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Abstract

Innovative firms typically have a high growth potential, need external funds to finance investment, and rely on the key effort and know-how of inside entrepreneurs. Given the limited amount of tangible assets and the non-contractible nature of entrepreneurial effort, these firms are often financially constrained. Access to external funds becomes an important factor in the expansion of innovative industries. This paper models a two sector economy of innovative and standard industries and shows how the pattern of comparative advantage is shaped by factor endowments and variables relating to corporate finance. In particular, a larger equity ratio of young entrepreneurial firms and tough corporate governance standards relax the financing constraints and create a comparative advantage in innovative industries.

Keywords

Innovative firms, corporate finance, comparative advantage.

JEL Classification

F11, G34, K22, L26.

1 Introduction

Countries differ substantially in their innovation potential and market dominance in advanced sectors. Comparative advantage in innovative industries is not only a matter of factor endowments but hinges as well on a number of fundamentals relating to corporate finance and legal institutions. Firms in a country vary by their innovation potential and, accordingly, face rather different financing constraints. We argue that young growth companies are more innovative than larger firms with mature technologies, and have more difficulty in attracting external funds to finance entry and expansion investment. The notion that young entrepreneurial firms are particularly innovative is consistent with stylized facts.¹ For instance, the European Association for Bioindustries refers to innovative firms as ones that are less than 15 years old and spend at least 15% of their expenditures on R&D.² Kortum and Lerner (2000) have shown that a Dollar of R&D spending in young venture capital backed firms creates more patents and more radical innovations than the same expenditure in other, typically more mature firms. They calculate that venture capital financed R&D accounts for roughly 14 percent of U.S. industrial innovation in 1998 although it amounts to only about 3 percent of all R&D funds. In general, venture capitalists are specialized in financing young firms in high technology sectors in their early stages of business growth.

Because they are more innovative, young entrepreneurial firms have a large growth potential and require substantial external funds. Using micro data, Aghion, Fally and Scarpetta (2007) show that access to finance matters for the entry of small firms and helps to expand new firms after successful start-up investment. In reviewing the literature, Hall (2002) emphasizes that small and new innovative firms experience high costs of capital. Large and more mature firms, in contrast, prefer internal funds to finance their investments. Aghion, Bond, Klemm and Marinescu (2004) report that larger, faster grow-

¹See Prusa and Schmitz (1992). Gromb and Scharfstein (2003) provide a theory why incentives in small firms are better.

²See www.europabio.org/articles/article275EN.

ing, and more profitable firms are more likely to issue new equity rather than new debt as alternative sources for outside funds. They explain this by observing that young innovative firms typically have little tangible assets so that outside investors tend to insist on control rights over the firm's decisions to protect themselves against entrepreneurial moral hazard. For the same reason, equity or equity like instruments such as convertible debt are commonly used in venture capital financing, as documented in Kaplan and Strömberg (2003). Although we do not distinguish between new debt and equity as alternative sources of outside funds and also do not specifically focus on venture capital financing in our theory, the evidence clearly points to the importance of financing constraints rooted in the special characteristics of innovative entrepreneurial firms: they have more attractive investment opportunities than less innovative firms and are more reliant on external funds; they have a high proportion of intangibles such as knowledge and reputation and have more specialized equipment with little collateral value; and there is a greater degree of asymmetric information between insiders and outsiders.³ We thus argue that financing frictions are an important factor to influence the process of creative destruction which is so important for the expansion of innovative industries.

These findings suggest that corporate finance matters in shaping a country's comparative advantage in innovative industries. Innovative firms have typically large market potential, need external funds on top of own equity to finance investment, and depend on the critical know-how of innovating entrepreneurs. These insiders often pursue non-financial objectives (private benefits) that are in conflict with the return expectations

³Also work in business economics indicates that financial constraints and governance are crucial for firm creation and innovations (see Markman, Balkin, and Schjoedt, 2001). Baldwin and Gellatly (2004) argue that financing - together with management, human resources, and marketing - is among the core set of "business skills" which determine the success of new companies through innovation and their performance relative to others. Findings by Baek, Kang, and Park (2004) and Kamhampati (2006) support the view that the relaxation of financial constraints leads to efficiency gains at the firm level. For a large sample of firms in the United Kingdom, Guariglia (2008) finds that financial constraints are particularly important for small and young firms and interprets this evidence as consistent with the hypothesis that these firms "are more prone to facing asymmetric information problems" (ibid., p. 1805).

of outside investors. The potential for opportunistic managerial behavior often restricts external financing and can result in credit rationing of profitable investment. We argue that incentive problems and financing frictions are particularly severe in innovative sectors so that the quality of corporate governance institutions (such as corporate transparency, commercial law, investor protection etc.) are critical for the expansion of these sectors.

Investment subject to financial constraints is a central theme in corporate finance (see Shleifer and Vishny, 1997; Holmstrom and Tirole, 1997; and Tirole, 2001; 2006). By way of contrast, the nexus between corporate finance, innovation, and firm entry is hardly recognized in international economics. An exception is Manova (2008) who finds empirical support for the view that financial constraints deter international trade. Manova (2006) presents a model of trade with financial constraints but they enter the analysis similar to iceberg costs of trade and, hence, are exogenous unlike in our analysis. In trade theory, the “classical” fundamentals determining a country’s international trade in competitive markets are relative factor endowments and relative productivity across sectors.⁴ However, there is agreement that the traditional fundamental variables in trade are related systematically to net exports but explain only a small fraction of the sectoral trade pattern (see Baldwin, 1971; and Treffer, 1993, 1995, for eminent examples, and Feenstra, 2004, for a survey of related work). Obvious candidates to explain net trade flows beyond factor endowments and technology are market imperfections and institutional characteristics. Recent theoretical (Melitz, 2003; Bernard, Redding, and Schott, 2007; Melitz and Ottaviano, 2008) and empirical research (Das, Tybout, and Roberts, 2007; Eaton, Eslava, Kugler, and Tybout, 2008; Helpman, Melitz, and Rubinstein, 2008) emphasizes the role of fixed costs and the extensive margin of trade via firm entry and exit. However, unlike in the literature on corporate finance, the coverage of these costs essentially depends on endowment (mostly with assets embodied in labor) and is not endogenous to the model.

It is this paper’s task to develop a theoretical model motivating and explaining the

⁴Dixit and Norman (1980) or Helpman and Krugman (1985) illustrate that the fundamental insights from classical and neo-classical trade theory – based on infinitesimally small and perfectly competitive firms – are still valid if firms entertain market power.

role of endogenous financial constraints and corporate governance for international trade. Specifically, we explore how two new fundamental variables relating to corporate finance affect a country's comparative advantage. We argue that own equity as a measure of financial robustness of firms and agency costs reflecting the presence of moral hazard importantly affect the financing of entry and expansion investment of entrepreneurial firms and thereby determine the growth of innovative industries. To link to classical trade theory, we also explore the role of factor endowments in a finance constrained economy. In our two sector model, we think of *innovative* goods to be intensive in entrepreneurial labor inputs. As in Aghion and Tirole (1994), young and innovative companies heavily rely on the managerial and technological inputs of their creators.⁵ These insiders are not replaced without serious interruption of the firm.⁶ To assure incentives and prevent opportunistic behavior, entrepreneurs must keep a substantial share of the profit, giving rise to agency costs. Agency costs limit the debt capacity of these firms and their ability to raise outside funds. Due to agency costs, not all firms in need of external funding are actually served. Moral hazard of entrepreneurial innovators thus introduces a market imperfection in that firms may be denied credit and may not be able to enter the market, despite of their investment generating a positive net present value.

By way of contrast, we think of the *standard* sector as being capital intensive. The sector consists of more mature firms which have exploited their growth opportunities and are not finance constrained. Production uses a standard technology, poses no particular management problem and can be operated without frictions by other managers as well. For the sake of simplicity, we adopt the extreme view that investment is not subject to moral hazard and financing constraints at all. The absence of financing problems

⁵Early empirical work in trade pointed to the role of skilled workers in a sector for a country's net exports in that sector (see Baldwin, 1971). Recent work emphasizes entrepreneurial or managerial talent (see Grossman and Helpman, 2004; Marin and Verdier, 2003, 2008) and the innovative capacity of young firms (see Prusa and Schmitz, 1991; De Vet and Scott, 1992; for early examples).

⁶Quite similarly, Antras (2005) assumed that dismissal of a manager in a fully owned subsidiary leads to an output loss. The control rights associated with ownership reduce this output loss, compared to the loss from misbehavior in an independent outsourcing relationship.

motivates our factor intensity assumption. It seems natural to assume the standard sector to be capital intensive and the innovative sector to be intensive in entrepreneurial labor.

