Relationship Banking and Firm Dynamics

Qingqing Cao
Michigan State University

Paolo E. Giordani
Luiss University

Raoul Minetti
Michigan State University

Pierluigi Murro
Luiss University

Abstract

This paper studies the impact of credit relationships on the dynamics of firms' entry and survival. We first document empirically the role of credit relationships in firm dynamics exploiting rich data from Italian local banking markets over the 1990-2015 period. We then assess to what extent a dynamic general equilibrium model of relationship lending can explain the empirical facts. Over the course of credit relationships, banks acquire information on firms' physical assets and human capital. While information on firms' assets benefits incumbents relative to entrant firms, banks' knowledge accumulation about human capital and employees bolsters firm entry by easing spin-offs of incumbent businesses. We characterize conditions under which a relationship-oriented structure of the banking sector boosts or depresses firms' turnover and the dynamism of the business sector.

Keywords: Credit Relationships, Firm Dynamics, Firm Entry, Spin-offs,

1 Introduction

The forces that shape the dynamics of firms' entry and survival are of fundamental interest for scholars and policymakers. The development of the credit market is reputed to be important in determining the ease with which new firms can break into markets, compete with incumbent businesses, and survive over time. An aspect that thus far has received little attention is the way the structure of the credit sector shapes the dynamics of the business sector, including the intensity and mode of entry of new businesses. Yet, the banking literature has extensively documented that a distinctive feature of the credit sector is the importance of banks' business models and lending technologies. Banks garner information over time about firms' physical assets and human capital (employees and managers). This leads to the accumulation of a large stock of soft information, which is not codified and not transferable across banks. Fundamental questions arise from these observations. How do bank-firm relationships impact the dynamics of the business sector? Do credit relationships favor incumbent firms or new entrants? And, among new entries, do they favor some modes of entry more than others?

This paper takes a step towards addressing these questions by investigating the impact of relationship banking on firms' dynamics (entry and survival) and age distribution. In the first part of the analysis, we exploit rich information from the Italian local credit markets and document how the importance of credit relationships in a local credit market affects the relative importance of entrant versus incumbent firms in the local market. To this end, we exploit detailed information on the intensity of credit relationships in Italian provinces from a large survey conducted by an Italian banking group. We document the following facts. Credit relationships appear to reduce the relative importance of entrant firms versus incumbents in the local market. However, there is significant sectoral heterogeneity in this effect. In industries characterized by stronger importance of firms' human capital relative to physical capital, credit relationships appear to better promote firms' entry in the local market. Conversely, a stronger importance of physical capital exacerbates the bias of relationship banking in favour of incumbent firms.[1] When we break down entrant firms into de novo entrants and spinoffs of incumbent businesses, we obtain that relationship lending biases entrant firms towards spinoffs rather than de novo entrants. These results are robust across a variety of estimation approaches, including panel estimations with detailed sets of fixed effects and IV estimations. In particular, when running IV estimates, we exploit the Italian historical banking regulation to assuage possible concerns of endogeneity of the importance of relationship lending.

In the second part of the paper, we ask to what extent a parsimonious general equilibrium model of relationship lending and firms' entry can rationalize the empirical findings. In the model, credit relationships shape the accumulation of banks' information over two dimensions. Banks gather information over firms' assets over the course of credit relationships. This raises their ability to monitor, repossess and liquidate firms' collateral assets, improving incumbent firms' access to credit. This first mechanism tends to skew the distribution of firms towards incumbent businesses. Entrant firms

[1] A similar sectoral heterogeneity appears when we consider the type of information acquired by the banks.

can partially commit this benefit of future credit relationships to lenders when entering the market and this helps promote firm entry. However, this effect on entry is dominated by the benefit on incumbents' access to credit. A second channel whereby credit relationships affect firms' distribution is by promoting the accumulation of banks' information on the human capital and skills of managers and employees and the personal relationships between firm managers or employees and loan officers. This mechanism favors the entry of new firms as spin-offs of incumbent ones: managers and employees of incumbent firms may found a business by borrowing from banks that accumulated information on their skills and human capital when employed in incumbent businesses.

Overall, the analysis predicts an ambiguous effect of the intensity of credit relationships on the relative importance of incumbents and entrant firms. We characterize conditions under which credit relationships favor relatively more incumbent or entrant firms. The analysis predicts, for example, that in sectors characterized by a stronger importance of human capital and skills (relative to physical capital) credit relationships should favor relatively more entrant firms. By contrast, in sectors where information on firms' assets is more specific, we expect that credit relationships can add more information when assets are characterized by more informational specificity...

The remainder of the paper unfolds as follows. In the next section we relate the paper to prior literature. In Section 3, we present the empirical setting, the data and the measurement of the variables. Section 4 details the empirical methodology and presents the results. In Section 5, we propose and simulate parsimonious theoretical model aiming at explaining the empirical facts. Section 6 concludes. Further details on empirical evidence and robustness analysis for the theoretical model are presented in the Appendix.

2 Prior Literature

The paper relates to an ample literature on relationship banking. Most of this literature focuses on partial equilibrium analysis. This literature stresses that, over the course of credit relationships, banks progressively accumulate information on the collateral assets of borrowing firms and their market (Diamond and Rajan, 2001). Relationship banks also acquire information about firms' human capital and employees and establish personal relationships with firm managers. Thus, banks' information can be attached to firms' physical capital or human capital. While information on firms' physical capital is inherently tied to incumbent firms, information on employees, their skills, and their trustworthiness may facilitate the creation of spin-offs (Drexler and Schoar, 2014).

The analysis also relates to a literature on firms' entry modes. A sizeable share of new entrants consist of spin-offs or divestitures of existing businesses rather than de novo entrants founded by new entrepreneurs. The importance of firms' spin-offs has been widely documented: several empirical studies document that spin-offs account from 20% to 35% of new firm entries (Klapper, ###). Klapper () argues that financial factors play a role in the decision to create firms' spin-offs. On the financial side, a well known feature of the financial sector is that in many countries credit flows to firms with established relationships with banks. Credit relationships are predominant in countries such as Germany and Japan, but are also pervasive in the credit systems of the United States. Most of the analysis on entry argues that financial factors may interact with the mode of entry of firms.

3 Empirical Setting

We test the impact of relationship lending on firm dynamics using rich data from the Italian local banking markets (provinces).

3.1 Institutional background

Italy represents an ideal setting to investigate the role of credit relationships in firms' dynamics. The financial system is dominated by the banking sector, while the stock market has a relatively low capitalization.[2] Moreover, the banking sector is characterized by marked geographical heterogeneity in the intensity of credit relationships. This is due to two main factors. The first is the heterogeneous presence in local credit markets of banks with a different propensity to engage in relationship lending. Local credit markets (which roughly coincide with Italian provinces) feature pronounced differences in the presence of local and cooperative banks relative to banks with a national scope. For example, local and cooperative banks have a strong presence in the northern regions of Veneto and Emilia Romagna, while they exhibit a weaker presence in southern provinces. The banking literature has documented that local and coop-

[2]The strong importance of the banking sector makes the Italian financial system close to that of other countries of continental Europe and of Japan. In 2000, in Italy the ratio of bank credit over the GDP equalled 70.33 percent, a figure similar to that of France (81.29 percent), Belgium (77.34) and Finland (51.38). Most importantly, the high dependence of Italian firms on banks is analogous to that observed in other countries of continental Europe (see, e.g., De Bonis et al., 2012, for a detailed overview of the Italian banking system). Thus, although the lessons from Italy are not necessarily transferable to other countries, the analysis can also provide useful insights for the banking development-inequality nexus in other countries.

erative banks are inclined to establish long-term credit relationships with firms which entail local ties between loan officers and firm managers. By contrast, banks with a national scope tend to resort to transactional-based lending technologies based on the usage of hard (verifiable and codified) information about firms. Importantly, we expect that the heterogenous presence of different categories of banks across provinces mostly reflects the impact of the Italian banking regulation which was enacted in 1936 and that remained in place until the early 1990s, effectively freezing the structure of local banking markets for several decades. The second aspect that we expect to induce variation in the importance of credit relationships is the broader effect of the 1936 banking regulation on the geography and structure of provincial banking markets.

Italian provinces also feature substantial variation in firm dynamics (see, e.g., King, 2015; Carree, Santarelli and Verheul, ; and regional reports of the Bank of Italy). This is also evident from our data: over the 1995-2006 period, in an average year the ratio of entrant firms over incumbent firms ranges from little more than 2% for some provinces to 10% in other provinces.

