Financial Constraints, Industry Structure and Firm's Boundaries

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Abstract

The first part of this Thesis analyzes the impact of financial constraints (FC) on industrial structure. Chapter 1 presents a model that disentangles several effects of FC on entry, turnover, productivity and firms size distribution. The framework is applied in Chapter 2 which develops an industry equilibrium model of vertical integration under contractual imperfections with specific input suppliers and external investors. I assume that vertical integration economizes on the needs for contracts with specific input suppliers at the cost of higher financial requirements. I show that the two forms of contractual imperfections have different effects on the degree of vertical integration, and that contractual frictions with external investors affect vertical integration through two opposing channels: a direct negative, investment, effect and an indirect positive, entry, effect. Using cross-country-industry data, I present novel evidence on the institutional determinants of international differences in vertical integration which is consistent with the predictions of the theoretical model. In particular, I show that countries with more developed financial systems are relatively more vertically integrated in industries that are dominated by large firms.

The second part (Chapter 3) asks whether vertical integration reduces or increases transaction costs with external investors. I build a model in which a seller produces a good that can be used by a buyer, or sold on a spot market. The buyer and the seller have no cash, need to finance investments for production, and can not foresee in advance whether the input is most efficiently traded on the spot market or among each other. I assume that ownership of physical assets gives control over contracting rights to those assets, that financial streams get transferred with ownership and that returns can not be perfectly verified. The net balance of the costs and benefits of integration in terms of pledgeable income depends on the relative intensities of a positive "*profits-pooling*" effect against a negative "*de-monitoring*" effect. I find that larger projects, more specific assets, and low investors protection are determinants of vertical integration. I discuss joint liability contracts between non integrated firms and how contractual externalities among investors favor integration.

34. Busca por el agrado de buscar, no por el de encontrar...

...

40. No juzgues al árbol por sus frutos ni al hombre por sus obras; pueden ser peores o mejores.

Fragmentos de un evangelio apócrifo, Jorge Luis Borges

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Maitreesh Ghatak, above all, provided excellent guidance and support on all the material in this Thesis. He drew my attention towards the understanding of the industrial organization of less developed countries.

Chapter 2 would have not been possible without the many advises provided by Tim Besley. I hope I will keep in future research the curiosity and broadness of his insights, as well as the relevance of his questioning.

My view on the themes treated in this Thesis has been fundamentally influenced by the work and words of Abhijit Banerjee. I feel I have been extremely privileged I had so many chances of discussing with him during my Ph.D.

My understanding of the material in Chapter 3 owns a lot to several insightful conversations with Leonardo Felli and Jean Tirole.

Last, but not least, the first person I have met during my graduate studies has been Francois Bourguignon. Although he did not directly supervise the material in this Thesis, without his example and early encouragements this work would have not been possible.

During the Ph.D. I had the chance of meeting several colleagues: some of them are now very close friends. I have decided to do a Ph.D. during the long afternoons spent in the library of the University of La Coruna in 98/99. Since those afternoons, I had the privilege of the continuing company and support of a smart colleague, tolerant flatmate and great friend. Thanks, Enrico.

Finally, I want to dedicate this Thesis to my Family, for all the trust, freedom and support, in other words love, they endlessly gave me.

Preface

Countries largely differ in terms of their level of income per capita and productivity. The richest countries in the world are as 50 times richer than the poorest countries in the world. Historically it is true that most of the countries managed to raise their per capita income levels and reduce poverty through (a phase of) industrialization. An emerging consensus within economics points towards the importance of institutions in explaining international differences in income per capita. One important challenge for current and feature research is to improve our understanding of *how* institutions affects income differences, i.e. the *mechanisms* through which institutional imperfections shape economic performance in general, and the industrialization process in particular.

This Thesis explores the mechanisms through which financial market imperfections shape industry structure and firm boundaries. While the underlying motivation and the "right hand side" variables of this work (contractual imperfections in the financial market), come from the fields of Development Economics and Corporate Finance, the focus on industry structure *and* firm boundaries as "left hand side" variables comes from an older tradition in Industrial Organization. Consequently, this Thesis is divided into two parts.

The first part provides a simple theoretical framework to analyze how financial market imperfections shape industry structure, in terms of entry, turnover and intraindustry factor re-allocation. I than embed into this framework a simple theory of firm boundaries (vertical integration) and jointly determine industry structure and firm boundaries as functions of financial market imperfections. The second part focuses on the relationship between financial market imperfections and firm boundaries. In particular, I provide a new theoretical approach to the long standing question of what determines firm boundaries and show that firm boundaries are an important tool to ease the process of raising funds from external investors.

While most of the work in this Thesis is theoretical, I have tried to link the theory to existing or original empirical evidence. It turns out that while there already exists important empirical work on the relationship between financial constraints and industry structure that supports the theoretical framework in Chapter 1, the relationship between financial market imperfections and vertical integration has received almost no empirical attention. Chapter 2 fills this gap in the literature, and provides original evidence on the relationship between vertical integration and financial market imperfections. Empirically, I rely on cross country and industry variation, which explain why the empirical contribution is paired with the industry equilibrium framework of Chapter 2. It turns out that the theoretical material presented in the second part, while consistent with existing, mostly anecdotal, evidence, would require data of a substantially different nature, most likely to be collected in appropriate future fieldwork.

The first part presents an analysis of the effects of financial market imperfections on industry structure.

