1

Table 17: Correlation Matrix

	Overall		Cap-Rich		Cap-Poor	
	railreturn	govreturn	railreturn	govreturn	railreturn	govreturn
railreturn	1		1		1	
govreturn	0.4211*	1	-0.0292*	1	0.4223*	1

Slicing the time period to investigate the relationship

The chapter divides the data into three decades 1880-1890, 1890-1900 and 1900-13. It then applies Fully Modified OLS techniques to test the relationship between returns of railway and government securities. From 1880-1890, the overall relationship between returns on railway and government securities is positive and significant. Countries disaggregated into capital-rich and capital-poor nations also exhibit a relationship of substitution and complementarity respectively. In the second decade from 1890-1900, the overall sample and that of capital-poor countries show the same results (same as for 1880-1890), but the substitution relationship between returns on government and railway securities becomes insignificant.

Table 18: FMOLS Regressions using Different Time Periods

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep.Variable	railreturn								
	Decade 1 (1880-1889)			Decade 2 (1890-1899)			Decade 3 (1900-1913)		
	Overall	Cap Rich	Cap Poor	Overall	Cap Rich	Cap Poor	Overall	Cap Rich	Cap Poor
govreturn	0.915***	-0.493***	1.136***	0.217***	-0.047	0.245***	0.280***	-1.057***	0.336***
	(0.07)	(0.081)	(0.028)	(0.018)	(0.125)	(0.019)	(0.032)	(0.188)	(0.024)
Constant	-1.132***	6.821***	-2.358***	2.351***	3.761***	3.423***	2.761***	8.410***	2.818***
	(0.416)	(0.459)	(0.195)	(0.098)	(0.653)	(0.129)	(0.155)	(0.842)	(0.142)
Observations	1,577	425	1,151	1,592	415	1,176	2,134	502	1,631
R-squared	0.41	0.589	0.323	0.548	0.422	0.465	0.323	0.428	0.304
Year Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1