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Banks as Catalysts for Industrialization[1]

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We provide a new theory of the role of banks as catalysts for industrialization. In their influential analysis of continental European industrialization, Gerschenkron and Schumpeter argued that banks promoted the creation of new industries. We formalize this role of banks by introducing financial intermediaries into a "big push" model. We show that banks may act as catalysts for industrialization provided they are sufficiently large to mobilize a critical mass of firms and that they possess sufficient market power to make profits from coordination. The theory provides simple conditions that help explain why banks seem to play a creative role in some but not in other emerging markets. The model also shows that universal banking helps to reduce the cost of acting as catalyst. *Journal of Economic Literature* Classification Numbers: G21, N2, O14, O16.

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1. INTRODUCTION

A significant problem in the study of emerging markets is that there are relatively few data points. It is therefore particularly important to go back in history

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to learn from all available experiences. Historically, economists accorded great importance to the role of banks in the development of new markets and industries. The influential work of Gerschenkron (1962) and Schumpeter (1934, 1939), for example, placed banks at the center of economic growth. Their accounts of the role of banks, however, differ in some important ways from our modern theories of banking, which emphasize the role of banks in screening and monitoring firms. In the modern view, the impetus for economic growth is generated in the real economy, and the banking system provides some important, but ancillary, services. The work of Schumpeter, Gerschenkron and others, however, is somewhat bolder. It accords banks a more active and creative role, where banks are central actors of the real economy who act as catalysts for industrialization and growth. Because this view does not fit well with modern banking theory, it has become almost forgotten. Yet it emerged from a careful study of industrialization in several European countries that were arguably some of the most successful emerging economies ever. What can a modern-day economist make of the notion of banks as catalysts for economic activity?

Gerschenkron related the creative role of banks specifically to the so-called catch-up problem. He argued that the main challenge for achieving rapid economic growth in 19th century continental Europe was coordination of industrial activity. Britain had already pioneered industrialization, and the issue in continental Europe was to mobilize resources to follow its example. Following the seminal work by Murphy *et al.* (1989), a recent literature on big-push models has formalized the notion of catch-up economy. This literature, reviewed by Matsuyama (1995a), has focused on a variety of positive externalities between investments in order to derive the existence of multiple Pareto-rankable equilibria. In the typical model, a low equilibrium is characterized by a self-perpetuating belief that no industrialization occurs, whereas a high equilibrium is sustained by a self-fulfilling expectation that industrialization will occur.

While big-push models have been used to explain periods of rapid industrialization, it may come as a surprise that the role of banks has not been addressed in this literature. In fact, big-push models study the conditions under which an economy may find itself stuck in a low equilibrium, but pay little attention to which institutions may remedy the coordination failure which generates the low equilibrium itself. We are thus left with some important open questions. Can banks affect the economy-wide equilibrium? What are the theoretical foundations for the role of banks as catalysts for industrialization? What does it mean to create new industries or to be a catalyst for growth? And under what circumstances would banks want to take such an active role in the economy?

This paper sets out to provide a modern economic understanding of the role of banks as catalysts for industrialization in emerging economies. The paper breaks out into three parts. We want to build a theory that is informed by history. In the first part of the paper we thus review historic evidence that suggests an active role for banks. Based upon the work of Schumpeter, Gerschenkron, and others, we provide historic evidence from three continental European countries that experienced periods of rapid industrialization: Belgium from 1830 to 1850, Germany from 1850 to 1870, and Italy from 1894 to 1914. We focus on what role banks play in these countries and uncover some interesting common patterns. In each country a small number of banks accounted for the bulk of investments in the industries that generated rapid economic growth. These banks invested in a portfolio of firms that depended on one another and that together pioneered new markets and industries. These banks were also large oligopolists that held powerful market positions at the beginning of the rapid-growth periods. Interestingly, these were also the banks that pioneered universal banking. These historical facts are clearly important for any economist interested in the role of banks in emerging markets. They also challenge us to provide a clear theoretical explanation.

In the second part of the paper we confront the historic approach with the tools of modern theoretical analysis and develop a new theory of the role of banks in promoting industrialization in emerging economies. Our starting point is a generic big-push model where there are two Pareto-rankable equilibria. We ask how a bank can induce the economy to move from the low to the high equilibrium. We show how a bank can mobilize a critical mass of firms, i.e., invest in a set of firms that induces other banks and firms to also invest in the emerging markets. Making such catalytic investments, however, is shown to be costly. A bank will only invest in a critical mass if it expects to recover its losses. This means that in the high equilibrium the bank needs to make profits on some additional firms outside the critical mass. The model then yields two important predictions. Banks will only play a catalytic role if they are sufficiently large to invest in a critical mass of firms. And they need to have enough market power to recoup the costs of mobilizing the critical mass. Next, we show that the costs mobilizing the critical mass are reduced if banks are allowed to own equity. The intuition is that equity allows the banks to participate in the value they create by mobilizing the critical mass. This leads to an additional prediction of the model that universal banks will find it easier to promote investments in new industries.

The third part of the paper takes the theory back to empirical evidence. We examine some additional facts not considered by Gerschenkron and Schumpeter. We look at cases where banks did not play a catalytic role in the industrialization of emerging economies and relate this variation in behavior to the predictions of the model. We also ask why should it be banks that play a catalytic role. This leads us to discuss two alternative catalysts: governments and conglomerates. Moreover, we derive further implications that can be formally tested.

We believe we are the first to introduce banks into a model of the big-push. This allows us to examine a new role for banks that has received scant attention in the literature: catalyst to industrialization. This role is distinct from the traditional roles attributed to banks, namely the allocation of capital and the screening and monitoring of individual firms (see Allen, 1990; Fama, 1980; Diamond, 1984; Ramakrishnan and Thakor, 1984; and Stiglitz, 1985; among others). For an extensive survey of modern theories of banking, see Bhattacharya and Thakor (1993). This catalytic role is also distinct from the literature on relationship banking (see, for example, Allen and Gale, 1997; Aoki and Patrick, 1994; Boot 2000; Dinç, 2000; Rajan, 1992; and von Thadden, 1995), since we are concerned about the economy-wide effects of the interactions of one bank with many firms at a time, as opposed to the details of the interaction between one bank with one client over time. We thus contribute a distinctly novel macro theory of banking.

A large literature has developed on the role of banks in economic development (see, for example, King and Levine, 1993; Rajan and Zingales, 1998; and especially the survey by Levine, 1997). This literature has focused on the role of financial intermediaries in facilitating exchange and providing liquidity (e.g., Bencivenga and Smith, 1991) and in diversifying risks (e.g., Acemoglu and Zilibotti, 1997), or on comparing banks and stock markets in facilitating economic development (e.g., Levine and Zervos, 1998)). Our paper complements this literature by examining the role of banks in coordinating investments. This paper is also related to the literature on the role of venture capital for firm creation and innovation (see Bottazzi and Da Rin, 2002; Lerner and Merges, 1998; Hellmann and Puri, 2000 and 2002; and Kaplan and Strömberg, 2002). And our theory contributes to the literature on universal banking, surveyed by Benston (1994).

The remainder of the paper is organized as follows. Section 2 provides historical evidence from three formerly emerging continental European countries—Belgium, Germany, and Italy—describing the role of banks in industrialization and linking it to the structure of the financial system. Section 3 develops the theoretical model, examining the conditions under which banks can act as a catalyst for industrialization. Section 4 confronts the model with further historic and modern evidence from countries where banks did not play a catalytic role. It then discusses why banks may be naturally positioned to be a catalyst, but that government and firms are potential alteratives. It also derives from the model several testable hypotheses and discussess recent relevant formal tests. It is followed by a brief conclusion. All the proofs are in the Appendix.

2. BANKS AND THE INDUSTRIALIZATION OF BELGIUM, GERMANY, AND ITALY

In his seminal work on economic development, Gerschenkron (1962, p. 45) wrote that "[t]he focal role in capital provision in a country like Germany must be assigned not to any original capital accumulation but to the role of credit-creation policies on part of the banking system." Rondo Cameron (1967, p. 129) wrote about Belgium: "[S]ubsequently [to 1830] the economy entered a period of explosive growth accompanied by the development of a unique set of banking institutions." Schumpeter (1939, Chap. 7) gave German *Kreditbanken* large credit for taking an entrepreneurial attitude and fostering the rise of large industries.

In this section we examine historical evidence from the three continental European countries that experienced fast industrialization in the 19th century, focusing on the initial stages of their industrialization: Belgium (from 1830 to

1850), Germany (from 1850 to 1870), and Italy (from 1894 to 1914). We devote particular attention to the structure of credit markets, an aspect often alluded to in the debate among economic historians but rarely linked explicitly to the role of banks as industrial promoters. We thus provide a novel perspective from which to look at well-known facts. For each country we show that a few large private banks financed the majority of new industrial firms. These banks did not develop as a consequence of industrialization, but pre-existed it. They enjoyed considerable market power in an oligopolistic banking market that was protected by regulatory barriers to entry. They actively promoted investment in industrial technology and engaged in coordination of industrial investments. And these banks acted not only as lenders but also as shareholders, thus pioneering universal banking.

2.1. Belgium

Belgium, the first country to follow Britain in the Industrial Revolution, achieved its industrialization roughly between 1830 and 1850. Over this period, its GNP grew at a yearly 2.5%, well above the 1.4% European average.[2] Industrialization transformed the structure of the economy, which until then was based on small firms engaged in traditional production. Between 1830 and 1860 its industrial capacity grew at a yearly average of 4.4%, more than twice that in the previous 30 years (Bairoch, 1982, p. 292). Modernization was most intense in the heavy industries. Between 1830 and 1850 coal mining grew at a yearly 5.3%, zinc mining at 20.0%, and steam engines at 7.9%.[3]

Critical to this success was the action of two banks. The Société Générale pour favoriser l'industrie nationale was the world's first joint-stock investment bank. It had been created in 1822 and became active in industrial finance from the early 1830s. The Banque de Belgique was founded in 1835, and engaged in industrial finance from the outset.[4] These two banks accounted for about two thirds of the capitalization of all industrial credit banks (Durviaux, 1947, p. 56),[5] and their assets grew by an average yearly rate of 3.8% between 1834 and 1850 (Chlepner, 1926, pp. 76–78). These two banks financed themselves mainly with their own capital; until 1850 deposits never accounted for more than 25% of the liabilities (Durviaux, 1947, p. 37). Other industrial banks existed, but were smaller and mostly local.[6] Entry of joint stock-banks into the financial sector was restricted, since

[2] Bairoch (1976, pp. 281–286). In per capita terms these two figures are 1.6 and 0.8%, respectively.