The novel treatment of corporate finance in a model of international trade leads to a modification of the core trade theorems such as the Stolper-Samuelson and the Rybczynski theorem. These theorems as well as comparative advantage in the innovative sector depend on new and unexplored structural parameters of corporate finance: agency costs of investment and the equity ratio of entrepreneurial firms. For instance, an increase in the equity ratio as a measure of financial robustness relaxes the financing constraint on innovative firms and allows firms with positive net present value to continue operations which otherwise would have been denied the required loans and driven out of the market. Similarly, in the spirit of the law and finance literature (La Porta et al. 1997, 1998, 2000) and La Porta et al. (2006), we argue that tough corporate governance standards and legal rights of external investors limit the scope for managerial discretion and moral hazard. In reducing agency costs, they relax firms' external financing constraints. These are novel propositions in trade theory while the standard results on factor endowments continue to hold in slightly modified form.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 analyzes the role of corporate finance for a country's industry structure. Section 4 explores the impact of fundamental corporate finance parameters on comparative advantage and goods trade. The paper concludes with a summary of the key findings.

2 A Model of Trade and Finance

2.1 Basic Assumptions

Consider a world economy with two countries, two goods and two factors. Goods are distinguished by their innovative content. An innovative industry produces new goods with a technology that intensively uses the innovators' key knowhow. The success of the

company depends importantly on the managerial effort of the entrepreneurial innovator. In producing knowledge intensive goods, these firms need to invest substantially to exploit their commercial potential. Typically, the firm’s own equity is not enough to finance investment so that the firm relies on external financing. However, external financing is difficult because of managerial moral hazard. Having firm specific knowledge, the insiders cannot be replaced by external managers without serious disruptions to the firm’s prospects. Their key role in the company’s development creates room for managerial discretion and opportunism, allowing them to pursue other objectives in conflict with external investors’ interest.⁷ The relationship between external investors and firms is fraught by corporate governance problems which limit the extent of external financing. In short, firms in the innovative sector are young entrepreneurial growth companies subject to finance constraints. We define a “growth company” in an innovative industry as a firm (i) with potentially large market opportunities due to the innovative nature of its business model, (ii) in need of external financing due to insufficient own equity, and (iii) with a key irreplaceable role of the innovating entrepreneur. The last trait creates a corporate governance problem and financing frictions when entrepreneurs have objectives (private benefits) different from those of outside financiers.

In contrast, firms in the traditional sector supply a standard good with a mature technology. Therefore, managers can easily be replaced by outsiders. The potential for managerial misbehavior is small, allowing external investors to commit a large amount of capital. We take the distinction to the extreme and assume that moral hazard is absent and external financing is unconstrained in the traditional sector.⁸ Naturally, the traditional sector is capital intensive. In sum, we start from the assumption that innovative industries are driven by young, entrepreneurial, finance constrained companies while tra-

⁷The surveys by Shleifer and Vishny (1997) and Tirole (2001) define corporate governance as “how to get back your money”.

⁸One can also think of the sectoral segmentation resulting from a life-cycle of firms. Firms start out small and finance constrained. As their technology matures, managerial moral hazard is narrowed down and finance constraints become less tight. This story is similar to Antras’ (2005) argument about changing headquarter intensity over a firm’s life-cycle.

ditional industries are capital intensive and populated by financially unconstrained firms.

The economy's total labor endowment is $L_T = L + 1$, where L refers to natural workers who can only work in the traditional sector. In addition, there is a mass one of entrepreneurial innovators⁹ who either start a firm (share E) or work in the traditional sector (share $1 - E$). Occupational choice is limited only to agents with entrepreneurial skills, while L is a sector specific endowment. Employment in the traditional sector is, thus, $L + 1 - E$, while entrepreneurial labor allocated to the innovative sector is E , equal to the number of firms started. A firm is managed by one entrepreneur. The economy's total capital endowment is $A_T = A_L L + A$ and is distributed unevenly in the population. All potential entrepreneurs are endowed with assets A per capita and all natural workers with A_L . This assumption allows for changes in aggregate capital without changing own equity per firm. Alternatively, we can consider the role of capital distribution for a given total asset endowment. Again, total assets will be allocated to the two sectors. The entrepreneurial, innovative sector requires one unit of labor (entrepreneur) and a fixed amount of investment I per firm, or IE in total. Investment returns are uncertain. Investment can succeed or fail and, if it is successful, the return can be higher or lower which creates firm heterogeneity ex post.

Production in the innovative sector requires managerial effort and a fixed investment $I > A$ which exceeds the entrepreneur's own equity A and yields an output $x \in [0, \infty)$ if it is successful, and zero if it fails. Investment and production follow a logic sequence of events: (i) Occupational choice with free entry; (ii) Productivity x of the firm becomes known. The firm continues if the entrepreneur earns a positive surplus and is able to attract external financing. It closes down if x is too low and credit is denied; (iii) Having obtained the required loan $I - A$, the entrepreneur manages the investment. She weighs the monetary gains and potential private benefits and chooses high or low effort. With high effort, the firm succeeds with probability p and fails with probability $1 - p$. Output is zero in case of business failure and all previous investment is lost. Shirking yields private

⁹We use the terms entrepreneurs, innovators, investors synonymously.

benefits to the entrepreneur but results in a low success probability $p_L < p$ and, thus, reduces expected income as well as repayment to the bank; (iv) If investment is successful, the firm sells output x at the going market price v and repays external debt. The entrepreneur collects residual profit and spends all income on consumption. If investment fails, output is zero, banks do not get repaid, and entrepreneurs have zero income.

Firm decisions in the innovative sector only involve discrete choice, starting with an occupational choice in stage (i) where the entrepreneur irrevocably gives up an alternative wage income w . Stage (ii) corresponds to a discrete continuation decision. If the firm is stopped, the entrepreneur is still left with her assets A which she invests in the deposit market at the going market rate of interest r to augment end of period consumption. In stage (iii), the entrepreneur injects all her assets into the firm to reduce the need for external financing, and makes a discrete effort choice. If at this stage the firm fails, the entrepreneur is left with zero income because all her wealth is lost in the process of bankruptcy. All agents are assumed risk neutral and are price takers with respect to w , r , and v in a perfectly competitive market environment.

2.2 Finance Constrained Investment

External Financing: When an entrepreneur starts a company, she injects her wealth as inside equity into the firm. Alternatively, she accepts employment in the traditional sector and invests in the deposit market. The deposit interest factor is $R = 1 + r$, giving the entrepreneur's opportunity cost AR . Since required investment exceeds own equity, a bank must finance the remaining part $D = I - A$, with cost R per unit of lending. Given a loan rate i , the bank collects repayment $(1 + i)D$ only if the firm is successful, and nothing if it fails. The firm's total surplus is split according to

$$\begin{aligned}
 \pi^e &= p(xv - (1 + i)D) - AR, \\
 \pi^b &= p(1 + i)D - DR, \quad D = I - A, \\
 \pi &= pxv - IR.
 \end{aligned}
 \tag{1}$$

In the simple two state model, outside equity and outside debt are equivalent. Keeping this in mind, we phrase the model in terms of external debt. With competitive banks, the break even condition $\pi^b = 0$ in bank lending implies $(1 + i)p = R$. The loan rate exceeds the deposit rate by an intermediation margin which reflects the rate of business failure and consequent credit losses, $i > r$.

In a first best situation without moral hazard, shirking can be perfectly avoided and firms can thus raise any amount of external funds without a financing constraint. Banks lend any amount, subject to break even rates $(1 + i)p = R$. A firm should continue if investment I yields a positive surplus:

$$\text{First Best: } pxv \geq IR \quad \Rightarrow \quad x \geq x_0^{FB} = IR/(pv) = (1 + i)I/v. \quad (\text{FB})$$

Credit Analysis: To go ahead with the venture, an entrepreneur must ask for a credit $D = I - A$. With perfect competition, banks break even and the firm gets the entire surplus. Having obtained credit, the entrepreneur chooses effort. Anticipating high effort, banks offer a competitive loan rate $(1 + i)p = R$ but give credit only if the required repayment is incentive compatible. In exerting full effort, the entrepreneur assures a high success probability p but she forgoes private benefits, $b = 0$. When she is shirking and enjoying private benefits, $b > 0$, the success probability falls to $p_L < p$. Shirking is avoided only if the required repayment to the bank leaves a large enough share $\beta^e = xv - (1 + i)D$ to the entrepreneur to make effort worthwhile. The incentive constraint is

$$IC^e : \quad p\beta^e \geq p_L\beta^e + b \quad \Leftrightarrow \quad \beta^e \geq \beta \equiv b/(p - p_L). \quad (2)$$