Chapter 1 presents a simple theoretical framework to disentangle several effects of financial constraints on entry, turnover, productivity and firms size distribution. The theoretical framework combines recent work on industry structure with heterogeneous firms developed in trade theory with a simple parametrization of financial market imperfections.

Chapter 2 provides a theoretical and empirical analysis of the institutional determinants of vertical integration. I find that contractual frictions with suppliers of intermediate inputs and with external investors have a radically different impact on the degree of vertical integration. I develop an industry equilibrium model with heterogeneous firms that combines a simple theory of vertical integration with a convenient parametrization of contractual frictions in input and financial markets. Fewer contractual imperfections with input suppliers unambiguously reduce vertical integration while fewer contractual imperfections in financial markets reduce vertical integration in industries that are dominated by small firms. I find empirical support for these predictions in an analysis of cross-country-industry data for the manufacturing sector. Contrary to conventional wisdom, I also document that there is no evidence of higher vertical integration in less developed countries.

The second part presents theoretical models of firm boundaries and financial market imperfections.

In Chapter 3, I build a model in which a seller produces a good that can be used by a buyer, or sold on a spot market. The buyer and the seller have no cash, need to finance investments for production, and can not foresee in advance whether the input is most efficiently traded on the spot market or among each other. I assume that ownership of physical assets gives control over contracting rights to those assets, that financial streams get transferred with ownership and that returns can not be perfectly verified. The net balance of the costs and benefits of integration in terms of pledgeable income depends on the relative intensities of a positive "*profits-pooling*" effect against a negative "*de-monitoring*" effect. I find that larger projects, more specific assets, and low investors protection are determinants of vertical integration. I discuss joint liability contracts between non integrated firms and how contractual externalities among investors favor integration.

With respect to the relationship between financial market imperfections and organizational form, the field of corporate finance has recently provided insightful analysis on the efficiency properties of conglomerates, and (horizontally) diversified firms. In contrast, the work in this Thesis mainly focuses on vertical relationships. When it comes to the analysis of horizontal differentiation, it is appropriate to leave the industry equilibrium framework which is the main focus of this work, and consider a general equilibrium framework. For this reason I have decided not to report here the results of some preliminary work in which I explore - theoretically and empirically - the relationship between financial market development and horizontal differentiation. Similarly, the work in this Thesis only tangentially deals with certain important aspects of the financial system and their relationship with industry structure or organizational forms. While the analysis in Chapters 3 sheds some preliminary light on the relationship between trade credit and firm boundaries, this, and other important themes such as the relationship between bank vs. market based financial systems and industry structure, are left for future research.

The reader of this Thesis will not find an analysis of the policy and political economy implications of this work. Why countries do not exert more effort to improve the functioning of their financial markets? Some very interesting work has been recently done on the political economy of financial market reform, but it is not discussed here. At a more substantial level, the aim of this work has been to provide a general framework to understand the mechanics of the relationship between financial market development and industrial development. With respect to policy implications, evil is in the detail. I hope that a careful analysis of the interaction between the forces underlined in this work and the characteristics of the particular setting under examination will however prove useful.

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Chapter 1

Credit Constraints and Industry Structure: Introduction

1.1 Introduction

There is now sound evidence that firms in developing countries suffer from scarce availability of financial resources. The results of the enterprise surveys at the World Bank show important cross-country variations in terms of the availability of external financial resources in the developing world. The average loan in many countries requires a collateral often above the value of the loan itself. Similarly, in many countries firms report that as much as 80% of investments are financed with internal funds.

The purpose of this introductory chapter is to analyze the implications of financial market imperfections on industry structure. To do so, I develop a simple industry equilibrium model with heterogeneous firms along the lines of Melitz (2003).[1] As in Melitz (2003), I assume that firms are heterogeneous in terms of productivity. The baseline model keeps productivity as the main source of heterogeneity across firms in order to make this framework as comparable as the one successfully used in many recent studies on the evolution of industrial structure in developing countries that did not focus on financial market imperfections. I embed into this framework a simple parametrization of financial market imperfections. The baseline model takes the supply of entrepreneurs in the industry as given, and consider the case in which financial market imperfections simply hinder the

[1] I follow Melitz (2003) in analyzing a model of (Dixit-Stiglitz) monopolistic competition. While it turns out that such formulation has convenient analytical properties, most of the key results follow from the "business stealing" effect of the formulation. Other frameworks, could in principle, deliver alternative results.

creation of new firms. Poor financial markets prevent the entry of new competitors in the industry. Because of the "business stealing" effect inherent to the monopolistic competition model, firms that operate in industries in which financial constraints are relevant tend to be larger. On average, better financial markets increase production in the industry but do not increase productivity, since better financial markets will enable relatively low productivity firms to enter the industry.

I then analyze several variations of the baseline models that explore the endogenous supply of entrepreneurs in the industry and the consequences of heterogeneity in financial market access. This last extension brings the theoretical framework closer to an older "development economics" tradition, in which access to wealth or informal networks is central in determining financial market access (see e.g. Banerjee and Newman (1993), Banerjee and Munshi (2004)). Finally, I propose an extension in which financial market imperfections directly affect firm's size. The framework is then suited to derive implications on firm's size distribution.

I do not review here an important empirical literature on financial constraints. Banerjee and Duflo (2004) provides an interesting proof of the existence of credit constraints in India, while Levine (2005) contains several references on research exploring the effects of cross-country financial development differences in shaping industry growth and structure.