[3] Cameron (1967, p. 148). Railways played a lesser role at this stage of the Belgian industrialization, though in these two decades 850 km of railroads were built, Mitchell (1980, tab G1).

[4] On the development of the Belgian financial sector see Cameron, 1967; Chlepner, 1926, 1930, 1943; Morrison, 1967; Société Générale de Belgique, 1922; and Wee, 1981).

[5] The initial capital of the Société Générale was 33 million francs, which was doubled in 1837; the initial capital of the Banque fu Belgique was 20 million francs (Durviaux, 1937, p. 11).

[6] See Cameron (1967, pp. 134–136); and Chlepner (1930, pp. 21–24). Seven such banks appeared in the late 1830s: The Banque Liégeoise, the Banque Commerciale d'Anvers, the Banque d'Industrie, the Banque de Flandre, the Banque Fonciére, the Caisse Hypotécaire, and the Caisse de Propriétaires (Chlepner, 1930, pp. 61–63).

the government had discretionary power in granting banking charters, according to Article 7 of the *Code du Commerce* (Neuville, 1974, pp. 109–111). Indeed, the Société Générale and the Banque de Belgique faced no competition from incorporated banks.

These two banks assisted and actively encouraged firms in fast growing industries to adopt the corporate form in order to raise large amounts of external finance.[7] Between 1835 and 1838 alone, the Société Générale organized 31 industrial joint-stock companies (*sociétés anonymes*), and the Banque de Belgique 24. They also helped these new firms raise a combined capital of 154 million francs. (Cameron, 1967, p. 145). The two banks invested a large share of their capital in industrial equity: 31% for the Société Générale and 26% for the Banque de Belgique in 1847 (Chlepner, 1930, p. 26). In 1860, the Société Générale controlled about a fifth of the country's industrial joint-stock capital, which amounted to 1 billion francs.[8] As Cameron (1967, p. 145) put it, "banks did not respond passively to demand for credit, but actively sought new firms, underwrote their stock issues, financed potential stockholders, held stock in their own names, placed their officers on the boards of directors of the companies they promoted, and ministered to the companies' needs for both working capital and new capital for expansion." These investments turned out to be profitable. The net income of the Société Générale, for instance, started at around 4% of assets in 1830 and increased constantly until 1860 (Société Générale, 1922, Annex).

The Société Générale and the Banque de Belgique were the first examples of universal banks. They identified industries with high growth potential to which they extended credit and in which they bought equity participations.[9] For this purpose they came up with an important innovation, financial trusts.[10] These were holding companies which managed the two banks' industrial portfolios.[11] This way they enhanced the coordination of investment decisions by otherwise scattered entrepreneurs (Wee, 1981, p. 6). Bank managers consulted their clients on business strategies and sometimes acted as their financial managers.[12] Cameron (1961, pp. 90–91) describes how the Société Générale actively encouraged mining companies and foundries to incorporate, obtained Royal charters for them, and provided the necessary financing. Banks thus carried out an intense coordination of industrial activities.

[7] Six industrial *sociétés anonymes* (joint-stock companies) existed in 1830, which grew to 150 in 1839, and to 200 in 1857 (Cameron, 1967, p. 130). Durviaux (1947, p. 53) gives a detailed sectoral breakdown, and Neuville (1974, pp. 113–115) yearly data.

[8] In the 1840s it controlled mining companies responsible for more than a quarter of the whole coal extraction, Neuville 1974, p. 123).

[9] See Société Générale (1922) for a detailed description of the bank's policy of sectoral investment.

[10] The Société Générale created one subsidiary and three investment trusts. The Banque de Belgique created two subsidiaries and two investment trusts; see Morrison (1967), Chlepner (1930, pp. 10–12, 36–37).

[11] The banks themselves did retain shareholdings of some corporations; see Lévy-Leboyer (1964, p. 641) for the Banque de Belgique, and Société Générale (1922, annex 6) for the Société Générale.

[12] Cf. Chlepner (1926, pp. 86–87); Wee (1981, pp. 5–6).

2.2. Germany

Germany is often cited as the quintessential case of bank-driven development. Between 1850 and 1870 the German economy experienced a quick industrialization which allowed it to become the first economic power on the continent. In this period its GNP grew at a yearly 2.4%, well above the 1.9% European average and its own 1.6% growth rate of the previous two decades (Bairoch, 1976, p. 281).[13] Between 1860 and 1880 its industrial capacity grew at a yearly 4.6%, up from 1.7% in the previous 30 years, and was concentrated in textiles and heavy industries (Bairoch, 1982, p. 292). Production of coal increased fivefold, and pig iron sixfold, spurred by a threefold expansion of railways (Mitchell, 1980, Tables E2, E8, G1). The German industrial credit banks, *Kreditbanken*, played an active role in industrial development combining commercial and investment banking activities and nurturing close relations with industry (Da Rin (1996)). Of the 40 *Kreditbanken* founded between 1848 and 1870, four accounted for most of the industrial credit activities: the Schaaffhausen Bankverein, the Disconto Gesellschaft, the Bank für Handel und Industrie, and the Berliner Handelsgesellschaft. Their capitalization accounted for nearly half of that of all industrial credit banks, and they were also much larger than the unincorporated industrial credit banks (*Privatbanken*), which operated locally. The average founding capital of these four *Kreditbanken* was 33 million marks (Riesser, 1911, Appendix 3), compared to only 1 million for the average Rhenish *Privatbankier*.[14] These four banks used mainly their own capital as a source of finance (Tilly, 1966a, Chap. 5). In Prussia, by far the largest German state, incorporations were granted discretionally by the government, and entry as a *Kreditbank* was restricted. Indeed the government granted a joint-stock charter only to the Schaaffhausen Bankverein (Tilly, 1966a, p. 111). The other three *Kreditbanken* were organized as unincorporated limited liability companies. This constraint seems to have been binding, for when incorporation was liberalized in 1871, there were scores of new joint-stock banks. The financial sector remained fairly concentrated even afterward, as a small number of very large *Kreditbanken*, the *Grossbanken*, dominated the smaller *Provinzbanken* (Jeidels, 1905, p. 112). *Grossbanken* acquired several *Provinzbanken* in order to retain a leading position and keep up with the growth of the economy. Six large bank groups, *Konzernen*, thus came to dominate the industrial credit sector, which independent *Provinzbanken* were never able to challenge (Riesser, 1911, part IV).

The credit channeled by *Kreditbanken* increased at an average yearly rate of 19.4% between 1852 and 1870, from 20 to 492 million marks (Hoffman, 1965, p. 743). Between 1851 and 1870, 259 firms incorporated, up from 102 in the previous 25 years. Incorporation was typically managed with the help of an industrial credit bank.[15] *Kreditbanken* acted as universal banks, providing loans and

[13] Per capita growth of GNP was 1.6% in Germany and 0.9% in Europe (Bairoch, 1976, p. 286).

[14] Tilly (1966a, p. 66). Rhenish *Privatbankiers* were the largest to engage in industrial finance.

[15] Riesser (1911, p. 38). *Kreditbanken* also supported firms that assumed unincorporated limited liability form (*Kommanditgesellschaft auf Aktien*). See also Jeidels (1905) and Motschmann (1915) for detailed accounts of the role of *Kreditbanken* in industrial finance.

issuance of securities for their clients but also retaining equity positions in those firms (Riesser, 1911, pp. 62–66). Their activity concentrated in few regions and industries: The Rhineland, Ruhr, Silesia, and Saxony; in mining, machinery, textiles, construction, and railways.

German banks frequently took equity participations in their clients. Riesser (1911, pp. 339–340) describes in detail the participations taken by *Kreditbanken* in railways and heavy industries in the 1850s. These equity holdings absorbed much of the banks' capital: from the 13% of the Schaaffhausen Bankverein (p. 72) to the 50% of the Bank für Handel und Industrie (p. 81). Many equity holdings arose from illiquid loans during the 1857 economic slump, but with time several of them became profitable.

Universal banking was overall profitable, though losses were experienced in the early years (Tilly, 1966a, Chap. 8). The average dividend in the 1850s and 1860s was 6.7% for the Bank für Handel und Industrie, 7.0% for the Disconto Gesellschaft, 7.2% for the Schaaffhausen Bankverein, and 7.3% for the Berliner Handelsgesellschaft (Riesser, 1991, p.68). Moreover each bank accumulated several million marks of reserves.

The personal nature of their business relationships allowed them to elicit and circulate information effectively and to have a strong influence on investment decisions. As Richard Tilly (1966b, p. 181) argued: "the contribution of German bankers to the mobilization of capital operated not only on the supply side but on the demand side as well; by organizing and allying themselves so closely with industrial enterprises, bankers strengthened and in part represented the demand for investment funds."

2.3. *Italy*

The last case we consider is Italy, which industrialized rapidly between the early 1890s and World War I. Between 1893 and 1913, its industrial output grew at a yearly 4.8%, up from 0.5% in the previous two decades, and GDP grew at 2.5%, up from 0.6%.[16] The yearly growth rate of manufacturing production (1896–1913) ranged from 4.0 to 6.2% according to alternative estimates.[17] Between 1894 and 1913 the yearly growth rates were 15% in electricity, 12.9% in chemicals, 10.7% in iron and steel, and 7.5% in engineering; all higher than in other European countries (Cohen, 1967, p. 364). The share of producers' goods in total production rose from 28 to 47% (Romeo, 1972, p. 68). Private industrial credit banks (*banche di credito ordinario*) played a key role in channeling savings toward industrial high growth sectors and in influencing the direction and timing of investments (Toniolo, 1988). The Banca Commerciale was founded in 1894

[16] Fuà (1965, Tables 1 and 3). Similar data are in Gerschenkron (1962, p. 75). The yearly per capita growth of GNP between 1890 and 1913 was 1.5%, and the European average 1.4% (Bairoch, 1976, p. 286).

[17] Federico and Toniolo (1991) discuss the reliability of different estimates.

and the Credito Italiano in 1895. They controlled nearly two thirds of the assets of all industrial credit banks.[18] Their funding came more from their own capital than from deposits, which typically accounted for less than a quarter of liabilities (Confalonieri, 1976, 1982, statistical annexes). The few competitors to the Banca Commerciale and the Credito Italiano were smaller banks, which generally operated in Northern Italy (Confalonieri, 1976, Vol. 3). The two leaders spurred investment in electricity, mechanical engineering, metals, and automobiles, while overlooking traditional industries such as textiles.[19] Also, they focused their efforts toward firms in the Northern triangle between Genoa, Turin, and Milan (Aleotti, 1990, pp. 58–60).