To guarantee high effort, the insider must receive at least $\beta^e = xv - (1 + i)D \geq \beta$. Pledgeable income is the maximum incentive compatible repayment $xv - \beta$ that can credibly be promised to the bank. The incentive income limits the repayment and, thereby, bank lending to $(1 + i)D \leq xv - \beta$. The lower the productivity draw x , the lower is output and revenue xv , and the lower is pledgeable income. Even if the firm promises the entire pledgeable income as repayment to the bank, $(1 + i)D = xv - \beta$, it may not be enough to

allow the bank to break even. Hence, there is a lowest productivity draw where pledgeable income just suffices to pay back. Combining with the bank's break-even condition yields the cut-off productivity

$$x_0 = \frac{\beta + (I - A)R/p}{v} > x_0^{FB}. \quad (3)$$

Only projects with high return $x > x_0$ are continued, less profitable ventures are denied credit and are closed down again. If the inequality would not hold, the firm would not be finance constrained, and the continuation decision would be first best. The problem would be uninteresting. Hence, we assume

$$p\beta > AR > 0, \quad (A)$$

which says that the minimum incentive compatible compensation of the entrepreneur, in expected value, exceeds the opportunity cost of her own equity. For all productivity draws $x > x_0$, the firm is given credit and allowed to continue. Due to (A), the threshold productivity x_0 yields a strictly positive surplus

$$\pi_0 = pvx_0 - IR = p\beta - AR > 0. \quad (4)$$

For slightly smaller x_0 , the innovator would still make a profit but is denied credit. Hence, the weakest firms with lowest productivity are credit constrained. Only firms with higher productivity receive credit since they have enough pledgeable income. With bank profits remaining zero, the managerial incentive constraint becomes slack.

Free Entry/Start-up Investment: At the first stage, productivity is not yet known. Firms face a distribution $G(x) = \int_0^x g(x') dx'$ with density $g(x)$. From all productivity draws, a fraction $G(x_0)$ will be stopped, either by the bank or because the entrepreneur is unwilling to continue. From now on, we use the short-hand $G_0 \equiv G(x_0)$ and $g_0 \equiv g(x_0)$. For all $x > x_0$, profits are strictly positive, $\pi(x) = vpx - IR$, and trivially increasing in x . Expected profit, conditional on getting financed with $x > x_0$, is defined as

$$\bar{\pi} = \int_{x_0}^{\infty} \pi(x) \frac{dG(x)}{1 - G_0} = vp\bar{x} - IR, \quad \bar{x} = \int_{x_0}^{\infty} x \frac{dG(x)}{1 - G_0}. \quad (5)$$

With probability G_0 , entry results in so low a productivity that the firm is denied credit and is shut down. The entrepreneur has already forgone a wage income but is still able to earn AR by investing her assets in the deposit market rather than injecting them into the firm. With probability $1 - G_0$, productivity is high enough to warrant continuation. The firm invests own equity and gets a loan.

Entry must be decided one stage earlier before the actual productivity of the firm is known. The expected net present value must be large enough to justify entry, i.e. to give up alternative wage earnings w ,

$$\bar{\pi}_e = (1 - G_0) \cdot \bar{\pi} \geq w. \quad (6)$$

Since $\pi(x) = pvx - IR$ is the surplus over the endowment value AR , expected end of period wealth from setting up the firm is $y = \bar{\pi}_e + AR$. Employment in the standard sector yields $y = w + AR$. Investors start a new venture in the innovative sector as long as $\bar{\pi}_e \geq w$. Free entry eliminates rents, making the inequality binding.

2.3 Standard Sector

Firms in the standard sector use a linear homogeneous technology combining capital and labor. To compare with innovative firms, suppose a firm is defined by one unit of capital so that aggregate investment K reflects an extensive margin only and is equal to the number of firms. Suppose cash-flow is ϕ per unit of capital. Assuming the same investment risk, the expected profit of a firm is $\pi_N = p\phi - R$. It may be split among owners and banks in the same way as in (1). Taking the extreme case that there are no agency costs and finance constraints in the standard sector, the Modigliani Miller theorem renders the distinction between internal and external funds irrelevant. Investment is, thus, at the first best level. Free entry implies $p\phi = R$. Define the cash-flow per unit of capital by $\phi \equiv p^{-\alpha} f_0 1^\alpha \tilde{l}^{1-\alpha} - w\tilde{l}$ which is available only if the initial investment was successful. Multiplying the zero profit condition by K and defining aggregate employment by $L = \tilde{l}pK$ thus yields $f_0 K^\alpha L^{1-\alpha} = wL + RK$.

Given linear homogeneity and absence of agency costs, production is analyzed in the standard way. Denote capital and labor per unit of output by k and l . Cost minimization $u(w, R) = \min wl + Rk$ s.t. $f_0 k^\alpha l^{1-\alpha} \geq 1$ yields $k = f_0 \left(\frac{\alpha w}{1-\alpha R}\right)^{1-\alpha}$ and $l = f_0 \left(\frac{\alpha w}{1-\alpha R}\right)^{-\alpha}$. Normalizing $f_0 = \alpha^\alpha (1-\alpha)^{1-\alpha}$ implies $u = R^\alpha w^{1-\alpha} = 1$. With zero profit, unit cost must be equal to one when the standard is the *numeraire*. Hence, the factor price frontier is $w = R^{-\alpha/(1-\alpha)}$. Since $du/dw = l$ and $du/dR = k$, the slope $w'(R) = -k/l$ is equal to the capital labor ratio. Substituting w into unit demands yields $k = \alpha/R$ and $l = (1-\alpha)/w(R)$. Introducing a sectoral index N , we summarize:

$$k_N = \alpha_N/R, \quad l_N = (1-\alpha_N)/w(R), \quad w(R) = R^{-\alpha_N/(1-\alpha_N)}, \quad w'(R) = -k_N/l_N. \quad (7)$$

2.4 Demand

Agents consume two goods and supply effort. We assume preferences to be linear homogeneous in commodity consumption and separable with respect to effort cost. Linear homogeneity of $u(\cdot)$ implies risk-neutrality with respect to income. Linear separability simplifies the effort problem. Effort (foregone private benefits b_j) and income y_j are conditional on the type and sectoral activity of the agent. The consumer problem is

$$U = \max_{c_{jN}, c_{jE}, b_j} u(c_{jN}, c_{jE}) + b_j \quad \text{s.t.} \quad c_{jN} + v c_{jE} \leq y_j, \quad (8)$$

where the lower index N, E denotes demand for standard and innovative goods by agent j . The standard good (consumption c_{jN}) is the *numeraire*, hence v is the relative price of good c_{jE} . Without loss of generality, we specify preferences to be Cobb Douglas,

$$u(c_{jN}, c_{jE}) = u_0 \cdot (c_{jN})^{1-\gamma} (c_{jE})^\gamma, \quad (9)$$

implying constant expenditure shares, $v c_{jE} = \gamma y_j$ and $c_{jN} = (1-\gamma) y_j$.

2.5 Equilibrium

The economy's labor endowment consists of a mass one of entrepreneurial agents and L workers. Of all potential entrepreneurs, a part $1-E$ opts for employment in the traditional

industry. The other part E starts a firm in the innovative sector. A fraction G_0 is closed again since productivity is too low. When an entrepreneur continues, the firm invests capital I and, together with managerial effort, produces expected output X_E . The total value of production is

$$Y = X_N + v \cdot X_E, \quad X_E \equiv p\bar{x} \cdot (1 - G_0) E. \quad (10)$$

Banks intermediate between savers and investors. All investment is financed out of the initial capital endowment $A_T = A_L L + A$. Asset endowment per worker A_L and per entrepreneur A differ which allows for different scenarios on equity capital per firm and the aggregate endowment. An agent who prefers employment over entrepreneurship, invests her full asset wealth in the deposit market, giving a supply $(1 - E) A$. The other part E starts a firm in the innovative sector. A fraction G_0 is closed again since productivity is too low, leaving wealth A to be invested in the deposit market. The others continue and invest equity A in their own firm, together with externally borrowed funds, to finance investment. Equilibrium requires that demand and supply of loanable funds clear, $A_L L + A(1 - E) + AG_0 E = (I - A)(1 - G_0) E + k_N X_N$, which gives $A_T = (1 - G_0) IE + k_N X_N$. Dividing capital demand by total output in the entrepreneurial sector in (10) yields unit capital demand k_E . Labor market clearing is $L_T = L + 1 = E + l_N X_N$. Similarly defining unit labor demand l_E gives the factor market conditions,

$$\begin{aligned} A_T &= k_E \cdot X_E + k_N \cdot X_N, \quad k_E \equiv I / (p\bar{x}), \\ L_T &= l_E \cdot X_E + l_N \cdot X_N, \quad l_E \equiv 1 / [(1 - G_0) p\bar{x}]. \end{aligned} \quad (11)$$

The L workers earn a wage w and interest on asset wealth, giving $w + A_L R$ per capita. Part E of the entrepreneurial agents start a firm and expect end of period wealth $\bar{\pi}_e + AR$ per capita where $\bar{\pi}_e$ is the expected surplus over asset wealth. The other part $1 - E$ prefers working and gets $w + AR$. Occupational choice with free entry implies $w = \bar{\pi}_e$ and yields aggregate income $Y = (w + A_L R) L + (w + AR)(1 - E) + (\bar{\pi}_e + AR) E$, or

$$Y = w \cdot L_T + R \cdot A_T. \quad (12)$$

Aggregate income equals the value of output in (10). To see this, note $wl_E + Rk_E = v$ by replacing unit demands with the definitions in (11), inserting $\bar{\pi}_e = w$ and using (5-6). Also note $wl_N + Rk_N = 1$. Replacing factor endowments in (12) by (11) and using the unit cost equations proves (10). National income is equal to the value of traditional and innovative sector output.