3.2 Data and measurement

In this section, we detail data sources and measurement of the variables.

3.2.1 Data sources and variables definitions

The Italian banking system is segmented across local credit markets (provinces). As a geographical and administrative unit, a province can be compared with a U.S. county. Provinces constitute the appropriate measure of local banking markets in Italy also according to regulatory authorities. For example, the Italian Antitrust Authority considers the province as the relevant market for banking activities. And, at the time of deregulation of entry into banking in the 1990s, the Bank of Italy defined the local market as the provincial one. In Italy, a strong local presence of bank branches is crucial for access to credit because it is difficult for firms to borrow in a market other than the local one (Petersen and Rajan, 2002; Guiso et al., 2004, 2013). Indeed, due to informational disadvantages, banks entering new provincial markets suffer from higher loan default rates (Bofondi and Gobbi, 2006).

Our main data sources are: the "Indagine sulle Imprese Manifatturiere", a survey carried out by the Italian banking group Capitalia; the Register of the Italian Chambers of Commerce; the Orbis database of Bureau van Dijk; and the "Rilevazione sul sistema delle Start-up innovative", a survey of start-ups carried out by the Italian Ministry of

Economic Development. We complement these main data sources with other databases, including data of the Italian National Istitute of Statistics (ISTAT) on institutional and economic characteristics of provinces; Bank of Italy data on the structure of Italian local banking sectors; and prior studies that provide industry-level measures of physical capital intensity and asset tangibility, human capital intensity and product information complexity.

Information of credit relationships comes from four waves of the Capitalia survey, which cover three-year periods ending respectively in 1997, 2000, 2003, and 2006. The Capitalia survey, directed to manufacturing firms within Italy, includes a representative sample of manufacturing firms with 10–500 employees (about 94% of the firms in the sample) and the universe of manufacturing firms with more than 500 employees. Approximately 4,500 firms were interviewed in each survey wave, for a total of 18,333 observations. The firms in the survey represent about 9% of the population in terms of employees and 10% in terms of value added. Collected data include details about balance sheets, company characteristics and demographics, relationships with banks, and sources of finance.[3]

Information on firm dynamics in the provinces comes predominantly from the Register of the Italian Chambers of Commerce[4], which provides details on the number of newly registered firms in a province in a year (entrants), on the number of firms exiting in a year, and on the total number of registered firms (incumbents). As detailed below, we also construct alternative indicators of firm entry and age distribution using the Orbis database of Bureau Van Dick. In all cases, we focus on manufacturing firms.

Finally, to study firms' mode of entry we use the survey of the Italian Ministry of Economic Development. This is the first census survey on startups based in Italy. Sent to all innovative startup founders[5] between March and May 2016, the primary aim of this study was to expand the evidence on these firms with information that is not easily obtained through Business Register data. This include the personal background of startup founders (family, studies, experience, skills) and their attitude towards fundraising (Italian Ministry of Economic Development, 2017).

[3]Some of these variables are available for each year covered by the survey; some refer to the time of interview; others refer to the three-year period covered by the survey.

[4]The Italian Business Register can be defined as the register of company details: it in fact contains information (incorporation, amendments, cessation of trading) for all companies with any legal status and within any sector of economic activity, with headquarters or local branches within the country, as well as any other subjects as required by law.

[5]The questionnaire was filled in by 2,250 firms, 44% of startups on the records at the reference date.

3.3 Measurement

In what follows, we detail data and measurement of the variables.

3.3.1 Banking relationships and firm dynamics

To measure the pervasiveness of relationship lending in a province, using the four waves of the Capitalia survey, we construct two indicators: the average length of credit relationships in the province and, as an inverse measure, the average number of banks from which a firm borrows in the province. This information is based on two questions in the survey that, respectively, ask each firm the number of years it has been doing business with its main bank; and the number of banks from which the firm borrows. Petersen and Rajan (1994) show that the length of the credit relationship is a suitable measure of the experience garnered by the main bank; multiple credit relationships can instead dilute the relationship with the main bank.

To capture firms' dynamics in a province and (two digit ATECO) manufacturing sector in the time frame of the survey waves, using the Register of the Italian Chambers of Commerce, we construct two measures of the relative importance of entrant firms over incumbent firms. We compute the ratio of newly registered firms over total registered firms in the province and sector, and the ratio of net entrants over incumbents (newly registered firms minus deregistered firms over total registered firms). In both cases, for each survey wave, we take the average over the years of the survey wave. We complement these indicators with alternative proxies of the relative importance of entrant versus incumbent firms. Using Orbis data, we compute the share of firms in a province and sector with no more than 4 years of activity and the average age of firms in the province and sector. Due to data availability, when using these alternative proxies we restrict attention to the last survey wave (2004-2006).

In the analysis, we also look at the modes of firm entry (whether the firm is a de novo entrant or a spin-off/spin-out of an existing firm). Using the Capitalia Survey, we construct an indicator variable equal to one if a firm in the survey generated a spin-off during the years of the survey. This information refers to the last survey wave (2004-2006). Using the survey of the Italian Ministry of Economic Development, we also compute the share of new firms in the province that are founded by former employees of firms in the same sector (relative to the total number of entrants). This information is available for the 2010-2015 period.

3.3.2 Controls and instruments

In the regressions, we insert a large battery of controls that may explain firms' dynamics. We include a measure of local economic conditions and development, the unemployment rate, proxies for the quality of provincial material infrastructures in the province, the degree of trade openeness of the province, the population growth rate of the province, local financial development (branches over population), a proxy for local banking concentration, and a measure of judicial efficiency. The material infrastracture proxy, trade openness, and judicial efficiency are measured at the mid-point of the sample (2001). The unemployment rate, population growth and local financial development are computed as the average for each survey wave. In all the regressions, we also saturate the empirical model with a full set of sectoral, time (survey wave) and broad geographical area fixed effects. In alternate tests, we drop time-invariant province-level controls and broad geographical area fixed effects and insert province fixed effects.

In addition to running regressions with a broad set of controls and fixed effects, we also present estimates from an instrumental variables approach. We construct instruments that capture exogenous regulatory restrictions on the entry of banks into local credit markets. To this end, we exploit information on the 1936 Italian regulation of local banking markets. In response to the 1930–1931 banking crisis, in 1936 the Italian Government approved a Banking Law with the goal of enhancing bank stability through severe restrictions on bank entry. The Banking Law imposed strict limits on the ability of different types of banking institutions to open new branches. In particular the Comitato Interministeriale per il Credito e il Risparmio (CICR) imposed that from 1938 each credit institution could open branches only in an area of competence (one or multiple provinces) determined on the basis of its presence in 1936. Banks were also required to shut down branches outside their area of competence. While the regulatory prescriptions were uniform across Italy, the constrictiveness of regulation varied across provinces and depended on the relative importance of different types of banks in the local market in 1936. For example, savings banks were less constrained by the regulation, while cooperative banks were more constrained. Guiso et al. (2003, 2004) demonstrate empirically that the 1936 regulation had a profound impact on local banking markets (creation and location of new branches) in the decades that followed. Entry into the provincial banking markets was liberalized during the 1990s, following also the introduction of European directives about the coordination of banking regulations across the European Union. We expect that the 1936 regulation had a long-lasting impact on the ability and incentive of banks to establish long-term credit relationships with firms, leading to substantial variation in the incidence of credit relationships across Italian provinces. Following Guiso et al. (2003, 2004) and Herrera and Minetti (2007), our set of instruments for the intensity of credit relationships consist of provincial data on the number of savings banks in 1936 (per 1000 inhabitants) and the number of new branches opened by incumbent banks in 1991-1998, during the deregulation period.

3.3.3 Sectoral characteristics

The banking literature stresses that over the course of credit relationships banks accumulate information in two main dimensions: the physical and collateralizable assets of the firms and (the trustworthiness of) firms' human capital, managers and employees (Diamond and Rajan, 2001; Repullo and Suarez, 1995). We then consider indicators for the relative importance of human and physical capital in the sector.

