GROWING THROUGH SPINOFFS.
CORPORATE GOVERNANCE, ENTRY, AND INNOVATION

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ABSTRACT

New firms are often based on ideas that the founders developed while working for incumbent firms. We study the macroeconomic effects of spinoffs through a growth model of product variety expansion, driven by firm entry, and product innovation. Spinoffs stem from conflicts of interest between incumbent firms' shareholders and employees. The analysis suggests that incumbents invest more in product innovation when knowledge protection is stronger. An inverted-U shape relationship emerges, however, between the intensity of spinoff activities and the strength of the rule of law. A calibration experiment indicates that, with a good rule of law, loosening knowledge protection by 53 reduces product innovation by one fifth in the short run and one seventh in the long run, but boosts the spinoff rate by one tenth and one sixth in the short and long run, respectively. Nevertheless, per capita income growth drops and welfare deteriorates. The trade-offs are broadly consistent with evidence from Italian firms.

KEYWORDS
Corporate Governance, Endogenous Growth, Spinoffs.

JEL
E44, O40, G30.

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Abstract

New firms are often based on ideas that the founders developed while working for incumbent firms. We study the macroeconomic effects of spinoffs through a growth model of product variety expansion, driven by firm entry, and product innovation. Spinoffs stem from conflicts of interest between incumbent firms' shareholders and employees. The analysis suggests that incumbents invest more in product innovation when knowledge protection is stronger. An inverted-U shape relationship emerges, however, between the intensity of spinoff activities and the strength of the rule of law. A calibration experiment indicates that, with a good rule of law, loosening knowledge protection by 5% reduces product innovation by one fifth in the short run and one seventh in the long run, but boosts the spinoff rate by one tenth and one sixth in the short and long run, respectively. Nevertheless, per capita income growth drops and welfare deteriorates. The trade-offs are broadly consistent with evidence from Italian firms.

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1 Introduction

In several countries firms' spinoffs account for a large share of firm entries, totalling up to 30% of new firms according to firm-level surveys (see, e.g., Klepper and Sleeper, 2005; Bernardt et al., 2002).[1] The history of high-tech companies, indeed, abounds of anecdotes in which would-be entrepreneurs

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[1] Klepper and Sleeper (2005) calculate spinoff rates (spinoff entries over total entries) around 20% for various U.S. industries from the 1960s to the early 1990s. Bernardt et al. (2002) report spinoff rates of 5-8% for small Dutch firms and 40% for large Dutch firms in the early 2000s. The estimated spinoff rate is 15% in Sweden for the 1993-2005

develop ideas while working for incumbent firms and use them as the founding stones of new businesses. For example, many point at innovative spinoffs as key for the development of the Silicon Valley (Moore and Davis, 2004) and of the rise of Detroit as the capital of the U.S. automobile industry at the onset of the 20th century (Klepper, 2002; Cabral et al., 2018). In spite of this fundamental role of spinoff activities in the dynamics of firm creation, the macroeconomics literature appears to lag behind the micro-oriented literature in investigating their aggregate consequences. Most studies treat firms' entry as essentially undifferentiated, not distinguishing between firms created ex novo by new entrepreneurs and spinoffs created by employees of incumbent firms. This can not only distort the conclusions about the aggregate effects of firm entry dynamics but also leave policy makers on uncertain grounds. A policy maker could be inclined to point out the social benefits of spinoffs, as these facilitate the dissemination of knowledge and accelerate firm creation. Yet, the policy maker has to face the preoccupation of incumbent firms that their employees with privileged access to firms' trade secrets would use the acquired knowledge to set up rival firms. As documented in Thompson and Klepper (2005), a large share of spinoffs originate indeed from conflicts between incumbent firms and their employees. Furthermore, the "law view" literature has pointed out that infringements of incumbent firms' proprietary knowledge associated with conflictual spinoffs dilute incumbents' incentive to invest in the innovation of their own products. Hence, the policy maker's aim of favoring knowledge dissemination through spinoffs could have the unintended consequence of slowing down the economy's pattern of investments.

The main objective of this paper is to develop an integrated, general equilibrium model of firm entry and knowledge investment that explains how spinoff activities affect income growth and welfare both in the short and in the long run. We assess quantitatively whether the benefits associated with the creation of startups that build on knowledge developed within existing firms are larger than the potential losses due to the dilution of shareholders' property rights. Following extensive evidence on the conflictual nature of a large number of spinoffs (Thompson and Klepper, 2005; Garvin, 1983; Brittain and Freeman, 1986), we focus on spinoffs that stem from conflicts of interest between employees and shareholders of incumbents firms.

To motivate the theoretical and quantitative analysis, we first present evidence for its mechanisms by exploiting rich data from the Italian local (provincial) markets. In Italy, as in several other advanced countries, a large share of firms' entry occurs through spinoffs created by former employees of incumbent businesses – it was more than 25% in recent years. The empirical results suggest that in Italian provinces with relatively poor judiciary and weak protection of incumbents' investments, there is a higher spinoff rate. However, the evidence also suggests that in provinces with poor judiciary, incumbent firms tend to invest less in the improvement of their own products, as reflected in the intensity of their R&D effort. The trade-off between entry and R&D investment lies at the core of our theoretical and quantitative analysis.

period (Andersson and Klepper, 2013), 12.3% in Denmark for 1981-2000 (Eriksson and Kuhn, 2006), and as high as 31% in Brazil for 1995-2001 (Muendler et al., 2012). For other country studies on spinoffs see also Hvide (2009) for Norway and Rocha et al. (2015) for Portugal.

In the model economy, growth is driven both by the foundation of new firms that offer new intermediate products and by the investment of incumbent firms in the improvement of their own intermediate products. New firms, in turn, comprise firms founded ex novo by households (de novo entries) and spinoffs of incumbent firms. To capture the sizeable share of spinoffs created in conflict with parent companies, we draw from the literature that has extended endogenous growth theory to include corporate governance frictions (e.g., Terry, 2017; Iacopetta et al., 2019; Celik and Tian, 2018). Households can act as firm managers and shareholders; managers are in charge of executing production and investment plans. Managers, however, also develop side projects that consist of setting aside some resources that the firm had earmarked for its own product quality improvement to help the start up of their own new firm (i.e., create a spinoff).

The main positive effect of spinoffs is the boost it gives to intermediate products variety, as this increases the productivity of the final good sector. On the other hand, spinoffs cause two damages to incumbent companies. One is the loss of the diverted resources that would otherwise be used to improve the quality of existing products. This reflects both the direct diversion of resources and the surplus appropriation associated with managers' incentivizing contracts.[2] The other damage is due to a classic business stealing phenomenon: the birth of rival firms takes a share of the market, eroding the return that parent companies expect from investment in product quality improvement.[3] In brief, spinoffs tend to slow the pace at which incumbent firms improve the quality of their products but expand the variety of intermediate products. The former effect depresses the productivity of the final good sector while the latter boosts it.

To quantify this trade-off and interpret the empirical evidence through the lens of the model, we calibrate the economy on the technological and preference parameters of an advanced economy and on the aforementioned Italian data to match the pattern of spinoff activities. We then propose two sets of experiments. In a first set of experiments, we compare the long-run equilibrium of economies that differ along the rule of law dimension. We obtain that, when the protection of investments is relatively poor, an improvement in protection can foster both the investment of incumbent firms and the creation of firm spinoffs. Intuitively, while lower resource diversion by managers tends to reduce their ability to create spinoffs, the size of the investments from which managers can spawn resources expands, as the reduced managerial diversion greatly boosts incumbents' investment incentives. In this "poor rule of law" region, incumbents' investment in product improvement can be promoted through more stringent investment protection without undermining spinoff creation. However, when investment protection is relatively good, a further improvement in protection generates a trade-off between spinoff creation and incumbents' investment. In this "good rule of law" region, a higher investment protection gives a smaller boost to the size of the investments from which managers can spawn resources, so managers' reduced ability to spawn resources causes a drop in the spinoff rate.

[2] Building on the literature, in our economy the shareholders of parent companies, anticipating the conflicts with managers, offer managers incentivizing contracts aimed at reaching the planned investments (see, e.g., Nikolov and Whited, 2014; Shleifer and Wolfenson, 2002).

[3] Clearly, the distortion in product quality investment and the appropriation of surplus by managers also erode the returns to de novo entry.

In this region, the law view is not necessarily supported, as protecting incumbents' investments depresses the dynamism of firm creation. The quantitative analysis suggests that, in this "good rule of law" region, an improvement in investment protection that lifts up incumbents' investment in quality improvement by a quarter is associated with a decline in firms' spinoff rate (spinoffs over total entrants) by a fifth. This hints at a roughly one-to-one trade-off between incumbents' investment and spinoff creation. The empirical estimates suggest a trade-off of the same order of magnitude.

In a second set of experiments, we study a policy shock that, perhaps unintentionally, makes it easier for managers to divert innovation resources (negative investment protection shock). To match the evidence from Italy, a country with a relatively advanced system of legal protection, we consider an economy that in the pre-shock stage is in the "good rule of law" region (thus, in the parameter region in which investment protection entails a trade-off between spinoff intensity and incumbents' investment). Following a negative investment protection shock, on impact there is a significant overshooting of spinoff entry relative to the long-run one. If this goes in the direction of promoting growth, the adjustment of incumbents' investment does not. Following the shock, incumbents react to the deteriorated investment protection by downsizing their investments in product quality improvement. On impact a shock that reduces the stringency of investment protection by 5% raises the spinoff rate by 20% of the pre-shock rate, spurring the overall firm entry rate by 2%. On the other hand, incumbents' investment drops by 11%. In the long run, the number of firms remains permanently higher by 0.63%. Nonetheless, driven by the fall in incumbents' investment, the GDP growth rate drops by 0.22 percentage points on impact and by 0.31 percentage points in the long run (10% and 14% of the pre-shock rate, respectively). To get a better sense of these effects, we also compare them with the effects of a policy that is typically implemented to directly promote firm entry, an entry subsidy. A subsidy designed to have the same long-run effect on income growth as the investment protection shock has a more substantial (five times larger) effect on the overall firm entry rate and induces a drop in incumbents' investment only a tenth of that triggered by the investment protection shock.

We study welfare by separating the intermediate product variety effect from the intermediate goods quality effect. We apply the welfare analysis to compare the long-run equilibrium of economies that differ in the rule of law quality and also to evaluate the consequences of a negative investment protection shock. Whether in the short or in the long run, welfare deteriorates when investment protection weakens. Thus, the welfare analysis supports the "law view".

Before we proceed, it is worth belaboring that, as our analysis focuses on spinoff activities that originate from conflicts between incumbent firms and their employees, the implications may not necessarily extend to spinoff activities that are voluntarily promoted by incumbent businesses, for example as a result of restructuring processes. The rest of the paper unfolds as follows. In Section 2, we relate the analysis to prior literature. Section 3 presents motivational evidence. Section 4 lays out the model and Section 5 solves for the equilibrium. Section 6 examines the steady state and the dynamics of the economy. In Section 7 we analyze the effects quantitatively. Section 8 concludes. Technical proofs and details on the data are relegated to the Appendix.

2 Prior Literature

The paper relates to two main strands of literature. A first strand investigates the role of firm entry, and its interaction with incumbents' investment decisions, in driving growth (see, e.g., Peretto, 1999; Young, 1998; Howitt, 1999; and, for a survey, Etro, 2009). This literature does not focus on the distinction between firm de novo entries and corporate spinoffs. This is perhaps due to the limited emphasis of the growth literature on the corporate governance conflicts from which spinoffs can originate.[4] A second related strand of literature has recently started to incorporate corporate governance frictions into endogenous growth models. Studies in this strand comprise Akcigit et al. (2019), Caselli and Gennaioli (2013), Cooley et al. (2014), Terry (2017), and Iacopetta et al. (2019). Akcigit et al. (2019) consider a growth economy where conflicts between managers and shareholders affect firms' investment decisions, but they take firm entry as given. In Iacopetta et al. (2019) conflicts between managers and shareholders affect the returns to de novo firm entry and to incumbents' investment. Do novo entry and incumbents' investment do interact with each other, but this interaction occurs solely through the structure of the industry.[5]

Besides the analysis of the aggregate impact of spinoffs, another element that distinguishes our paper from previous works on the macroeconomic effects of corporate governance frictions is that the conflicts of interest between managers and shareholders are not modelled by contrasting a productive use of resources within firms against managers' unproductive objectives (e.g., perks, tunneling, or a "quite life"). In fact, in our economy managers employ diverted resources to establish new firms in a more efficient way than de novo entrepreneurs. We develop this insight by building on a broad micro-oriented literature on firms' spinoffs. A typical theme of this literature is that spinoffs are more common when workers feel that parent companies resist the development of new ideas and products (Hellmann and Thiele, 2011; Garvin, 1983). Brittain and Freeman (1986) study the semiconductor industry and find that firms that hired an outside CEO that were acquired by non-semiconductor firms had higher spinoff rates. They attribute this to the tension resulting from control changes. Thompson and Klepper (2005) observe that managers who spawned new firms often had conflicting views with shareholders of parent companies about the development of new projects. Franco and Filson (2006) study how managers' decision to leave incumbent firms and create spinoffs changes as the distribution of know-how in the industry evolves. Chatterjee and Rossi-Hansberg (2012) investigate managers' decision to create spinoffs or sell innovative ideas to incumbent firms in an industry where managers have private information on the quality of their ideas. In line with these studies, in our economy, in conflict with shareholders of parent companies, managers divert resources earmarked to the product improvement of the parents with the intent to develop new products in new enterprises (spinoffs). In creating new intermediate

[4] For a discussion of the literature on the growth effects of knowledge spillovers see, e.g., Aghion and Howitt (1998).

[5] For studies on financial markets and growth see, e.g., Aghion et al. (2005) and Cooley and Quadrini (2001).

products, managers exploit knowledge they acquired while working for incumbent firms. Thus, spinoffs contribute to variety expansion and do not replace parent companies which continue to operate existing product lines. Christensen (1993), for instance, finds that spinoffs in the disk drive industry developed new, smaller disk drives relative to those produced by parent companies.[6] In this dimension, our paper also broadly relates to a strand of studies that contrast the benefits of the patent protection of inventors against the hurdle that such protection poses to the diffusion of ideas (see, e.g., Boldrin and Levine, 2013, and Stiglitz, 2014).