Turning to the trade balance, observe that commodity demand follows from (8-9) and depends individual income. A worker with wealth A_j earns $w + A_j R$. An innovator closing down early and investing in the deposit market earns AR while failing after investing in one's own firm leaves zero. Successful entrepreneurs get $\pi(x) + AR$, depending on realized productivity. Since demand is linear, agent heterogeneity doesn't matter. Demand depends only on aggregate income in (12) and is $C_N = (1 - \gamma)Y$ and $C_E = \gamma Y/v$. The income expenditure identity $C_N + vC_E = Y = X_N + vX_E$ yields the trade balance

$$(C_N - X_N) + v \cdot (C_E - X_E) = 0. \quad (13)$$

In the absence of international capital flows, a trade surplus in innovative goods must be offset by a deficit in traditional commodities.

We consider first the small open economy with a fixed prices v . The solution of the model proceeds with the following steps: (i) Get the factor price changes by deriving a modified version of the Stolper Samuelson theorem. (ii) Get the supply changes from factor endowments (Rybczynski theorem) and from factor price changes. (iii) Compute aggregate income from factor endowments and factor prices, and derive aggregate demand. (iv) Get the impact on excess demand and the trade pattern.

3 Industrial Structure

To establish how corporate governance shapes comparative advantage in innovative industries, we first turn to a small open economy taking world goods prices as given. We first study how an increase in the world price v of innovative goods affects factor prices. We

thus reestablish the Stolper Samuelson theorem in an economy with finance constrained firms. Second, we consider an increase in the economy's total capital endowment A_T , keeping constant the inside equity A of firms. In this scenario, the endowment comes from more assets of workers which does not directly affect the borrowing needs of entrepreneurial firms. We then establish a modified version of the Rybczynski theorem in the presence of credit rationing. Then we turn to aspects of corporate finance. The third scenario considers an increase in inside equity A which determines the financial strength and robustness of innovative firms, keeping constant aggregate capital endowment A_T . Hence, the scenario considers an increase in A which is compensated by a reduction in A_L . This experiment can also be interpreted as moving to a more uneven distribution of the capital endowment among workers and potential entrepreneurs. We find that not only the level but also the distribution of capital endowment is important! Finally, we turn to the role of legal institutions. The empirical law and finance literature has emphasized the importance of tight investor protection, commercial law for increased corporate transparency to outside investors etc. These regulations determine the quality of corporate governance which limits managerial autonomy and discretion, make managers more accountable to outside stakeholders, and thereby reduce agency costs and facilitate external financing. We interpret better governance as a reduction in the private benefits β of shirking.

3.1 Unit Demands

Unit factor demands importantly depend on cost shares which reflect the factor intensity assumptions. We have argued in the introductory section that the finance constrained innovative sector is intensive in (entrepreneurial) labor and the traditional sector is capital intensive. In the traditional sector, unit cost is $wl_N + Rk_N = 1$, with cost shares $\alpha_N = Rk_N$ and $1 - \alpha_N = wl_N$. With free entry, unit cost in the innovative sector must be equal to the output price, $wl_E + Rk_E = v$, see (12). The average share of capital cost is $\alpha_E = Rk_E/v = IR/(vp\bar{x})$ where the second equality uses the definition of unit demand in (11). The share of 'entrepreneurial labor cost' is $1 - \alpha_E = wl_E/v = \bar{\pi}/(vp\bar{x})$. The second

equality again substitutes (11) and notes the occupational choice condition $w = (1 - G_0) \bar{\pi}$ which states that profit income must ultimately be large enough to compensate for the outside option in the traditional sector. To check consistency, add up the cost shares and get $vp\bar{x} = IR + \bar{\pi}$ as in (5). Hence, the average value of output per firm in the innovative industry consists of the cost of capital plus the average expected profit required to compensate the entrepreneurial labor input.

To analyze comparative statics, we take log-differentials. The hat notation indicates relative changes such as $\hat{x}_0 \equiv dx_0/x_0$. Exceptions are explicitly mentioned. The continuation decision in (3) determines the threshold value x_0 , giving $vp x_0 (\hat{x}_0 + \hat{v}) = DR\hat{R} - AR\hat{A} + \beta p\hat{\beta}$ in differential form. Divide by the value of output, use the cost share α_E defined above, and denote the debt asset ratio of the firm by $\delta \equiv D/I$ and, correspondingly, the equity ratio by $1 - \delta = A/I$,

$$\frac{x_0}{\bar{x}} \cdot \hat{x}_0 = \delta \alpha_E \cdot \hat{R} - (1 - \delta) \alpha_E \cdot \hat{A} - \frac{x_0}{\bar{x}} \cdot \hat{v} + \frac{\beta}{v\bar{x}} \cdot \hat{\beta}. \quad (14)$$

A higher deposit rate R makes credit rationing more severe and drives the weakest firms out of business, i.e. a higher threshold productivity is required to obtain credit. A higher price boosts revenues and pledgeable income which relaxes the credit constraint and allows weaker firms to continue. Higher own equity A as a measure of financial strength reduces the need for external funding and allows for a lower threshold. Note that $\beta/(v\bar{x})$ expresses the agency cost as a share of the output value of the average firm.

A higher threshold productivity raises average productivity of innovative firms by

$$\hat{\bar{x}} = \frac{\bar{x} - x_0}{\bar{x}} \frac{x_0 g_0}{1 - G_0} \cdot \hat{x}_0. \quad (15)$$

Unit factor demands in the entrepreneurial sector are defined in (11) and exclusively depend on the threshold value x_0 ,

$$\hat{k}_E = -\frac{\bar{x} - x_0}{\bar{x}} \frac{x_0 g_0}{1 - G_0} \cdot \hat{x}_0, \quad \hat{l}_E = \frac{x_0}{\bar{x}} \frac{x_0 g_0}{1 - G_0} \cdot \hat{x}_0. \quad (16)$$

Factor prices affect unit demands only via their impact on the threshold value,

$$\hat{l}_E = \frac{x_0 g_0}{1 - G_0} \left[\delta \alpha_E \hat{R} - (1 - \delta) \alpha_E \hat{A} - \frac{x_0}{\bar{x}} \hat{v} + \frac{\beta}{v\bar{x}} \hat{\beta} \right], \quad \hat{k}_E = -\frac{\bar{x} - x_0}{x_0} \cdot \hat{l}_E. \quad (17)$$

In the traditional sector, unit demands adjust according to (7),

$$\hat{k}_N = -\hat{R}, \quad \hat{l}_N = -\hat{w} = \frac{\alpha_N}{1 - \alpha_N} \cdot \hat{R}. \quad (18)$$

3.2 Factor Prices

With free entry, unit cost in both sectors is equal to the output price, $Rk_E + wl_E = v$ and $Rk_N + wl_N = 1$. Log-differentiating these conditions yields

$$\begin{aligned} \hat{v} &= \alpha_E (\hat{R} + \hat{k}_E) + (1 - \alpha_E) (\hat{w} + \hat{l}_E), \\ 0 &= \alpha_N (\hat{R} + \hat{k}_N) + (1 - \alpha_N) (\hat{w} + \hat{l}_N). \end{aligned}$$