The indicator of human capital intensity is from Ciccone (2009). To measure the importance of physical capital, we consider proxies for asset specificity and (lack of) asset redeployability. For asset specificity, we use the degree of comovement between the value added of the firm and that of other firms in the same industry. As Shleifer and Vishny (1992) argue, when the conditions of the firms in an industry are positively correlated, the redeployability of the assets of the firms in that industry is likely to be low. The highest value second-hand users of a firm's assets are probably its industry peers, since they have the experience and know how to use these assets most effectively. If these second-hand users themselves face financial problems, they will be willing to buy, if at all, at low prices; otherwise, the firm will have to sell to less efficient, out-of-industry users whose willingness to pay is low. We borrow the measure of the comovement of sales from Guiso and Minetti (2010), who compute is using data from Compustat firms over the period 1950-2000 for a total of 251,782 firm-year observations (see the Appendix). As an alternative measure of asset specificity, we consider the indicator in Nunn (2007). The product information complexity index in Nunn (2007) is based on the extent to which products in a sector are traded in a market with many alternative buyers and sellers. Information on products that are traded in a thick market is generally deeper than for highly specific products. Following Nunn (2007), we construct a dummy that takes the value of one if the product is informationally complex, zero otherwise.

In addition to measures of the human and physical capital intensity of the sectors, we also employ data on the type of information acquired by banks in the sectors. The 2003 wave of the Capitalia survey asks the firms whether their banks especially value information about the physical, collateralizable assets of the firms, or instead they especially acquire information about the firm's management and human capital.

4 Methodology and Results

4.1 The empirical model

To investigate the impact of credit relationships on firm dynamics in local (provincial) credit markets, we estimate the following model

$$FirmDynamic_{ijt} = \alpha_1 + \alpha_2 Relation_{it} + \alpha_3 \mathbf{Z}_i + \alpha_4 \mathbf{C}_{it} + \gamma_j + \gamma_t + \varepsilon_{itj} \tag{1}$$

where $FirmDynamic_{ijt}$ is the measure of dynamics (or age structure) of businesses in province i, sector j, period t (where periods are three-year windows based on the survey waves); $Relation_{it}$ is the measure of credit relationship intensity in province i and period t; Z_i is a vector of time-invariant province-level control variables measured in year 2001, the mid-point of the sample; C_{it} is a vector of time varying province-level control variables; γ_j is a vector of sector fixed effects; γ_t is a vector of time (survey wave) fixed effects; and ε_{itj} denotes the residual. In a tighter specification, we saturate the model with province fixed effects and drop time-invariant, province-level controls and macro-area dummies.

Considering the local entities (provinces) of a country reduces the risk of omitted variable bias and implicitly controls for differences in formal institutions. Further, we saturate the model with a rich set of fixed effects. Nevertheless, there remains the possibility that in a local credit market banking relationships and firm dynamics are jointly determined and that unobserved factors are correlated with both. To further assuage possible endogeneity concerns, we complement the OLS estimates with an instrumental variable (IV) approach. Let I_i be a vector of instruments that are correlated with the local structure of credit relationships but affect firm dynamics only through the banking channel. The effect of these instruments on $Relation_{it}$ is captured by β_2 in the local banking equation

$$Relation_{it} = \beta_1 \mathbf{Z}_i + \beta_2 \mathbf{C}_{it} + \gamma'_t + \beta_3 Ip + u_{it}$$

where Z_i and C_{it} refer to the control variables in the second stage equation, Ip is the vector of instruments and u_{it} is the residual. As noted, as instruments we employ the indicators of banking regulation in 1936, namely the number of savings banks in the province in 1936, normalized by the population of the province, and the number of new branches created in the province in the deregulation period, per 1,000 inhabitants.

4.2 Summary statistics

Table 1 displays summary statistics for the variables used in the analysis. Across the four survey waves, the average length of credit relationships in a province equals 16.5 years. The mean number of banks funding a firm in a province is 5. There is substantial heterogeneity in the intensity of credit relationships across provinces. Figure 1 reveals that on average relationship lending is more pervasive in some northern provinces, especially in the regions of Veneto, Emilia Romagna and Trentino. By contrast, credit relationships appear to be weaker in some southern provinces. The same degree of variation is observed when looking at the number of banks from which a firm borrows.

On average, in a province the ratio of entrant firms over total firms equals 4.99%, while the ratio of exiters over total number of firms is ##%. Southern provinces exhibit a somewhat higher turnover of firms than provinces of the North. As for firms' age distribution in the provinces, the average age of firms equals ###, while the median is ###. Table 1 also reports summary statistics for the control variables used in the analysis.

4.3 Baseline results

Table 2 displays the baseline results. As noted, we regress the measures of relative importance of entrant firms over incumbent firms in a sector and province on the province-level indicators of the intensity of relationship lending (average length of credit relationships and mean number of banks). As measures of relative importance of entrants vis-a-vis incumbents in a province, we use the ratio of entrant firms over incumbent firms and the ratio of net entrants over incumbents. The OLS estimates suggest that, after controlling for macro-area, sector, and time fixed effects and for relevant province-level characteristics, in provinces where credit relationships are tighter the share of entrant firms over incumbents is lower. This holds regardless of the indicator of relative importance of entrants over incumbents and of whether we measure the intensity of relationship lending in a province with the average length of credit relationships or (as an inverse measure) with the average number of banks tapped by a firm in the province (Panel A, columns 1-4). The results are confirmed when we drop province-level controls in favor of province fixed effects (columns 5-8).[6] They are also

[6]The results for the controls are essentially in line with expectations. Higher unemployment appears to be associated with higher entry, suggesting that self-employment and entrepreneurship might

robust to using an instrumental variable approach (columns 9-12). In the first stage, the instruments perform well in explaining the intensity of relationship lending in a province (the F-test statistic is well above the threshold values for weak instruments). The second stage estimates confirm the OLS ones.

In Panel B of Table 2, we adopt an alternative definition of the dependent variable, and measure the relative importance of entrants relative to incumbents with the share of firms with no more than 4 years of age. We again find evidence of a negative impact of relationship lending on the share of entrant firms. Further, in Panel C, we uncover a positive impact of the average length of credit relationships on the average age of firms in the province and sector.[7]

4.4 Sectoral heterogeneity

In this section, we exploit cross-sectoral heterogeneity in the importance of firms' physical capital and human capital to investigate in what sectors the impact of credit relationships on firm entry dynamics is relatively stronger. In Table 3 we insert in the regressions interaction terms between the measures of the intensity of relationship lending and sectoral indicators of the intensity of human capital and of the asset specificity and (lack of) asset redeployability in the sector.

We obtain evidence that credit relationships especially reduce the share of entrant firms in sectors that exhibit a lower incidence of human capital (columns # and #) and a stronger redeployability and liquidity of assets (columns # and #). When looking at product specificity, as captured by the Nunn indicator, we find that in sectors where information about products is more specific, relationship banks tend to reduce the share of entrant firms.

The last wave of the Capitalia survey asks each firm two questions regarding the criteria that have driven the selection of the main bank, and the criteria adopted by the main bank when granting credit to the firm. Among the possible answers the questionnaire includes knowledge and information of the main bank about the firms' managerial human capital and the firms' physical and collateralizable assets. Using these questions, we code two dummies: the first takes the value of one if the bank heavily relies on information about the firm's physical capital; the second equals one

effectively substitute for lower employment. Material infrastructures appear to drive up the ratio of net entrants over incumbents. Population growth also appears to positively affect the entry rate of new firms.

[7] These results are robust across specifications and in particular carry through when we saturate the model with province fixed effects.

if the bank relies on information about the firm's physical assets. To measure the relative importance attributed by banks to these two dimensions of information in a sector, we than compute the average of these two indicators across the firms in the sector. Columns ## of Table 3 show the results. Consistent across regressions, the intensity of credit relationships has a more favorable impact on incumbents relative to entrants in sectors where banks especially rely on information about physical capital. By contract, when information on human capital is more relevant, relationship lending tends to be relatively more favorable to entrant firms.

To recapitulate, in sectors where the importance of (banks' information on) firms' human capital is stronger, credit relationships better promote entrant firms relative to incumbent ones. By contrast, in sectors where the relative importance of information on firms' specific assets is stronger, relationship lending appears to promote incumbent firms relatively more.

4.5 Entry modes

The last piece of evidence regards firms' entry mode. In Table 4, we present results of two tests. First, using survey-level data from Capitalia, we study the impact of credit relationships on the probability that a firm engages in a spinout of the firm. Second, using information from ISTAT, we test the impact of the province-level indicators of the intensity of credit relationships on the share of firms created as spin-offs rather than de novo. Both sets of tests indicate that credit relationships tend to increase the incidence of firms created through spin-offs relative to de novo entrants. For example, in provinces where ...