1.2 The baseline model

1.2.1 Set Up

Environment

I consider an economy with population L that produces goods using only labor. There are $J+1$ sectors. One sector provides a single homogeneous good. This good is used as the numeraire, and its price is set equal to 1. It is produced under constant return to scale, with a technology employing 1 unit of labor to produce 1 unit of the homogeneous good. Provided that the economy produces the homogeneous good, the wage will be $w=1$. In the remaining part of this chapter, I will assume that this is true. The other J sectors supply a continuum of differentiated goods. In each of these sectors there is a fixed set of potential entrepreneurs described later. Each firm is a monopolist over the variety it produces.

The workers are the only consumers, each endowed with 1 unit of labor. They all have the same CES preferences over the differentiated goods. A consumer that receives q_0 units of the homogeneous good, and $q(\theta)$ of each variety $\theta \in \Theta_j$ (to be determined in equilibrium) of the differentiated goods produced by industry $j \in \{1,..j,..J\}$, gets a utility U

$$U \equiv q_0^{1-J\varphi} \prod_{j=1}^{J} \left(\int_{\theta \in \Theta_j} q(\theta)^{\alpha_j} d\theta \right)^{\frac{\varphi}{\alpha_j}}$$

where $\varepsilon_j = \frac{1}{1-\alpha_j} > 1$ is the elasticity of substitution between two varieties of the differentiated goods in industry j.

If all varieties in the set Θ_j are available at a particular price $p(\theta)$ these preferences yield aggregate demand functions

$$q(\theta) = A_j p(\theta)^{-\varepsilon_j}$$

where $p(\theta)$ is the price of a particular variety θ and

$$A_j = \frac{\varphi L}{\left(\int_{\theta \in \Theta_j} p(\theta)^{-\alpha_j \varepsilon_j} d\theta \right)}$$

The monopolist of variety θ in industry j treats A_j as a constant, and so perceives a constant elasticity of demand ε_j. I denote $P_j = \left[\int_{\theta \in \Theta_j} p_j(\theta)^{-\alpha_j \varepsilon_j} d\theta \right]^{-\frac{1}{\alpha_j \varepsilon_j}}$ as the price index in industry j. The price index is inversely related to the level of "competitition" in the industry. Competition is, *ceteris paribus*, increasing in the number of varieties produced in the industry, and decreasing in the (average) price charged by competitors.

Since the set of potential entrepreneurs in each industry is, for now, taken as exogenously given, and production of the homogeneous good in the economy implies $w = 1$, industries can be treated independently. Therefore, I suppress the subscript j from industry variables.

For now, I assume that in each industry there is a fixed pool of potential entrepreneurs that are heterogenous with respect to their productivity θ. Each entrepreneur draws her productivity level θ from a distribution with associated continuous cumulative function $G(\theta)$ and observe her productivity before deciding whether to start production. To simplify, I also assume that the mass of potential entrepreneurs is equal to L in each industry. I take the distribution of the productivity parameter θ as exogenous. For analytical purposes, it is convenient to focus on the case in which $G(\theta)$ follows a Pareto distribution, i.e. $G(\theta) = 1 - (\frac{1}{\theta})^{\sigma}$, for $\theta \geq 1$.

I now turn to the description of firms' technology. In order to enter the industry, the firm has to pay fixed costs f. After having paid the fixed costs, the production function of a firm is

$$q(\theta) = \theta x$$

where I denote by x the labor employed by the firm.

I now turn to the determination of the industry equilibrium. In order to solve the industry equilibrium, I first compute the profit functions for a firm. I then define the industry equilibrium.

From the demand equation it is clear that firms charge a constant mark up determined by the elasticity of substitution of consumer demand. We thus have

$$p(\theta) = \frac{1}{\alpha\theta}$$

By substitution in the demand equation, we obtain the variable profits as

$$\Pi(\theta) = \alpha^{\alpha\varepsilon} A \theta^{\alpha\varepsilon}(1-\alpha)$$

The industry equilibrium is uniquely defined by a threshold θ^e such that firms with $\theta \geq \theta^e$ enter the industry since they are productive enough to cover their fixed costs. The threshold θ^e is uniquely identified by the solution to

$$\alpha^{\alpha\varepsilon} A (\theta^e)^{\alpha\varepsilon}(1-\alpha) = f$$

Recalling the expression for A, this last equality can be rewritten as

$$\frac{\varphi L}{\int_{\theta^e}^{\infty} \theta^{\alpha\varepsilon} dG(\theta)} (\theta^e)^{\alpha\varepsilon} (1-\alpha) = f$$

Assuming $\sigma > \alpha\varepsilon$, when $G(\theta)$ follows a Pareto distribution with shape parameter σ, we obtain $\int_{\theta^e}^{\infty} \theta^{\alpha\varepsilon} dG(\theta) = \frac{\sigma}{\sigma-\alpha\varepsilon} (\theta^e)^{\alpha\varepsilon-\sigma} = \omega (\theta^e)^{\alpha\varepsilon-\sigma}$, and thus

$$\left[\frac{\varepsilon}{\omega}\frac{\varphi L}{f}\right]^{-\frac{1}{\sigma}} = \theta^e$$

In equilibrium, conditional on being active in the market, the size of a firm with productivity θ (in terms of labor) is given by

$$x(\theta) = \alpha \frac{(\varphi L)^{1-\frac{1}{\omega}}}{\omega \left[\frac{\omega}{\varepsilon f}\right]^{\omega}} \theta^{\alpha\varepsilon}$$

We note that, the size of the firm is increasing in the size of the market (φL), in the level of firm productivity (θ) and in the level of fixed costs (f). Note also that if θ is distributed according to a Pareto distribution with shape parameter σ, then $x(\theta)$ also follows a Pareto distribution with shape parameter $\sigma - \alpha\varepsilon$.