In the case of Italy sheer size seems to have been enough to deter entry by other large industrial credit banks. Indeed the Banca Commerciale and the Credito Italiano managed to impose exclusive relationships to many of their clients (Confalonieri, 1976, Vol. 2, p. 329).

Italian industrial credit banks were another instance of universal banking. Between 1900 and 1913 Italian joint stock companies grew from 848 to 3069, and between 1900 and 1907 they raised about 2.7 billion lire on the stock exchange (Aleotti, 1990, pp. 61–67). In 1897 there were 30 listed companies in the Milan Stock Exchange. In 1908 they had grown to 169. Both the Banca Commerciale and the Credito Italiano played a major role in planning and financing these operations, encouraging firms to incorporate and helping them issue equity and bonds. Between 1894 and 1906 the Banca Commerciale took part in 145 capital market operations, and the Credito Italiano in 84 (Confalonieri, 1976, Vol. 2, pp. 341–345). Confalonieri describes in detail the involvement of the Banca Commerciale in the steel, electric, and mechanical sectors (1976, Vol. 3) and that of the Credito Italiano in sugar refining, iron, and chemicals (1976, Vol. 2). He concludes that investment banking activities favored their role as promoters of industrial undertakings.

Investments in industrial securities (equity and bonds) by the Banca Commerciale and the Credito Italiano ranged from 5 to 10% of their assets between 1895 and 1906, and contributed a corresponding share of their net income.[20] Large loans to large industrial firms accounted for another 20–30% of assets and income (Confalonieri, 1976, Vol. 3, p. 486). The net income of Banca Commerciale Italiana rose from 1.3 million lira in 1895 to 12.7 million in 1913, and that of Credito Italiano from 0.9 to 5.4, respectively (Confalonieri, 1976, 1982, statistical annexes). In both cases income growth was steady and accelerating.

Like the Belgian banks with investment trusts, the Italian banks managed their industrial participations through subsidiaries. But unlike their Belgian colleagues, they did so by acquiring control in industrial companies which they used as holding companies. This was the case in the fast growing industries: electricity, chemicals,

[18] Confalonieri (1976, Vol. 3), discusses the evolution of the Italian financial system.

[19] The Banca Commerciale's stated goal was to be an "active part...in all the major and worthy signs of economic development in our country" (Confalonieri, 1976, Vol. 3, p. 42, our translation).

[20] Confalonieri (1976, Vol. 2, p. 322; Vol. 3, p. 476).

iron, and steel.[21] Gerschenkron (1962, p. 88) argued that in Italy "[a]s in Germany, not only capital, but a good deal of entrepreneurial guidance was channeled to the nascent and expanding industrial enterprises. As in Germany, the policy was to maintain an intimate connection with an industrial enterprise and to nurse it for a long time before introducing it to the capital market."

2.4. Issues Raised

The historic evidence we have presented raises a number of important questions. What does it mean for a bank to promote industrialization and to be a catalyst? Under what circumstances can private banks take such a role and under which conditions would they actually choose to take it? What are the costs and benefits of such actions? Also, is the historical similarity in financial market structures across countries a mere coincidence or is there a definite relationship between bank size, bank market power, and bank activity in industrial promotion? What is the significance of universal banking for the promotion of industrialization in emerging economies?

To answer these important questions and to make sense of these episodes in economic history, we seek guidance from theory. Theories of the big-push have so far focused on identifying the reasons for the multiplicity of equilibria and for the existence of coordination failures, but have given little attention to addressing possible remedies. In particular, the role of financial intermediaries has not been addressed in this literature. This is our starting point for developing a model to examine under what circumstances profit-motivated banks would act as catalysts for industrialization.

3. A THEORY OF BANKS AS CATALYSTS

3.1. The Model Setup

The model follows closely the standard assumptions of big-push models. There are N firms, who have a choice of either doing nothing or investing. For simplicity, we assume that the N firms are identical and indexed by $n = 1 \ldots N$. Investing requires an amount K. Each firm has an endowment W, with $W < K$, and thus needs to raise an external amount of finance, equal to $X = K - W > 0$. We assume that there is no discounting. The gross returns to any particular firm n are given by

[21] Some such cases were Società Edison (BCI), Vizzola (BCI), Società Industrie Elettro-Chimiche (CI), Unione Italiana Concimi (CI), Montecatini (CI), Ferriere Italiane (CI), Società Elba, Acciaierie Terni (BCI), and Acciaierie Savona (BCI). Confalonieri (1976, Vol. 3, Chap. 3) details their history, which is also studied by Cohen (1967, pp. 378–380) and Romeo (1972, pp. 77–83). Holding companies were used to coordinate bank activities also in the mechanical industry, but to a lesser extent. Such instances were offered by Officine Meccaniche (BCI and CI) and Cantieri Pattison (CI). BCI also used the Società Generale di Navigazione Marittima to coordinate its activity in steamship; see Confalonieri, 1976, Vol. 2, Chap. 6.4).

$f(\bar{n})$, where $\bar{n}$ is the number of firms actually investing. We assume that f is an increasing function of $\bar{n}$, i.e., a firm's returns depend positively on the investment decisions of all other firms.

Firms raise funds from investors. Based on our historical analysis, we focus on banks. Accordingly, we first examine pure debt contracts. We denote the lending rate by r, so that a bank's gross returns are $(1+r)X$. Later, we also introduce equity. Throughout the analysis we assume that a contract between a bank and a firm cannot be made contingent on the decisions of any other party.

Banks have some costs of intermediation. We assume that there are $B+1$ banks, where $B > 1$. The first B banks are all identical. Each of them has an intermediation cost of $\bar{\phi}$ per unit of investment. The competitive market rate is thus $r = \bar{\phi}$. To model market power, we assume that there exists one large bank with market power. We denote it by L. We use a standard model of Bertrand competition, where L has a cost advantage over its competitors $b = 1, \ldots, B$. To keep the model as simple as possible, we assume that L can finance up to A firms at a lower intermediation cost $\underline{\phi}$ (where $\underline{\phi} < \bar{\phi}$). We can think of this cost advantage as stemming from superior skills, a lower cost of capital, or some regulatory advantages. L's market power is measured by its total cost advantage, given by $\alpha \equiv A(\bar{\phi} - \underline{\phi})X$.

Let r_n be the interest rate of a contract offer to firm n. The profits for firm n from accepting this offer is given by:

$$\pi(\bar{n}, r_n) = f(\bar{n}) - (1 + r_n)X,$$

where $\bar{n}$ is the number of firms actually investing (which includes firm n itself). A bank's net profit from offering r_n to an individual firm n is then given by

$$\rho(r_n) = (r_n - \bar{\phi})X\delta_n^b,$$

where $\delta_n^b = 1$ if the firm n accepts b's offer and $\delta_n^b = 0$ otherwise. Let $\hat{b}$ be the set of firms that receive an offer from a particular bank b. For $b = 1, \ldots B$, we denote a bank's net profits by:

$$\varrho_b = \sum_{n \in \hat{b}} (r_n - \bar{\phi})X\delta_n^b = \sum_{n \in \hat{b}} \rho(r_n).$$

For $b = L$, however, we also need to account for his lower intermediation costs. Let $\hat{L}$ be the set of firms that receive an offer from L; then

$$\varrho_L = \sum_{n \in \hat{L}} (r_n - \underline{\phi})X\delta_n^L = \sum_{n \in \hat{L}} \rho(r_n) + (\bar{\phi} - \underline{\phi})X\delta_n^L.$$

It is useful to define $k = K + \bar{\phi}X$. This can be thought of as the total cost of investment, including the cost of intermediation, evaluated at the market rate. In line with the standard big-push model, we assume that $f(1) < k < f(N)$, so that it is not profitable for a single firm to invest on its own, but it is profitable for a firm to invest if all other firms also invest.

The standard big-push model consists of a single-stage game, where all firms simultaneously decide whether to invest. To introduce banks into this model, we augment the game structure as follows. In the first stage all banks make simultaneous offers. In the second stage, all firms simultaneously decide whether or not to accept these offers. Within each stage game all agents make simultaneous decisions, so that we consider all Nash equilibria. There are no asymmetries of information, so that all agents observe all actions at all stages. We therefore assume subgame perfection across the two stages.

It is useful to describe each stage in some further detail. At the first stage, all banks make simultaneous contract offers. Each bank's strategy set consists of choosing which firms receive offers and at what interest rate. Each bank $b = 1, \ldots, B$ maximizes ϱ_b. The set of contracts that b offers is denoted by $\theta_b = \{r_n \mid n \in \hat{b}\}$. Moreover, let $\theta_B = \{\theta_b \mid b = 1, \ldots B\}$ be the set of all contracts offered by the first B banks. L's objective is to maximize ϱ_L. The set of contracts that L offers is denoted by $\theta_L = \{r_n \mid n \in \hat{L}\}$. All the actions of the first stage are then summarized by $\theta = \{\theta_L, \theta_B\}$.

At the second stage, all firms simultaneously decide whether to accept or reject the offers they have received. Each firm either rejects all its offers or accepts the offer with the lowest interest rate. The strategy set for each firm n consists of either choosing $\delta_n^b = 0$ for all offers or choosing $\delta_n^b = 1$ for exactly one offer and $\delta_n^b = 0$ for all others. Each firm's objective is to maximize $\pi(\beta(\theta), r_n)$, subject to the participation constraint $\pi(\beta(\theta), r_n) \geq W$. We define $\beta(\theta)$ as the belief about the number of firms actually investing. We now turn to the structure of these beliefs.

Beliefs pertain to the selection of equilibria at the second stage, i.e., to the number of firms investing. If there is a single equilibrium, then beliefs are simple: all agents expect that equilibrium to occur. Depending on the contracts offered in the first stage, however, it may be that there are multiple equilibria at the second stage. Given any set of contracts θ, we denote the set of all possible equilibria at the second stage by $\Omega(\theta)$. Since firms are symmetric, equilibria differ only in the number of firms investing.[22]

Equilibrium theory by itself does not provide any guidance as to what equilibrium in $\Omega(\theta)$ is to be selected. Agents in the model can have a variety of rational self-fulfilling beliefs about which equilibrium will occur. We retain the assumption of common priors, so that all agents start with the same beliefs. Moreover, since they observe the same information at each stage, all agents retain a common belief throughout the game. This belief may depend on the actions in the first stage, as summarized by θ. The belief about which equilibrium occurs at the second stage can therefore be represented by a function $\beta(\theta)$ that maps θ into an equilibrium

[22] We ignore mixed strategy equilibria, which are never stable in this model. We denote the individual equilibria by $\bar{n}$, the number of firms actually investing. If, for example, some θ generates two equilibria, one with all and one with no firms investing, then we write $\Omega(\theta) = \{0, N\}$.