5 The Model

Motivated by the facts documented in the empirical analysis, we study a parsimonious general equilibrium, infinite-horizon model of credit relationships. Our goal is to assess how far such a parsimonious model can go in rationalizing qualitatively and quantitatively the facts documented in the empirical analysis.

5.1 Environment

Time is discrete and indexed by $t = 0, 1, 2....$ There is a final good which can be invested and consumed. The economy is populated by entrepreneurs and investors. Agents' discount factor is assumed equal to 1.

At each t, a unit measure of new entrepreneurs enters the economy. In each period of her life, an entrepreneur (indexed by i) can undertake an investment of size $i_{i,t}$ and earn a gross return of $\bar{R}_t > 1$ with probability π. $\bar{R}_t > 1$ will depend on the aggregate stock of projects, as shown later. An entrepreneur dies with probability $(1-\pi)$ in each period, in which case she does not consume but transfers her remaining wealth (after any repayment to lenders) to future generations. If she has invested and then dies prematurely (that is, before the project comes to fruition), each unit of the project is liquidated at value $L_{i,t} \equiv \overline{L} l_{i,t}$, where $l_{i,t}$ is an *i.i.d.* process across entrepreneurs and time, distributed according to G in the support $\left[\underline{l}, \bar{l}\right]$ (with $\bar{l} < \bar{R}/\overline{L}$) and $\overline{L} \in R_+$ is a common component measuring the asset liquidity of all projects.

When entrepreneur i enters the economy in period t, she does it with initial wealth $w_{i,t-1}$, which depends on previous-period bequests. To invest an amount $i_{i,t}$, she needs a loan of size $(i_{i,t} - w_{i,t-1})$, and a manager to work with. If an entrepreneurs does not invest, she retires and has access to a storage technology with gross return of 1 until she dies.

A surviving entrepreneur i in period t can consume $c_{i,t}$ with log utility $\log(c_{i,t})$. Transfers to future generations do not enter entrepreneurs' utility. Investing entrepreneurs also incur a fixed utility (effort) cost ζ:

$$U_t = \sum_{j=0}^{\infty} \pi^j \left[\log(c_{i,t+j}) - 1_{i,t+j}(invest)\zeta\right].$$

We also posit that all bequests are pooled together through a mutual fund. Each new entrant in period $t+1$ receives an equal share of all bequests made in period t.

A measure larger than 1 of infinitely-lived investors can act as lenders or managers (randomly assigned to each task every period) and pool resources through a mutual fund. The managerial and credit markets are competitive. Investors have access to the same storage technology as entrepreneurs.

5.2 Lenders

In period t, the contract between a lender and an entrepreneur specifies a payment $d_{i,t}$ in case of project success (π) and the liquidation value accruing to the lender in case of failure $(1-\pi)$. We consider a standard debt contract under which all the liquidation value L_i is appropriated by the lender. The credit market features limited output pledgeability. A lender can mitigate the limited pledgeability by acquiring information about a firm's managerial and human capital (e.g., the manager's skills and trustworthiness) and about the firm's physical capital. The information acquired on the manager ($\lambda_{i,t}^H$) allows the lender to verify the manager's output. It also turns into reputational capital of the manager that is transferable to any project the manager starts. The information acquired on the capital assets of the firm ($\lambda_{i,t}^A$) allows the lender to recover value in case of project failure and asset liquidation and is specific to the firm's assets (non-transferable to other projects).

The monitoring effort choices of a lender solve the following problem:

$$\max_{\lambda_{i,t}^A,\lambda_{i,t}^H} \Pi \equiv \pi\bar{R}_t i_{i,t}\lambda_{i,t}^H + (1-\pi)\,\overline{L}l_{i,t}i_{i,t}\lambda_{i,t}^A - \pi\frac{c^H\cdot\bar{R}_t i_{i,t}\left(\lambda_{i,t}^H\right)^2}{2} - (1-\pi)\frac{c^A\cdot\overline{L}l_{i,t}i_{i,t}\left(\lambda_{i,t}^A\right)^2}{2},$$

where $c^H, c^A > 1$ govern the costs of monitoring the firm's human capital and assets, respectively. The optimal monitoring efforts are $\lambda_{i,t}^J = 1/c^J\ \forall i,t$, for $J = A,H$. Our hypothesis $c^H, c^A > 1$ ensures that $\lambda_{i,t}^A, \lambda_{i,t}^H < 1$, which can then be interpreted as fractions: when the project yields $\bar{R}_t i_{i,t}$ in case of success (or the project is liquidated at $\overline{L}l_{i,t}$ in case of failure), the lender receives $\bar{R}_t i_{i,t}\lambda_{i,t}^H$ (or $\overline{L}l_{i,t}i_{i,t}\lambda_{i,t}^A$), and the entrepreneur receives $\bar{R}_t i_{i,t}(1-\lambda_{i,t}^H)$ (or $\overline{L}l_{i,t}i_{i,t}(1-\lambda_{i,t}^A)$).

The lender's participation constraint (LPC) reads

$$\pi\bar{R}_t i_{i,t}\lambda_{i,t}^H + (1-\pi)\,\overline{L}l_{i,t}i_{i,t}\lambda_{i,t}^A - \pi\frac{c^H\cdot\bar{R}_t i_{i,t}\left(\lambda_{i,t}^H\right)^2}{2} - (1-\pi)\frac{c^A\cdot\overline{L}l_{i,t}i_{i,t}\left(\lambda_{i,t}^A\right)^2}{2} \geq i_{i,t} - w_{i,t-1}. \tag{2}$$

Using $\lambda_{i,t}^H = \frac{1}{c^H}$ and $\lambda_{i,t}^A = \frac{1}{c^A}$, the constraint becomes

$$\frac{\pi\bar{R}_t i_{i,t}}{2c^H} + \frac{(1-\pi)\bar{L}l_{i,t}i_{i,t}}{2c^A} \geq i_{i,t} - w_{i,t-1}.$$

At the beginning of period t, there are three types of agents in their second period of life who can start a new project: (i) entrepreneurs who did not start a project in period $t-1$. These are potential, *de-novo* entrants in t (denoted by the superscript N); (ii) entrepreneurs who started a project in $t-1$. These are incumbent entrepreneurs (denoted by the superscript I); (iii) potential spin-off entrants. These are managers employed in incumbent firms who can start themselves a new project (denoted by the superscript S). These three types of agents differ in terms of initial wealth and in terms of monitoring costs.

Lenders face different costs for monitoring the three types of agents above. We posit $c^J \equiv c\Psi^J$ for $J = A,H$, where c measures the overall efficiency of lenders' monitoring (e.g., reflecting financial development) and Ψ^J depends on the type of agent.

In particular, (i) $\Psi^J = 1,\ J = A, H$ for *de-novo* entrants; (ii) $\Psi^A = 1, \Psi^H = \overline{\Psi}\psi^H < 1$ for spin-off entrants (iii) $\Psi^J = \overline{\Psi}\psi^J < 1,\ J = A, H$, for incumbents. $\overline{\Psi} \in (0, 1)$ captures the cost advantage in monitoring the human and physical capital of an incumbent or in monitoring the human capital of a spinoff manager.

The rationale behind these parameter restrictions is that the cost of acquiring information on the human and physical capital of an incumbent is lower than that for *de-novo* entrants (as incumbents are already known to lenders). On the other hand, spin-off entrants can rely on reputational capital (as managers are known by lenders for their previous activity in incumbent firms). Hence, the cost of acquiring information on the human capital of spinoffs is the same as that of incumbents.[8] Since the cost advantage captured by $\overline{\Psi}$ is due to previous engagement of lenders with incumbent firms we interpret it as the intensity of relationship lending.