1.2.2 Credit Constraints

I now introduce financial market imperfections. I assume that fixed costs have to be paid up-front, i.e. before production takes place and that firms have no liquidity and need to borrow from external investors in order to finance the fixed cost investment. I assume for simplicity that the risk free interest rate in the economy is equal to zero, and that a large supply of risk neutral investors lend capital at this interest rate.

However, because of contractual imperfections, credit markets are not perfect. I model credit constraints in a rather crude, but simple, way. Specifically, I assume that the fixed costs f need to be financed in advance, and are in fact composed of a continuum of small investments. I assume that a fraction $1 - \lambda$ of this investments is contractible: external investors can easily make sure that the capital is effectively invested in the project (for instance renting corporate buildings, acquiring specific machines, etc.). In contrast, the remaining fraction λ is not contractible, in the sense that the external provider of finance can not make sure that the capital is effectively invested in production (e.g. hiring the appropriate product designer, purchase of some specific services, etc.). While λ certainly captures characteristics of the industry, it also depends on the availability of legal instruments protecting external investors, such as borrowers' public register, courts, etc. Since industries can be treated in isolation, lower λ has to be interpreted as a decrease in the industry-country specific degree of contractual frictions between firms and external investors.

After borrowing from external investors, the entrepreneur can choose among two different behaviors. She can invest the borrowed cash to pay the fixed costs and start production. Alternatively she can divert the cash corresponding to the fraction λ of non-contractible investments. For simplicity, I assume that such a diversion of cash occurs at no cost.

From this simple model, it follows that an entrepreneur with productivity θ can enter the industry if and only if the variable profits $\Pi(\theta)$ are such that $\Pi(\theta) \geq (1 + \lambda)f$.When $\lambda = 0$ financial markets are perfect, and any firm with variable profits $\Pi(\theta)$ can enter the industry as soon as the variable profits are greater than the fixed costs. When $\lambda > 0$ financial markets are not perfect, and some firms with variable profits $\Pi(\theta) > f$ may not be able to enter the industry and start production. In this sense, some projects with positive net present values will not be financed, giving rise to financial constraints. Below, I discuss some alternative ways of introducing financial market imperfections.

The industry equilibrium will now be modified. It will be defined by a new threshold $\widehat{\theta}^e$ such that

$$\alpha^{\alpha\varepsilon} A(\widehat{\theta}^e)^{\alpha\varepsilon}(1-\alpha) = (1+\lambda)f$$

and hence we obtain

$$\left[\frac{\varepsilon}{\omega}\frac{\varphi L}{(1+\lambda)f}\right]^{-\frac{1}{\sigma}} = \widehat{\theta}^e$$

In equilibrium, conditional on being active in the market, the size of a firm with productivity θ (in terms of labor) is given by

$$x(\theta) = \alpha \frac{(\varphi L)^{\frac{\alpha\varepsilon}{\sigma}}}{\omega\left[\frac{\omega}{\varepsilon f(1+\lambda)}\right]^{\omega}}\theta^{\alpha\varepsilon}$$

It is clear from this expression, that conditional on entry in the industry, firms are larger the greater is λ, i.e. the more severe the financial market imperfections. In other words, a first effect of financial markets imperfection is to shelter firms from competition. This naturally leads towards an increase in firm's size (measured in terms of labor, or revenues).

With respect to productivity, it is useful to define two different concepts. Omitting for simplicity fixed costs, and taking real output per worker θ as a measure of productivity we can define the average intra-firm productivity as the unweighted average of output per worker ratios in the industry, i.e.

$$P_{intra} = \frac{\int_{\widehat{\theta}^e}^{\infty} \theta dG(\theta)}{1-G(\widehat{\theta}^e)} = \frac{\frac{\sigma}{\sigma-1}\left(\widehat{\theta}^e\right)^{1-\sigma}}{\left(\widehat{\theta}^e\right)^{-\sigma}} = \frac{\sigma}{\sigma-1}\widehat{\theta}^e$$

Similarly we can define industry productivity ("inter-firm") as the labor-weighted average of output per worker ratios in the industry, i.e.

$$P_{inter} = \frac{\int_{\widehat{\theta}^e}^{\infty} \alpha^{\varepsilon} A\theta^{\varepsilon} dG(\theta)}{\int_{\widehat{\theta}^e}^{\infty} \alpha^{\varepsilon} A\theta^{\alpha\varepsilon} dG(\theta)} = \frac{\frac{\sigma}{\sigma-\varepsilon}\left(\widehat{\theta}^e\right)^{\varepsilon-\sigma}}{\frac{\sigma}{\sigma-\alpha\varepsilon}\left(\widehat{\theta}^e\right)^{\alpha\varepsilon-\sigma}} = \frac{\sigma-\alpha\varepsilon}{\sigma-\varepsilon}\widehat{\theta}^e$$