Relative to prior studies on the microeconomic determinants of spinoffs and on their impact on the industry equilibrium, the main contribution of our work is that it investigates the macroeconomic implications of the spinoff phenomenon with respect to the investment, entry and growth dynamics of the economy in a unified, general equilibrium framework. This proves to be useful when carrying out a welfare analysis. As noted, while some argue that spinoffs are beneficial because they spur new technologies that might have stayed dormant in parent companies, others are concerned that conflictual spinoffs infringe the investors' rights of parent companies by taking away valuable resources. Our analysis allows to investigate this trade-off offering insights into the policies that can better promote long-run growth and welfare.

3 Some Motivational Evidence

In this section, we present evidence that motivates the theoretical and quantitative analysis. A key component of the theoretical model is that, in an economy with a good rule of law, when the protection of incumbents' investments in innovation gets poorer, the probability that employees of incumbent firms engage in spinoff creation is higher. On the other hand, a poorer legal protection of incumbents' investments is predicted to slow down incumbents' innovation. The goal of this section is to show that such patterns are present in the data.

To carry out the empirical analysis, we use detailed data from the Italian business sector. Our geographical unit of observation consists of the Italian provinces, which are similar in size to U.S. counties. The sectoral unit of observation is the NACE 2-digit level sectors. Italy is an ideal testing ground to investigate the role of shareholders' property rights and investment protection in the creation of new firms and in the incidence of spinoffs in firm entry. While the same laws apply across the Italian territory, judicial efficiency exhibits marked heterogeneity across provinces (World Bank, 2013; Carmignani and Giacomelli, 2009). The cost of bankruptcy court procedures as a share of firms' assets goes from 2.4% for the courts of the northern province of Trieste to 33.9% for the courts of the southern province of Lecce (data of the Italian National Institute of Statistics, ISTAT). Heterogeneity exists even across provinces within the same geographical area. For instance, the cost of court procedures in the provinces of Brindisi and Taranto - both located in the South - are equal to 3.7% and 29.3% of firms' assets, respectively. Figure 1.c illustrates the

[6] Samaniego and Sun (2019) develop a model where a weak rule of law leads to the proliferation of substandard intermediate goods by incumbent firms.

significant heterogeneity of judicial efficiency across provinces.

We draw data from three main sources: the "Rilevazione sul Sistema delle Start-up Innovative", a survey of start-ups carried out by the Italian Ministry of Economic Development; the "Survey on Italian Manufacturing Firms", which was conducted by a major Italian banking group, UniCredit; data of ISTAT on judicial efficiency at the provincial level. We complement these databases with other sources, including ISTAT data on institutional and economic characteristics of the Italian provinces, Bank of Italy data on the structure of provincial banking sectors, and data of the Institute Guglielmo Tagliacarne on the quality of infrastructures in the provinces. More details on the data sources are in the Appendix.

Information on the share of spinoffs in a province and sector comes from the survey "Rilevazione sul Sistema delle Start-up Innovative". This is the first national survey on startups based in Italy and was sent to startup founders between March and May 2016. The survey is ideally suited for our work as it focuses on innovative startups, in line with our theoretical framework, where, as noted, spinoffs create new intermediate products. The questionnaire was filled in by 2,250 firms, 44% of the innovative startups registered at the Italian Chambers of Commerce during the 2010-2015 period. The information in the survey includes the personal background of startup founders. For each province and sector we can then compute the share of startups in which the majority of owners was previously employed in a firm operating in the same sector, relative to the total number of startups in the province and sector (see, e.g., Andersson and Klepper, 2013, for a similar definition of spinoffs). As shown in Table 1, on average the share of spinoffs over total startups in a province and sector is approximately 25% in this period. This is in line with the share of spinoffs observed, e.g., in the United States (Klepper, 2005), Brazil (Muendler and Rauch, 2013) and Netherlands (Bernardt et al., 2002). Provinces are characterized by significant heterogeneity in the share of spinoffs, as shown in Figure 1.a; the standard deviation equals 0.44.

Information on the investments in innovation of incumbent firms in a province and sector is drawn from the latest available wave of the UniCredit Survey on Italian Manufacturing Firms (which was conducted in 2006).[7] This survey targets the universe of publicly listed companies and a large representative sample of non-listed firms with no less than 10 employees. This threshold number of employees implies that the UniCredit survey naturally focuses on incumbent businesses: the mean age of the firms in the survey is 22 years, and the first age decile is 6 years. To proxy for the intensity of R&D, we use the share of firms in a province and sector that have positive R&D expenses. The average share of firms carrying out R&D investments in a province and sector is 53% (see Table 1, and Figure 1.b for the distribution across province).

To measure investment protection we consider a widely used proxy for judicial (court) efficiency in the provinces. Using ISTAT data, we consider the costs of bankruptcy procedures in the provinces normalized by the total assets of the firms. As noted, this can be thought as an inverse measure of court efficiency in business cases.

[7] Later surveys on Italian firms tend to cover also the crisis period that started in 2008. To avoid confounding effects due to the crisis, we then considered the 2006 UniCredit Survey.

We estimate the following empirical models:

$$Spinoff_{ij} = \alpha + \beta Court_i + \gamma^\top X_i + \delta_j + \varepsilon_{ij} \tag{1}$$

and

$$R\&D_{ij} = \alpha' + \beta' Court_i + \gamma'^\top X_i + \delta'_j + \varepsilon'_{ij}, \tag{2}$$

where $Spinoff_{ij}$ is the spinoff rate (share of start-ups accounted for by spinoffs) in province i and sector j; $R\&D_{ij}$ is the share of firms carrying out R&D investments in province i and sector j; $Court_i$ is the (inverse) measure of court efficiency in province i; and X_i is a comprehensive vector of province-level controls, including economic conditions (unemployment rate), population growth, banking development and concentration, trade openness, material infrastructures, courts workload, and area dummies for North, Center and South. We saturate the regressions with a full set of 2-digit sector fixed effects, δ_j and δ'_j. ε_{itj} and ε'_{itj} denote the residual.

In Table 2, column 1 we present the coefficient estimates for the effect of local court efficiency on the share of spinoffs in a province and sector. We detect evidence that in provinces where courts are more efficient the incidence of spinoffs in firm entry is lower. The estimated coefficient $\widehat{\beta}$ suggests that a one percentage point increase in the cost of court procedures (about 5% of the average cost) is associated with a 0.5 percentage points increase in the spinoff rate (2% of the mean rate). Column 2, in turn, shows a positive association between judicial efficiency and the average R&D investment of incumbents. The estimated coefficient $\widehat{\beta'}$ suggests that a one percentage point increase in the cost of court procedures is associated with a 0.45 percentage points decrease in the share of R&D investors in the province (0.8% of the mean share). While suggestive, these patterns are broadly consistent with the mechanisms of the theoretical model, as we elaborate below.

4 The Model

Time is continuous and runs up to infinity. The economy is closed. It is populated by a mass of households L, each supplying inelastically one unit of time to a final good sector. Besides supplying labor, households can act as shareholders (founders) and managers of intermediate goods firms. The final good sector combines labor and a variety N of non-durable intermediate goods to produce an homogenous consumption good. Intermediate goods are produced from the final good. In what follows we detail the technology of the final and intermediate goods sectors, and the decisions of shareholders, managers, and households about investments, entry, and consumption.

4.1 Final producers

A competitive representative firm produces a final good that can be consumed, used to produce intermediate goods, invested in the improvement of the quality of existing intermediate goods, or invested in the creation of new intermediate goods. The final good is our numeraire. The final good production technology is

$$Y = \int_0^N X_i^\theta \left[Q_i \frac{L}{N^{1-\sigma}} \right]^{1-\theta} di, \quad 0 < \theta, \alpha < 1, \ 0 \leq \sigma < 1 \tag{3}$$

where X_i is the amount of intermediate good i used in production, N is the mass of intermediate goods and L denotes labor. The quality, Q_i, of intermediate good i is the good's ability to raise the productivity of the other production factors. The parameter σ governs the intermediate product variety externality; θ is the elasticity of output to intermediates.

Let P_i be the price of intermediate good i and w be the wage. The profit maximization problem yields that the final producer demands intermediate goods and labor according to:

$$X_i = \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} Q_i \frac{L}{N^{1-\sigma}}, \tag{4}$$

$$L_i = \frac{(1-\theta)}{\theta} \frac{P_i X_i}{w}.$$

Therefore, the final producer pays

$$\int_0^N P_i X_i di = \theta Y, \quad wL = \int_0^N w L_i di = (1-\theta) Y \tag{5}$$

to, respectively, suppliers of intermediate goods and labor.

4.2 Intermediate firms and managerial activities

Intermediate firms can invest final good to develop their stock of knowledge and, hence, improve the quality of their intermediate products. To model spinoff activities that originate from conflicts between employees and shareholders of incumbent firms, we posit separation of ownership and control in intermediate firms. As shown by a broad body of studies (e.g., Klepper and Sleeper, 2005; Thompson and Klepper, 2005; Hellmann and Veikko, 2011; Garvin, 1983; Brittain and Freeman, 1986), employees can devote effort, ideas and R&D findings ("investment resources") to plan and set up their own businesses (spinoffs) rather than to increase the stock of knowledge of parent firms.

Precisely, we posit that, since the founder of the intermediate firm i lacks the skills to run the investment project, he delegates the task of research and development to a manager. The manager, however, has the ability to divert a fraction S_i of the investment resources that the founder has earmarked for the development of the firm's stock of knowledge. Hence, the stock of knowledge of the firm, Z_i, evolves according to

$$\dot{Z}_i = (1 - S_i(E_i)) \cdot I_i \tag{6}$$

where I_i denotes investment and E_i is the manager's effort in diverting investment resources. The firm's rise in the stock of knowledge helps improve the quality Q_i of its intermediate product. This is given by

$$Q_i = Z_i^\alpha Z^{1-\alpha}. \tag{7}$$

In words, the contribution of good i to factor productivity downstream depends on the knowledge of firm i, Z_i, and on the average knowledge of all intermediate firms, $Z = \int_0^N (Z_i/N)\,di$. The founder of firm i can offer an incentivizing contract to contain the manager's diversion effort E_i. Specifically, the manager receives a variable compensation $\omega_i \dot{Z}_i$ proportional to $\dot{Z}_i$, the rate of technological improvement.[8]

The manager can employ the diverted investment resources to start up firms (spinoffs). For every unit of investment outlays diverted, the manager covers $e_i > 1$ entry cost. The assumption that e_i is larger than one captures the idea that the manager can benefit from the knowledge and experience accumulated while working in the current firm to reduce the entry cost. It also means that the action of the manager can generate positive spillovers to other firms. Put differently, the R&D manager, while under the payroll of firm i, develops a parallel startup project in the backyard using seeds subtracted to firm i. These seeds, however, are worth relatively more when used to start up a firm than if employed in the incumbent firm i, an assumption intended to capture positive spillovers associated with the knowledge and experience acquired by the manager. This assumption also implies that it is better for the manager to commit the diverted resources to the foundation of new firms than to consume them right away.

The manager's flow of gains is the sum of the contractual component, $\omega_i \dot{Z}_i$, and of the non-contractual component, net of the effort cost of resource diversion $c_E(E_i) \cdot I_i$, where the function $c_E(E_i)$ is continuous, increasing and convex. The contractual component is $\omega_i \dot{Z}_i$, or more explicitly, $\omega_i(1 - S_i(E_i))I_i$. The non-contractual component corresponds to the market value, V_i, of the new firms the manager sets up with the diverted funds $e_i S_i(E_i) I_i$. The number of spinoffs set up by the manager is then $\frac{e_i S_i(E_i) I_i}{C_i^{\text{entry}}}$, where C_i^{entry} is the entry cost and the gross gain from spinoffs is $\frac{e_i S_i(E_i) I_i}{C_i^{\text{entry}}} \times V_i$. Because of free entry, the value of a new firm is equal to the entry cost, that is $V_i / C_i^{\text{entry}} = 1$. Therefore, the manager's flow utility can be expressed as

$$u_i = \omega_i(1 - S_i(E_i))I_i + e_i S_i(E_i) I_i - c_E(E_i) \cdot I_i.$$

The manager's choice of E_i satisfies

$$(e_i - \omega_i) \frac{\partial S_i(E_i)}{\partial E_i} = \frac{\partial c_E(E_i)}{\partial E_i}. \tag{8}$$

The compensation share ω_i discourages diversion because the manager's costly effort would be partly directed at diverting resources from himself; hence, the difference $e_i - \omega_i$ is the net gain for each unit of diverted resources.

[8] Given our focus on the aggregate effects of spinoffs, we specify the managerial sector in a simplified way. In particular, we do not model a managerial market, or hiring and firing processes of managers. Accordingly, in our economy shareholders partially discipline managers through incentivizing contracts, rather than through firing threats. Thus, a manager who acts as the founding shareholder of a spinoff can be thought as continuing to operate as the manager of the parent company. On the other hand, given that managers are homogenous and behave the same way, the parent company would have no incentive to fire him and hire a new manager.

We indicate the reaction function implied by (8) with $E_i^*(\omega_i)$ and the associated fraction of investment diverted with $S_i^*(\omega_i)$. The manager's surplus operating in firm i then is

$$V_i^M(t) = \int_t^\infty e^{-r(\tau-t)}[\omega_i(\tau)(1-S_i^*(.)) + e_i S_i^*(.) - c_E(E_i^*(.))] \cdot I_i(\tau).$$

Next, we study a founder's choices about the paths of production and investment and the contractual arrangement ω_i with the manager.