5.3 Incumbents

Conditional on retiring and using the storage technology (denoted by superscript R), an entrepreneur with initial wealth $w_{i,t-1}$ solves the following problem:

$$\begin{aligned} V^R(w_{i,t-1}) &= \max_{c_{i,t}, w_{i,t}} \pi \left[\log(c_{i,t}) + V^R(w_{i,t})\right], \\ \text{s.t.} \quad c_{i,t} + w_{i,t} &= w_{i,t-1}. \end{aligned}$$

V^R is the value function before the idiosyncratic death shock realizes. It can be easily shown that $c_{i,t} = (1-\pi)w_{i,t-1}$ and

$$V^R(w_{i,t-1}) = \frac{\pi \log(w_{i,t-1})}{1-\pi} + \frac{\pi \log(1-\pi)}{1-\pi} + \frac{\pi^2 \log(\pi)}{(1-\pi)^2}.$$

Conditional on investing, an entrepreneur with initial wealth $w_{i,t-1}$ solves the following problem:

$$V^I(w_{i,t-1}, l_{i,t}) = \max_{c_{i,t}, w_{i,t}, i_{i,t}} \pi \left[\log(c_{i,t}) - \zeta + \int_{\underline{l}}^{\bar{l}} \max\{V^R(w_{i,t}), V^I(w_{i,t}, l_{i,t+1})\} dG(l_{i,t+1})\right]$$

$$\text{s.t.} \quad c_{i,t} + w_{i,t} = \left(1 - \frac{1}{c\bar{\Psi}\Psi^H}\right) \bar{R}_t i_{i,t},$$

[8] The implicit hypothesis here is that, when a spin-off is started, the incumbent does not incur a cost.

$$\frac{\pi \bar{R}_t i_{i,t}}{2c\bar{\Psi}\Psi^H} + \frac{(1-\pi)\bar{L} l_{i,t} i_{i,t}}{2c\bar{\Psi}\Psi^A} \geq i_{i,t} - w_{i,t-1}. \tag{3}$$

We use the fact that $c^H = c\bar{\Psi}\Psi^H$ and $c^A = c\bar{\Psi}\Psi^A$ for incumbents, as well as the fact that incumbents retain $1 - \lambda_{i,t}^H = 1 - \frac{1}{c\bar{\Psi}\Psi^H}$ fraction of output in case of project success. When constraint (3) binds,

$$i_{i,t} = \frac{w_{i,t-1}}{1 - \frac{\pi \bar{R}_t}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c\bar{\Psi}\Psi^A}},$$

and

$$\left(1 - \frac{1}{c\bar{\Psi}\Psi^H}\right) \bar{R}_t i_{i,t} = \frac{(1 - \frac{1}{c\bar{\Psi}\Psi^H})\bar{R}_t}{1 - \frac{\pi \bar{R}_t}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c\bar{\Psi}\Psi^A}} w_{i,t-1} \equiv R_t^I(l_{i,t}) w_{i,t-1}.$$

To ensure that incumbents need a downpayment to borrow, we assume that $1 - \frac{\pi \bar{R}_t}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c\bar{\Psi}\Psi^A} > 0$ for all $l_{i,t}$. Equivalently,

$$\text{Assumption 1} \quad : 1 - \frac{\pi \bar{R}_t}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L}\bar{l}}{2c\bar{\Psi}\Psi^A} > 0$$

On the one hand, a lower Ψ^H means that the monitoring cost is lower, and the pledgeable value of output is higher (as in the denominator of the above expression). On the other hand, a lower Ψ^H slows down the wealth accumulation of entrepreneurs (as in the numerator of the above expression), because the entrepreneur retains a smaller share of output. One can show that $R_t^I(l_{i,t})$ is decreasing in Ψ^H if

$$1 - \frac{\pi \bar{R}_t}{2} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c\bar{\Psi}\Psi^A} < 0.$$

We will make this assumption for all $l_{i,t} \geq \underline{l}$:

$$\text{Assumption 2} \quad : 1 - \frac{\pi \bar{R}_t}{2} - \frac{(1-\pi)\bar{L}\underline{l}}{2c\bar{\Psi}\Psi^A} < 0$$

Given the net worth, the incumbent maximizes her value subject to constraint

$$c_{i,t} + w_{i,t} = R_t^I(l_{i,t}) w_{i,t-1}.$$

Guess that the investment decision follows a threshold strategy, that is,

$$V^I(w_{i,t-1}, l_{i,t}) > V^R(w_{i,t-1}) \quad \text{if} \quad l_{i,t} > \hat{l}_t^I.$$

In particular, $\hat{l}_t^I$ is independent of individual incumbent's wealth $w_{i,t-1}$. We will later verify this guess. Then the value function becomes

$$V^I(w_{i,t-1}, l_{i,t}) = \max_{c_{i,t}, w_{i,t}, i_{i,t}} \pi \left[\log(c_{i,t}) - \zeta + \int_{\underline{l}}^{\hat{l}_{t+1}^I} V^R(w_{i,t}) dG(l_{i,t+1}) + \int_{\hat{l}_{t+1}^I}^{\bar{l}} V^I(w_{i,t}, l_{i,t+1}) dG(l_{i,t+1}) \right].$$

The following can be shown.

Lemma 1 *Conditional on investing, the incumbent's value function and consumption function satisfy*

$$c_{i,t} = (1-\pi) R_t^I(l_{i,t}) w_{i,t-1},$$

$$V^I(w_{i,t-1}, l_{i,t}) = \frac{\pi \log(w_{i,t-1})}{1-\pi} + \frac{\pi \log(1-\pi)}{1-\pi} + \frac{\pi^2 \log(\pi)}{(1-\pi)^2} + W_t^I(l_{i,t}) = V^R(w_{i,t-1}) + W_t^I(l_{i,t}),$$

where $W_t^I(l_{i,t})$ is the gap between incumbent value and retiree value. It follows

$$W_t^I(l_{i,t}) = \pi \left[\frac{\log R_t^I(l_{i,t})}{1-\pi} - \zeta + \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) \right].$$

$\pi \left(\frac{\log R_t^I(l_{i,t})}{1-\pi} - \zeta \right)$ *measures the direct utility gain of investing: an incumbent pays utility cost ζ and earns a higher return $R_t^I(l_{i,t})$ on her wealth than using storage (a gross return of 1). The second term $\pi \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1})$ is the option value of being an incumbent.*

An incumbent invests if and only if $V^I(w_{i,t-1}, l_{i,t}) > V^R(w_{i,t-1})$, that is, $W^I(w_{i,t-1}, l_{i,t}) > 0$. The lemma below verifies our previous guess on $\hat{l}_t^I$.

Lemma 2 *Threshold $\hat{l}_t^I$ is determined by the following recursive equation:*

$$\frac{\log R_t^I(\hat{l}_t^I)}{1-\pi} - \zeta + \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) = 0.$$

Because $\int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) \geq 0$, it must be that $\frac{\log R_t^I(\hat{l}_t^I)}{1-\pi} - \zeta \leq 0$.

$W_t(l_{i,t})$ is decreasing in $\bar{\Psi}$, Ψ^A and Ψ^H because $R_t^I(l_{i,t})$ is decreasing in $\bar{\Psi}$, Ψ^A and Ψ^H under assumption 2. Therefore, $\hat{l}_t^I$ is increasing in $\bar{\Psi}$, Ψ^A and Ψ^H. (This statement is not necessarily true because $W_{t+1}^I(l_{i,t+1})$ also depends on these parameters. But can prove this result for the steady state.)

5.4 New entrants

Now consider a new entrant with wealth $w_{i,t-1}$. Conditional on retiring, a new entrant has the same value function as a retiring incumbent:

$$V^R(w_{i,t-1}) = \frac{\pi \log(w_{i,t-1})}{1-\pi} + \frac{\pi \log(1-\pi)}{1-\pi} + \frac{\pi^2 \log(\pi)}{(1-\pi)^2}.$$

Conditional on investing, the new entrant solves:

$$V^N(w_{i,t-1}, l_{i,t}) = \max_{c_{i,t}, w_{i,t}, i_{i,t}} \pi \left[\log(c_{i,t}) - \zeta + \int_{\underline{l}}^{\hat{l}^I_{t+1}} V^R(w_{i,t}) dG(l_{i,t+1}) + \int_{\hat{l}^I_{t+1}}^{\bar{l}} V^I(w_{i,t}, l_{i,t+1}) dG(l_{i,t+1}) \right],$$

$$\text{s.t.} \quad c_{i,t} + w_{i,t} = \left(1 - \frac{1}{c}\right) \bar{R}_t i_{i,t},$$

$$\frac{\pi \bar{R}_t i_{i,t}}{2c} + \frac{(1-\pi)\bar{L} l_{i,t} i_{i,t}}{2c} \geq i_{i,t} - w_{i,t-1}, \tag{4}$$

We use the fact that $c^H = c^A = c$ for new entrants. Conditional on investing, an entrant becomes incumbent in the next period and therefore the future value is $V^I(.)$. We have already shown that incumbents' decision on investment follows a threshold strategy again ($\hat{l}^I_t$).