We can now state the following result

Proposition 1.1 *Financial market imperfections*

i) reduce entry ($\frac{\partial \widehat{\theta}^e}{\partial \lambda} > 0$),

ii) conditional on entry, increase firms size ($\frac{\partial x(\theta)}{\partial \lambda} > 0$)

iii) increase firm productivity ($\frac{\partial P.}{\partial \lambda} > 0$)

Discussion

The model above formalizes two simple ideas. First, financial market imperfections act as a barrier to entry in the industry. Second, firms that, despite financial market imperfections are active in the industry, benefit from lower competition and are thus larger (and earn higher profits). Apparently the more controversial result from the framework is the fact that financial market imperfections tend to increase the productivity of firms in the industry. First of all, note that this does not mean that efficiency in the economy will be higher. Some factors, in particular entrepreneurial talent ($\theta < \widehat{\theta}^e$) remain underemployed. Secondly, note that this result follows from the fact that financial constraints systematically prevent the entrance of relatively unproductive firms in the industry. Some of the extensions in the next session provides examples in which this is no longer the case.[2]

1.3 Extensions

1.3.1 Endogenous entry

In this subsection I modify the previous model in the following way. I assume that in order to discover her own productivity θ, an entrepreneur needs to pay up-front a fixed cost F.

[2] It is important to understand whether this crucial feature of the model depends on the particular way financial markets imperfections are modelled. As a matter of examples consider the case in which financial markets imperfections are modelled through a standard moral hazard problem. The entrepreneur has to exert some effort m that increases the probability $p(m)$ of a success, in which case profits $\Pi(\theta)$ are realized. Under the alternative scenario of a failure, let us assume that no profits are realized. Assume that profits are contractible, but the effort is not. The entrepreneurs borrow cash f, and commit to repay an amount B in case of success. If she has no wealth to post as collateral, in case of failure she repays nothing. Denoting by m^e the equilibrium level of effort, the zero profits constraints for the lender implies $p(m^e)B = f$. It is straightforward to check that m^e is increasing in $\Pi(\theta)$,and that there exists a critical θ^e such that entrepreneurs with $\theta \leq \theta^e$ are not financed. A similar model endogeneizes the probability of success (i.e. the observed distribution of productivity), and implies that relatively unproductive firms are left outside the market. The model would however generates further feed-backs. Better financial markets, by fostering entry, would reduce $\Pi(\theta)$ for some firms, which would in turn leads to higher interest rates for those firms. Due to the non-linear interaction between θ and m, it is hard to analytically solve this model. Similarly, financial markets imperfections could be introduced through adverse selection on (some other than θ) underlying characteristics. I believe this would not change the main insights.

These fixed costs have to be financed, since the entrepreneur again has no cash. I assume that, once θ is revealed, both the bank and the firm observe it. The setting is interesting since it highlights other effects of financial constraints on entry and productivity.

In particular it will be possible to underline different effects that financial constraints impose on firms depending whether the financial imperfections are at the "entry" or at the "production" stage.

The game, has to be solved backward. First of all, for a given mass M_e of entrepreneurs in the industry, it is easy to show that - as before - there exists a unique threshold $\widehat{\theta}^e$ such that only firms that have productivity $\theta \geq \widehat{\theta}^e$ receive finance to continue their operations and hence survive in the industry. Let B denote the amount of debt that the firm has to repay to the investor that financed the entry stage in the industry. Following the derivation in the previous section, it is straightforward to show that

$$\left[\frac{\omega}{\varepsilon}\frac{\varphi}{[(1+\lambda)f+B]}\frac{L}{M_e}\right]^{-\frac{1}{\sigma}}=\widehat{\theta}^e$$

A first implication is that the larger the mass of entrepreneurs in the industry M_e, the more productive the entrepreneurs must be in order to survive in the industry. Note that with respect to the corresponding equation in the previous section, there are two differences. First, the "effective" size of the market must now be "normalized" M_e. Ceteris paribus, an increase in the number of firms in the industry, is equivalent to a reduction in market size. Secondly, the firm has to repay an original amount of debt B. The higher B, the harder will be to satisfy the incentive compatibility constraint for the financing decision at the production stage. It is this force that generates the interesting interactions between financial constraints at the entry and at the production stages.

An entrepreneur thus, after observing her productivity θ will remain in the industry with probability $1-G(\widehat{\theta}^e)$, i.e.

$$\Pr ob\left[\theta \geq \widehat{\theta}^e\right]=\frac{\omega}{\varepsilon}\frac{\varphi}{[(1+\lambda)f+B]}\frac{L}{M_e}$$

Denoting by M the mass of firms that are active in the industry, we obtain that

$$M=\left(1-G(\widehat{\theta}^e)\right)M_e \Longleftrightarrow M=\frac{\omega}{\varepsilon}\frac{\varphi L}{[(1+\lambda)f+B]}$$

Note that the mass of firms that are active, i.e. produce, in the industry depends on B. The higher B, i.e. the more difficult has been to finance the entry in the industry, the smaller will be the number of firms producing in the industry.