$\bar{n}$ at the second stage. The restriction that beliefs are rational implies that a belief generates a self-fulfilling equilibrium, i.e., $\beta(\theta) = \bar{n} \in \Omega(\theta)$. Note that this specification of beliefs accounts for all beliefs off the equilibrium path. This is because $\beta(\theta)$ is defined for all possible offers θ. Moreover, the specification captures the way beliefs are updated. This is because all updating is based on the information obtained in the first stage, namely the realized actions θ.

A central insight of the big-push literature is that an economy can have different rational belief structures that lead to different self-fulfilling equilibrium outcomes. In the standard model (see Murphy *et al.*, 1989), there are only exactly two rational beliefs. Either all firms are pessimistic, expecting no one else to invest, or they are optimistic, expecting everyone else to invest. Introducing banks into a standard big-push model complicates the belief structure, which now also depends on the banks' actions θ. It is useful to focus on the two belief structures that correspond most closely to the standard big-push model. We say that beliefs are *optimistic* if, for any θ, we have $\beta(\theta) = \text{Max}\{\bar{n} \mid \bar{n} \in \Omega(\theta)\}$. This says that, for all θ, agents always believe the equilibrium with the highest number of firms will obtain. And beliefs are *pessimistic* if, for any θ, we have $\beta(\theta) = \text{Min}\{\bar{n} \mid \bar{n} \in \Omega(\theta)\}$. That is, for all θ, agents always believe the equilibrium with the lowest number of firms will obtain. Optimistic beliefs correspond to a world where firms spontaneously coordinate and find the highest equilibrium, even though the lower equilibria still exist. Pessimistic beliefs correspond to a world where such spontaneous coordination does not occur.

Naturally, there also exists many other belief structures that we call hybrid beliefs. In particular, it may be that firms have pessimistic beliefs when they see certain actions in the first stage, but optimistic beliefs when they see other actions. In other words, there exists a variety of hybrid belief structures $\beta(\theta)$, where $\beta(\theta) = \text{Min}\{\bar{n} \mid \bar{n} \in \Omega(\theta)\}$ for some realizations of θ, but $\beta(\theta) = \text{Max}\{\bar{n} \mid \bar{n} \in \Omega(\theta)\}$ for other θ. Hybrid beliefs constitute an intermediate case between pessimistic and optimistic beliefs. For most of the analysis we focus on pessimistic and optimistic beliefs. At the end of Section 3.3, and in the Appendix, we show how incorporating hybrid beliefs does not affect the basic insights of the model.

3.2. *Multiple Competitive Equilibria*

In this section we examine the equilibria when financial markets are perfectly competitive. The equilibrium where all firms invest ($\bar{n} = N$) is called the high equilibrium, and the equilibrium where no firm invests ($\bar{n} = 0$) is called the low equilibrium.

PROPOSITION 1. *Suppose L has no market power* (*i.e.*, $\alpha = 0$); *then all firms are charged* $r = \bar{\phi}$. *If there are optimistic beliefs*, *the high equilibrium obtains. If there are pessimistic beliefs*, *the low equilibrium obtains.*

All proofs are in the Appendix. Proposition 1 shows that the basic properties of the big-push model are preserved in a model with perfectly competitive financial markets. The optimal contract is very simple. Banks always make offers at the competitive rate $r = \bar{\phi}$. We denote the resulting set of contracts by $\theta^{\bar{\phi}} = \{r_n = \bar{\phi} \mid n = 1, \ldots, N\}$. Proposition 1 follows from $f(1) < k < f(N) \Leftrightarrow \pi(1, \bar{\phi}) < W < \pi(N, \bar{\phi})$. The low equilibrium is supported by a self-fulfilling pessimistic belief $\beta(\theta^{\bar{\phi}}) = 0$. Firms do not invest unless not investing is not an equilibrium. This captures the notion that the economy is in a status-quo and does not expect to naturally leap out of it. The high equilibrium is supported by a self-fulfilling optimistic belief $\beta(\theta^{\bar{\phi}}) = N$. In such an economy, firms find it easy to coordinate their beliefs and actions, leading to spontaneous simultaneous investments.[23]

3.3. Banks as Catalysts

The main insight from the previous section is that the introduction of banks per se does not change the fundamental insights of the big-push model. With perfectly competitive financial markets, the model continues to have two equilibria. We now examine how a bank with market power can change this. We propose the notion of a catalyst, i.e., an agent whose actions precipitate a change of equilibrium. The question we ask is under what circumstances a bank with market power may act as such a catalyst.

For firms to invest, it is necessary that they believe a critical mass of other firms also invest simultaneously. The critical mass C is defined as the smallest number $\bar{n}$ such that investing is the *only* equilibrium strategy for all other firms. Formally, the critical mass C must satisfy $f(C) < k \le f(C+1) \Leftrightarrow \pi(C, \bar{\phi}) < W \le \pi(C+1, \bar{\phi})$. Let $c = 1, \ldots, C$ denote an index for all firms in the critical mass. With this, we introduce a constraint that we call the *elimination constraint*,

$$\pi\left(c, r_c^{\varepsilon}\right) = W,$$

for $c = 1, \ldots, C$. Throughout the analysis we use the superscript ε to refer to a contract that satisfies the elimination constraint. The constraint implies a different interest rate r_c^{ε} for each firm in the critical mass. Below we show that the role of the elimination constraint is to mobilize all firms in the critical mass, i.e., to induce them to invest. This will eliminate the low equilibrium. We also define $\alpha^* \equiv \sum_{c=1}^{C} -\rho(r_c^{\varepsilon}) = \sum_{c=1}^{C} k - f(c) > 0$. This is the cost of mobilizing the critical mass.

PROPOSITION 2. *Suppose banks only use debt contracts and suppose $A \ge C$.*

(i) *If there are optimistic beliefs, then the high equilibrium obtains. All firms are charged $r = \bar{\phi}$. L's net profits are $\varrho_L = \alpha$.*

[23] Note that we assumed that a contract between a bank and a firm cannot be made contingent on the decisions of any other party. If a contract for one firm can be made contingent on the investment decisions of all other firms, then it is trivial to implement the high equilibrium. L can offer a lending rate $r(\bar{n})$ that satisfies $\pi(\bar{n}, r(\bar{n})) = f(\bar{n}) - (1 + r(\bar{n}))X \ge W$ for any realization of $\bar{n}$. These kind of contingent debt contracts are not observed empirically. Presumably they would be very costly to write and enforce, especially if there is ambiguity about who exactly the other firms are and what exactly it means for them to invest. See Hart and Moore (1999) and Segal (1999a). Segal (1999b) also uses a similar restriction to bilateral contracting.

(ii) *If there are pessimistic beliefs, the high equilibrium obtains for* $\alpha \geq \alpha^*$. *L charges an interest rate* r_c^ε *which satisfies the elimination constraint. This interest rate is below the market rate, i.e.,* $r_c^\varepsilon < \bar{\phi}$. *All firms outside the critical mass are charged the market rate* $r = \bar{\phi}$. *For* $\alpha < \alpha^*$, *the low equilibrium obtains. L's net profits are* $\varrho_L = Max[\alpha - \alpha^*, 0]$.

If beliefs are optimistic, the high equilibrium naturally obtains. Comparing Propositions 1 and 2 we find that the addition of market power does not matter for optimistic beliefs. The difference lies with pessimistic beliefs. If L has sufficient market power ($\alpha > \alpha^*$), L induces the high equilibrium. L faces a set of agents that always expect the lowest equilibrium to occur. By mobilizing the critical mass of firms, the high equilibrium becomes the only equilibrium. Despite pessimistic beliefs, all firms always invest in this equilibrium. In this sense, L is a catalyst for change.

To see how L can achieve this, it is useful to distinguish between the firms in the critical mass and those outside it. Because of Bertrand competition, the optimal contract for all firms outside the critical mass is always $r = \bar{\phi}$. For firms in the critical mass, however, the optimal contract charges $r_c^\varepsilon < \bar{\phi}$, which is below the market rate. In the Appendix we explain that this is due to the elimination constraint. The rates r_c^ε are chosen so that each firm in the critical mass is willing to invest irrespective of whether firms outside the critical mass also invest. This requires low interest rates. The elimination constraint thus guarantees that all firms in the critical mass always invest. But if this is true, we know that all others firms also want to invest. The elimination constraint thus eliminates the low equilibrium and ensures that the high equilibrium is the only equilibrium. Even though all firms have pessimistic beliefs, L's optimal contract induces the high equilibrium, precisely because it eliminates the low equilibrium.

The cost of mobilizing the critical mass is given by $\alpha^* = -\sum_{c=1}^{C}(r_c^\varepsilon - \bar{\phi})X > 0$. In order to be willing to mobilize the critical mass, L needs a positive incentive. This comes from the exercise of market power. For $\alpha > \alpha^*$, L wants to mobilize the critical mass, because the cost of doing so is smaller than the profits L can obtain from exercising his market power. But for $\alpha < \alpha^*$, L has too little market power to be willing to do so. We therefore obtain our central result that market power is a necessary condition for a bank to acts as a catalyst for industrialization.[24]

It is important to note that market power includes two dimensions: cost advantage and size. Proposition 2 shows that both matter. L requires a sufficient cost advantage to recover the losses from mobilizing the critical mass, i.e., $\alpha > \alpha^* (\Leftrightarrow (\bar{\phi} - \underline{\phi}) > \frac{\alpha^*}{AX})$. But L also needs to be sufficiently large to mobilize the critical mass, i.e., $A \geq C$. For $A < C$, L might still invest in A firms, but this will not be enough to mobilize the critical mass. L then fails to be a catalyst.

[24] Note that Proposition 2 does not depend on our particular specification of market power. For the Bertrand model, it is tedious but straightforward to use more general cost structures. And in Da Rin and Hellmann (2001), we show that Proposition 2 also carries over to other models of imperfect competition.