When (4) binds,

$$i_{i,t} = \frac{w_{i,t-1}}{1 - \frac{\pi \bar{R}_t}{2c} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c}},$$

and

$$\left(1 - \frac{1}{c}\right) \bar{R}_t i_{i,t} = \frac{\left(1 - \frac{1}{c}\right) \bar{R}_t}{1 - \frac{\pi \bar{R}_t}{2c} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c}} w_{i,t-1} \equiv R^N_t(l_{i,t}) w_{i,t-1}.$$

Assumption 1 ensures that new entrants need downpayment to borrow. That is, under assumption 1, $1 - \frac{\pi \bar{R}}{2c} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c} > 0$ for all $l_{i,t}$.

Then the entrant solves a consumption-saving problem.

Lemma 3 *Conditional on investing, the entrant's value function and consumption function satisfy*

$$c_{i,t} = (1-\pi) R^N_t(l_{i,t}) w_{i,t-1},$$

$$V^N(w_{i,t-1}, l_{i,t}) = V^R(w_{i,t-1}) + W^N_t(l_{i,t}),$$

where $W_t^N(l_{i,t})$ is the gap between new entrant value and retiree value. It follows

$$W_t^N(l_{i,t}) = \pi \left[\frac{\log R_t^N(l_{i,t})}{1-\pi} - \zeta + \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) \right].$$

An entrant invests if and only if $V^N(w_{i,t-1}, l_{i,t}) > V^R(w_{i,t-1})$.

Lemma 4 *Threshold $\hat{l}_t^N$ is determined by the following recursive equation:*

$$\frac{\log R_t^N(\hat{l}_t^N)}{1-\pi} - \zeta + \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) = 0.$$

5.5 Spinoffs

Now consider a manager with wealth $w_{i,t-1}$. Conditional on retiring, a manager has the same value function as a retiring incumbent:

$$V^R(w_{i,t-1}) = \frac{\pi \log(w_{i,t-1})}{1-\pi} + \frac{\pi \log(1-\pi)}{1-\pi} + \frac{\pi^2 \log(\pi)}{(1-\pi)^2}.$$

Conditional on investing, the manager solves:

$$V^S(w_{i,t-1}, l_{i,t}) = \max_{c_{i,t}, w_{i,t}, i_{i,t}} \pi \left[\log(c_{i,t}) - \zeta + \int_{\underline{l}}^{\hat{l}_{t+1}^I} V^R(w_{i,t}) dG(l_{i,t+1}) + \int_{\hat{l}_{t+1}^I}^{\bar{l}} V^S(w_{i,t}, l_{i,t+1}) dG(l_{i,t+1}) \right],$$

$$\text{s.t.} \quad c_{i,t} + w_{i,t} = \left(1 - \frac{1}{c\bar{\Psi}\Psi^H}\right) \bar{R}_t i_{i,t},$$

$$\frac{\pi \bar{R}_t i_{i,t}}{2c\bar{\Psi}\Psi^H} + \frac{(1-\pi)\bar{L} l_{i,t} i_{i,t}}{2c} \geq i_{i,t} - w_{i,t-1}, \tag{5}$$

We use the fact that $c^H = c\bar{\Psi}\Psi^H$, $c^A = c$ for spinoffs. Conditional on investing, a spinoff becomes incumbent in the next period and therefore the future value is $V^I(.)$. We have already shown that incumbents' decision on investment follows a threshold strategy again ($\hat{l}_t^I$).

When (5) binds,

$$i_{i,t} = \frac{w_{i,t-1}}{1 - \frac{\pi \bar{R}_t}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c}},$$

and

$$\left(1 - \frac{1}{c\bar{\Psi}\Psi^H}\right) \bar{R}_t i_{i,t} = \frac{\left(1 - \frac{1}{c\bar{\Psi}\Psi^H}\right) \bar{R}_t}{1 - \frac{\pi \bar{R}_t}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L} l_{i,t}}{2c}} w_{i,t-1} \equiv R_t^N(l_{i,t}) w_{i,t-1}.$$

Assumption 1 ensures that new entrants need downpayment to borrow. That is, under assumption 1, $1 - \frac{\pi \bar{R}}{2c\bar{\Psi}\Psi^H} - \frac{(1-\pi)\bar{L}l_{i,t}}{2c} > 0$ for all $l_{i,t}$.

Then the entrant solves a consumption-saving problem.

Lemma 5 *Conditional on investing, the entrant's value function and consumption function satisfy*

$$c_{i,t} = (1-\pi)R_t^S(l_{i,t})w_{i,t-1},$$

$$V^S(w_{i,t-1}, l_{i,t}) = V^R(w_{i,t-1}) + W_t^S(l_{i,t}),$$

where $W_t^S(l_{i,t})$ is the gap between new entrant value and retiree value. It follows

$$W_t^S(l_{i,t}) = \pi \left[\frac{\log R_t^S(l_{i,t})}{1-\pi} - \zeta + \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) \right].$$

A manager invests if and only if $V^S(w_{i,t-1}, l_{i,t}) > V^R(w_{i,t-1})$.

Lemma 6 *Threshold $\hat{l}_t^S$ is determined by the following recursive equation:*

$$\frac{\log R_t^S(\hat{l}_t^N)}{1-\pi} - \zeta + \int_{\hat{l}_{t+1}^I}^{\bar{l}} W_{t+1}^I(l_{i,t+1}) dG(l_{i,t+1}) = 0.$$

For any given $l_{i,t}$, $R_t^N(l_{i,t}) < R_t^S(l_{i,t}) < R_t^I(l_{i,t})$ under assumption 2. Comparing Lemma 2, Lemma 4 and Lemma 6, the following lemma follows directly.

Lemma 7 $\hat{l}_t^N > \hat{l}_t^S > \hat{l}_t^I$ *for all t.*

5.6 Aggregation

Recall that in every period there is a measure 1 of potential entrants. Thus the measure of new entrants is

$$M_t^N = 1 - G(\hat{l}_t^N).$$

Note also that all measures are defined before the realization of the death shock. In period $t-1$, the measure of surviving entrepreneurs (including new entrants, incumbents, and spinoffs) is $\pi \left(M_{t-1}^I + M_{t-1}^N + M_{t-1}^S \right)$. When these entrepreneurs invest in period t, they become incumbents in period t. Thus, the measure of incumbents is characterized by

$$M_t^I = \left[1 - G(\hat{l}_t^I) \right] \pi \left(M_{t-1}^I + M_{t-1}^N + M_{t-1}^S \right).$$

In period $t-1$, the measure of managers equals the measure of entrepreneurs (including new entrants, incumbents, and spinoffs), which is $\left(M_{t-1}^I + M_{t-1}^N + M_{t-1}^S\right)$. In period t, with a probability σ these managers have the opportunity to create a spin-off. Thus, the measure of spinoffs

$$M_t^S = \left[1 - G(\hat{l}_t^S)\right] \sigma \left(M_{t-1}^I + M_{t-1}^N + M_{t-1}^S\right).$$

In steady state,

$$M^N = 1 - G(\hat{l}^N),$$

$$M^I = \frac{\pi \left[1 - G(\hat{l}^I)\right] M_N}{1 - \pi \left[1 - G(\hat{l}^I)\right] - \sigma \left[1 - G(\hat{l}^S)\right]} = \frac{\pi \left[1 - G(\hat{l}^I)\right] \left[1 - G(\hat{l}^N)\right]}{1 - \pi \left[1 - G(\hat{l}^I)\right] - \sigma \left[1 - G(\hat{l}^S)\right]}.$$

$$M^S = \frac{\sigma \left[1 - G(\hat{l}^S)\right] M_N}{1 - \pi \left[1 - G(\hat{l}^I)\right] - \sigma \left[1 - G(\hat{l}^S)\right]} = \frac{\sigma \left[1 - G(\hat{l}^S)\right] \left[1 - G(\hat{l}^N)\right]}{1 - \pi \left[1 - G(\hat{l}^I)\right] - \sigma \left[1 - G(\hat{l}^S)\right]}.$$

The ratio of entrants over incumbents is

$$\frac{M_N + M_S}{M_I} = \frac{1 - \pi \left[1 - G(\hat{l}^I)\right]}{\pi \left[1 - G(\hat{l}^I)\right]}.$$

The ratio depends on $\hat{l}^I$ and is increasing in $\hat{l}^I$, and therefore increasing in $\bar{\Psi}$, Ψ^A, and Ψ^H.[9]

Denote the wealth of (potential) incumbents, (potential) entrants, (potential) spinoffs and retirees at the beginning of period t by W_{t-1}^I, W_{t-1}^N, and W_{t-1}^R. In period t, an incumbent with $l_{i,t} > \hat{l}_t^I$ invests and survives with probability π. She then receives a return $R_t^I(l_{i,t})$ on her wealth and saves a fraction π for the next period. An analogous argument applies to an entrant in period t. Therefore, W_t^I follows

$$W_t^I = \pi^2 \int_{\hat{l}_t^I}^{\bar{l}} R_t^I(l_{i,t}) dG(l_{i,t}) W_{t-1}^I + \pi^2 \int_{\hat{l}_t^N}^{\bar{l}} R_t^N(l_{i,t}) dG(l_{i,t}) W_{t-1}^N + \pi^2 \int_{\hat{l}_t^S}^{\bar{l}} R_t^S(l_{i,t}) dG(l_{i,t}) W_{t-1}^S.$$

[9] Higher measures of new entrants and spinoffs will eventually lead to a higher measure of incumbents. These effects cancel out.