4.3 Founders (principal)

The intermediate firm i produces an intermediate good by transforming final good with a one-to-one technology. It also faces an operating cost of ϕQ_i. The firm's cash flow is then

$$\Pi_i = (P_i - 1)X_i - \phi Q_i, \tag{9}$$

where P_i is the monopolistic price. The founder earns a flow of income, D_i, given by the cash flow Π_i net of the investment outlays and of the managerial compensation

$$D_i = \Pi_i - I_i - \omega_i(1 - S_i^*(\omega_i))I_i. \tag{10}$$

Over an horizon $\tau \in [t, \infty)$ the founder chooses the paths of $P_i(t)$, planned investment $I_i(t)$, and a contract ω_i to maximize

$$V_i^{\text{founder}}(t) = \int_t^\infty e^{-r(\tau-t)} D_i(\tau)\, d\tau, \tag{11}$$

subject to the demand and technology constraints discussed above and to the participation constraint of the manager:

$$V_i^M(t) \geq 0. \tag{12}$$

Specifically, assuming that the firm is already operating, the founder solves the Hamiltonian

$$H_i^{\text{founder}} = D_i + q_i \cdot (1 - S_i^*(\omega_i)) \cdot I_i$$

subject to (6), (10), (12), and where $S_i^*(\omega_i)$ satisfies (8). The first-order conditions with respect to P_i and ω_i are:

$$\frac{\partial (P_i - 1) X_i}{\partial P_i} = 0 \Rightarrow P_i = \frac{1}{\theta}; \tag{13}$$

$$1 - S_i^*(\omega_i) = (\omega_i - q_i)\frac{\partial S_i^*(\omega_i)}{\partial \omega_i}. \tag{14}$$

The left- and right-hand sides of (14) are the marginal cost and benefit of increasing the compensation of the manager, respectively. The first-order condition with respect to I_i yields

$$q_i = \omega_i + \frac{1}{1 - S_i^*(\omega_i)}. \tag{15}$$

Replacing this into (14), we obtain

$$1 - S_i^*(\omega_i) = -\frac{1}{1 - S_i^*(\omega_i)} \frac{\partial S_i^*(\omega_i)}{\partial \omega_i}.$$

Observe that this relationship does not have any dynamic component, implying that the paths of ω_i, S_i, and E_i do not depend on time and therefore $\dot{q}_i = 0$.

Finally, the optimal condition on Z_i gives $-\dot{q}_i + rq_i = \frac{\partial \Pi_i}{\partial Z_i}$. Since $\dot{q}_i = 0$, and given equations (4), (7), and (9), we can write the return to investment in firm i as

$$r = r_{Z_i} \equiv \frac{\alpha}{q_i}[(P-1)\frac{X_i}{Z_i} - \phi(\frac{Z}{Z_i})^{1-\alpha}]. \tag{16}$$

The investment distortion caused by managers' diversion is captured in the above expression by the internal cost of capital q_i. As indicated by (15), the compensation variable, ω_i, and the fraction of resources diverted, S_i^*, both lift up the cost of investment q_i, depressing the internal return on investments.

We now turn to the entry decision of a de novo firm. The cost of entry is βX_i, that is, it is proportional to the targeted level of production X_i. Free entry implies that $V_i = \beta X_i$. Taking logs and time derivatives yields the return to de novo entry

$$r = r_{E_i} \equiv \frac{D_i}{V_i} + \frac{\dot{V}_i}{V_i} = \frac{1}{\beta}\frac{D_i}{X_i} + \frac{\dot{X}_i}{X_i}. \tag{17}$$

Observe that this condition is relevant only for de novo founders. The overall entry rate will depend not only on (17) but also on the amount of investment resources diverted to spinoff activities, $\int_0^N e_i S_i I_i$.

The adverse effect of spinoffs on entry is contained in the flow of dividends D_i. The current D_i is lower in an environment where the founder has to offer a generous managerial compensation ω_i to discourage the manager from diverting investment resources. Further, the diversion of investment resources also limits the future growth of Z_i. This dynamic loss is captured by the more modest rate of increase, $\frac{\dot{V}_i}{V_i}$, or, equivalently, by the slower growth of the average firm's market size $\frac{\dot{X}_i}{X_i}$.

4.4 Households

The representative household has L members. Each household member is endowed with one unit of labor and there is no labor-leisure choice. Consequently, the household's labor supply is L. The household has preferences

$$U(0) = \int_0^\infty e^{-\rho t}\left[L(t)\log\left(\frac{C(t)}{L(t)}\right)\right]dt, \quad L(t) = e^{\lambda t}, \quad \rho > \lambda \tag{18}$$

where 0 is the point in time when it makes decisions, ρ is the intertemporal discount rate and $C(t)$ is total household consumption. The household's budget constraint reads

$$\dot{A} = rA + wL + M - C, \tag{19}$$

where A is the household's wealth, r is the rate of return on assets, wL is the wages of final good workers, and M is the overall managerial compensation that includes both the contractual allowance and the value of the diverted resources, that is,

$$M = \int_0^N [\omega_i(1 - S_i) + e_i S_i] I_i di.$$

The term $\int_0^N \omega_i(1 - S_i) I_i di$ is the contractual flow of resources accruing to managers. The term $\int_0^N e_i S_i I_i di$ is the non-contractual flow of managers' income. Because this comes with a loss of $\int_0^N S_i I_i di$ from founders' perspective, spinoffs create a per period household net gain of wealth of $\int_0^N S_i(e_i - 1) I_i di$. As we will see in the general equilibrium analysis, this one-time personal gain is small relative to the dynamic distortions associated to the increase in the investment cost q_i.

Finally, the intertemporal consumption plan that maximizes (18) subject to (19) consists of the Euler equation

$$r = \rho - \lambda + \dot{C}/C, \tag{20}$$

the budget constraint (19) and the usual boundary conditions.

4.5 Discussion

Before moving to the general equilibrium, it is useful to review the channels through which spinoff activities affect agents and anticipate their aggregate effects.

Let us start from the point of view of shareholders. Conflictual spinoffs have detrimental effects on the investment incentives of incumbent firms. This captures the essence of the "law view" in this model, i.e. the idea that poor investment protection may induce incumbent firms to be more conservative about expanding their production capacity. Formally, it is the cost $q_i > 1$ (where one is the internal cost of investment in an economy without managers-shareholders conflicts) that measures the size of the distortion, encompassing both the contractual component ω_i and the outright diversion of investment S_i (see equation (16)). This mechanism, to which we will refer as *investment distortion* channel, turns out to play a key role in accounting for the welfare loss occasioned by increases in spinoff activities. Second, spinoffs make entry of de novo firms less attractive because prospective founders anticipate that managers can divert resources (causing a decline of the returns to de novo entry, see (17)) and furthermore expect stronger *competition* in the product market – i.e., a downward shift of the demand curve for each intermediate product.

From the point of view of spinoff managers, there are two positive aspects. One is the value of the diverted resources amounting to $S_i e_i I_i$ (against a cost for incumbents of $S_i I_i$). The second is the bonus ω_i that the founder agrees to pay in order to discourage the diversion of investment resources. Recall that the terms S_i and ω_i are the two wedges that distort the cost of capital q_i.

From the society's point of view, there is a net gain as the "seeds" are more valuable once they are brought out of incumbent firms. This corresponds to the term $\int_0^N S_i(e_i - 1) I_i di$ in the households' budget constraint (19). Such a gain, however, turns out to be quite small relative to the reduction of investment of incumbent firms caused by the investment distortion. As is typical in any class of models with a dynamic perspective, the important gains are to be identified in long-lasting effects. Spinoffs bring an increased number of firms and, hence, a larger array of intermediate products. An economy with greater input *variety* enjoys permanent gains in the productivity of the final good sector, with the magnitude of the productivity gains depending on the social return to variety σ. The benefits of higher productivity brought by spinoffs are nevertheless to be contrasted with the increased operating costs of running more firms. Ultimately, determining the sign of the welfare effects of spinoffs requires a thorough investigation of how the *investment distortion,* the *competition,* and the *variety* channels interact in general equilibrium.

5 General Equilibrium

For the remainder of the analysis we assume the same spinoff spillovers across firms, i.e. $e_i = e$. Models of this class have symmetric equilibria in which firms charge the same price, $P = 1/\theta$, and have the same quality level at all times. As they receive $NPX = \theta Y$ from the final producer, we have $X = \theta^2 Y/N$. Writing the production function (3) under symmetry and using this result to eliminate X, we obtain

$$Y = \theta^{\frac{2\theta}{1-\theta}} \cdot N^{\sigma} Z \cdot L. \tag{21}$$

This reduced-form representation of final production makes clear that, for an average level of technology Z, labor productivity Y/L is increasing in the mass of firms, N, and the more so when σ is large. We define "firm size" the volume of production, adjusted for the state of technology:

$$x \equiv \frac{X}{Z} = \frac{L}{N^{1-\sigma}} \theta^{\frac{2}{1-\theta}}. \tag{22}$$

Spinoffs contribute to the stock of firms as $N = N^{\text{ex-novo}} + N^{\text{spinoffs}}$ and at the same time slow down the growth of the average intermediate firm size. They increase the productivity of the final good sector through the *variety* effect and at the same time tend to shrink the average firm size as more intermediate producers share the same final market. This *competition effect* reduces the returns to both entry and innovation. Specifically, using the cash flow definition (10), the innovation and entry returns (16)-(17) can be written as

$$r = r_Z \equiv \frac{\alpha}{q} \left[\left(\frac{1}{\theta} - 1 \right) x - \phi \right]; \tag{23}$$

$$r = r_E \equiv \frac{1}{\beta x} [\left(\frac{1}{\theta} - 1 \right) x - (\phi + qz)] + \frac{\dot{x}}{x} + z\,, \tag{24}$$

respectively, where $z \equiv \dot{Z}/Z = I(1-S)/Z$ is the investment rate. Equation (23) shows that the *competition* effect, by reducing the size of the firm, has a negative effect on the return of quality improvement investments. The adverse effect of the *investment distortion* is summarized by the variable q. Equation (24) says that when the industry becomes more competitive, i.e. x shrinks, it sparks two opposite effects on entry: a positive one, captured by the entry term at the denominator, βx, and a negative one which is linked to the lower profitability of the firm after entry (as the operating cost and cost of investments can be spread on a smaller volume of production). Overall, it is the profitability aspect that dominates. Therefore, both the returns in (23) and in (24) are adversely affected by the intensification of industry competition generated by spinoff activities.

The competition effect emerges more clearly through the dragging term of the operating cost ϕZ when one calculates the Gross Domestic Product (GDP). This can be obtained by subtracting from the final output Y the cost of intermediate inputs NX and the fixed cost ϕZN. Using (22), the GDP can be written as

$$G = [1 - \frac{\theta}{P}\left(1 + \frac{\phi}{x}\right)]Y,$$

and, replacing Y with the expression in (21), we have that per capita GDP is

$$\frac{G}{L} = [1 - \theta^2\left(1 + \frac{\phi}{x}\right)](\theta^{\frac{2\theta}{1-\theta}} \cdot N^{\sigma} Z). \tag{25}$$

Therefore, the drag effect of spinoffs is represented by a reduction in the firm size, x, or equivalently a decline of the L/N ratio. Nevertheless, spinoffs also help lift up productivity through the term N^{σ} (*variety* channel) and hence bring about an expansion of per capita income. The *competition* channel through which spinoffs condition the evolution of GDP is the pattern of Z. As noted, knowledge accumulation is adversely affected by spinoffs, because they tend to limit firm growth.

As discussed in Section 4.2 spinoffs generate wealth for the managers who carry out the endeavour in the measure of $N^{\text{spinoffs}}\, V$. The total wealth of the economy is the aggregate value of de novo and spinoff firms:

$$A = (N^{\text{ex-novo}} + N^{\text{spinoffs}})V. \tag{26}$$

The following proposition states the accounting link between the dynamic households' budget constraint and the resource constraint of the economy.

Proposition 1 *(Budget Constraint). The households' budget constraint (19) satisfies the economy's resource constraint*

$$\dot{N}^{ex\text{-}novo}\beta X + NI + NX + \phi NZ + C = Y. \tag{27}$$

Proof. See the Appendix. ■

5.1 Welfare

So far we have discussed the channels (*investment distortion, competition,* and *variety*) through which spinoffs affect the incentives to invest and the level of GDP. We can also evaluate how these channels alter households' welfare. Replacing $\frac{C}{L}$ with

$$\frac{C}{L} = c\frac{Y}{L} = c\theta^{\frac{2\theta}{1-\theta}} \cdot N^{\sigma} Z, \tag{28}$$

the welfare function (18) evaluated on an equilibrium pattern can be written as

$$W = \int_0^\infty e^{-(\rho-\lambda)t}[\log c(t) + \sigma \log(N^{\text{ex-novo}}(t) + N^{\text{spinoffs}}(t)) + \log(Z(t))] \tag{29}$$

where, without loss of generality, we normalize $L(0) = Z(0) = N(0) = 1$. As it will be clarified below, the consumption-output ratio $c(t)$ is increasing in the contractual and non-contractual compensation accruing to managers. The expression (29) also emphasizes the positive role of spinoffs in consumption through N^σ – the *variety* effect. The negative effects of spinoffs are captured by the last term: because of the *competition* and *investment distortion* effects, the return to quality declines, and the pattern of Z will be flatter.

6 Steady State and Dynamics

We have now the elements to study the steady state and the dynamics of the economy.

6.1 The steady state

We characterize the steady state, a situation in which both the firm's size, x, and the consumption-output ratio, C/Y, are constant. A constant x implies that $\frac{\dot{N}}{N} = n = \frac{\lambda}{1-\sigma}$ (see (22)). This suggests that in the long run the rate of entry is eventually tied to population growth. However, as discussed in the previous section, the level of N depends on the intensity of spinoffs. We may have two economies that in the long run have the same entry rate and yet at each point in time have a very different mass of firms, and differ in the value of wealth.

Exploiting the property that $\frac{\dot{C}}{C} = \frac{\dot{Y}}{Y}$, using the production function (21) we have that $\frac{\dot{C}}{C} = \sigma n + z + \lambda$. Combining this result with (20) and using the result $n = \frac{\lambda}{1-\sigma}$,

$$r = \frac{\sigma}{1-\sigma}\lambda + z + \rho. \tag{30}$$

Substituting this expression in the returns to investment (23) and to entry (24) and setting $\dot{x} = 0$, we obtain

$$z = \frac{\alpha}{q}\left[\left(\frac{1}{\theta} - 1\right)x - \phi\right] - \frac{\sigma}{1-\sigma}\lambda - \rho \tag{31}$$

and

$$z = \frac{1}{q}\left\{\left[\frac{1}{\theta} - 1 - \left(\frac{\sigma}{1-\sigma}\lambda + \rho\right)\beta\right]x - \phi\right\} \tag{32}$$

where $q = \omega + \frac{1}{1-S}$ is the symmetric internal cost of investment. The crossing of the loci (31)-(32) yields the steady state firm size x. These two equations say that the spinoff rate S and the contractual remedy that founders use to partly contain managers' diversion (ω) both contribute to make innovation and entry less attractive. Whether a higher q affects relatively more entry or innovation, and eventually the equilibrium level of x, depends on the underlying set of parameters. For instance, in an economy in which α is relatively high, i.e. an economy in which incumbent firms can appropriate a greater share of innovation returns, an increase of q tends to depress the investment of incumbents in product improvement relatively more.

Proposition 2 solves for the steady state.