Use (18) and get $\alpha_N \hat{k}_N + (1 - \alpha_N) \hat{l}_N = 0$. The same does not hold for the entrepreneurial sector because factor use is distorted on account of the finance constraint. Use (16) and the definitions α_E and π_0 to get [note $x_0 - \alpha_E \bar{x} = \pi_0 / (vp)$]

$$\alpha_E \hat{k}_E + (1 - \alpha_E) \hat{l}_E = \frac{x_0 - \alpha_E \bar{x}}{\bar{x}} \frac{x_0 g_0}{1 - G_0} \hat{x}_0 = \mu \frac{x_0}{\bar{x}} \hat{x}_0, \quad \mu \equiv \frac{\pi_0}{vp} \frac{g_0}{1 - G_0}. \quad (19)$$

This term would be zero in a first best world with $\pi_0^{FB} = 0$, see (FB). In a credit constrained economy, the marginal firm makes a positive profit $\pi_0 > 0$, indicating that entry is too small. The parameter μ may, thus, be seen as a measure of the capital market distortion due to moral hazard which is small if either π_0 (deviation from the first best) or the density of firms near the threshold level is small. Since x_0 rises with R , this term acts to magnify the effect of a higher capital cost R on the output price. Using (19) together with (14) yields

$$\begin{bmatrix} \alpha_N & 1 - \alpha_N \\ (1 + \mu\delta)\alpha_E & 1 - \alpha_E \end{bmatrix} \begin{bmatrix} \hat{R} \\ \hat{w} \end{bmatrix} = \begin{bmatrix} 0 \\ (1 + \mu\frac{x_0}{\bar{x}})\hat{v} - \frac{\beta}{v\bar{x}}\mu\hat{\beta} + (1 - \delta)\alpha_E\mu\hat{A} \end{bmatrix}.$$

Given that the traditional sector is capital intensive and the innovative sector intensive in (entrepreneurial) labor, the determinant must be positive, $\lambda_\alpha = \alpha_N - \alpha_E - (1 - \alpha_N)\mu\delta\alpha_E > 0$. In the first best case with $\mu = 0$, the standard condition would be $\alpha_N > \alpha_E$. With finance constraints, the condition becomes more stringent: $\lambda_\alpha > 0$

requires $(\alpha_N - \alpha_E) / [(1 - \alpha_N) \alpha_E] > \mu\delta \geq 0$. The larger the financing frictions, the more capital intensive the traditional sector must be to guarantee $\lambda_\alpha > 0$. We thus assume the deviation from the first best to be not too large. Inverting the system yields the solution

$$\hat{R} = -\varepsilon_{Rv} \cdot \hat{v} + \varepsilon_{R\beta} \cdot \hat{\beta} - \varepsilon_{RA} \cdot \hat{A}, \quad \hat{w} = -\frac{\alpha_N}{1 - \alpha_N} \cdot \hat{R}, \quad (20)$$

where elasticities are [as a convention, all parameters are defined positive]

$$\varepsilon_{Rv} \equiv \frac{1 - \alpha_N}{\lambda_\alpha} \left(1 + \mu \frac{x_0}{\bar{x}}\right), \quad \varepsilon_{R\beta} \equiv \frac{1 - \alpha_N}{\lambda_\alpha} \frac{\beta}{v\bar{x}} \mu, \quad \varepsilon_{RA} \equiv \frac{1 - \alpha_N}{\lambda_\alpha} (1 - \delta) \alpha_E \mu.$$

Proposition 1 (*Stolper Samuelson*) (a) *If the innovative sector is intensive in (managerial) labor ($\lambda_\alpha > 0$), a higher price reduces interest and raises wages: $\hat{R} < 0 < \hat{w}$.*
(b) *More financial strength (own equity $\hat{A} > 0$) and better governance (agency costs $\hat{\beta} < 0$) of firms in the innovative sector affect factor prices qualitatively in the same way.*

The magnification effect noted in Jones (1965), $\hat{w} > \hat{v} > 0 > \hat{R}$, holds if $\hat{w}/\hat{v} = \frac{\alpha_N}{\lambda_\alpha} (1 + \mu \frac{x_0}{\bar{x}}) > 1$. Substituting λ_α and rearranging, this condition is equivalent to $\mu \frac{x_0}{\bar{x}} \alpha_N > 0 > -[1 + (1 - \alpha_N) \mu\delta] \alpha_E$ and is naturally fulfilled.

The statement on financial strength stems from the scenario that the total capital endowment is kept constant, i.e. the asset endowment of workers is simultaneously reduced when potential entrepreneurs are endowed with more assets, $\hat{A} > 0 > \hat{A}_L$. Hence, in essence, the statement about the financial strength of firms is a statement about the *distribution of financial wealth* in the economy. The importance of this distributional result is new in trade theory. Assuming that it is the more wealthy people who start a firm, $A > A_L$, we could say that a more unequal distribution of the asset endowment boosts interest and reduces wages, thus reinforcing inequality.

How exactly does financial robustness change factor prices? When new firms in the innovative industry come with more equity, they need less external funds to finance the required capital investment. Therefore, some marginal firms which were previously denied credit, are now able to obtain a loan if their balance sheet improves. Having more own

equity, they require a smaller loan so that pledgeable income is enough to repay the credit. Along with a lower productivity of the marginal firm, average productivity \bar{x} declines as well. Capital demand per unit of output, $k_E = I/(p\bar{x})$, rises. The marginal firm uses the same investment but produces much less output than other firms so that unit capital demand rises when more firms at the low productivity margin are financed. When a firm has more equity and credit rationing is relaxed, an entrepreneur is allowed to continue more often and, thus, produces more output per unit of labor. Equivalently, labor demand per unit of output falls. With unit capital demand rising and unit labor demand falling, unit cost equal to the output price v in zero profit equilibrium, can only remain constant when interest falls and the wage rate rises.

When agency costs β increase due to weaker corporate governance standards and more severe moral hazard, it becomes more costly to compensate entrepreneurs for their managerial effort. Pledgeable income shrinks and debt capacity of firms declines. Banks can no longer expect credible repayment from some marginal firms and will deny credit. Therefore, start-ups are terminated more often, the productivity x_0 of the marginal firm increases which, in turn, yields higher average productivity. Therefore, capital demand per unit of industry output falls and unit labor demand rises. Given a constant output price, unit cost is fixed in zero profit equilibrium, requiring a rise in interest and a decline in the wage rate, see (20).

Figure 1 depicts the solution in the factor price space and illustrates the modified Stolper Samuelson theorem. The two curves are the sectoral zero profit conditions. The comparative statics is determined by the system following (19). For a given output price, entrepreneurial firms make a larger profit when they are financially stronger and need less outside funding ($\hat{A} > 0$). To lure away more entrepreneurial agents from employment in the traditional sector, innovative sector firms compete up the wage rate until profits are zero. The unit cost curve shifts to the right. When labor gets more scarce and expensive, the traditional sector must shrink. Being capital intensive, it releases relatively more capital than labor. Given a higher wage rate, interest must fall until traditional sector

firms can break even. A lower interest, however, boosts profits of innovative firms, allowing them to compensate entrepreneurs for an even higher wage. The process continues until, in the new intersection in Figure 1, firms in both sectors are on their cost curves and simultaneously break even at a lower interest and higher wage. Lower agency costs or a higher price for innovative goods induces the same adjustment.

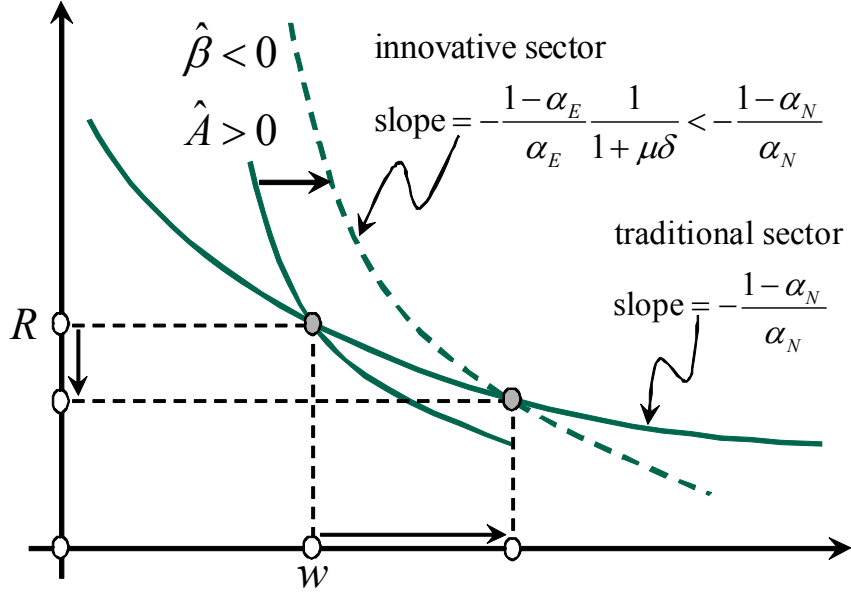


Fig. 1: Financial Robustness, Agency Costs and the Stolper Samuelson Theorem

3.3 Sectoral Outputs

The Rybczynski theorem of classical trade theory explains a country's sectoral structure in terms of factor endowments, $A_T = A_L L + A$ and $L_T = L + 1$ in the present case. With an increase in total asset endowment we mean an endowment of workers only, keeping the equity ratio of firms in the innovative industry constant. Log-differentiating the factor market conditions in (11) yields

$$\begin{aligned} \hat{A}_T - \hat{k} &= s_A \hat{X}_E + (1 - s_A) \hat{X}_N, & \hat{k} &= s_A \hat{k}_E + (1 - s_A) \hat{k}_N, & s_A &= k_E X_E / A_T, \\ \hat{L}_T - \hat{l} &= s_L \hat{X}_E + (1 - s_L) \hat{X}_N, & \hat{l} &= s_L \hat{l}_E + (1 - s_L) \hat{l}_N, & s_L &= l_E X_E / L_T. \end{aligned} \quad (21)$$