Similarly, W_{t-1}^N and W_{t-1}^R follow

$$
\begin{aligned}
W_t^N &= (1-\pi)W_{t-1}^R \frac{1}{1+\sigma\left(M_t^I+M_t^N+M_t^S\right)}, \\
W_t^S &= (1-\pi)W_{t-1}^R \frac{\sigma\left(M_t^I+M_t^N+M_t^S\right)}{1+\sigma\left(M_t^I+M_t^N+M_t^S\right)}, \\
W_t^R &= \pi^2 W_{t-1}^R + \pi^2 G(\hat{l}_t^I)W_{t-1}^I + \pi^2 G(\hat{l}_t^N)W_{t-1}^N + \pi^2 G(\hat{l}_t^S)W_{t-1}^S.
\end{aligned}
$$

Note that once investing incumbents or entrants die, they transfer their entire liquidation value to lenders. Therefore, only retirees who use storage technologies can leave a bequest to new entrants. At the beginning of period $t+1$, all available bequests from the previous period is $(1-\pi)W_{t-1}^R$. They are shared among all potential entrants (measure of 1) and all potential spin-offs (measure of $\sigma\left(M_t^I+M_t^N+M_t^S\right)$).

Because the wealth accumulations are all linear, we need concavity somewhere. I suggest we assume that entrepreneurs who invest rent capital to a final good producer, who uses aggregate capital K_t and inelastic (fixed) labor to produce final goods. The final good producer solves:

$$
\max_{K_t} AK_t^\alpha \bar{H}^{1-\alpha} - \bar{R}_t K_t - W_t \bar{H}.
$$

As a result

$$
\bar{R}_t = \alpha A K_t^{\alpha-1}\bar{H}^{1-\alpha}.
$$

K_t is the sum of investments by surviving incumbents and new entrants:

$$
K_t = \int_{\hat{l}_t^I}^{\bar{l}} \frac{W_{t-1}^I}{1-\frac{\pi\bar{R}}{2c\bar{\Psi}\Psi^H}-\frac{(1-\pi)\bar{L}l_{i,t}}{2c\bar{\Psi}\Psi^A}} dG(l_{i,t}) + \int_{\hat{l}_t^N}^{\bar{l}} \frac{W_{t-1}^N}{1-\frac{\pi\bar{R}}{2c}-\frac{(1-\pi)\bar{L}l_{i,t}}{2c}} dG(l_{i,t}) + \int_{\hat{l}_t^S}^{\bar{l}} \frac{W_{t-1}^S}{1-\frac{\pi\bar{R}}{2c\bar{\Psi}\Psi^H}-\frac{(1-\pi)\bar{L}l_{i,t}}{2c}} dG(l_{i,t})
$$

I think this will imply a stable steady state of entrepreneurs' wealth. When wealth W_{t-1}^I is low, investment K_t is low and the return $\bar{R}_t$ is high. Therefore, investing thresholds $\hat{l}_t^I$ and $\hat{l}_t^N$ are lower. In other words, more incumbents invest and more entrants enter, speeding up wealth accumulation.

6 Numerical results

6.1 Parameters

- $l_{i,t}$ is assumed to follow truncated normal distribution on $[\underline{l}, \bar{l}]$. I assume it has mean 1 and std of 1/3, so that $\underline{l}$ and $\bar{l}$ are 3 std away from the mean.
- π and $\hat{l}^I$ jointly determine the share of entrants (see Page 23). To target the share of entrants smaller than 10%, we need π very close to 1, and $G(\hat{l}^I)$ very close to 0. One can adjust ζ to adjust the value of $\hat{l}^I$.
- Naturally, σ influences the share of spin-offs.

Table 1: Parameters

Parameter	Symbol	Value	Target
Probability of survival	π	0.97	The measure of incumbents
Aggregate liquidation value	$\bar{L}$	1	Normalized
Upper bound on idiosyncratic liquidation value	$\bar{l}$	2	
Lower bound on idiosyncratic liquidation value	$\underline{l}$	0	
Highest information cost	c	1.5	
Overall information advantage	$\bar{\Psi}$	1	Normalized
Information advantage on physical capital	Ψ^A	0.8	
Information advantage on human capital	Ψ^H	0.8	
Probability of spin-off	σ	0.016	The measure of spin-offs
Utility cost of investing	ζ	2.6	The measure of incumbents
Aggregate productivity	A	1	Normalized
Aggregate labor	$\bar{H}$	100	Arbitrary value (irrelevant)
Capital share	α	1/3	

Table 2: Steady State Results

Stats	Symbol	Value
Project return	$\bar{R}$	2.06
Share of entrants	$\frac{M^N+M^S}{M^I}$	0.064
Share of spin-offs	$\frac{M^S}{M^N}$	0.337
Wealth share	$\frac{W^N}{W^I}$	0.015
	$\frac{W^S}{W^I}$	0.003
Wealth share per firm	$\frac{W^N/M^N}{W^I/M^I}$	0.321
	$\frac{W^N/M^N}{W^I/M^I}$	0.181
Mean leverage	Incumbents	6.509
	New entrants	3.118
	Spin-offs	6.407

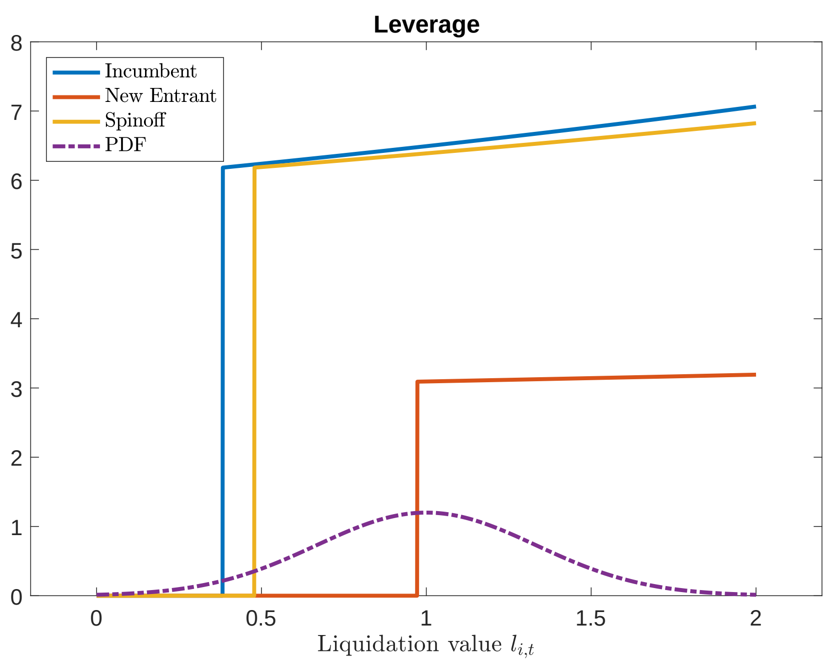

Figure 1: Leverage of firms as a function of liquidation value $l_{i,t}$

7 Conclusions

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A Appendix

Proof of Lemma 1. The proof is immediate. After substituting for $\lambda^J = 1/c^J$ and plugging the appropriate c^J for each type of entrepreneur into (**??**), we can solve it by l_i to find the three thresholds, $\hat{l}_t^{N,2}, \hat{l}_t^S, \hat{l}_{i,t}^I$ contained in expressions (**??**), (**??**) and (**??**).