Proposition 2 focuses on two natural belief structures, where agents always expect either the highest or the lowest equilibrium to obtain. In the Appendix we also derive the equilibria for hybrid belief structures. We introduce some intuitive restrictions that eliminate some artificial cases. We then show that the model yields results very similar to Proposition 2. The main difference is that the cost of mobilizing the critical mass lays between 0 and α^*. Hybrid beliefs can therefore be thought of as an intermediate case between pessimistic and optimistic beliefs.

Conceptually, the main difference between hybrid and pessimistic beliefs is that with hybrid beliefs, spontaneous coordination may occur. By contrast, pessimistic beliefs rule out this possibility. Firms invest if and only if not investing is not an equilibrium. The main difference between hybrid and optimistic beliefs is that spontaneous coordination is conditional on the realization of θ for the former, but unconditional for the latter.

Which belief structure is the "correct" one: pessimistic, optimistic, or hybrid? The whole point of models of multiple equilibria is that they do not *prescribe* which equilibrium occurs. Instead their purpose is to *describe* the various equilibria. The role of Proposition 2 is to explain how different belief structures map into different equilibria. Without further context, however, the theory remains silent on which outcome is to occur.

Naturally, if we want to use the model as a theoretical framework for interpreting economic history, certain equilibria may be more relevant than others. Interpretations of the big-push model typically focus on the pessimistic equilibrium; see Matsuyama (1995). This also applies to our specific historic context. For continental European industrialization spontaneous coordination appears to be an unlikely explanation. The equilibrium where a large bank mobilizes a critical mass, and thereby acts as a catalyst for the high equilibrium, provides a more useful theoretical framework.

3.4. The Role of Equity

So far we assumed that banks only use standard debt contracts. We now introduce equity. We denote L's percentage ownership by s. A contract is now represented by a vector $\theta_n = (r_n, s_n)$. If $\bar{n}$ firms invest, the profits of firm n are given by:

$$\pi(\bar{n}, \theta_n) = (1 - s_n)[f(\bar{n}) - (1 + r_n)X].$$

A bank's profits from financing firm n are given by:

$$\rho(\bar{n}, \theta_n) = s_n[f(\bar{n}) - (1 + r_n)X] + (r_n - \bar{\phi})X.$$

PROPOSITION 3. *Suppose banks can finance firms with both debt and equity. Proposition 2 continues to apply. Moreover*:

(i) *the cost of mobilizing the critical mass is smaller, i.e.,* $\alpha_s^* < \alpha^*$. *Also,* α_s^* *is an increasing function of* W, *with* $\alpha_s^* = 0$ *for sufficiently low* W.

(ii) *Under pessimistic beliefs, the optimal security offered to firms in the critical mass is either pure equity or a combination of debt and equity. For all other firms, the choice of securities does not matter.*

The main insight from Proposition 3 is that equity lowers the cost of mobilizing the critical mass. The intuition for this comes from the elimination constraint. To see this, note that in equilibrium (where $\bar{n} = N$), a firm's profits are given by $\pi(N, \theta_c^\varepsilon)$, where θ_c^ε is the optimal contract to a firm in the critical mass. By contrast, the elimination constraint pertains to an off-the-equilibrium-path scenario with $\bar{n} = c$, where profits are lower; i.e., $\pi(c, \theta_c^\varepsilon) < \pi(N, \theta_c^\varepsilon)$. The elimination constraint ensures that at these lower off-the-equilibrium profits, firms are just willing to invest. In equilibrium, however, the higher profits obtain. With a pure debt contract, the firm receives the entire difference between the lower off-the-equilibrium-path profits and the higher on-the-equilibrium-path profits. Equity, however, allows the bank to share in this difference. This reduces the cost of mobilizing the critical mass. As a consequence, L prefers to use equity over debt.

In the Appendix we derive the optimal combination of debt and equity. The elimination constraint favors equity over debt. However, the optimal contract also has to satisfy the competitive constraint $\rho(N, \theta_c^\varepsilon) \leq 0$. This simply says that if L were to make too much profit on the firms in the critical mass, they would desert it and accept more competitive offers from other banks. In the Appendix we show that $\rho(N, \theta_c^\varepsilon)$ depends on W: the larger W, the lower X, the lower L's equity stake s_c, and thus the lower $\rho(N, \theta_c^\varepsilon)$. For large values of W, the competitive constraint is not binding (i.e., $\rho(N, \theta_c^\varepsilon) < 0$) and the optimal choice of security is pure equity. For smaller values of W, however, the competitive constraint is binding. In this case it is optimal to use a combination of debt and equity, so that $\rho(N, \theta_c^\varepsilon) = 0$. Note also that α^* is increasing in W because $\rho(N, \theta_c^\varepsilon)$ is decreasing in W.

The elimination constraint only concerns firms in the critical mass. For all other firms the Modigliani–Miller theorem applies; i.e., the choice of security does not matter for them.[25]

In summary, our model provides a novel rationale for why a bank may want to hold equity that has nothing to do with standard reasons of providing incentives for monitoring. Instead, equity allows a bank to participate in the gains that it creates when inducing a higher equilibrium.[26]

[25] For simplicity we consider only debt and equity contracts. In Da Rin and Hellmann (2001) we extend the model to consider a general security design problem and show how the results carry over to such a more general model.

[26] Our model identifies the benefits of having a bank with sufficient size and market power to induce a critical mass of investments. In Da Rin and Hellmann (2001) we extend the model to examine some potential disadvantages of such a mechanism. In particular, we show that large banks have a vested interest in preserving concentration in both the financial and the industrial sectors. This may retard the development of financial markets and slow down economic growth at later stages of industrialization. These results also help understand the findings by Fohlin (1998a,b,c) and others, surveyed in Edwards and Ogilvie (1996) and Guinnane (2001). These papers argue that banks had a negigible, if not negative, role in the later stages of German industrialization.

4. THE LIMITS OF THE GERSCHENKRON–SCHUMPETER VIEW

The fundamental insight from our model is that for banks to play a role as a catalyst, they need to be sufficiently large and to have sufficient market power in order to be willing to incur the cost of coordination. The power of the theory is thus to identify the conditions under which we can or cannot expect banks to take the role of catalyst for industrialization. Our theory is consistent with the evidence from Section 2, which focused on the success stories of Belgium, Germany, and Italy, where a few large universal banks played a significant role in promoting industrialization.

In this section we take the theory one step further by confronting it with additional historic evidence. If our theory is useful in identifying the conditions under which their argument holds, we now want to concern ourselves with the limits of that argument. We structure this analysis in three parts. First, we consider historic evidence from some countries that failed to industrialize. Second, we discuss why should it be banks and not other private institutions to act as catalysts. Third, we discuss what formal empirical evidence exists in the literature and what additional predictions can be gained from our model.

4.1. Violating the Necessary Conditions: Evidence from Countries That Failed to Industrialize

Our theory establishes the necessary conditions for a bank to be able to act as a catalyst for industrialization. We now look at what happens when these conditions are violated and examine the experience of some countries that failed to industrialize: Russia, Spain, and Italy before 1890. The failure to industrialize can clearly be attributed to multiple causes. This evidence therefore cannot provide a definite test of our theory. What we want to emphasize, however, is that the necessary conditions for bank coordination were not satisfied in each of these countries.

Crisp (1967) shows that Russian industrial credit banks developed slowly and remained small and dispersed over an immense country. The behavior of the Russian state was far from enticing a catalytic role of banks. The state maintained a tight grip on new economic activities and kept limiting the growth of banks. For example, the government viewed as usury any activity involving a monetary compensation for risk-taking. This attitude strongly limited how much banks could charge their borrowers and therefore their market power.[27] Only from the 1890s did banks based in St. Petersburg start engaging in some industrial credit, but they were many (10 in 1900 and 13 in 1914), and so there was much competition, which kept them small.[28] The result was a pattern of economic growth which owed more to the rationalization of agriculture than to industrialization.

[27] For instance, an attempt to set up a large joint-stock industrial credit bank in Moscow in the 1860s failed because investors feared to offend the authorities.

[28] Joint-stock Russian banks totalled 40 in 1893, and 50 in 1914 (Crisp, 1967, p. 197).

Spain in the second half of the 19th century represents another case which illustrates the consequences of repressing the activity of industrial banks. While incorporation was initially subject to governmental approval, it was liberalized after 1856, leading to the creation of several banks. By 1870 about 30 credit companies and issue banks had appeared and had engaged in commercial banking (Tortella, 1972, p. 93). Four of these became quite large. However, they shunned investment in manufacturing firms because of constraints the government imposed on their actions, curtailing their ability to invest in manufacturing and encouraging purely speculative investments in railroads and mining companies. Tortella (1972) forcefully argues that the government's policy impeded a rapid and stable economic growth. In particular, the government prevented banks from effectively coordinating complementary activities: its policy of subsidization of railways while restricting the growth of manufacturing meant that there were not enough goods to transport and therefore too little business for the railways to be profitable. In this environment, banks had not enough power, nor incentives, to engage in investment coordination.

Interestingly, the Italian experience before 1890 also lends support to our interpretation. Polsi (1996) describes how a large number of small banks competed for the financing industry since the 1860s. They extended little equity finance and competed also with the six banks of issue. The situation changed drastically by the mid-1890s. The Banca d'Italia was set up in 1894 and was conferred a monopoly over note issuing. Existing industrial credit banks collapsed after a period of speculation. The creation of the Banca Commerciale and Credito Italiano, both much larger than any previous industrial credit bank, brought about a very different environment.

We notice one common trait shared by all these countries in their failures to industrialize: a financial market structure which was not conducive to bank coordination. The example of Italy is particularly interesting since it uses "time-series-like" reasoning as opposed to "cross-section-like" reasoning to illustrate the insights from our model. Soon after Italy changed its financial structure, its banks started engaging in coordination, as we discussed in Section 2.