Proposition 2 *(Steady State). Let $q = \omega + \frac{1}{1-S}$. In steady state the average firm size is*

$$x^* = \frac{(1-\alpha)\phi - q(\frac{\sigma}{1-\sigma}\lambda + \rho)}{(1-\alpha)\left(\frac{1}{\theta} - 1\right) - \left(\frac{\sigma}{1-\sigma}\lambda + \rho\right)\beta},$$

the innovation rate is

$$z^* = \frac{\alpha}{q}\left[\left(\frac{1}{\theta} - 1\right)x^* - \phi\right] - (\frac{\sigma}{1-\sigma}\lambda + \rho),$$

and the entry rate is

$$n^* = \frac{\lambda}{1-\sigma}.$$

Finally, the consumption-output ratio is

$$c^* = 1 - \theta + (\rho - \lambda)\beta\theta^2 + \frac{z}{1-S}\frac{\theta^2}{x}(\omega + eS). \tag{33}$$

Proof. See Appendix. ■

Expression (33) says that the consumption-output ratio is proportional to the labor share $1-\theta$, and that it is higher in economies where individuals are more impatient or where population growth is lower. The last term captures the effects of diversion through spinoffs on the optimal consumption relative to output: households consume a higher share of output, and therefore, a higher share of their assets, as $A = \beta\theta^2 Y$. Because the last term increases both with the investment rate, z, and with the intensity of diversion, S, ex ante it is unclear whether the consumption output-ratio is smaller or bigger in economies with a better investment protection.

Using the results in Proposition 2, we can determine the steady state welfare level:

$$W^* = \frac{\log(c^*)}{\rho - \lambda} + \int_0^\infty e^{-(\rho-\lambda)t}(\frac{\sigma}{1-\sigma}\lambda t + z^* t)dt, \tag{34}$$

where we have normalized $N(0) = Z(0) = 1$. Relative to an economy with no spinoffs with the same initial condition $L(0) = N(0) = Z(0)$, the spinoff economy consumes a larger fraction of output that integrated over the infinite horizon amounts to $\frac{\log[\frac{z}{1-S}\frac{\theta^2}{x}(\omega+eS)]}{\rho-\lambda}$ (see (33)). Nevertheless the "size of the pie" does not expand as rapidly because of the lower innovation rate z^*. One important element missing from (34) is the higher productivity of the final good sector in the presence of a larger array of intermediate inputs. Although in the long run the entry rate is eventually pinned down by population growth, along the transition it is conditioned by the intensity of spinoffs. Thus, in the next section we will return to the welfare analysis to consider scenarios in which the economy is not in the steady state.

6.2 Dynamic system

The dynamic equilibrium can be represented by a phase diagram in two variables: the firm size, x, which is the state variable of the system, and the consumption output ratio, $c \equiv \frac{C}{Y}$, which is a jump variable. While the dynamics may exhibit phases in which either n or z or both are zero, here we focus on a scenario in which both are positive. Proposition 3 summarizes the result. The Appendix provides details on the derivation and discusses the conditions for having $n > 0$ and $z > 0$.

Proposition 3 *(Dynamic System). Let $c \equiv \frac{C}{Y}$. The dynamic system when both entry and innovation are active is characterized as follows*

$$\frac{\dot{c}}{c} = \lambda - [\rho + \frac{1}{\beta\theta^2}(1-\theta-c) + \frac{1}{\beta}\frac{z}{(1-S)}\frac{1}{x}(\omega(1-S)+Se)]. \tag{35}$$

The evolution of the firm size is

$$\frac{\dot{x}}{x} = \lambda - (1-\sigma)n. \tag{36}$$

The entry and innovation rates are, respectively,

$$n = \frac{1}{\beta\theta^2}(1-c) - \frac{1}{\beta}[1 + \frac{\phi}{x} + \frac{z(1-Se)}{x(1-S)}], \tag{37}$$

and

$$z = \frac{1}{\psi}\left\{ (\frac{\alpha}{q} - \frac{1}{\beta x}) \left[\left(\frac{1}{\theta} - 1 \right) x - \phi \right] - \lambda + (1-\sigma)[\frac{1}{\beta\theta^2}(1-c) - \frac{1}{\beta}(1+\frac{\phi}{x})] \right\} \tag{38}$$

where $\psi = 1 - \frac{q}{\beta x} + (1-\sigma)\frac{1-Se}{\beta x(1-S)}$. Replacing the expressions (38) and (37) into (35) and (36) yields a two-dimensional system in (c, x).

Proof. See the Appendix. ■

In running the dynamic experiments (Section 7) we verify that the system exhibits a saddle-path dynamics by computing the Jacobian and evaluating its eigenvalues around the steady state.

7 Quantitative Analysis

The objective of this section is to quantify the short- and long-run aggregate effects of spinoff activities. We are interested in the effects on firm entry and on incumbents' investments, and the implications for growth and welfare. We are also interested in the feedback from the macroeconomy to the intensity of spinoffs and incumbents' investment. In carrying out the quantitative analysis, in line also with the empirical analysis of Section 3, we alter the degree of protection of incumbents' investments, as captured by managers' effort cost in diverting investment resources (δ) or by the efficiency of diversion (b). The effects will be shown first for a baseline economy calibrated with the set of technological and market structure parameters typical of an advanced economy, and with a good investment protection, and then for economies that have a more or less stringent protection of incumbents' investments.

7.1 Calibration

The baseline parameterization of the economy is displayed in Table 3. While we especially refer to the Italian data in Section 3 to match spinoff activities, we choose other macroeconomic values in line with those typically adopted by the literature for modern growing economies. We set the population growth $\lambda = 1\%$. This is close to the population growth rate of the Italian provinces during the 2013-2014 period (the mid-point of the sample for the spinoff data in Section 3). The social return to variety is determined through (36) with $\dot{x} = 0$: $\sigma = 1 - \lambda/n$. The Italian Chambers of Commerce report a firm entry rate of about 0.8% for the 1995-2006 period, close to population growth. This would imply $\sigma = 0$. The World Bank Entrepreneurship database, however, indicates that from 1982 to the 2008 crisis firms' net entry rate in other advanced countries was higher – for instance it was 2.5% in the United States, implying $\sigma = 0.6$.[9] We choose a baseline $\sigma = 0.25$, with associated $n = 1.35\%$, but also study an economy with $\sigma = 0.3$ (see the Appendix). The private return to quality, α, is set to 0.33. In Jones and Williams (1998) the social rate of return on R&D – a proxy for product quality investment – is in the 30-100 percent range, with R&D spillovers, $1 - \alpha$, of 77%. While the implied spillovers could appear large, others have calculated similar spillovers through alternative methods for estimating uncompensated external benefits (Baumol, 2002, pp.133-134). The monopolistic price P is 1.3 (and hence $\theta = 0.769$) – within the range of mark-up ratios for the manufacturing sector in advanced countries reported by Christopoulou and Vermeulen (2012). We set $\rho = 3\%$ and target a growth rate of per capita income, $g_{G/L}$, of 2.2%, and an interest rate of 5.2%. We choose the growth rate to reflect the performance of an economy that has a relatively stable growth. The parameters ϕ and β are set to match $g_{G/L} = 2.2\%$ and a long-run saving rate ($s = 1 - C/G$) of about 6.3%.[10] The resulting investment rate $z = y - \sigma n = 1.87\%$.

For the spinoff effort cost we employ a simple logarithmic function

$$c(E) = -\delta \log(1 - E) \tag{39}$$

and assume that the manager can appropriate a share

$$S = bE, \tag{40}$$

with $\sqrt{\delta} < b < 1$, of the parent company's investment spending. One can think of δ as the cost of diversion effort and of b as the manager's capacity in profiting from the diversion effort. Stronger rule of law, as determined by higher quality of the judiciary and better investment protection, will likely result in a higher diversion cost δ and a lower diversion efficiency b. With these specifications (39)-(40), the Nash equilibrium conditions (8), (14), and (15) yield an equilibrium diversion of

$$S = \frac{b - \sqrt{\delta}}{1 - \sqrt{\delta}},$$

[9] See also Lee and Mukoyama (2015) for the entry rates in the U.S. manufacturing sector.

[10] According to data from the Bureau of Economic Analysis the U.S. gross national saving rate in the post-war period fluctuated between 15% and 20%. Allowing for a depreciation rate of 10%, this would imply a net saving rate, as a ratio of GDP, in the interval of 5-10%. Our calibration delivers a saving rate in the lower part of this interval.

a contractual arrangement of

$$\omega = e - \frac{\delta(1-\sqrt{\delta})}{\sqrt{\delta}(1-b)},$$

and an internal cost of investment of

$$q = e + \frac{(1-\sqrt{\delta})^2}{1-b}.$$

We set the parameter $e = 1.25$, implying a moderate static spillover of spinoffs of 25%, and then choose the baseline values of δ and b to target a spinoff rate (ratio of spinoffs over total entrants, $n^{spinoff}/n$) of about 10%. The empirical Section 3 reported an average spinoff rate for Italian firms of approximately 25%. Also, Klepper and Sleeper (2005) calculated that the spinoff rates in the U.S. laser, automaker, and disk drive industries are 17%, 20%, and 24% respectively. However, these figures include spinoffs that are voluntarily created by incumbent firms, for example as part of restructuring activities. Investigating a large sample of Portuguese businesses, Rocha, Carneiro and Varum (2015) calculate that slightly more than one third of spinoffs are voluntarily created by firms in distress ("pushed spinoffs"). The remaining two thirds are either voluntarily created by firms in good health or originate from conflictual decisions of employees of incumbent firms. Assuming an equal incidence of the latter two types of spinoffs would then suggest that about one third of spinoffs stem from conflictual departures from parent companies. Given a total spinoff rate of 25% in our data, this would entail a conflictual spinoff rate of 8.7%, quite close to our target of 10%. Thus, when comparing the empirical observations on the Italian provinces against the outcome of our analysis on the spinoff rate, we use an adjustment factor of 2.5.

The three middle plots of Figure 2 illustrate the sensitivity of diversion (S), the contractual agreement (ω), and the cost of capital (q), to deviations of the cost diversion parameter δ and of the diversion efficiency parameter b from their baseline values in Table 3. When δ is higher managers' diversion S goes down as it becomes more costly. The contractual arrangement ω has a $U-$shaped relationship with respect to δ. In an environment where diversion is difficult, the founder is tempted to offer a rather stingy contract; on the other hand, the marginal benefit of reducing diversion is higher when diversion is difficult. The second effect dominates for relatively higher levels of δ. Finally, an increase in δ unambiguously reduces the cost of investment q. Similarly, the three middle plots of Figure 4 indicate that both S and q decline when the diversion efficiency goes down (i.e. b drops). They also show that when diversion is relatively easy (high b), the founder saves on the contract share ω – a different set of parameters may nevertheless generate an inverted $U-$shaped relationship, as in the case of δ.

7.2 Spinoff activities in the long run

We first study how the rule of law, and hence the stringency of investment protection, can help explain long-run cross-country differences in the incidence of spinoffs. We consider a range of steady state economies that differ only in one aspect at a time: the cost of diversion, captured by the parameter δ, and the efficiency of diversion, captured by b.

Rule of law and cost of diversion. In an economy where diversion of investment resources is very costly, i.e. with high δ, managers choose to exert a modest effort E in diversion. This implies that, for a given investment rate, there is a relatively low spinoff rate (spinoffs over entrants, $n^{spinoff}/n$). Nevertheless, in such an economy, because investors' interests in incumbent firms are protected (q is small) the investment rate z tends to be high, which creates a large base from which potential spinoff managers can divert resources (i.e., a large pie for diversion). Whether the former or the latter effect dominates depends on the initial diversion cost δ. The inverted-U-shape of the top left plot of Figure 2 suggests that, in the region where economies have relatively poor rule of law (low δ), when the rule of law improves the spinoff rate and, consequently, the fraction of households' wealth created through spinoffs, go up. Conversely, in the region where the rule of law is relatively good (high δ), a further rise in δ causes a more modest decline in the internal cost of capital q, and consequently a smaller increase in investment. This is not sufficiently large to compensate for the drop in managers' diversion effort E, so the spinoff rate drops.

This quantitative exercise also allows to interpret the empirical observations of Section 3. Figure 3.B shows the relationship between the spinoff rates and the cost of court proceedings for the Italian provinces ("spinoff curve"). The bulk of the spinoff rates of the Italian provinces lie in the [0.1, 0.4] interval. The line that best interpolates the observations is an inverted-U-shaped curve: it starts from a spinoff rate of 24% when the judicial cost is relatively high, increases up to 27 percent, and then declines to 21 percent as the judicial cost declines – this cost moves in the opposite direction of the model's parameter δ as it refers to the quality of courts. Using an adjustment factor of 2.5 to net voluntary spinoffs out, the residual spinoff rates lie in the [0.385, 0.1538] range, with an inverted-U curve that goes from 8 to 9.23 percent, with a peak slightly above 10 percent; that is, they lie in the oval-shaped region in Figure 3.A. In particular, the Italian provinces are located both around the ascending and the descending section of the spinoff curve, although they are more numerous in the descending section where there is a relatively better judiciary. This characterization concords with the baseline parameter value $\delta = 0.27$ which places the baseline economy just past the peak of the curve in Figure 3.A, at a spinoff rate of 10.49 percent (see Table 4). As for the relationship between R&D intensity and cost of diversion, the negative correlation between R&D intensity and judicial cost shown in Figure 3.D is also in agreement with the model's implied ordering of economies in the (δ, z) space shown in Figure 3.C.

From the quantitative exercise we can also derive the steady-state relationship between incumbents' investment rate and the spinoff rate ("spinoff-innovation frontier"), shown in Figure 3.E. This has an inverted-U shape. The "poor" and "good" rule of law regions lie in the ascending and descending sections of the frontier, respectively. In the section of the Italian provinces, a half percentage point increase in incumbents' investment in product improvement (one fourth of the baseline investment rate), due, for instance, to an improvement of the rule of law, is associated with a decline of the spinoff rate by two percentage points (one fifth of the baseline rate). Hence, the quantitative exercise hints at a roughly one-to-one trade-off between incumbents' investment rate and the spinoff rate in this region. Our coefficient estimates in Section 3 suggested that a one percent increase in the cost of the judiciary is associated with an increase of the average spinoff rate of about 2 percent (0.51/24.8) and with a decline of the R&D intensity of 0.85 percent (-0.41/53.15) – see Tables 1-2. Hence, from the data one would read a trade-off of one-to-two between incumbents' investment rate and the spinoff rate.