In a first step, we hold product prices as well as own equity A and agency costs β of innovative firms constant which implies that factor prices remain constant as well. Hence,

unit factor demands remain in variant, $\hat{k}_j = \hat{l}_j = 0$. The determinant of the system, $s_A - s_L$, is negative and $\lambda_s = s_L - s_A > 0$, if the innovative sector is labor intensive and, thus, absorbs a larger share of the labor endowment. Inverting the system yields

$$\begin{aligned}\hat{X}_E &= \frac{1}{\lambda_s} \left[(1 - s_A) (\hat{L}_T - \hat{l}) - (1 - s_L) (\hat{A}_T - \hat{k}) \right], \\ \hat{X}_N &= \frac{1}{\lambda_s} \left[s_L (\hat{A}_T - \hat{k}) - s_A (\hat{L}_T - \hat{l}) \right].\end{aligned}\quad (22)$$

The magnification effect results in $\hat{X}_E = \frac{1-s_A}{s_L-s_A} \hat{L}_T > \hat{L}_T$ and $\hat{X}_N = \frac{s_L}{s_L-s_A} \hat{A}_T > \hat{A}_T$.

Proposition 2 (Rybczynski) *If the innovative sector is labor intensive, an increased labor endowment expands the innovative sector (using entrepreneurial labor intensively) and contracts the capital intensive standard sector.*

Next, we turn to the impact of changes in output prices and the structural parameters (financial strength and governance of firms) that characterize the innovative sector. Unit factor demand in the innovative sector depends on \hat{x}_0 only, see (16). We thus need to evaluate the change in the threshold productivity in (14). Substituting the change in the interest rate given in (20) yields

$$\frac{x_0}{\bar{x}} \hat{x}_0 = - \left(\varepsilon_{Rv} \delta \alpha_E + \frac{x_0}{\bar{x}} \right) \cdot \hat{v} + \left(\varepsilon_{R\beta} \delta \alpha_E + \frac{\beta}{v \bar{x}} \right) \cdot \hat{\beta} - (\varepsilon_{RA} \delta + 1 - \delta) \alpha_E \cdot \hat{A}. \quad (23)$$

The effect of a higher price is to allow some marginal firms to continue which would otherwise have been finance constrained. Increased financial strength has the same effect. Observe that a lower threshold value also erodes the average productivity \bar{x} in the innovative sector. The marginal and financially weakest firms are the least productive. When more of them continue, because a higher price or more own equity boosts their debt capacity and relaxes the financing constraint, average productivity declines.¹⁰ However, one must be reminded that even marginal firms generate a positive net present value to society when entry is finance constrained. The decline in average productivity is, thus, not

¹⁰This is consistent with the empirical finding of Lerner (2002) that venture capital backed investments are less productive and generate less value added in boom periods when the industry expands.

to be seen as damaging. Quite to the contrary, since entry is finance constrained, more entry is an improvement. Finally, higher agency costs tighten the financing constraint and lead to a higher threshold productivity needed for continuation.

Unit factor demands in the innovative sector depend on the change in factor prices via their impact on the threshold productivity while unit demands in the traditional sector depend on factor prices as in standard cost minimization. Armed with these results, we evaluate the change in unit factor demands in (21) by first substituting (17-18), collecting terms and finally replacing \hat{R} with (20). After some computations,

$$\hat{k} = \varepsilon_{kv} \cdot \hat{v} + \varepsilon_{kA} \cdot \hat{A} - \varepsilon_{k\beta} \cdot \hat{\beta}, \quad \hat{l} = -\varepsilon_{lv} \cdot \hat{v} - \varepsilon_{lA} \cdot \hat{A} + \varepsilon_{l\beta} \cdot \hat{\beta}, \quad (24)$$

where the elasticity parameters are again defined with positive values,

$$\begin{aligned} \varepsilon_{kv} &\equiv s_A \frac{(\bar{x} - x_0) g_0}{1 - G_0} [\delta \alpha_E \varepsilon_{Rv} + x_0/\bar{x}] + (1 - s_A) \varepsilon_{Rv}, \\ \varepsilon_{lv} &\equiv s_L \frac{x_0 g_0}{1 - G_0} [\delta \alpha_E \varepsilon_{Rv} + x_0/\bar{x}] + (1 - s_L) \varepsilon_{Rv} \frac{\alpha_N}{1 - \alpha_N}, \\ \varepsilon_{k\beta} &\equiv s_A \frac{(\bar{x} - x_0) g_0}{1 - G_0} [\delta \alpha_E \varepsilon_{R\beta} + \beta/(v\bar{x})] + (1 - s_A) \varepsilon_{R\beta}, \\ \varepsilon_{l\beta} &\equiv s_L \frac{x_0 g_0}{1 - G_0} [\delta \alpha_E \varepsilon_{R\beta} + \beta/(v\bar{x})] + (1 - s_L) \varepsilon_{R\beta} \frac{\alpha_N}{1 - \alpha_N}, \\ \varepsilon_{kA} &\equiv s_A \frac{(\bar{x} - x_0) g_0}{1 - G_0} \alpha_E [\delta \varepsilon_{RA} + 1 - \delta] + (1 - s_A) \varepsilon_{RA}, \\ \varepsilon_{lA} &\equiv s_L \frac{x_0 g_0}{1 - G_0} \alpha_E [\delta \varepsilon_{RA} + 1 - \delta] + (1 - s_L) \varepsilon_{RA} \frac{\alpha_N}{1 - \alpha_N}. \end{aligned}$$

According to proposition 1, a higher price of innovative goods reduces interest and boosts the wage rate since the innovative sector is assumed to be labor intensive. Both work to augment unit capital demand and reduce unit labor demand. Higher own equity of innovative firms tilts the factor price frontier in the same way, yielding the same change in unit factor demands while higher agency costs induce the opposite adjustment. Combining

(22) and (24), we can derive the impact on sectoral output,

$$\begin{aligned}
\lambda_s \hat{X}_E &= (1 - s_A) \hat{L}_T - (1 - s_L) \hat{A}_T + [(1 - s_A) \varepsilon_{lv} + (1 - s_L) \varepsilon_{kv}] \cdot \hat{v} \\
&: + [(1 - s_A) \varepsilon_{lA} + (1 - s_L) \varepsilon_{kA}] \cdot \hat{A} - [(1 - s_A) \varepsilon_{l\beta} + (1 - s_L) \varepsilon_{k\beta}] \cdot \hat{\beta}, \quad (25) \\
\lambda_s \hat{X}_N &= s_L \hat{A}_T - s_A \hat{L}_T - [s_L \varepsilon_{kv} + s_A \varepsilon_{lv}] \cdot \hat{v} \\
&: - [s_L \varepsilon_{kA} + s_A \varepsilon_{lA}] \cdot \hat{A} + [s_L \varepsilon_{k\beta} + s_A \varepsilon_{l\beta}] \cdot \hat{\beta}.
\end{aligned}$$

Note that all coefficients are defined positive, i.e. $\lambda_s > 0$. Apart from the Rybczynski effects in Proposition 2, we have

Proposition 3 (*Supply Changes*) *The innovative sector expands when the output price rises ($\hat{v} > 0$), firms are financially more robust ($\hat{A} > 0$), and corporate governance improves ($\hat{\beta} < 0$).*

Aggregate supply importantly depends on the number of entrants E and the number of mature firms $M \equiv (1 - G_0) E$ which are continued beyond the initial start-up phase. Using (10-11), we can relate the changes in firm numbers to changes in aggregate supply according to $E = l_E X_E$ and $M = k_E X_E / I$, yielding $\hat{E} = \hat{l}_E + \hat{X}_E$ and $\hat{M} = \hat{k}_E + \hat{X}_E$. First, pure endowment effects at a constant output price v leaves factor prices and unit demands unchanged. Therefore, a larger labor endowment leads to an expansion of the innovative industry which exclusively occurs on the extensive margin, raising both the number of entrants and mature firms. The cut-off and average productivities remain constant. How does a higher market price expand the innovative sector? By the Stolper Samuelson theorem, interest declines while the wage rate increases. Both adjustments relax the financing constraint, allow more marginal firms to continue and, thereby, reduce average productivity. By (16), a lower cut-off productivity raises unit capital demand and squeezes unit labor demand, $\hat{k}_E > 0 > \hat{l}_E$. Clearly, a higher output price raises the number of mature firms in the innovative sector while the number of entrants becomes ambiguous. Hence, the expansion is shifted from the extensive (number of entrants) to the intensive margin (increased continuation rate).