Another interesting case is that of France, which also industrialized in the latter half of the 19th century. France provides an example of a failed catalyst rather than of a failed industrialization. The Crédit Mobilier was one of the earliest industrial credit banks (Cameron, 1961). It was founded in 1852 by the Péreire brothers to foster the industrialization of France (Paulet, 1999). The Crédit Mobilier went bankrupt in 1871 when it failed to rescue its real estate subsidiary, the Compagnie Immobilière. Two features stand out in the experience of the Crédit Mobilier. First, it was relatively small, since its charter prevented it from issuing bonds or deposits beyond twice its paid-in capital. In fact its capital of 60 million francs put a cap to its lending capacity, a limitation its founders repeteadly (but unsuccessfully) tried to have repealed by the government (Cameron, 1961, p. 145). Second, the Crédit Mobilier did not focus its investment policy on the industrialization of the French economy. Rather, it invested mainly in real estate and in the stocks and bonds of railroads all over Europe, from Spain to Austria to Italy (Paulet, 1999, Chap.2). The French experience thus gives us the example of a bank which acted more as an unfocused speculator rather than a focused catalyst.[29]

4.2. Why Banks?

Our starting point is the observation that banks played a catalytic role in the industrialization of several continental European countries. Our theoretical model derives conditions under which an investor can coordinate beliefs about investment decisions. The model shows that an investor needs to be sufficiently large and have enough market power. This large investor also needs to be sufficiently networked to reach a diverse set of complementary firms and influence their investment decisions. Based on our historical motivation we conveniently call this large investor a bank. Because of their unique position in the payment system, banks are naturally in contact with a large and diverse set of firms. And through their lending activity, banks are in a natural position to influence investment behavior. If regulations allow banks to become large and powerful, they are a natural candidate to play the role of catalyst.

However, we do not exclude the possibility that other institutions could also play this role. Governments and conglomerates would seem two natural candidates. Indeed, government has been the main focus of the big-push literature. The point of this paper is to show that private agents, such as private banks, can also take on such economic leadership roles under certain conditions. The historic analysis is important here, since it provides concrete examples of private agents taking such initiative. This is particularly relevant to the analysis of emerging markets since there is a growing consensus among economists that government-led big-push policies of the type advocated in the 1950s and 1960s may not be appropriate (see Matsuyama (1995b)). By now, many economists warn against poor incentives for government bureaucrats and the opportunities of diverting resources for alternative

[29] The view of Gerschenkron and Schumpeter applies only to economies that suffer from a coordination problem. Coordination is likely to be most important for catch-up economies, and, as argued by Matsuyama (1995b), it becomes less important as the economy approaches the technological frontier. The best example of an economy that is believed to have industrialized near the technological frontier is, of course, Britain, which led the first Industrial Revolution. Acemoglu and Zilibotti (1997) hold that experimentation and risk diversification were the crucial problems Britain had to solve to become the first country to industrialize. They argue that the fragmented British banking sector was actually instrumental for sustaining experimentation and diversification. Clearly, this fragmented structure also implied that the necessary conditions for bank coordination were not satisfied. Also the industrialization of the United States during the latter part of the 19th century owed little to industrial credit banks, whose development was restricted by tight regulation (Roe, 1994). However, in the U.S. case the size of the internal market and the geographic extension of the economy made its industrialization very different from that of Britain or of continental Europe. Indeed, Chandler (1977) shows that, because of its unique geography, the development of railways provided a focal point for the development of the U.S. industrial structure.

uses (see Roland (2002) for a survey). One advantage of private banks is that their incentives are more clearly defined. Indeed, our model shows that being a catalyst is consistent with profit maximization. Private banks may also find it easier to price-discriminate. The optimal contract in Proposition 2 charges different interest rates to otherwise identical firms. If a government-owned bank cannot price-discriminate, it would always make bigger losses than its private counterpart.

It is also interesting to notice that the distinction between private banks and government is frequently blurred. First, governments typically used development banks to implement these policies, as in the case of Korea in the 1960s (Cho and Hellmann, 1994). Moreover, it would be innocent to assume that these powerful catalyst banks remain free from political influences. In all our examples from continental Europe, there was an intricate interplay between the banks and their governments. In Belgium, for example, the government created the Banque Nationale in 1850, in a deliberate move to take away control of monetary policy from the Société Générale and the Banque de Belgique. Even within the Société Générale there was a delicate task of balancing political influence. The board of the Société Générale maintained a bipartisan structure, where both leading parties maintained board seats, irrespective of which party was currently in power (Chlepner, 1930).[30] Recent contributions surveyed by Pagano and Volpin (2002) provide a more systematic analysis of the political economy of financial development.

The other private agent that may act as catalysts is firms themselves. One theoretical solution would be for one firm to internalize the externalities by launching all the complementary opportunities itself. Such an extreme horizontal and vertical integration, however, may undermine the provision of efficient incentives (see Grossman and Hart (1986) and the survey by Stein (2002) on internal capital markets). A more effective approach might then be that of a conglomerate, where a large number of firms are linked by the investments made by a holding company. Conglomerates may clearly satisfy the model conditions of being sufficiently large, powerful, and networked (Khanna, 2002). Japan before World War II provides a clear-cut historical example for such an approach. Fruin (1992) and Morikawa (1992), among others, document the role of the *zaibatsus* in fostering and coordinating industrialization. *Zaibatsus* were family-dominated conglomerates centered around a trading company which commercialized the products of member firms. Therefore *zaibatsus* grew by focusing on trading complementarities among their own companies. One interesting aspect of prewar Japan was that regulations forced banks to limit their action to short-term lending and also limited the size and power of its banking institutions, (Patrick, 1967). This helps to explain the emergence of conglomerates as functional substitutes. Another interesting aspect

[30] The channels of influence can run both ways. In Germany, for example, *Kreditbanken* exerted pressure on the government, asking for protection and support for their clients. They pursued favorable charter conditions for clients who wanted to incorporate and diplomatic assistance to their clients for export activities (Riesser, 1911). Rajan and Zingales (2001) provide modern evidence of the same type.

is that as their industrial activities grew, many conglomerates, such as Mitsui or Sumitomo, used banks to coordinate their internal investment activities (Masaki, 1986). Even though the Japanese conglomerates thus had a distinct institutional origin, the need to coordinate investments naturally led them to use bank-like institutions. We therefore find the distinction between banks and conglomerates somewhat blurred, as both institutional arrangements may play similar functional roles.

Finally, note that our notion of banks relies on the ability to make investments, but not on the ability to intermediate savings. What matters is that the bank has access to enough funds to finance a large number of firms. But the model does not prescribe whether these funds have to come from depositors or other sources. Again, there is interesting historic support for this. Even the large and powerful banks in Belgium, Germany, and Italy did not necessarily start out as financial intermediaries. In Belgium, the Société Générale received its initial capital from the Dutch king (Chlepner, 1926). German *Kreditbanken* were founded with the capital of *Privatbankiers* (Riesser, 1911) and Italian credit banks initially relied on the capital contribution of a small number of founders (Confalonieri, 1976, Vol. 1). As their industrial lending portfolio grew, however, these banks turned to financial intermediation to raise additional funds. For instance, the creation of the Deutsche Bank in 1870 marked the start of the opening of local branches where deposits were raised from wealthy individuals (Da Rin, 1996). Confalonieri (1976, Vol. 2), shows that deposits rapidly increased as a source of banks' funds after the turn of the century. The historic evidence thus suggests that it is possible for investors to act as catalysts without financial intermediation. On the other hand, the need to raise a significant amount of funds may naturally lead those investors to become financial intermediaries.

4.3. Testable Hypotheses

We begin our paper with a historical motivation which contains the puzzling observation that banks seems to have played a catalytic role in the industrialization of some countries, but not of others. We then develop a theoretical model that explains under what conditions we can expect banks to play such a role of catalyst. The model provides a conceptual framework that helps us to better understand the historical evidence and to assess its interpretation by Schumpeter and Gerschenkron. But our model also yields interesting empirical predictions that could be tested empirically.

A first prediction of the model is that market power in banking favors industrialization. Our analysis in Sections 2 and 4.1 provides anedoctal historic evidence which is consistent with this hypothesis. Formal econometric tests could be developed to confront these predictions with evidence. For example, one could employ either industry segments or countries as the unit of analysis. For younger industries (or less industrialized countries) we would expect a positive relationship between banking concentration and industrial growth. We would also expect a positive relationship between banking concentration and innovation, which might be measured with patents or R&D expenditure, or between banking concentration and firm natality rates.

Cetorelli (2001) and Cetorelli and Gambera (2001) perform some closely related tests. They do not look at industrialization per se, but instead use data from 36 manufacturing industries in 41 industrialized countries over the 1980–1990 period. Their findings are supportive of our hypotheses. Indeed, their main result is that concentrated banking is associated with higher growth rates in industries with younger firms, whereas it is associated with lower growth rates in industries with more established firms. Also the results of Beck and Levine (2002) conform to the predictions of our theory. They find that firm natality rates increase with financial development, so that one should observe increased enterprise formation once catalytic banks start operating.

There may be several reasons why concentrated banking leads to such a pattern of industrial growth. Petersen and Rajan (1995), for example, argue that financing a new firm entails risks that can only be compensated in an ongoing relationship. Too much competition may undermine relationship banking if it makes it too easy for a successful firm to exit a relationship. Such a relationship-based explanation is complementary to ours. The main difference is that our macro approach does not rely on the interaction of one bank with one firm but rather looks at bank portfolios. In the relationship model, if a bank incurs initial investment losses, it needs to recover them from the same client. In our model, instead, it is possible for the bank to make losses on some clients, as long as these investments help the bank to make profits from investments in other clients.

Our macro perspective allows us to derive some additional empirical implications beyond those already tested by Petersen and Rajan. In particular, it predicts that the portfolios of the large catalytic banks should differ systematically from those of smaller banks. These should have well-diversified portfolios across industries. The larger industrial banks, however, should have portfolios that are concentrated on a set of firms which share significant externalities. Such a portfolio is likely to be less diversified. Our model also predicts that large banks should invest in a large number of industry pioneers, as opposed to industry followers.

Finally, our model also provides a new set of predictions about the use of equity financing and the role of universal banks. The model predicts that universal banks should have a competitive advantage over banks that are restricted to pure loan financing, especially in new industries that require some kind of catalytic coordination. One could then test whether such industries develop faster in emerging markets which allow universal banking. The model also predicts that the minimum size of a catalytic bank is lower if the bank can make equity investments. As a consequence, the relationship between banking concentration and industrial growth should be less pronounced in cases where banks are allowed to hold equity.