The bottom plots of Figure 2 compare welfare across the steady state economies. The rule of law view has the upper hand on both key components of the welfare equation (34), the consumption-output ratio and the rate of investment in innovation. The consumption-output ratio includes a component – see the last term of (33) – that reflects the distortion associated with the contractual and non-contractual compensations of managers. The greater the distortion, the lower is the return on assets, r, and the stronger is households' tendency to consume presently a larger share of output. Going towards the region with a stronger rule of law (higher δ), the welfare associated with the consumption-output ratio first rises and then falls, tracking the movement of the ratio. Conversely, stronger rule of law favors investments all the time. Overall the bottom-right plot of Figure 2 supports the "law view": the welfare gain due to faster innovation dominates the welfare loss associated with the possible decline of the consumption-output ratio. The welfare comparison of economies when they are in their steady state has, however, an important limitation. While these economies exhibit the same entry rate, it is unclear how they differ with respect to the number of intermediate products, N. In the comparison we assumed that all economies along the rule of law spectrum have the same number of intermediate products. Section 7.3 proposes a different, and arguably more balanced, welfare decomposition, taking the point of view of an economy that experiences a weakening of the rule of law.

Diversion efficiency. A similar trade-off as that for the cost of diversion arises when comparing economies along managers' capacity to divert resources, b. On the one hand, in economies where managers are more efficient at diverting investment resources, knowledge creation for incumbent firms is more costly and, consequently, they tend to invest less. Therefore, managers can draw from a smaller pool of resources to be used in spinoffs. On the other hand, managers are now able to transform more efficiently the diminished investment resources in spinoffs. The top-left plot of Figure 4 displays an-inverted U relationship between the spinoff rate, $n^{spinoff}/n$, and the diversion efficiency, b. Such a non-monotonic relationship is consistent with that between the spinoff rate and δ in Figure 2: in economies with a strong rule of law (relatively low b) a weakening of the rule of law favors the creation of spinoffs. Conversely, for economies with a high b, a further deterioration of the rule of law depresses the creation of spinoffs. As b moves in the poor rule of law region the surge in the price of investment q is particularly strong and has a sharper negative effect on incumbents' investments. Because the welfare patterns are qualitatively similar to those in Figure 2 we omit their discussion.

We can also study the sensitivity of the relationship between spinoffs and the efficiency of diversion b with respect to the intensity of social spillovers, σ. Stronger variety externalities, σ, make the final good sector more productive and intermediate firms face a stronger demand for their products. Thus, the volume of production X and the average firm size $x = X/Z$ are larger, despite the higher long-run entry (recall that $n^* = \frac{\lambda}{1-\sigma}$). The larger scale of firms makes investments in product improvement more profitable. It is this general equilibrium mechanism that makes more investment resources available for managers' spinoff activities. This insight is represented in the top two right plots of Appendix Figure 7.

7.3 Shocks and spinoff activities in the short run

The previous section compared steady state economies that differ along the rule of law dimension. In the short run there are mechanisms that enrich the analysis. Figure 5 plots the adjustment process over time of a number of key macroeconomic variables resulting from a permanent increase of managers' diversion efficiency b by 5% in our baseline economy. This change is comparable to a decline of the World Bank strength of investor protection index (Doing Business project) of 0.5 points out of 10, due for instance to a weakening of the judicial enforcement of intellectual property rights. To interpret the effects, recall that our baseline economy lies just past the peak of the spinoff curve in Figure 3.A, in the descending, "good rule of law" region.

The simulation reveals that the spinoff rate, $n^{spinoff}/n$, goes up by 2.1 percentage points and 1.4% percentage points in the short and long run respectively (20% and 14% of the pre-shock spinoff rate of 10.5%). Driven by the more intense creation of spinoffs, the total firm entry rate n (spinoff plus de novo entries) goes up by 0.026 percentage points (2% of the pre-shock entry rate), generating a cumulative increase of the mass of firms by 0.63% (Table 5, Panel A). On the other hand, the deterioration of investment protection raises the internal cost of investment by 8.5%. The investment rate z drops in the immediate aftermath of the shock and then it further slows down during the adjustment process, for a total drop of 0.31 percentage points (14% of the pre-shock rate) – see the bottom-left plot of Figure 5 and Table 5, Panel A. The immediate drop of z reflects the deterioration of shareholders' capacity to appropriate returns; the following decline is driven by firms' downsizing during the adjustment process.

The response of the saving rate s is the consolidation of different mechanisms at work. On impact, it jumps up less than half a percentage point because of the stronger dynamics at entry. Nevertheless, along the adjustment process, the lower investment rate becomes the prevailing force, as the entry rate slowly declines; the long-run decline of the investment rate brings down the saving rate by 0.153 percentage points. The consumption-output ratio c drops following the decline of managers' income – see Figure 5, second-right plot.

In the long run, the per capita GDP growth rate drops by 0.31 percentage points (14% of the pre-shock rate) as the investment rate. On impact, however, on top of product quality investment, there are two additional forces that affect its movement. A positive one comes from the increase in product variety by 0.048 percentage points, which, given an externality parameter σ of 0.25, translates into additional growth for 0.012 percentage points – the cumulative productivity effects of product variety are much larger, as discussed in Section 5.1. A negative one is linked to the costs of operating a greater number of firms. Overall, on impact the net effect of the shock on per capita GDP growth is a drop by 0.22 percentage points.

Welfare. Following the analysis of Section 4.1, Table 6, Panel A, decomposes the welfare effects of a 5% permanent increase in b along three channels (see equation 29): (i) the consumption-output ratio; (ii) the quality of intermediate goods (investment distortion); and (iii) the variety of intermediate goods – this was not apparent in the steady state welfare analysis. Because the shock brings a larger number of firms, the variety effect (iii) raises welfare thanks to the higher productivity of the final good sector. Its magnitude depends on the social gain to variety (σ). Conversely, the other two welfare components are negative, reflecting the decline of the consumption-output ratio and the slowdown in product quality investment. A closer look at the magnitude of the welfare changes confirm what we anticipated in Section 4.2: the investment decline caused by the greater investment distortion that results from a larger b is the most prominent welfare component. This dominates the welfare gain associated with the expanding variety of intermediate goods. Increasing the degrees of externalities σ would not alter this conclusion. Hence, the quantitative experiment suggests that the "law view", which stresses the damaging effects of weakening the investment protection of incumbent firms, has the upper hand relative to the view that highlights the benefits of knowledge spillovers from incumbents to spinoffs.

Finally, Table 7 displays the effects of a shock that generates a comparable long-run impact on per capita income growth in an economy with a poor rule of law (ascending region of the spinoff curve in Figure 3.A). As the table shows, in the poor rule of law region such a shock not only leads to a lower investment rate but also to a decline in the spinoff rate.

7.4 Diversion shocks and entry subsidies

To gain additional insights, we compare the effects of a negative investment protection shock with those of a policy that directly promotes firm entry. Suppose the government subsidizes entry through a flat tax on labor income and that it keeps a balanced budget in every period. Since labor supply is inelastic, the tax is non-distortionary. With a tax rate τ, the per period tax revenue is τwL. With an entry cost of βX, each of the $\dot{N}$ new firms is entitled to a subsidy of $\frac{\tau wL}{\dot{N}}$.[11]

Consider a tax shock that alters the steady state GDP growth rate in the same way as the diversion shock that permanently increased b by 5%. Figure 6 and Table 5, Panels A and B, display the responses following the two shocks. Though the spinoff rate rise with the subsidy shock is only a tenth of that observed with the diversion shock, firm entry jumps up more robustly (three times more). Hence, the introduction of the subsidy alters the structure of the industry more dramatically, significantly reducing firms' size over time. In contrast with its stronger effect on entry, on impact the subsidy shock has a modest negative effect on the innovation rate of incumbents z: on impact this goes down a tenth of what observed with the b shock. Indeed, because the cost of investment has not been affected by the shock, the reaction of investment is only due to the firm downsizing, a slow motion phenomenon. In the long run, however, the progressive change in the industry structure and firm downsizing lead to an investment drop three times larger following

[11] See also the Appendix for details on this extension with entry subsidies.

the subsidy shock than following the investment protection shock. Since along the transition the innovation rate declines slowly, so does the per capita GDP growth rate.

Table 6 compares the two shocks from a welfare perspective (see Panels A and B). The welfare gain due to variety expansion is about three times larger with the subsidy shock than with the diversion shock (0.15 vs. 0.05); this is in line with the difference in the number of additional firms under the two policies (0.63% vs. 1.92%) reported in Table 5. Table 6 also says that the long-run welfare reduction attributable to the consumption-output ratio is significantly greater (by about a factor of nine) in the $\tau-$ than in the $b-$experiment. This is due to the reduction of disposable income caused by the introduction of the labour tax and the absence of the diversion boost, which, in the $b-$experiment, partially contrasts the investment decline. Further, the table shows that the welfare reduction due to the investment drop is smaller in the $\tau-$ than in the $b-$experiment. Overall, both with the subsidy shock and with the negative investment protection shock, the diminished investment is the predominant force in the total welfare change. With the subsidy shock, it is however the competition channel, rather than the investment distortion channel, the main source of the investment decline.

8 Conclusion

This paper has investigated the short- and long-run aggregate consequences of spinoffs in an economy where spinoffs stem from conflicts between employees and shareholders of incumbent firms. Our analysis was motivated by two contrasting views. On the one hand, the law view voices the concern that incumbent firms may react to the potential diversion of trade secrets associated with conflictual spinoffs by reducing their investment in knowledge creation and product improvement. On the other hand, spinoffs may be a useful vehicle to spur the rapid dissemination of new technologies: new businesses bring new ideas. Our empirical evidence supported the notion that the intensity of spinoffs is correlated with the quality of the judiciary and of investment protection.

In the model economy we assumed that current employees with special access to investment resources earmarked to product quality improvement can channel a fraction of these resources to the creation of spinoffs. We found that an economy with a good rule of law relatively more favorable to such a practice tends to have a wider set of intermediate products, and, given the average quality of intermediate products, a more productive final good sector. It also has a more competitive industry with firms of smaller size. On the other hand, in such an economy the internal cost of capital is higher, reflecting the greater amount of diversion and incumbent firms' attempt to offer contracts to employees that deter the diversion of trade secrets. This reduces shareholders' return from innovation; as a result the economy invests less in quality improvement. In brief, the source of growth is distorted in favor of greater input variety and to the detriment of the amelioration of quality. Our quantitative analysis revealed that, following a loosening of investment protection, the negative impact of the reduced amelioration of quality on GDP growth and welfare outweighs the positive effect through the increased spinoff creation and the resulting faster introduction of new inputs. This conclusion holds also when the level of social gains to intermediate product variety is relatively higher.

While in our calibrated economy the depressive effect of investment on output growth tended to be the predominant welfare component, there could certainly be situations where the acceleration of firm entry associated with spinoffs may create enough new wealth to compensate for the investment drop. For example, spinoffs originating from a joint reorganization effort of incumbent firms' shareholders and managers may not entail the same degree of diversion of trade secrets associated with the conflictual spinoffs investigated in our analysis. This could imply a smaller distortion of incumbents' investment. However, spinoffs predominantly arising from reorganization processes might also entail a lower degree of innovativeness than startups created by employees of incumbents firms. We leave this and other relevant issues to future research.

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Table 1: Variable Definitions and Summary Statistics

Variable	Definition and data source	Obs	Mean	Std dev
Share spin-offs among entrants in province	Percentage ratio in province and sector between spin-offs (firms in which the majority of owners was previously employed in a firm of the same industry) and total entrants. (MED)	436	24.800	32.400
Share R&D investors in province	Share (in percentage) of firms in province and sector that carry out R&D investments. (SIMF)	1,153	53.162	37.767
Judicial efficiency	Cost of bankruptcy procedures over total firm assets (percentage points) at provincial level. (ISTAT)	439	22.042	6.311
Unemployment rate (log)	Logarithm of provincial unemployment rate. (ISTAT)	439	1.746	0.558
Trade openness (log)	Logarithm of ratio of trade to GDP in province in 2001. (ISTAT)	439	-0.997	0.758
Material infrastructure (log)	Index (0-100) of material infrastructures in province. Infrastructures: Road Network, Railways, Ports, Airports, Environmental Energy Networks, Broadband Services, Business Structure. (GEOWEB)	439	4.653	0.386
Population growth	Growth rate of population in province. (ISTAT)	439	0.009	0.005
Courts workload	Number of civil suits pending in each of the 27 district courts of Italy, scaled by the population of the district. We imputed this variable to the provinces according to the district to which they belong. (ISTAT)	439	3.420	1.272
Bank branches density	Number of bank branches in province, per 1,000 inhabitants. (Bank of Italy)	439	0.589	0.190
Bank concentration (HHI)	Herfindahl-Hirschman index of bank branches in province. (Bank of Italy)	439	0.067	0.028

Note: This table reports variable definitions, sources and summary statistics for the variables used in the analysis.

Table 2: Quality of Judiciary, Spinoff Intensity, and R&D Investments

	(1) Spinoff intensity	(2) R&D intensity
Judicial efficiency	0.51*	-0.45**
	(0.003)	(0.002)
+ Controls for provincial economic and banking conditions and structural characteristics (see note)	Y	Y
Macro area dummies	Y	Y
Industry dummies	Y	Y
Observations	435	1,143
R-squared	0.171	0.068

Note: This table reports OLS estimates for the effects of court efficiency on the share of startups accounted for by spinoffs in a province and sector (column 1) and on the share of firms conducting R&D in a province and sector (column 2). The regressions control for: (log) unemployment rate; population growth rate; bank branches density; bank concentration (HHI); (log) trade openness; (log) material infrastructures; courts workload; macro area dummies for North, Center and South; and 2-digit NACE industry dummies. Detailed definitions of the variables are in Table 1. *, **, *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 3: Parameters

σ	α	θ	ϕ	β	ρ	λ	e	b	δ
0.25	0.33	0.768	1	1.878	0.03	0.01	1.25	0.679	0.27

Note: Values used in the baseline calibration.

Table 4: Steady State

(Percentages)

	z	$g_{G/L}$	r	s	n	$n^{spinouts}/n$	ω	S	q	x
Baseline	1.87	2.20	5.20	6.30	1.35	10.49	47	33	1.97	4.37
Higher b	1.55	1.89	4.89	6.14	1.35	11.89	38	40	2.05	4.35
Higher τ	1.55	1.89	4.89	6.22	1.35	9.15	47	33	1.97	4.30

Note: The parameter b moves up by 5%. The tax rate τ goes from 0 to 0.2078%. The two shocks have an equivalent effect on $g_{G/L}$.