3.4 Demand Side

Consumer demand for innovative goods is $C_E = \gamma \cdot Y/v$ and depends on aggregate income as noted in (12). Given an asset income share $\omega \equiv RA_T/Y$, higher factor income raises aggregate spending by $\hat{Y} = \omega \left(\hat{R} + \hat{A}_T \right) + (1 - \omega) \left(\hat{w} + \hat{L}_T \right)$. Substituting the factor price changes in (20) yields

$$\hat{Y} = \omega \cdot \hat{A}_T + (1 - \omega) \cdot \hat{L}_T - \theta \cdot \hat{R}, \quad \theta \equiv \frac{\alpha_N - \omega}{1 - \alpha_N} > 0. \quad (26)$$

The sign of θ reflects our factor intensity assumptions. When the traditional industry is capital intensive, we must have $\alpha_N > \omega > \alpha_E$, i.e. the income share of capital is larger in the traditional sector than in the economy at large.¹¹ The average share, in turn, exceeds the share of capital income in the innovative industry which is populated by young entrepreneurial companies with most of the return being a reward for managerial labor inputs (wage opportunity cost of entrepreneurship). The factor price frontier reflects cost minimization in the traditional, capital intensive sector. Given the factor intensity assumption, a higher interest and, correspondingly, a lower wage rate erode aggregate income. Substituting the equilibrium interest rate in (20) yields

$$\hat{Y} = \omega \cdot \hat{A}_T + (1 - \omega) \cdot \hat{L}_T + \theta \varepsilon_{Rv} \cdot \hat{v} - \theta \varepsilon_{R\beta} \cdot \hat{\beta} + \theta \varepsilon_{RA} \cdot \hat{A}. \quad (27)$$

A higher world price for innovative goods raises aggregate income. Part of it reflects the fact that a higher price boosts pledgeable income and helps the expansion of finance constrained entrepreneurial firms in the innovative sector. The elasticity ε_{Rv} defined in (20) is magnified by the parameter μ which parameterizes the tightness of the financing constraint. This parameter is defined in (19) and would be zero in a first best world where continuation occurs until profit of the marginal firm is driven down to zero. For the same reasons, the equity ratio of firms and agency costs are relevant only in a finance

¹¹To prove this, multiply (11) by R and use $\alpha_E = Rk_E/v$ and $\alpha_N = Rk_N$, giving $RA_T = \alpha_E v X_E + \alpha_N X_N$. Dividing by Y and noting $vC_E = vX_E = \gamma Y$ and $C_N = X_N = (1 - \gamma)Y$ under balanced trade gives $\omega = \gamma \alpha_E + (1 - \gamma) \alpha_N$.

constrained economy with $\mu > 0$. In the first best, the interest elasticities in (27) with respect to these parameters would be zero.

Given that young entrepreneurial growth companies in innovative industries tend to be finance constrained, a larger equity ratio of firms (higher A) which characterizes financially more robust firms with stronger balance sheets, raises aggregate income. The reason is that a larger equity ratio facilitates external funding of investments with strictly positive net present value ($\pi_0 > 0$ at the margin). With lower equity, a larger credit is needed. These marginal firms would be denied credit since the given pledgeable income would not suffice to repay the larger required loan. Finally, bad legal institutions also reduce aggregate income. Inadequate corporate governance standards make insiders more autonomous and less accountable to outside investors. Such institutions invite managerial misbehavior and opportunism and, thereby, raise the agency costs of investment β in innovative industries which intensively rely on entrepreneurial inputs. Larger agency costs reduce pledgeable income and, thereby, the debt capacity of these firms.

Aggregate income and relative prices determine demand for innovative goods,

$$\hat{C}_E = \hat{Y} - \hat{v} = \omega \cdot \hat{A}_T + (1 - \omega) \cdot \hat{L}_T - (1 - \theta\varepsilon_{Rv}) \cdot \hat{v} - \theta\varepsilon_{R\beta} \cdot \hat{\beta} + \theta\varepsilon_{RA} \cdot \hat{A}, \quad (28)$$

where $1 - \theta\varepsilon_{Rv} = [\omega - \alpha_E - \mu \cdot (\delta\alpha_E(1 - \alpha_N) + (\alpha_N - \omega)x_0/\bar{x})] / \lambda_\alpha$ uses the definitions of ε_{Rv} , θ and λ_α . The factor intensity assumption implies $\alpha_N > \omega > \alpha_E$. We argue for $1 > \theta\varepsilon_{Rv}$ which is fulfilled if finance constraints are not too tight and μ is close to zero. In this case, a higher output price restrains demand. Note that, even with a degenerate demand reaction, excess demand for innovative goods would still decline with a higher own price as long as the supply change dominates.

3.5 Trade Balance

Excess demand in the domestic economy, $\zeta_E \equiv C_E - X_E$, results in a trade balance deficit for innovative goods. Consistent with both autarky and perfectly symmetric countries, we evaluate comparative static effects at the point where $\zeta_E = 0$. In particular, we are

interested in how the trade balance in innovative goods responds to changes in the novel fundamental parameters introduced by our analysis: the abundance of total assets A_T in the economy, the financial robustness of innovative firms measured by A at given A_T , and the extent of agency costs as captured by β . The associated comparative static effects involve $\hat{\zeta}_E = \hat{C}_E - \hat{X}_E$ for the domestic economy. Substituting (28) and (25) yields

$$\hat{\zeta}_E = -\varepsilon_{Zv} \cdot \hat{v} + \varepsilon_{ZA_T} \cdot \hat{A}_T - \varepsilon_{ZL} \cdot \hat{L}_T - \varepsilon_{ZA} \cdot \hat{A} + \varepsilon_{Z\beta} \cdot \hat{\beta}, \quad (29)$$

where coefficients are defined as [use $\lambda_s = s_L - s_A > 0$ when necessary]

$$\begin{aligned} \varepsilon_{ZA_T} &\equiv \frac{\omega\lambda_s + 1 - s_L}{\lambda_s} = \varepsilon_{ZL}, \\ \varepsilon_{Zv} &\equiv \frac{1 - s_A}{\lambda_s} \varepsilon_{lv} + \frac{1 - s_L}{\lambda_s} \varepsilon_{kv} + 1 - \theta \varepsilon_{Rv}, \\ \varepsilon_{ZA} &\equiv \frac{1 - s_A}{\lambda_s} \varepsilon_{lA} + \frac{1 - s_L}{\lambda_s} \varepsilon_{kA} - \theta \varepsilon_{RA}, \\ \varepsilon_{Z\beta} &\equiv \frac{1 - s_A}{\lambda_s} \varepsilon_{l\beta} + \frac{1 - s_L}{\lambda_s} \varepsilon_{k\beta} - \theta \varepsilon_{R\beta}. \end{aligned}$$

In restricting ourselves to a neighborhood of the first best equilibrium, the elasticities are all positive, despite of the countervailing influence of the terms associated with θ . To see this, note the assumption (A) in section 2.2 which implies that finance constraints are binding. Hence, some firms with positive net present value are rationed. The marginal firm makes a strictly positive profit π_0 , leading to $\mu > 0$. Letting the agency cost approach the borderline case from above, $\beta p \rightarrow AR$, implying $\pi_0 \rightarrow 0$ and $\mu \rightarrow 0$, moves the equilibrium arbitrarily close to the first best. In fact, the first best equilibrium is well defined although the size of own equity and agency costs have no influence on the equilibrium in this case. By the Modigliani Miller theorem, the distinction between external debt and own equity become irrelevant in a first best world. All terms multiplying with μ drop out, leaving the classic two sector trade model with the Modigliani Miller theorem applying to investment financing in both sectors. Letting private benefits of shirking and, thus, agency costs only marginally exceed the borderline case of assumption (A), we keep close to the first best. Consider now, for example, the elasticity $\varepsilon_{Z\beta}$ stated above. Since $\mu \rightarrow 0$ implies $\varepsilon_{R\beta} \rightarrow 0$, the last term vanishes while the elasticities $\varepsilon_{l\beta}$ and $\varepsilon_{k\beta}$ listed in (24) remain

strictly positive where the debt and equity ratios δ and $1 - \delta$ are exogenous to the model. The same holds for the other elasticities in (29) as long as we restrict ourselves to a neighborhood of the first best.