5. CONCLUSION

In this paper we provide a new theory of the role of banks as catalysts for industrialization. Our theory formalizes the view of Gerschenkron, Schumpeter, and others who studied the industrialization of some continental European countries. We introduce banks into a model of the big-push to examine under what circumstances profit-motivated banks would engage in the coordination of industrial investments. The model establishes a theoretical link between the role of banks as catalysts for industrialization and the necessity of market power for these banks. The theory also shows why universal banking helps to reduce the (endogenous) cost of coordination, thus improving the efficiency of banks as catalysts. We use the model to interpret a diverse set of observations on the role of banks in the industrialization of emerging economies. We show that in cases where banks took an active role in promoting industrialization we also find that the necessary conditions derived from theory—size and market power in banking—are satisfied. We also discuss a number of cases where the lack of industrialization seems at least in part related to a violation of these necessary conditions. These examples help sharpen our understanding of when the Gerschenkron–Schumpeter view does or does not apply. We then consider some alternative catalysts, such as the government or industrial conglomerates. Finally, we spell out several predictions of the model which can be formally tested.

The debate about the role of banks in industrialization is not merely a historical issue, but central to the debate about the role of banks in emerging markets. Our analysis highlights that in some of the most successful emerging economies, banks played a creative role in the promotion of new industries.

APPENDIX

Proof of Proposition 1. We solve the model by backward induction. At the second stage all firms face a set of contracts given by $\theta^{\bar{\phi}} = \{r_n = \bar{\phi} \mid n \in N\}$. From the assumption of $f(1) < k < f(N)$ it follows that $\pi(1, \bar{\phi}) < W < \pi(N, \bar{\phi})$. Given $\theta^{\bar{\phi}}$, there are two equilibria at the second stage, namely $\Omega(\theta^{\bar{\phi}}) = \{0, N\}$. With optimistic beliefs, $\bar{n} = N$ is chosen and with pessimistic beliefs $\bar{n} = 0$ is chosen. Now consider the first stage. To see that $\theta^{\bar{\phi}}$ is optimal, we use standard Bertrand reasoning. With perfect competition there cannot be any positive profits, so that $r_n \leq \bar{\phi}$. But banks obtain nonnegative profits only for $r_n \geq \bar{\phi}$. Thus $r_n = \bar{\phi}$. ■

Proof of Proposition 2. For part (i), consider first the case of optimistic beliefs, where we claim that $\theta^{\bar{\phi}}$ is again optimal. From Proposition 1 we already know that at the second stage we have $\Omega(\theta^{\bar{\phi}}) = \{0, N\}$ and that with optimistic beliefs, $\bar{n} = N$ is chosen. At the first stage, banks $b = 1, \ldots, B$ engage in Bertrand competition, so that from Proposition 1 they all charge $r = \bar{\phi}$. Consider now L, who has a lower intermediation cost. Using standard Bertrand reasoning, his optimal offer is also given by $r = \bar{\phi}$. In equilibrium we then have $\varrho_L = A(\bar{\phi} - \underline{\phi})X = \alpha$.

For part (ii), consider now the case of pessimistic beliefs. It is useful to subdivide $\hat{L}$ into two groups: the set of firms in the critical mass, denoted by $\hat{C}$, and the set of firms outside the critical mass, denoted by $\hat{O}$. Let $\theta_C = \{r_n \mid n \in \hat{C}\}$ and $\theta_O = \{r_n \mid n \in \hat{O}\}$, so that $\theta_L = \{\theta_C, \theta_O\}$. Again we solve the model by backward induction. For the second stage, we derive all the equilibria that result from $\theta^\varepsilon = \{\theta_C^\varepsilon, \theta_O^{\bar{\phi}}, \theta_B^{\bar{\phi}}\}$, where $\theta_C^\varepsilon = \{r_c^\varepsilon \text{ s.t. } \pi(c, r_c^\varepsilon) = W \mid c = 1, \ldots C\}$, $\theta_O^{\bar{\phi}} = \{r_n = \bar{\phi} \mid n \in \hat{O}\}$, and $\theta_B^{\bar{\phi}} = \{r_n = \bar{\phi} \mid n \in \hat{B}\}$. We claim that $\Omega(\theta^\varepsilon) = \{N\}$, so that $\bar{n} = N$ is the only equilibrium. To see this, consider first the investment decisions of firms in the critical mass. Their contracts all satisfy the elimination constraint $\pi(c, r_c^\varepsilon) = W$, $c = 1, \ldots, C$. We now examine how this constraint works. Note that r_1^ε satisfies $\pi(1, r_1^\varepsilon) = W$. This implies that firm $c = 1$ always invests, irrespective of all other firms' decisions. Since there is symmetric and complete information, everybody knows this. In particular, firm $c = 2$ knows it. Firm $c = 2$ faces a rate r_2^ε such that $\pi(2, r_2^\varepsilon) = W$. Since firm $c = 2$ knows that firm $c = 1$ always invests, it also invests, irrespective of all other firms' decisions. Again, everybody knows this, including firm $c = 3$. And so on. We have thus constructed an inductive chain that leads all the way up to $c = C$. That is, given θ_C^ε, the only equilibrium for all firms $c = 1, \ldots C$ is to invest. Now consider the decisions of all other firms. Each firm knows that $\pi(C + 1, \bar{\phi}) \geq W$, so that each firm is willing to invest, irrespective of what all other firms outside the critical mass do. What matters is that everyone knows that all firms in the critical mass do invest. It follows that, given θ^ε, investing is the only equilibrium for all firms. We have thus shown that $\Omega(\theta^\varepsilon) = \{N\}$. Despite pessimistic beliefs, all firms believe that everybody invests, because this is the only equilibrium of the game at the second stage.

Consider now the game at the first stage. Because of Bertrand competition, we always have $r_n = \bar{\phi}$ for $n \in \hat{O}$ and $n \in \hat{B}$. We therefore focus on the contracts in $\hat{C}$. We say that θ' has higher interest rates than θ'' if $r_n' \geq r_n''$ for all n, and with a strict inequality for at least one n. We denote this by $\theta' \succ \theta''$. We claim that there exists no $\theta' \succ \theta^\varepsilon$, so that $\Omega(\theta') = \{N\}$. That is, among the set of contracts that have $\bar{n} = N$ as the only equilibrium, θ^ε has the highest interest rates. Consider θ_C' that has exactly one interest rate higher than θ_C^ε. This higher rate is offered to some firm c', and we denote it by $r' > r_{c'}^\varepsilon$. We know from above that θ_C' is such that all firms with $c < c'$ always invest. Consider now the decision of c'. Since $\pi(c', r') < W$, firm c' is unwilling to invest, unless it knows that some other firms will also invest. Suppose it believes that no other firm will invest. We denote this belief by $\beta(\theta_C') = c' - 1$. This belief constitutes a rational self-fulfilling equilibrium. To see why, consider any firm c'' with $c' < c'' < C$. If c'' believes that only $c' - 1$ other firms invest, it evaluates its profits at $\bar{n} = c' - 1 + 1 = c'$. It thus believes its profits will be $\pi(c', r_{c''}^\varepsilon)$. Using $r_{c''}^\varepsilon > r_{c'}^\varepsilon$, we get $\pi(c', r_{c''}^\varepsilon) < \pi(c', r_{c'}^\varepsilon) < W$. It follows that c'' does not want to invest. Similarly, for all firms outside the critical mass, we get $\pi(c', \bar{\phi}) < \pi(c', r_{c'}^\varepsilon) < W$. Thus, if all these firms believe that only $c' - 1$ other firms invest, then they do not want to invest themselves. It follows that $\beta(\theta_C') = c' - 1 \in \Omega(\theta_C')$, i.e., the belief that $c' - 1$ invests is an equilibrium belief. Obviously, this is not the only belief, since there also exists an equilibrium where all other firms invest. θ'_C thus generates multiple equilibria, namely $\Omega(\theta'_C)=\{c'-1, N\}$. In other words, any contract that has exactly one higher interest rate than θ^{ε}_C generates multiple equilibria. It is easy to see that contracts with more than one higher interest rate than θ^{ε}_C also generate multiple equilibria. The lowest of these equilibria is always given by $c'-1$, where c' is the lowest value of $c=1,\ldots,C$ where $r'>r^{\varepsilon}_c$. It follows that θ^{ε} is the highest offer where $\bar{n}=N$ is the only equilibrium.

With pessimistic beliefs, agents always expect the lowest equilibrium to occur. If L wants to implement $\bar{n}=N$, it cannot choose any contract with higher rates than θ^{ε}_C. Obviously, L never wants to choose a contract with lower rates than θ^{ε}_C either. We now need to examine when it is that L is willing to implement $\bar{n}=N$. For this, we need to compare θ^{ε}_C with the outcome of the low equilibrium, where $\bar{n}=0$ and where L makes zero profits.

There are some costs associated with mobilizing the critical mass. By definition, $\pi(C,\bar{\phi})<W$, so that $\pi(c,\bar{\phi})<W$ for all $c=1,\ldots C$. Since $\pi(c,r^{\varepsilon}_c)=W$, it follows that $r^{\varepsilon}_c<\bar{\phi}$ for all $c=1,\ldots C$. L's net profits are thus given by $\varrho_L=\sum_{c=1}^{C}(r^{\varepsilon}_c-\bar{\phi})X+\sum_{n\in\hat{O}}(r_n-\bar{\phi})X+A(\bar{\phi}-\underline{\phi})X$. Using $\pi(c,r^{\varepsilon}_c)=W\Leftrightarrow f(c)-(1+r^{\varepsilon}_c)X=W\Leftrightarrow r^{\varepsilon}_c=\frac{f(c)-K}{X}$, we get after some transformations that $-\sum_{c=1}^{C}(r^{\varepsilon}_c-\bar{\phi})X=\sum_{c=1}^{C}k-f(c)=\alpha^*$. Moreover, Bertrand competition implies $r_n=\bar{\phi}$ for all $n\in\hat{O}$. Thus we get $\varrho_L=\alpha-\alpha^*$. L therefore finds it optimal to offer θ^{ε}_C whenever $\alpha\geq\alpha^*$. For $\alpha<\alpha^*$ the low equilibrium obtains.