Table 5: Short and Long Run Changes (Baseline Economy)

Panel A, higher b											
	(Percentage Point Changes)									(Abs. Change)	
	z	$g_{G/L}$	r	s	n	$n^{spin.}$	N	ω	S	q	x
Impact	-0.213	-0.219	-0.215	0.066	0.048	0.0285	0	-9.20	7.067	0.085	0
BGP	-0.314	-0.314	-0.314	-0.153	0	0.0189	0.63	-9.20	7.067	0.085	-0.02
Panel B, higher τ											
	(Percentage Point Changes)									(Abs. Changes)	
	z	$g_{G/L}$	r	s	n	$n^{spin.}$	N	ω	S	q	x
Impact	-0.013	-0.019	0	0.593	0.146	0.004	0	0	0	0	0
BGP	-0.314	-0.314	-0.314	-0.0821	0	-0.018	1.92	0	0	0	-0.063

Note: The parameter b moves up by 5%. The tax rate τ goes from 0 to 0.2078%. The two shocks have an equivalent effect on the Balanced Growth Path (BGP), $g_{G/L}$.

Table 6: Shock and Welfare Changes Decomposition, Transition (Baseline Economy)

Panel A: higher b				Panel B: higher τ			
log(C/Y)	σ log(N)	log(Z)	Total	log(C/Y)	σ log(N)	log(Z)	Total
-0.0311	0.0522	-4.23	-4.21	-0.2883	0.1704	-3.28	-3.40

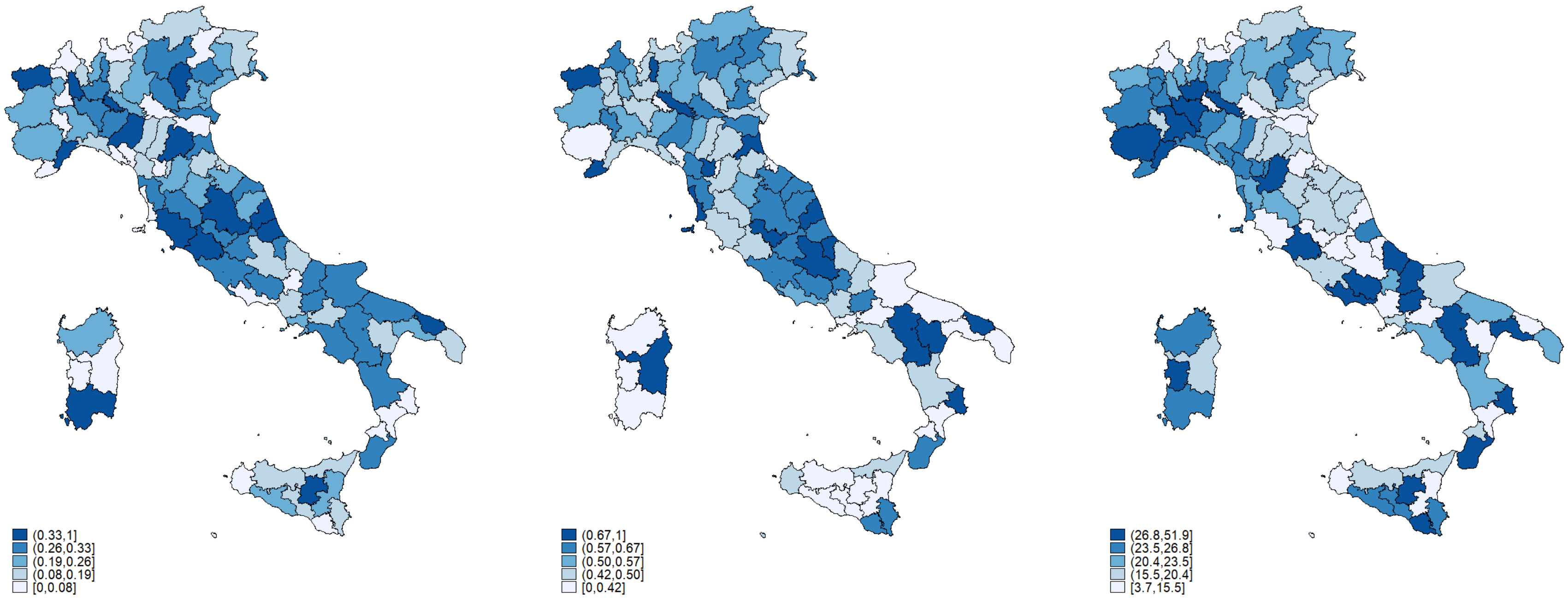
Note: In panel A the parameter b goes up by 5%. In Panel B the tax rate τ goes from 0 to 0.2078%. The welfare changes are calculated over an horizon of a century.

Table 7: Short and Long Run Changes, Economy with Poorer Rule of Law

	(Percentage Point Changes)									(Abs. Changes)	
	z	$g_{G/L}$	r	s	n	$n^{spin.}$	N	ω	S	q	x
Impact	-0.194	-0.203	-0.20	0.189	0.067	-0.0068	0	-12.12	4.81	0.11	0
BGP	-0.314	-0.314	-0.314	-0.11	0	-0.0307	0.008	-12.12	4.81	0.11	-0.03

Note: The parameter b goes up goes up by 3%. It has the same BGP effect on per capita GDP growth, $g_{G/L}$, as that of a 5% rise of b in the baseline economy (Table 3.a).

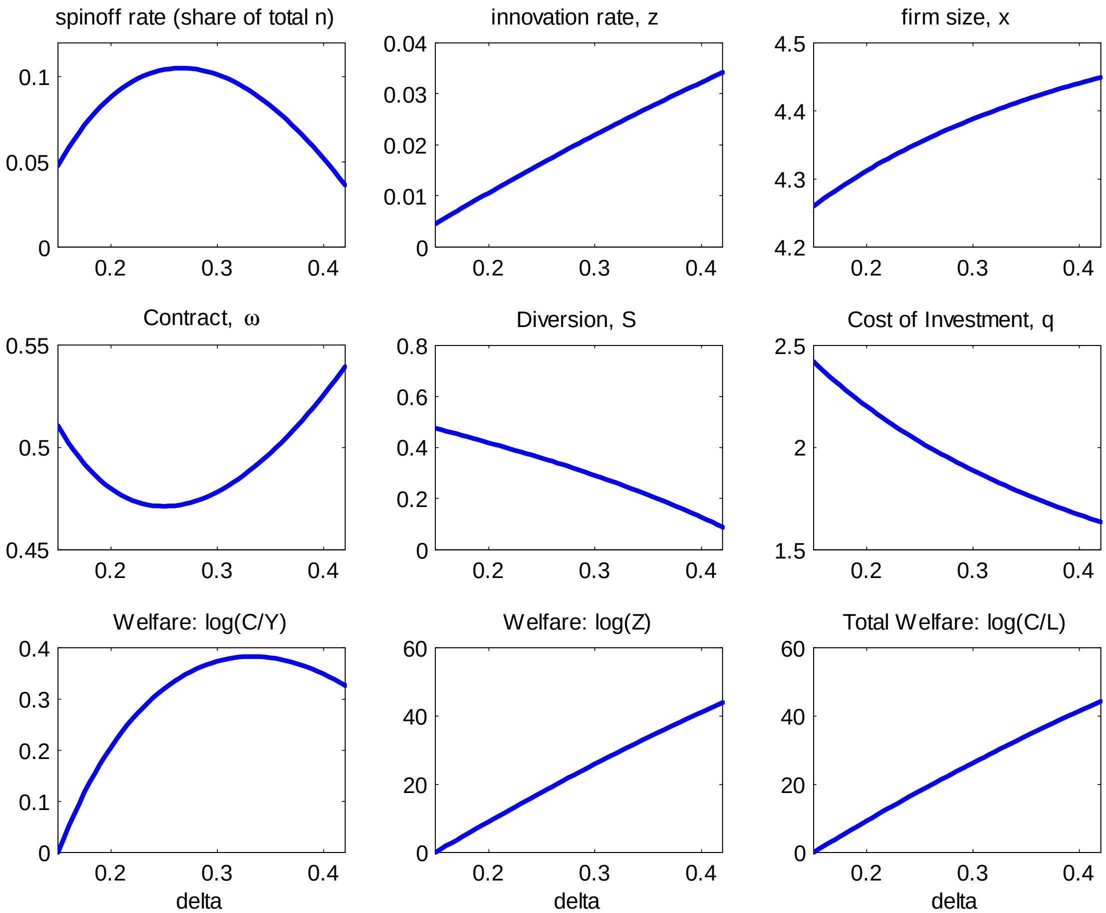
Figure 1: Spinoffs, R&D and Judiciary in Italian Provinces



Panel A. Spinoff Rates   Panel B. R&D Intensity   Panel C. Cost of Judiciary

Note: The figures display the spinoff rates (Panel A), R&D intensities (Panel B), and cost of accessing courts (Panel C) in Italian provinces. See Section 3 for detailed definitions.

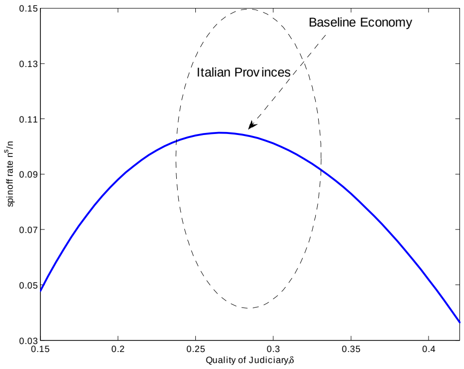
Figure 2: Rule of Law (Diversion Cost) – Comparative Steady State



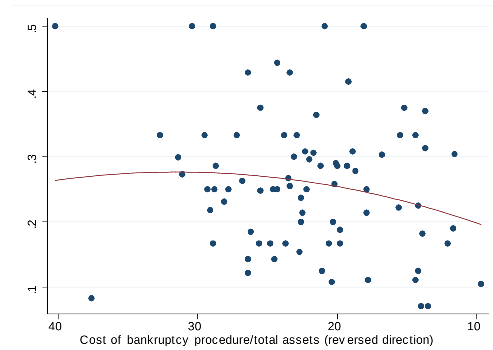
– Note: The welfare values are in differences relative to the economy with the lowest value of δ in the range shown in the figure. For remaining parameters see Table 4.

Figure 3: Rule of Law and the Entry-Innovation Frontier

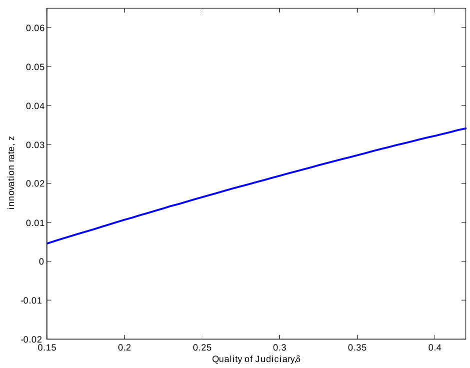
Panel A: Spinoffs and Rule of Law, Model



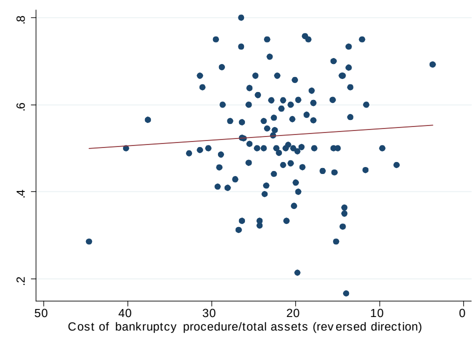
Panel B: Spinoffs and Judiciary, Data



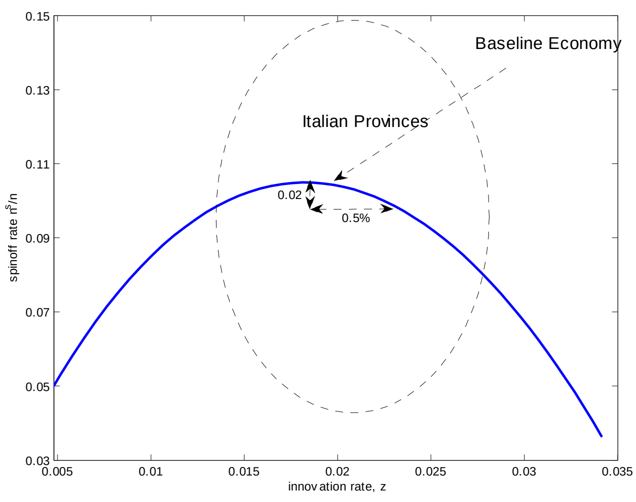
Panel C: Innovation Rate and Rule of Law, Model