We now have to compute the ex-ante expected profits Π_e for the entrepreneur, when he pays the fixed costs F in order to discover her productivity θ. These profits are given by

$$\begin{aligned}\Pi_e &= \mathbf{E}\left[\Pi(\theta)|\,\theta \geq \widehat{\theta}^e\right] = \\ &= \int_{\widehat{\theta}^e}^{\infty} \Pi(\theta)dG(\theta) - (f+B)\left[1 - G(\widehat{\theta}^e)\right]\end{aligned}$$

The first term simply captures the fact that, in a given industry equilibrium, the entrepreneur will receive variable profits $\Pi(\theta)$ that depends on her productivity. However, conditional on remaining active on the industry, which happens with probability $1-G(\widehat{\theta}^e)$, the entrepreneur has to repay the debt with which she financed the entry stage, as well as the fixed costs associated with production f. Note that $B \geq F$, as the zero profits constraints of the lender at the entry stage must take into account the fact the firm may not be able to survive the industry. Instead, the debt at production stage is necessarily equal to f, as once θ is discovered, there is no longer any uncertainty on the profits that will be realized by the firm (provided the incentive compatibility constraint is satisfied).

Assuming that a fraction λ_e of the fixed costs F can not be monitored by the external lender, ex-ante, the number of entrepreneurs that receive finance is implicitly given by the equation associated with the financial constraints,

$$\frac{\omega\varphi L}{M_e}(1-\alpha) - (f+B) \times \left[\frac{\omega}{\varepsilon}\frac{\varphi}{[(1+\lambda)f+B]}\frac{L}{M_e}\right] \geq \lambda_e F$$

The repayment B must satisfy the expected zero profits constraints for the lender, i.e.

$$\Pr ob\left[\theta \geq \widehat{\theta}^e\right] \times B \geq F$$

Perfect competition among lenders drives B down till the point in which the above inequality is satisfied with equality, implying

$$B = \frac{(1+\lambda)fF}{\left(\frac{\omega}{\varepsilon}\frac{\varphi L}{M_e} - F\right)}$$

Combining the two inequalities hence yield an expression for the number of firms that receive finance, M_e which is implicitly given by the unique solution to

$$\begin{aligned}\frac{\omega\varphi L}{\varepsilon M_e} - \left(f + \frac{F}{\Pr ob\left[\theta \geq \widehat{\theta}^e\right]}\right) \times \Pr ob\left[\theta \geq \widehat{\theta}^e\right] &= \lambda_e F \Longleftrightarrow \\ \frac{\omega\varphi L}{\varepsilon M_e} - \frac{1}{(1+\lambda)}\left(\frac{\omega}{\varepsilon}\frac{\varphi L}{M_e} - F\right) &= (1+\lambda_e)F\end{aligned}$$

For the particular case in which $\lambda = 0$, so that financial market imperfections are present only at the entry decision, the equilibrium number of firms is given by

$$\frac{\omega\varphi L}{\varepsilon M_e} = \frac{F}{\lambda}\left[(1+\lambda)(1+\lambda_e) - 1\right]$$

We summarize the results of this model in the following

Proposition 1.2 *Higher financial market imperfections at the entry stage (higher λ_e)*

i) reduce the number of firms that enter the industry ***and*** *survive in the industry ($\frac{\partial M}{\partial \lambda_e} < 0$ and $\frac{\partial M_e}{\partial \lambda_e} < 0$)*

ii) increase the probability of surviving in the industry, conditional on entry ($\frac{\partial \widehat{\theta}^e}{\partial \lambda_e} < 0$)

iii) decrease the average productivity in the industry

Higher financial market imperfections at the production stage (higher λ)

i) increase the number of firms entering the industry ***but*** *reduce the number of firms surviving in the industry ($\frac{\partial M}{\partial \lambda_e} > 0$ and $\frac{\partial M_e}{\partial \lambda_e} < 0$)*

ii) reduce the probability of surviving in the industry, conditional on entry ($\frac{\partial \widehat{\theta}^e}{\partial \lambda} > 0$)

iii) increase the average productivity in the industry conditional on survival

Discussion

The model underlines the different implications of financial market imperfections (FMI) on industry entry and exit rates. Financial constraints at the entry stage reduce the number of firms in the industry, and create a softer environment for firms that have good productivity draws. This implies that not only entry rates, but also exit rates will tend to be relatively small. This has profound implications for the productivity of the industry. Because of low entry, even firms which are not so productive can survive in the industry: the selection process is not very strong.

FMI at the production stage instead have quite opposite effects. First of all, they tend to raise the profits of surviving firms. However, they also have a direct effect on the number of firms that exit the industry. As in the first section, financial constraints at the production stage makes the selection process more competitive increasing the average productivity in the industry. FMI at the production stage also increase entry in the industry. This result is entirely due to the business stealing effect of the monopolistic competition framework we are using: FMI at the production stage increase profits by limiting competition. This effect dominates over the higher probability of having to exit the industry, and in total expected profits go up.

1.3.2 Heterogeneity in credit constraints

I now modify the previous analysis to allow for a second source of heterogeneity. I assume that in the population there are two groups of entrepreneurs: the "insiders" and the "outsiders". I assume that a fraction μ of the population are insiders and a fraction $1-\mu$ are instead outsiders. I assume that the insiders have an advantage when it comes to access external finance. Insiders can be thought as entrepreneurs which are embedded into local community networks that make it easier to raise external finance. Alternatively, it may be that insiders are simply richer entrepreneurs that have access to savings accumulated in other sectors of the economy. Entrepreneurs are heterogeneous in terms of productivity, as well as "institutional access". The environment described in this subsection is inspired by some empirical work done by economic historians on entrepreneurship in XIX° century New England (Lamoureux (1996) and Porter and Livesay (1971)) and by similar environments described in modern India (see e.g. Banerjee (2005) and Banerjee and Munshi (2004)).