To complete the proof, we need to show that L never wants to induce any other equilibrium than either $\bar{n}=0$ or $\bar{n}=N$. For this we use the condition $A\geq C$. Consider any equilibrium with $0<\bar{n}<N$ firms investing. Clearly, $C\leq\bar{n}<N$ can never be an equilibrium. Consider any equilibrium where $0<\bar{n}<C$. With pessimistic beliefs, the optimal contract is analogous to the θ^{ε}_C, except that it is only offered to $\bar{n}<C$ firms. (The proof for this is the same as when we explained why r^{ε}_c is necessary to mobilize the critical mass.) We denote this optimal contract by $\theta^{\varepsilon}_{\bar{n}}=\{r^{\varepsilon}_c\mid c=1,\ldots,\bar{n}\}$. We have $\varrho_L(\bar{n},\theta^{\varepsilon}_{\bar{n}})=\sum_{c=1}^{\bar{n}}(r^{\varepsilon}_c-\underline{\phi})X$. Since r^{ε}_c is an increasing function of c, $\varrho_L(\bar{n},\theta^{\varepsilon}_{\bar{n}})$ is an increasing function of $\bar{n}$. Denote L's net profits from implementing the high equilibrium by $\varrho_L(N,\theta^{\varepsilon})=(A-C)(\bar{\phi}-\underline{\phi})X+\sum_{c=1}^{C}(r^{\varepsilon}_c-\underline{\phi})X$. For all $\bar{n}<C$, we have $\varrho_L(\bar{n},\theta^{\varepsilon}_{\bar{n}})<\varrho_L(C,\theta^{\varepsilon}_C)\leq\varrho_L(N,\theta^{\varepsilon})$. Thus implementing the high equilibrium dominates implementing an equilibrium with $0<\bar{n}<N$ firms investing.

Proposition 2 focuses on the two extreme cases of optimistic and pessimistic beliefs. Consider now hybrid belief structures. Some functions $\beta(\theta)$ are void of economic meaning. To focus our discussion, we therefore introduce two simple restrictions on the structure of $\beta(\theta)$. First, we assume that all that matters in θ is the set of best offers. This means that if two sets of contracts, θ' and θ'', differ only in terms of interest rates that are dominated anyway, then $\beta(\theta')=\beta(\theta'')$. It also means that if two sets of contracts, θ' and θ'', have the same best offers, but differ in terms of the identities of the banks making the offers, then again $\beta(\theta')=\beta(\theta'')$. This restriction excludes trivial belief structures, where beliefs change based on actions that have no economic content. Second, we assume that for any θ, either

$\beta(\theta) = \text{Min}\{\bar{n} \mid \bar{n} \in \Omega(\theta)\}$ or $\beta(\theta) = \text{Max}\{\bar{n} \mid \bar{n} \in \Omega(\theta)\}$. This says that if more than two equilibria exist, agents never expect any of the intermediate equilibria to occur. While it is possible to construct examples where more than two equilibria exist, they seem to have no good economic meaning. In particular, it is difficult to see how agents would be able to spontaneously coordinate on an intermediate equilibrium, but be unable to coordinate on the highest equilibrium. With these restrictions, the beliefs depend only on $\theta_C = \{r_c \mid c = 1, \dots C\}$.

We now examine the optimal contract under hybrid beliefs. Because of Bertrand competition, we again have $\theta_O = \theta_O^{\bar{\phi}}$ and $\theta_B = \theta_B^{\bar{\phi}}$. The optimal choice of θ_C maximizes $\varrho_L(\theta_C)$, subject to $\beta(\theta = \{\theta_C, \theta_O^{\bar{\phi}}, \theta_B^{\bar{\phi}}\}) = N$. We denote this optimal choice by $\theta_C^H = \{r_c^H \mid c = 1, \dots, C\}$. The superscript H refers to the optimal choice under hybrid beliefs. We denote the cost of mobilizing a critical mass by $\alpha_H^* = -\sum_{c=1}^{C} (r_c^H - \bar{\phi})X$. To see that $\alpha_H^* \geq 0$, note that $\alpha_H^* < 0$ would imply that some firms accept offers with $r_c^H > \bar{\phi}$, which is impossible under Bertrand competition. To see that $\alpha_H^* \leq \alpha^*$, note that $\alpha_H^* > \alpha^*$ would imply that L prefers θ_C^{ε} over θ_C^H, which is impossible since θ_C^H is the optimal choice. This shows that the results from Proposition 2 continue to hold under hybrid beliefs. The only difference is that L prefers to induce the high equilibrium for $\alpha > \alpha_H^*$. Note also that we can use α_H^* as an index to sort all hybrid beliefs on a continuum that ranges from optimistic beliefs (where $\alpha_H^* = 0$) to pessimistic beliefs (where $\alpha_H^* = \alpha^*$). ■

Proof of Proposition 3. The model with equity has the same logic as the base model. The main difference concerns the choice of optimal securities. Consider first all firms in $\hat{O}$ and $\hat{B}$. To show that the Modigliani–Miller theorem holds for these firms, note that all optimal contracts in $\hat{O}$ and $\hat{B}$ only have to satisfy the Bertrand condition $\rho(N, \theta_n) = 0$. This implies $s_n = \frac{(1+\bar{\phi})X - (1+r_n)X}{f(N) - (1+r_n)X}$. We substitute this into $\pi(N, \theta_n) = (1 - s_n)[f(N) - (1 + r_n)X]$ to obtain $\pi(N, \theta_n) = f(N) - (1 + \bar{\phi})X$. This does not depend on the relative choice of r_n and s_n. Hence the choice of securities does not matter.

Unlike for the contracts to firms in $\hat{O}$ and $\hat{B}$, the contracts for firms in $\hat{C}$ have to satisfy two constraints. In addition to the Bertrand constraint $\rho(N, \theta_c^{\varepsilon}) \leq 0$, they have to satisfy the elimination constraint $\pi(c, \theta_c^{\varepsilon}) = W$. The two constraints may therefore affect the optimal structure of this vector; i.e., they may affect the optimal choice of securities.

The proof proceeds as follows. We first show that the elimination constraint favors the use of equity. The competitive constraint, however, generates an upper bound on the amount of equity that L can hold. For low values of W, the competitive constraint is not binding. In this case pure equity is optimal. For higher values of W, however, the competitive constraint is binding. In this case a combination of debt and equity is optimal. This establishes part (ii) of the proposition. Finally, to establish part (i), we also show that $\alpha_s^* < \alpha^*$ with $\alpha_s^* = 0$ for sufficiently low W.

We first show that the elimination constraint favors equity. From the elimination constraint we note that the optimal combination of r_c and s_c, denoted by r_c^{ε} and

s_c^ε, must satisfy $s_c^\varepsilon = 1 - \frac{W}{f(c)-(1+r_c^\varepsilon)X}$. Using this, we obtain after some transformations $\rho(N, \theta_c^\varepsilon) = [f(c) - k] + s_c^\varepsilon[f(N) - f(c)]$. The first term is negative and represents the loss L suffers from financing firms in the critical mass. This is the same term as in the model with pure debt contracts. The second term is positive and represents L's share in the additional gains, related to the shift in beliefs from $\bar{n} = c$ to $\bar{n} = N$. Since $\rho(N, \theta_c^\varepsilon)$ is increasing in s_c^ε, L wants to increase s_c^ε and reduce r_c^ε.

Next, we note that the competitive constraint imposes an upper bound on L's equity stake. The competitive constraint requires $\rho(N, \theta_c^\varepsilon) \leq 0 \Leftrightarrow s_c^\varepsilon \leq \frac{k-f(c)}{f(N)-f(c)}$. The upper bound on s_c^ε is thus given by $\overline{s_c^\varepsilon} \equiv \frac{k-f(c)}{f(N)-f(c)}$.

Consider now how L's equity share depends on W. In the case of pure equity, we have $s_c^\varepsilon = 1 - \frac{W}{f(c)}$. For any c, pure equity is optimal if the competitive constraint is not binding; i.e., $\rho(N, \theta_c^\varepsilon) < 0$. This requires $1 - \frac{W}{f(c)} < \frac{k-f(c)}{f(N)-f(c)} \Leftrightarrow W > f(c)\frac{f(N)-k}{f(N)-f(c)} \equiv W^*(c)$. Note that $W^*(c)$ is an increasing function of c. For $W > W^*(C)$ the competitive constraint is therefore not binding for any c. In this case equity is the optimal security for all firms in the critical mass.

If, however, $W < W^*(C)$ the competitive constraint is binding at least for some firms in the critical mass. Let $c^* \in \{1, \ldots, C\}$, so that $W^*(c^*-1) < W < W^*(c^*)$. For $c < c^*$ we still have $\rho(N, \theta_c^\varepsilon) < 0$ as above, so that pure equity is optimal. But for $c \geq c^*$ we have $\rho(N, \theta_c^\varepsilon) = 0$, so that the upper bound for L's equity stake, given by $s_c^\varepsilon \leq \overline{s_c^\varepsilon}$, is binding. L's optimal choice of securities now involves a combination of debt and equity, with $(1+r_c^\varepsilon)X = f(c) - \frac{W}{(1-s_c^\varepsilon)} > 0$ and $s_c^\varepsilon = \overline{s_c^\varepsilon} > 0$. This proves part (ii) of the proposition.

To conclude the proof, we show part (i). If the competitive constraint is never binding, L's profits from inducing the high equilibrium are given by $\varrho_L = \sum_{c=1}^{C} \rho(N, \theta_c) + A(\bar{\phi} - \underline{\phi}) = \alpha - \alpha_s^*$, where $\alpha_s^* \equiv -\sum_{c=1}^{C} \rho(N, \theta_c^\varepsilon)$. We note that $\rho(N, \theta_c^\varepsilon) = [f(c) - k] + s_c^\varepsilon[f(N) - f(c)] > f(c) - k = \rho(N, r_c^\varepsilon)$, which implies $\alpha_s^* < \alpha^*$. With equity, L requires less market power, since the cost of mobilizing the critical mass is lower. To see that α_s^* is a decreasing function of W, we use $s_c^\varepsilon = 1 - \frac{W}{f(c)}$ to obtain $\rho(N, \theta_c) = f(N) - k - \frac{f(N)-f(c)}{f(c)}W$. With $W^*(c) = f(c)\frac{f(N)-k}{f(N)-f(c)}$ we get $\rho(N, \theta_c) = [f(N) - k]\frac{W^*(c)-W}{W^*(c)}$. It follows that $\rho(N, \theta_c)$ is a decreasing function of W. Thus α_s^* is an increasing function of W.

If the competitive constraint is binding, L's net profits are given by $\varrho_L = A(\bar{\phi} - \underline{\phi})X + \sum_{c=1}^{c^*-1} \rho(N, \theta_c)$, so that $\alpha_s^* = -\sum_{c=1}^{c^*-1} \rho(N, \theta_c)$. Using $\rho(N, \theta_c) = [f(N) - k]\frac{Min[0, W^*(c) - W]}{W^*(c)}$ we see again that $\rho(N, \theta_c)$ is a decreasing (and α_s^* an increasing) function of W. Also note that for $W < W^*(1)$ we have $\alpha_s^* = 0$. ■

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