Panel D: R&D Probability and Judiciary, Data

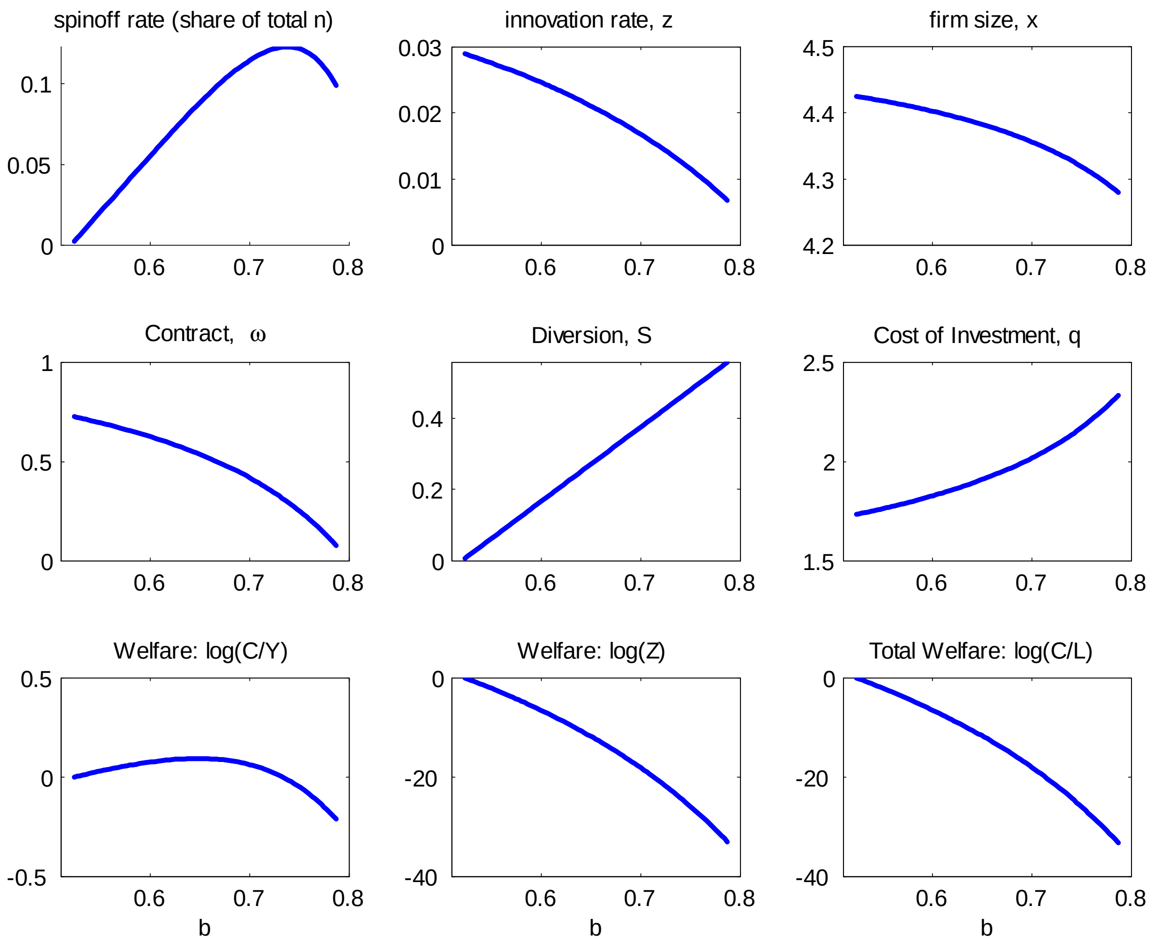


Panel E: Spinoff-Innovation Frontier



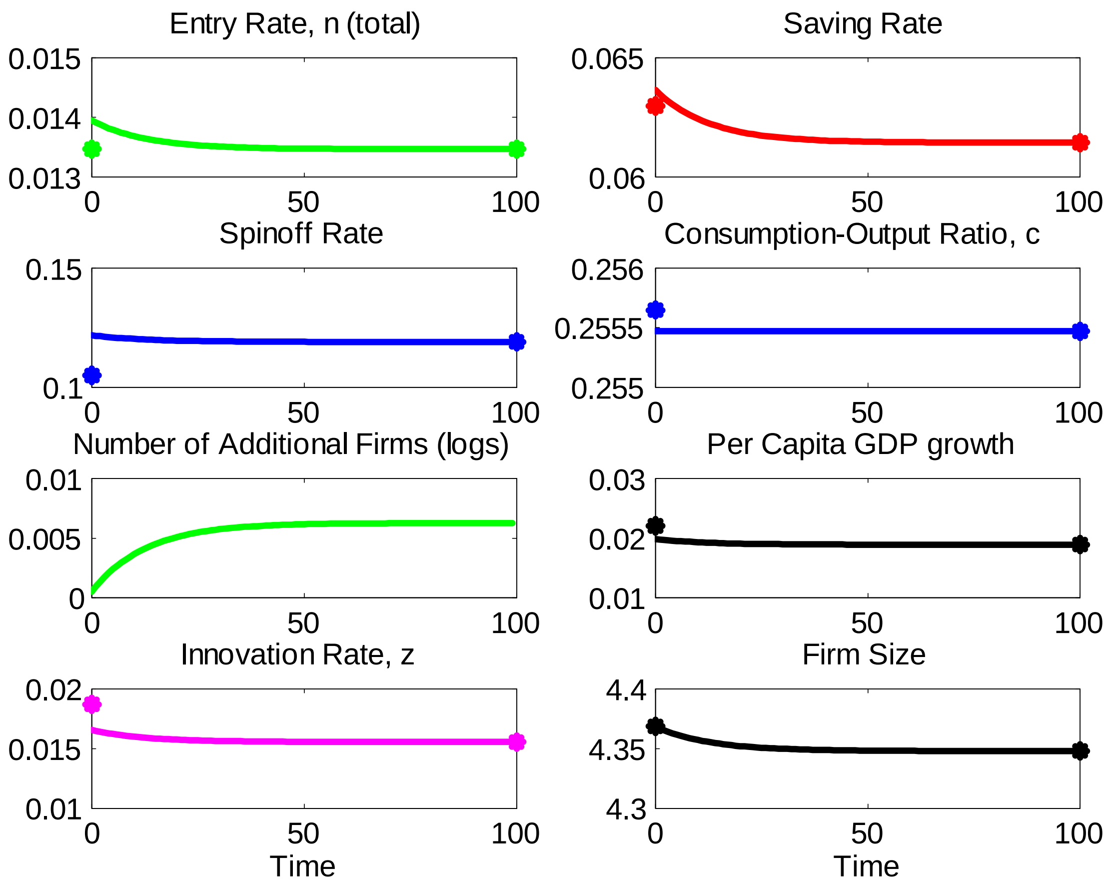
– Note: We use a factor of 2.5 to relate the overall spinoff ratios of Italian provinces plotted in Panel B with conflictual spinoff ratios of the model in Panel A. In Panel E only the parameter δ varies along the frontier. It show that a decline of $n^{spinoff}/n$ of 0.02 around the baseline economy, that is a fifth of of the baseline rate (0.10), is associated with a decline of the z of 0.5%, that is about a quarter of the baseline value (1.87%) (see Table 4).

Figure 4: Rule of Law (Diversion Efficiency) – Comparative Steady State



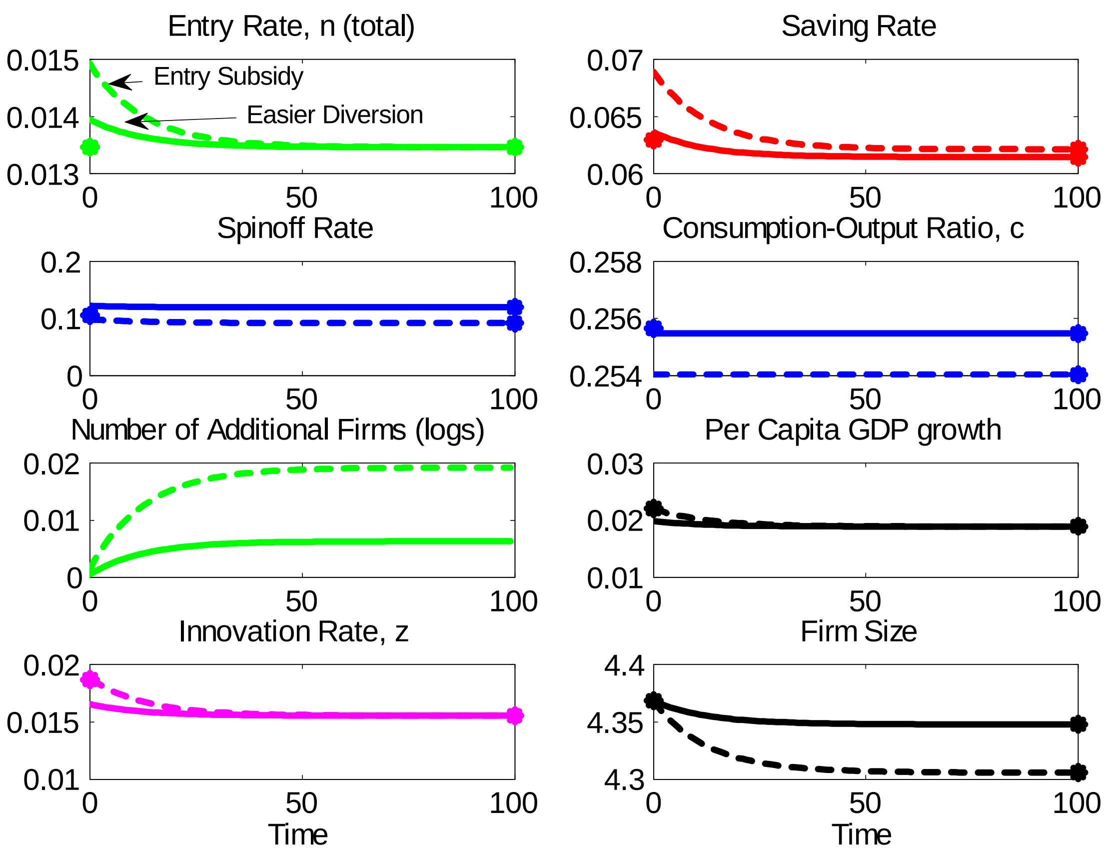
– Note: The welfare values are in differences relative to the economy with the lowest value of b in the range shown in the figure. For remaining parameters see Table 4.

Figure 5: Shock: Higher Diversion Efficieny



– Note: The parameter b goes up by 5%.

Figure 6: Shock: Subsidy vs. Diversion



– Note: The parameter b goes up by 5% in the economy represented by continuous lines. The tax rate τ goes from 0 to 0.2078% in the economy represented by dashed lines.

APPENDIX

This Appendix provides more details on data and data sources (A1) proofs omitted from the main text (A2) and further details on the model extension with entry subsidies in Section 7.4 (A3).

A1. More Details on Data and Data Sources

Our main data sources are: the "Rilevazione sul sistema delle Start-up innovative", a survey of start-ups carried out by the Italian National Institute for Statistics (ISTAT) and the Italian Ministry of Economic Development (MISE) and the "Indagine sulle Imprese Manifatturiere", run by the Italian banking group UniCredit. We complement these main data sources with data of ISTAT on institutional and economic characteristics of the provinces; Bank of Italy data on the structure of Italian provincial banking sectors; and data of the Institute Guglielmo Tagliacarne for the quality of material infrastructures in the provinces.

In March 2016, with a mass mailing to all the innovative startups listed in the Italian Register on Innovative Start-ups on 31 December 2015, ISTAT and MISE launched the "Rilevazione sul sistema delle Start-up innovative", the first national statistical survey of innovative startups. This survey came from the need to investigate certain aspects of innovative enterprise in Italy, which cannot be obtained from the Register data. The survey questionnaire was composed by four sections: 1) Human capital and social mobility, 2) Growth funding, 3) Innovation, and 4) Level of information and satisfaction with policies.

On the survey end date (May 2016), 2,250 innovative startups had completed the questionnaire, over 44% of the total. Most of the companies interviewed were located in the North of Italy: 31.2% in the North West and 26.8% in the North East. The other areas of the country were also well represented: 22% were based in the South and 20% in the Centre. Service companies were 79.6% of the total: 29.7% produced software, 16.4% operated in research, 6.9% in data processing and 5.3% in commerce and tourism. 20.3% operated in industry (including construction), and of these 3.5% produced innovative machinery. Both the territorial distribution and the sector distribution of the respondents reflected the population of innovative startups as a whole. 60.2% of companies recorded a value of production of up to €100,000 in the 2015, 30.1% between 100,000 and 500,000, with 9.6% generating more than €500,000.

Information on the share of firms with R&D investments in the provinces comes from the tenth wave of the UniCredit survey, which covers a three-year period ending in 2006. The UniCredit survey, which targets 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 5,000 firms were interviewed in the survey). 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, product and process innovation, R&D and other innovation variables, company characteristics and demographics, sources of finance, relationships with banks and mechanisms of information acquisition by banks. The surveyed firms have been in business on average 22 years; 60% of them have fewer than 50 employees (less than 4% have more than 500 employees); 71% are based in the North. Only 1% are listed on the Stock Exchange, while 37% have balance sheets certified by external auditors.

A2. Proofs

Proposition 1 (Budget Constraint)

The households' budget constraint (19) is

$$\dot{A} = rA + wL - C + M$$

where M is

$$M = [\omega(1-S) + Se]NI.$$

The definition of assets (26) implies

$$\dot{A} = (\dot{N}^{\text{ex-novo}} + \dot{N}^{\text{spinouts}})V + N\dot{V}$$

and, using (17), this becomes

$$\dot{A} = (\dot{N}^{\text{ex-novo}} + \dot{N}^{\text{spinouts}})V + rA - ND.$$

Furthermore, replacing D through (9) and (10) we get

$$\dot{A} = (\dot{N}^{\text{ex-novo}} + \dot{N}^{\text{spinouts}})V + rA - N[(P-1)X - \phi Z - I - \omega_i(1 - S_i^*(\omega_i))I].$$

Combining this result with (19), using the factor payment results $wL = (1-\theta)Y$ and $NPX = \theta Y$, and the entry condition $V = \beta X$, we obtain

$$(\dot{N}^{\text{ex-novo}} + \dot{N}^{\text{spinouts}})\beta X - \theta Y + N[X + \phi Z + I + \omega_i(1 - S_i^*(\omega_i))I] = (1-\theta)Y - C + [\omega(1-S) + Se]NI.$$

Since the flow of spinoffs correspond to

$$\dot{N}^{\text{spinoffs}} = e\frac{SNI}{\beta X}$$

the above expression simplifies to

$$\dot{N}^{\text{ex-novo}}\beta X + N[X + \phi Z + I] + C = Y,$$

that corresponds to (27).

Proposition 2 (Steady State)

To obtain x^* it suffices to equate the right-hand sides of eqs. (31) ad (32). The expression for z^* can simply be obtained by replacing x with x* in (31). The entry rate n is derived from (22). Finally, we obtain c^* by equating the right hand side of 35 in Proposition (3) to zero:

$$0 = \lambda - [\rho + \frac{1}{\beta\theta^2}(1-\theta-c) + \frac{z}{(1-S)}\frac{1}{\beta x}(\omega + Se)],$$

which, rearranged yields the expression in 33.