To keep the analysis close to the framework in the previous section, I will consider the case in which the financial market imperfections λ differ across the two groups and, for simplicity, I will set $\lambda_i = 0$ and $\lambda_o = \lambda > 0$. A part from the distinction with respect to the exogenous differences in financial market access, the two groups are identical, in particular $G_i(\theta) = G_o(\theta) = G(\theta)$ at any $\theta \geq 1$.

In equilibrium there will be two thresholds $\widehat{\theta}_i$ and $\widehat{\theta}_o$ implicitly defined by

$$\alpha^{\alpha\varepsilon} A(\widehat{\theta}_g)^{\alpha\varepsilon}(1-\alpha) = (1+\lambda_g)f$$

where $g \in \{i, o\}$. Entrepreneurs with productivity θ belonging to group g can enter the industry if and only if $\theta \geq \widehat{\theta}_g$. Moreover, recalling the expression for A (and keeping the assumption that $G(\cdot)$ follows a Pareto distribution with shape parameter σ), we have

$$A = \frac{\varphi L}{\mu \int_{\widehat{\theta}_i}^{\infty} p(\theta)^{-\alpha_j \varepsilon_j} dG(\theta) + (1-\mu)\int_{\widehat{\theta}_o}^{\infty} p(\theta)^{-\alpha_j \varepsilon_j} dG(\theta)} = \frac{\varphi L}{\omega \alpha^{\alpha\varepsilon}[\mu \left(\widehat{\theta}_i\right)^{\alpha\varepsilon-\sigma} + (1-\mu)\left(\widehat{\theta}_o\right)^{\alpha\varepsilon-\sigma}]}$$

Noting that from the definition of $\widehat{\theta}_o$ and $\widehat{\theta}_i$ we necessarily have $\frac{\widehat{\theta}_o}{\widehat{\theta}_i} = (1+\lambda)^{\frac{1}{\alpha\varepsilon}} > 1$ and hence we can solve for the equilibrium as

$$\frac{\varphi L}{\omega[\mu \left(\widehat{\theta}_i\right)^{\alpha\varepsilon-\sigma} + (1-\mu)\left(\widehat{\theta}_i(1+\lambda)^{\frac{1}{\alpha\varepsilon}}\right)^{\alpha\varepsilon-\sigma}]}(\widehat{\theta}_i)^{\alpha\varepsilon}(1-\alpha) = f$$

which becomes

$$\left[\frac{\omega}{\varepsilon}\frac{\varphi L}{\left(\mu + (1-\mu)(1+\lambda)^{1-\frac{\sigma}{\alpha\varepsilon}}\right) f}\right]^{-\frac{1}{\sigma}} = \widehat{\theta}_i$$

and

$$\left[\frac{\omega}{\varepsilon}\frac{\varphi L}{\left(\mu(1+\lambda)^{\frac{\sigma}{\alpha\varepsilon}} + (1-\mu)(1+\lambda)\right) f}\right]^{-\frac{1}{\sigma}} = \widehat{\theta}_o$$

Some interesting properties of this framework deserves comments. First of all, it is clear that since $\frac{\widehat{\theta}_o}{\widehat{\theta}_i} > 1$ the insiders are, conditional on being active in the industry, less productive than the outsiders. Second, there are now two ways of conceptualizing a reduction in financial market imperfections. An increase in μ, raises the proportion of firms with perfect financial market access. I will refer to an increase in μ as an increase in "financial depth". The second way to think about better financial market is a reduction in λ, as in the previous section.

What are the effects of better financial markets on entry, firm's size and productivity levels in the industry? To tackle the issue of entry, we start noting that the total number of firms active in the industry is given by

$$M(\mu, \lambda) = \mu(1 - G(\widehat{\theta}_i)) + (1-\mu)(1 - G(\widehat{\theta}_o))$$