Proof of Lemma 2. (i) We first define the two continuation values of being either an incumbent with wealth $w_{i,t}$ or a *de-novo* in period $t+1$, starting with the latter. We have

$$V_{t+1}^N = \int_{\hat{l}_{t+1}^{N,2}} \pi U(w_{i,t+1}) dG\left(l_{i,t+1}\right) = \pi G\left(\hat{l}_{t+1}^{N,2}\right) U(\underline{w}_{t-1}) + \int_{\hat{l}_{t+1}^{N,2}}^{\bar{l}} \pi U\left(\bar{R} - R_{i,t+1}^N\right) dG\left(l_{i,t+1}\right),$$

where $R_{i,t+1}^N$ is obtained, as a function of the extracted liquidation value, from the LPC (which is always binding) as

$$R_{i,t+1}^N = \frac{2c\left(1-\underline{w}_{t-1}\right) - (1-\pi)\,\overline{L} l_{i,t+1}}{\pi}.$$

We can show that V_{t+1}^N is decreasing in c. Similarly, conditional on wealth $w_{i,t}$, the continuation value of incumbents is

$$V_{t+1}^I\left(w_{i,t}\right) = \pi G\left(\hat{l}_{i,t+1}^I\left(w_{i,t}\right)\right) U(w_{i,t}) + \int_{\hat{l}_{i,t+1}^I(w_{i,t})}^{\bar{l}} \pi U\left(\bar{R} - R_{i,t+1}^I\right) dG\left(l_{i,t+1}\right).$$

where $R_{i,t+1}^I$ is obtained from the (binding) LPC as

$$R_{i,t+1}^I = \frac{\psi^H}{\psi^A} \frac{2c\overline{\Psi}\psi^A\left(1-w_{i,t}\right) - (1-\pi)\,\overline{L} l_{i,t+1}}{\pi}.$$

We can show that $V_{t+1}^I\left(w_{i,t}\right)$ is decreasing in $\overline{\Psi}$. It is increasing in $w_{i,t}$, since $\hat{l}_{i,t+1}^I\left(w_{i,t}\right)$ is decreasing in $w_{i,t}$. As a result, the expression given by the difference between the two continuation values, $V_{t+1}^I\left(w_{i,t}\right) - V_{t+1}^N$, is increasing in $w_{i,t}$ and thus decreasing in $R_{i,t}$, which means that (**??**) implicitly imposes an upper bound on $R_{i,t}$, which we denote as $\hat{R}_t^{N,1}$. We can finally find the threshold $\hat{l}_t^{N,1}$ such that, for all $l_{i,t} > \hat{l}_t^{N,1}$ the LPC is satisfied, as the one given in (**??**).

(ii) We first prove that $\hat{R}_t^{N,1} > \hat{R}_t^{N,2}$, that is, the highest return that entrepreneurs are willing to concede to the lender is higher in their first rather than in their second period of life. We do it by showing that $R_{i,t} = \hat{R}_t^{N,2}$ would strictly satisfy (**??**). In fact, $R_{i,t} = \hat{R}_t^{N,2}$ implies $w_{i,t} = \underline{w}_{t-2}$. When $w_{i,t} = \underline{w}_{t-1}$, it is $\hat{l}_{i,t}^I \left(\underline{w}_{t-1}\right) < \hat{l}_t^{N,2}$ (as $\overline{\Psi}\psi^J < 1,\ J = A, H$). Hence $V_{t+1}^I \left(\underline{w}_{t-1}\right) > V_{t+1}^N$. As a result, it must be $\hat{R}_t^{N,1} > \hat{R}_t^{N,2}$ in order for the equality $V_{t+1}^I \left(w_{i,t}\right) = V_{t+1}^N$ to be restored. Finally, the fact that $\hat{R}_t^{N,1} > \hat{R}_t^{N,2}$ implies that $\hat{l}_t^{N,1} < \hat{l}_t^{N,2}$.

Expressions for the bequests. The total amount of bequests is contributed by three types of agents: (i) *de-novo* entrants ending their second period of life:

$$
\begin{aligned}
B_t^N &= \pi G\left(\hat{l}_{t-1}^{N,1}\right) \int_{\hat{l}_t^{N,2}} \pi b_{i,t} dG\left(l_{i,t}\right) \\
&= \pi G\left(\hat{l}_{t-1}^{N,1}\right) \frac{\pi\gamma}{1+\gamma} \left[G\left(\hat{l}_{t+1}^{N,2}\right) \underline{w}_{t-2} + \int_{\hat{l}_t^{N,2}}^{\bar{l}} \left(\bar{R} - R_{i,t}^{N,2}\right) dG\left(l_{i,t}\right) \right];
\end{aligned}
$$

(ii) spin-off entrants:

$$
B_t^S = \pi \left[1 - G\left(\hat{l}_{t-1}^{N,1}\right)\right] \frac{\pi\gamma}{1+\gamma} \left[G(\hat{l}_t^S)\underline{w}_{t-1} + \int_{\hat{l}_t^S}^{\bar{l}} \left(\bar{R} - R_{i,t}^S\right) dG\left(l_{i,t}\right) \right];
$$

There was a mistake here in the earlier version: "potential" spin-offs who use storage technology also make bequests.

(iii) incumbents ending their second period of life:

$$
B_t^I = \pi \int_{\hat{l}_{t-1}^{N,1}}^{\bar{l}} \left[\int_1^{\hat{l}_t^I} \frac{\pi\gamma}{1+\gamma} w_{i,t-1} dG\left(l_{i,t}\right) + \int_{\hat{l}_t^I}^{\bar{l}} \frac{\pi\gamma}{1+\gamma} \left(\bar{R} - R_{i,t}^I\right) dG\left(l_{i,t}\right) \right] dG\left(l_{i,t-1}\right).
$$

$\overline{w}_i < \underline{w}$ for at least one i. It is easy to prove that there is at least one incumbent whose wealth is strictly lower than the one of a *de-novo* entrepreneur. In fact, the lowest value of $\overline{w}_i$, call it $\overline{w}_i^{\min}$, is obtained for $R_{i1} = \hat{R}_1^N$ and can be written as $\overline{w}_i^{\min} \equiv \bar{R} - \hat{R}_1^N$. Given that $\hat{R}_1^N > \hat{R}_2^N$ where $\hat{R}_2^N = \bar{R} - \underline{w}$, it then is $\overline{w}_i^{\min} < \bar{R} - \left(\bar{R} - \underline{w}\right) = \underline{w}$.

Whenever $\underline{w}_{t-2} = \underline{w}_{t-1}$, it is $\hat{l}_t^S < \hat{l}_t^{N,2}$ (as $\overline{\Psi}\psi^H < 1$): relationship lending facilitates the entry of spin-offs compared to that of *de-novo* entrepreneurs. On the other hand, it is $\hat{l}_{i,t}^I \lesseqgtr \hat{l}_t^S, \hat{l}_t^{N,2}$ given that, as we show below, $w_{i,t-1} \lesseqgtr \underline{w}_{t-2}, \underline{w}_{t-1}$.

Hold-up. We now consider the possibility that the credit relationship be affected by a hold-up problem (introduce literature here). Specifically, after signing the debt contract with the borrower, the lender can appropriate a share γ of the project return in case of success. We now show that including this feature does not change any of our results. The new PC of borrowers is given by

$$\bar{R}\,(1-\gamma) - R_{i,t} > w_{i,t-1},$$

from which we obtain $\hat{R}_t^{N,2} = \bar{R}\,(1-\gamma) - w_{i,t-1}$. LPC, instead, writes as

$$\pi\left[R_{i,t} + \bar{R}\gamma\right]\lambda_{i,t}^{H} + (1-\pi)\,\overline{L}l_{i,t}\lambda_{i,t}^{A} - \pi\frac{c^{H}\cdot\left[R_{i,t}+\bar{R}\gamma\right]\left(\lambda_{i,t}^{H}\right)^{2}}{2} - (1-\pi)\,\frac{c^{A}\cdot\overline{L}l_{i,t}\left(\lambda_{i,t}^{A}\right)^{2}}{2} > 1 - w_{i,t-1}.$$

Substituting for $R_i = \hat{R}_t^{N,2}$, we obtain exactly the same three thresholds as above. The hold-up problem does not affect the firms' entry behavior.

Comparative statics.

Additional Data Information. They classify into 64 industries using a two-digit classification and then, for each industry, regress the standardized annual rate of growth of firms' sales on a full set of year dummies. If firms within an industry comove significantly, the year dummies will explain a large part of sales variability. They thus retain the R2 of these regressions and use it as a measure of comovement of firms in the industry. Industries with high R2 will be high comovement industries. We then impute this measure to the firms in our sample using the industry code.