Proposition 3 (Dynamic System)

The evolution of c can be derived through the Euler equation (20), the household budget constraint (19) and the free entry condition $\beta X = V$. This last condition implies that $\beta NX = A$, and together with the factor payment $NPX = \theta Y$, that $\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A}$. Therefore (19) can be expressed as

$$\frac{\dot{Y}}{Y} = \frac{1}{\beta\theta^2}(1-\theta-c) + r + \frac{z}{(1-S)}\frac{1}{\beta x}(\omega + eS)$$

Combining this with the Euler equation (20) we obtain

$$\frac{\dot{c}}{c} = \lambda - [\rho + \frac{1}{\beta\theta^2}(1-\theta-c) + \frac{z}{(1-S)}\frac{1}{\beta x}(\omega + eS)],$$

which is the expression in (35). The evolution of the firm size can be derived from equation (22). The entry rate n can be derived from the resource constraint

$$\dot{N}^{\text{ex-novo}}\beta X + NI + NX + \phi NZ + C = Y.$$

Since $\dot{N}^{\text{spinoffs}} = e\frac{SaNI}{\beta X}$, the previous equation can also be written as

$$(\dot{N}^{\text{ex-novo}} + \dot{N}^{\text{spinoffs}})\beta X - SeNI + NI + NX + \phi NZ + C = Y.$$

After a rearrangement, this becomes

$$\dot{N}\beta X + NI - eSNI + NX + \phi NZ + C = Y.$$

Let $z \equiv \frac{\dot{Z}}{Z}$. Using equation (6) the typical firm's technology increases at the rate $z = (1-S) \cdot \frac{I}{Z}$. This property and the definition $x = \frac{X}{Z}$ allow us to express the above equation as

$$n\beta NX + N\frac{zZ}{(1-S)} - (Se)N\frac{zZ}{(1-S)} + NX + \phi NZ + C = Y.$$

Dividing both sides by NX and noticing that the factor payment (5) tells us that $NX = \theta^2 Y$, we obtain

$$n = \frac{1}{\beta\theta^2}(1-c) - \frac{1}{\beta}[1 + \frac{\phi}{x} + \frac{z(1-Se)}{x(1-S)}],$$

that corresponds to (37). Finally, equating (23) and (24) gives

$$\frac{\alpha}{q}\left[\left(\frac{1}{\theta}-1\right)x - \phi\right] = \frac{1}{\beta x}[\left(\frac{1}{\theta}-1\right)x - (\phi + qz)] + \frac{\dot{x}}{x} + z.$$

Replacing $\frac{\dot{x}}{x}$ with the right-hand-side of (36) and making using of (37), after some rearrangements we obtain the expression in (38).

Observe that for entry to be active, we need that the return to entry (24) is to be equal to that on saving (20). For x sufficiently small, $\frac{1}{\beta x}[\left(\frac{1}{\theta}-1\right)x - (\phi + qz)] + \frac{\dot{x}}{x} + z < \rho - \lambda + \dot{C}/C$ and there is no entry. There could be situations in which entry is active, i.e. equating (24) to (20) has a solution, but inhouse innovation is not, namely the return r_Z in (23) is lower than r_N in (24):

$$\frac{\alpha}{q}\left[\left(\frac{1}{\theta}-1\right)x-\phi\right] < \frac{1}{\beta x}[\left(\frac{1}{\theta}-1\right)x-\phi]+\lambda-(1-\sigma)n$$

or replacing n when $z=0$

$$\frac{\alpha}{q}\left[\left(\frac{1}{\theta}-1\right)x-\phi\right] < \frac{1}{\beta x}[\left(\frac{1}{\theta}-1\right)x-(\phi)]+\lambda-(1-\sigma)\frac{1}{\beta\theta^2}[1-\theta^2-c-\frac{\phi}{x}]$$

In such a case $z=0$.

A3. Model Extension

This section explain how the basic model is to be amended to incorporate the role of the government that collects a labor tax on labor τwL and distributes the proceeds among the flow of new firm $\dot{N}$.

First, the household budget constraint (19) becomes

$$\dot{A}=rA+(1-\tau)wL+M-C \tag{41}$$

The main text has explained that a tax rate τ implies that the portion ΣX of the entry cost is subsidized by the government where

$$\Sigma=\frac{\tau(1-\theta)}{n\theta^2}$$

and the the actual cost entry cost for the new firm is $\tilde{\beta}=(\beta-\Sigma)$. The dynamic arbitrage entry condition (24) then is

$$r=r_N\equiv\frac{1}{\tilde{\beta}x}[\left(\frac{1}{\theta}-1\right)x-(\phi+qz)]+\frac{\dot{x}}{x}+z. \tag{42}$$

The expressions for the return on innovation and for saving are the same as in 23 and 20, respectively. Following the same argument we used for the baseline model, one can show that combining 42 with 23, 20, and 41, and the aggregate resource constraint gives the following dynamical system (when both entry and innovation are active)

$$\frac{\dot{c}}{c}=\lambda-[\rho+\frac{1}{\tilde{\beta}\theta^2}((1-\theta)(1-\tau)-c)+\frac{z}{(1-S)}\frac{1}{\tilde{\beta}x}(\omega(1-S)+eS)].$$

$$z=\frac{1}{\psi}\left\{(\frac{\alpha}{q}-\frac{1}{\tilde{\beta}x})\left[\left(\frac{1}{\theta}-1\right)x-\phi\right]-\lambda+(1-\sigma)[\frac{1}{\beta\theta^2}(1-c)-\frac{1}{\beta}(1+\frac{\phi}{x})]\right\}$$

where $\psi=1-\frac{q}{\tilde{\beta}x}+(1-\sigma)\frac{1-Se}{\beta x(1-S)}$. The evolutions of x and n are characterized by the expressions in (36) (37) of Proposition 1, that for convenience we report here:

$$\frac{\dot{x}}{x}=\lambda-(1-\sigma)n,$$

and

$$n = \frac{1}{\beta\theta^2}(1-c) - \frac{1}{\beta}[1 + \frac{\phi}{x} + \frac{z(1-Se)}{x(1-S)}],$$

respectively.

One can verify that in this extended model, the steady state

$$\Sigma^* = \frac{\tau\,(1-\theta)\,(1-\sigma)}{\lambda\theta^2}.$$

and the firm size

$$x^* = \frac{(1-\alpha)\phi - q(\frac{\sigma}{1-\sigma}\lambda + \rho)}{(1-\alpha)\left(\frac{1}{\theta}-1\right) - \left(\frac{\sigma}{1-\sigma}\lambda + \rho\right)(\beta - \Sigma^*)}$$

declines with the intensity of the entry subsidy Σ^*. Consequently, the investment rate is smaller as this depends on the scale of the firm: in an economy with smaller firms, the rate of investment is lower (see the expression for z^* in Proposition 2).

The consumption-output ratio in (33) is slightly modified and becomes

$$c^* = (1-\theta)(1-\tau) + (\rho-\lambda)(\beta-\Sigma^*)\theta^2 + \frac{z^*}{1-S}\frac{\theta^2}{x^*}(\omega + eS).$$

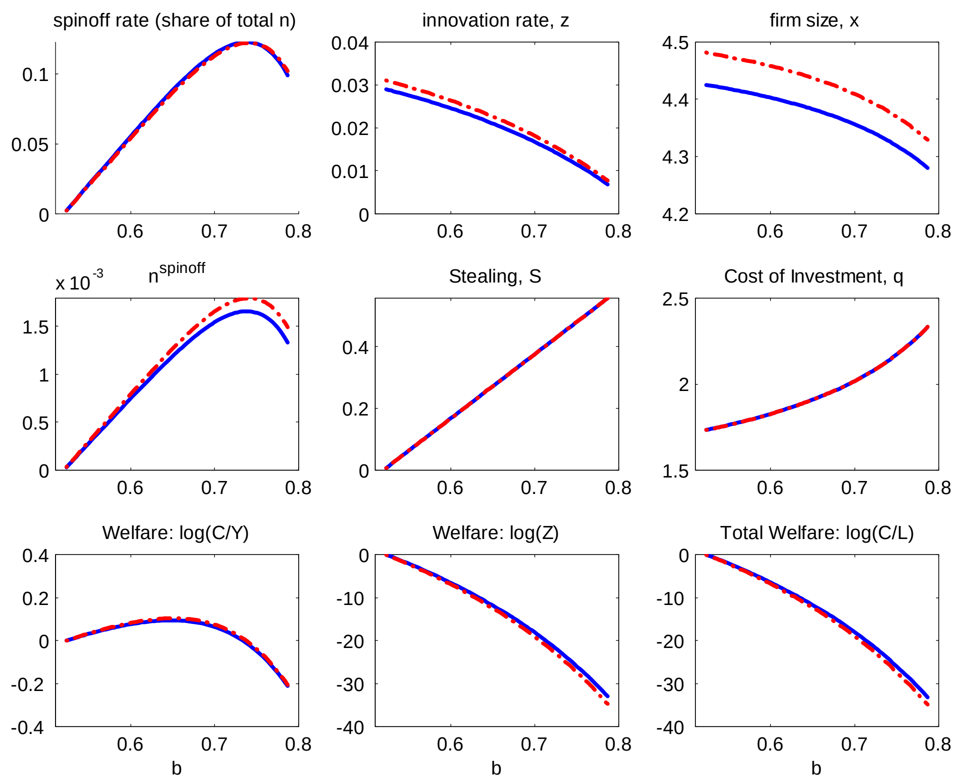
Hence, the steady state expressions for the firm size, innovation rate, entry rate, x^*, z^* and n^*, respectively, displayed in Proposition (2) will hold provided that β is replaced with $\tilde{\beta}^* \equiv \beta - \Sigma^*$. The proportion of new firms generated through spinoffs, which is

$$n^{\text{spinoff}} = \frac{1}{(\beta-\Sigma^*)x^*}\frac{z^*}{(1-S)}Se,$$

tends to increase both as a result of the subsidy Σ^* and of the general equilibrium effect that leads to a reduction in the firm size x^*. Nevertheless, as noted, smaller firms invest less. The resulting drop in z^* may be sufficiently strong to prevail over the positive effects associated with x^* and Σ^*. This is for instance the case in the top-left plot of Figure (8) that shows how n^{spinoff} varies across economies with different values of Σ^*. The strong reaction of z^* to Σ^* implies a negative relationship between c^* and Σ^* because the amount of wealth generated through spinoffs is smaller in economies with more generous entry subsidies (see bottom-left plot of Figure 8). Not surprisingly, one adverse effect on the consumption-output ratio is through the labor tax. A second less obvious adverse effect is accounted for by the second term: it says that because an economy with a lower entry cost is populated by a larger number of firms, more resources are taken away from consumption to set them up. Conversely, the last term captures the positive wealth effect of the spinoffs. Because on average firms are smaller, managers can establish more of them. Nevertheless, the volume of resources available for diversion is also smaller. These observations imply some ambiguity in the effect of the subsidy policy on c^*.

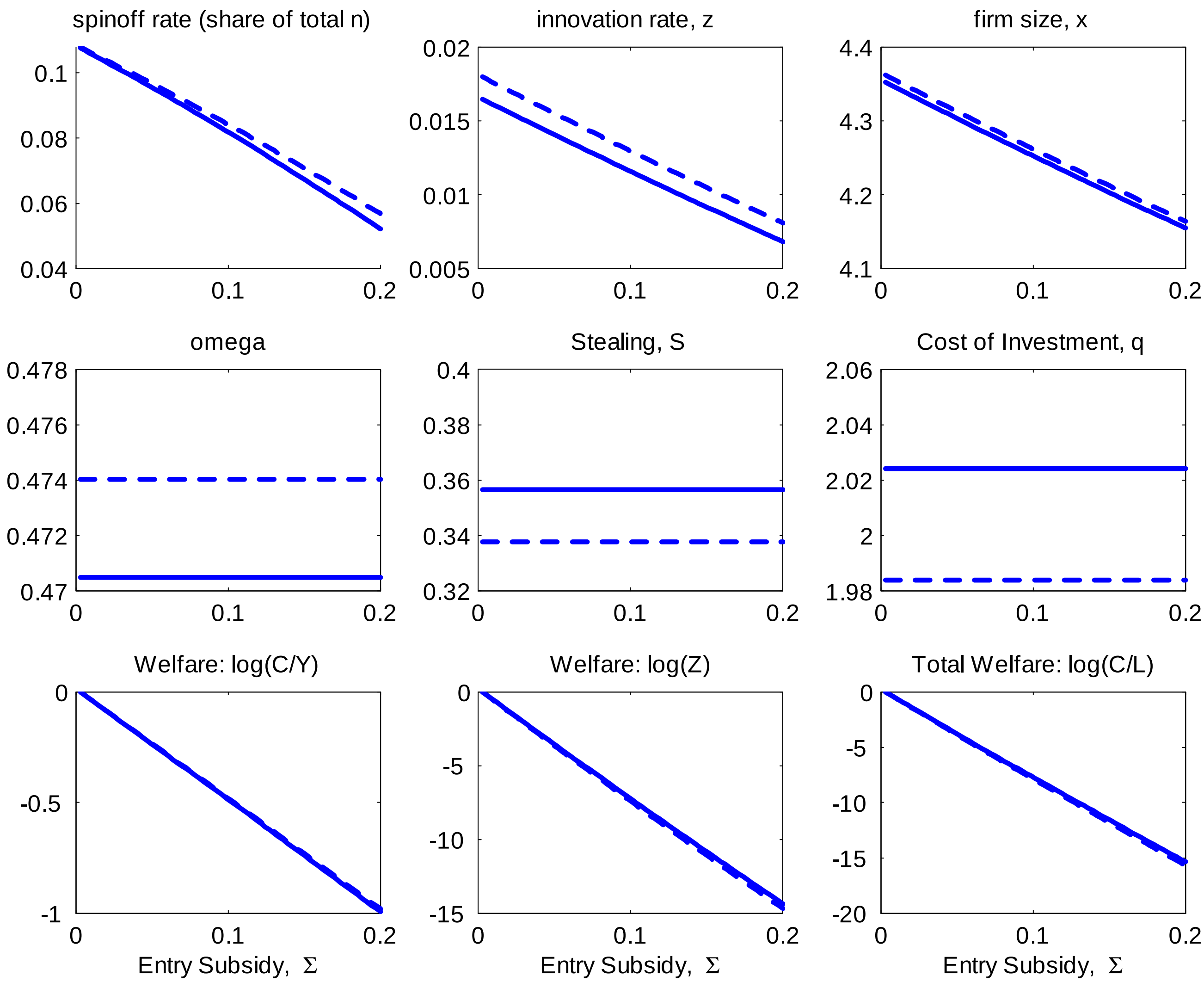
Finally, figure 8 also suggests that the better quality of the judiciary (higher δ) rotates the n^{spinoff} loci upward, implying that spinoffs decline less rapidly as Σ^* increases.

Figure 7: Diversion Efficiency, Interaction with Variety Externalities



– Note: In the economies represented by the dashed-dotted lines the externality parameter, σ, is higher than that of the baseline economy (0.31 and 0.25, respectively, see table 4).

Figure 8: Entry Subsidy and Diversion Efficiency



– Note: In the economies represented by dashed lines the judicial efficiency δ is 5% higher than in the baseline economies (continuous lines).

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