Suppose the allocation is close to first best and trade is balanced in the initial equilibrium. When the economy gets richer in financial assets, it starts to develop a surplus in the traditional capital intensive sector while the innovative sector relying intensively on entrepreneurial inputs records an excess demand, resulting in a trade deficit. Given that demand declines in its own price ($1 > \theta \varepsilon_{Rv}$), a higher output price of innovative goods expands output and results in a trade surplus in this sector (sectoral excess demand falls). Finally, higher agency costs lead to a trade deficit in innovative goods. When entrepreneurial firms are endowed with stronger balance sheets, the entrepreneurial sector expands, resulting in a trade surplus in innovative goods.

4 Comparative Advantage

In the following analysis, we study three scenarios: autarky where v is endogenous and depends on domestic variables only, the case with two large countries where v is jointly determined by domestic and foreign fundamentals, and a scenario of a small open economy with exogenous v when the number of symmetric countries is large.

Autarky: Under autarky, $\zeta_E = \hat{\zeta}_E = 0$. Using this in (29) results in

$$\hat{v} = \frac{\varepsilon_{ZA_T}}{\varepsilon_{Zv}} \cdot \hat{A}_T - \frac{\varepsilon_{ZL}}{\varepsilon_{Zv}} \cdot \hat{L}_T - \frac{\varepsilon_{ZA}}{\varepsilon_{Zv}} \cdot \hat{A} + \frac{\varepsilon_{Z\beta}}{\varepsilon_{Zv}} \cdot \hat{\beta}. \quad (30)$$

Since in (29), $\varepsilon_{ZA_T} = \varepsilon_{ZL}$, the price change \hat{v} is homogeneous of degree zero with respect to a ceteris paribus proportional change $\hat{A}_T = \hat{L}_T$ of capital and labor endowments. This holds despite of the fact that the number of potential entrepreneurs is held fixed. However, while natural workers can only be employed in the traditional sector, entrepreneurs can perform both tasks. In an interior equilibrium, more entrepreneurship means less

employment in the traditional sector and conversely. The free entry, occupational choice condition means that (entrepreneurial) labor is reallocated freely across sectors, and so is financial capital. A ceteris paribus increase in own equity of new firms, $\hat{A} > 0$, relaxes the financing constraint and expands the innovative industry, leading to excess demand and requiring a lower relative price.¹² Lower agency costs in financing entrepreneurship ($\hat{\beta} < 0$), for example due to improved corporate governance standards or financial institutions, favor expansion in the innovative sector and also reduce the output price. Lower agency costs relax the incentive constraint and boost pledgeable income, allowing more of the marginal firms to be finance which otherwise would have been credit constrained.

Two Large Countries: Let us focus on parameter domains with imperfect specialization so that production of both innovative and standard goods takes place in either country also after changing fundamental parameters. Assume that countries are perfectly symmetric initially. Use a star to denote foreign variables and assume that the coefficients in (29) are symmetric across countries. Hence, foreign excess demand changes by

$$\hat{\zeta}_E^* \equiv \hat{C}_E^* - \hat{X}_E^* = -\varepsilon_{Zv} \cdot \hat{v} + \varepsilon_{ZA_T} \cdot \hat{A}_T^* - \varepsilon_{ZL} \cdot \hat{L}_T^* - \varepsilon_{ZA} \cdot \hat{A}^* + \varepsilon_{Z\beta} \cdot \hat{\beta}^*, \quad (31)$$

with $\hat{v} = \hat{v}^*$. The change in the two economies' excess demands for innovative goods must add up to zero for the world market of innovative goods to clear,

$$\begin{aligned} \hat{\zeta}_E + \hat{\zeta}_E^* &= -2\varepsilon_{Zv} \cdot \hat{v} + \varepsilon_{ZA_T} \cdot (\hat{A}_T + \hat{A}_T^*) - \varepsilon_{ZL} \cdot (\hat{L}_T + \hat{L}_T^*) \\ &: -\varepsilon_{ZA} \cdot (\hat{A} + \hat{A}^*) + \varepsilon_{Z\beta} \cdot (\hat{\beta} + \hat{\beta}^*) = 0. \end{aligned} \quad (32)$$

Consider the comparative static effects of changes in domestic fundamentals, keeping foreign fundamentals constant ($\hat{A}_T^* = \hat{L}_T^* = \hat{A}^* = \hat{\beta}^* = 0$). Under these assumptions, the comparative static effects on \hat{v} with two large countries are proportional to the ones under autarky, with a factor of proportionality equal to 1/2.

¹²Note that $\hat{A} > 0$ at $\hat{A}_T = 0$ relaxes the financial constraints for a given total capital endowment and, thereby, also reflects a more unequal distribution of wealth between workers to potential entrepreneurs.

With large countries, a change in A_T , L_T , A or β induces direct (first-order) effects on excess demands $\hat{\zeta}_E$ and $\hat{\zeta}_E^*$ and indirect (second-order) ones through \hat{v} . Inserting the solution \hat{v} from (32) into (29) yields, under the adopted assumptions, total (first- plus second-order) comparative static effects on domestic excess demand equal to

$$\hat{\zeta}_E = (1 - 1/2) \cdot \left(\varepsilon_{ZA_T} \cdot \hat{A}_T - \varepsilon_{ZL} \cdot \hat{L}_T - \varepsilon_{ZA} \cdot \hat{A} + \varepsilon_{Z\beta} \cdot \hat{\beta} \right). \quad (33)$$

In qualitative terms, the insights correspond to the case discussed in (29).

Proposition 4 (*Comparative Advantage*) *Better investor protection and corporate governance standards reflected in lower agency costs (lower β) and a higher equity ratio of entrepreneurial firms (higher A) create a comparative advantage in innovative industries.*

Small Open Economy: Under the adopted symmetry assumptions, the result in (33) may easily be generalized to the case of an arbitrary number of J countries. In general, we may write $\hat{v} = \Xi / (J \cdot \varepsilon_{Zv})$ and $\hat{\zeta}_E = (1 - 1/J) \cdot \Xi$, where $\Xi \equiv \varepsilon_{ZA_T} \cdot \hat{A}_T - \varepsilon_{ZL} \cdot \hat{L}_T - \varepsilon_{ZA} \cdot \hat{A} + \varepsilon_{Z\beta} \cdot \hat{\beta}$. The second-order effects of changes in domestic fundamentals through \hat{v} become less important as the number of countries grows. For a small open economy, we obtain $\lim_{J \rightarrow \infty} \hat{\zeta}_E = \Xi$. The magnitude of the comparative static effects is larger in a small open economy than with a finite number of large countries since the dampening second-order world market price effects do not materialize.

5 Conclusions

This paper provides an analysis of the role of endogenous financial constraints on the extensive margin of firm activity and international trade. We consider economies with two industries, a standard and an innovative sector. Firms in the standard sector are symmetric, financially unconstrained and use capital intensively. Companies in the innovative sector are heterogeneous with regard to productivity and crucially depend on the managerial input of the founder. Entrepreneurs of innovative firms demand more capital than

they own and have to rely on external financing through (perfectly competitive) banks. Since managerial effort is not verifiable, entrepreneurs and banks cannot write contracts to avoid moral hazard. To prevent managerial misbehavior, entrepreneurs must keep a sufficiently large financial interest in the firm which limits pledgeable income and debt capacity. As a result of these agency costs, some marginal firms with positive net present value will be denied external funding in equilibrium, thereby limiting the expansion of innovative industries.

The analysis brings about two novel fundamental parameters determining financial constraints, firm entry, and international trade simultaneously: an innovative firm's equity ratio (as a measure of financial robustness) and the extent of agency costs. Lower agency costs relax the financial constraint by raising an innovative firm's pledgeable profit and debt capacity. A higher equity ratio reduces the need for external funding so that even a lower pledgeable profit suffices to repay debt. Both fundamentals facilitate the financing of firms with relatively low productivity but still positive net present value and thereby support the expansion of innovative industries. We have thereby illustrated how fundamental parameters of corporate finance affect core theorems in international trade such as the Stolper-Samuelson theorem, the Rybczinsky theorem, and the law of comparative advantage. We hope that some of the insights will prove useful in subsequent empirical work in international economics.

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