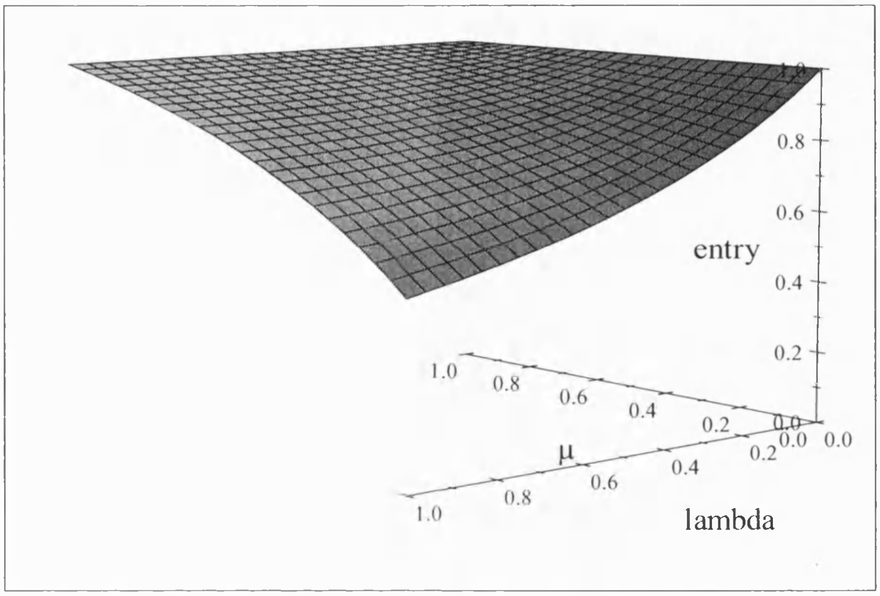


Figure 1.1: Heterogeneity in Financial Access: Entry

$$\frac{\mu}{\mu+(1-\mu)(1+\lambda)^{\frac{\sigma}{\alpha\varepsilon}-1}}+\frac{(1-\mu)(1+\lambda)^{-\frac{\sigma}{\alpha\varepsilon}}}{\mu+(1-\mu)(1+\lambda)^{\frac{\sigma}{\alpha\varepsilon}-1}}$$

which, recalling the equilibrium values of $\widehat{\theta}_i$ and $\widehat{\theta}_o$, can be rewritten as

$$M(\mu,\lambda)=\frac{\omega}{\varepsilon}\frac{\varphi L}{f}\left(\frac{\mu+(1-\mu)(1+\lambda)^{-\frac{\sigma}{\alpha\varepsilon}}}{\mu+(1-\mu)(1+\lambda)^{1-\frac{\sigma}{\alpha\varepsilon}}}\right)$$

It can be easily seen from this expression, that both higher financial depth (higher μ) and lower contractual imperfections (lower λ) increase entry in the industry, as illustrated in the figure. An increase in financial depth expands the mass of firms that are not financially constrained, by increasing the proportion of insiders in the industry. Note however that this beneficial effect on entry is partially offset by the fact that, because of increased competition, it will be harder for firms to remain in the industry, and hence both $\widehat{\theta}_o$ and $\widehat{\theta}_i$ go up). An increase in contractual imperfections decreases entry by reducing the number of outsiders in the industry. Again, this effect will be partially offset by the fact that, because of lower competition, more insiders firms will be able to enter the industry. For the case of an identical Pareto distributions across the two groups however, the first direct effect always dominates.

I now turn to the issue of firm size. Recall that the size (in terms of labour) of a firm with productivity θ is given by a function $x(\theta, A)$ such that $\frac{\partial x}{\partial \theta}$ and $\frac{\partial x}{\partial A}>0$. From the

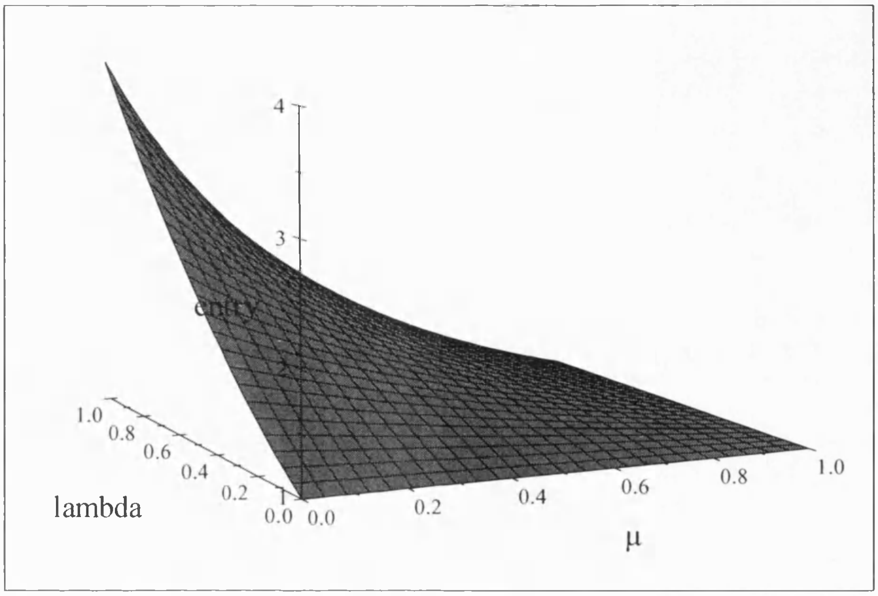


Figure 1.2: Heterogeneity in Financial Access: Firm's Size

expression above, it is easy to see that

$$A = K\left(\mu + (1-\mu)(1+\lambda)^{1-\frac{\sigma}{\alpha\varepsilon}}\right)^{-\frac{\alpha\varepsilon}{\sigma}}$$

for some positive constant K.

Improvements in financial markets have unambiguous effects on firm size. An increase in financial depth (higher μ) or a reduction contractual imperfection (lower λ) reduce firms' size by fostering the entrance of new firms in the industry and hence increasing competition.

Finally, I turn to the issue of average productivity. As before I compute P_{intra} as the unweighted average of the productivity levels of active firms in the industry, i.e.

$$P_{intra} = \frac{\mu\int_{\widehat{\theta}_i^e}^{\infty}\theta dG(\theta) + (1-\mu)\int_{\widehat{\theta}_o^e}^{\infty}\theta dG(\theta)}{\mu\left(1-G(\widehat{\theta}_i^e)\right) + (1-\mu)\left(1-G(\widehat{\theta}_o^e)\right)} = \frac{M_i\overline{\theta}_i + M_o\overline{\theta}_o}{M_i + M_o}$$

where M_g and $\overline{\theta}_g$ represent the mass and average productivity of firms that are active in the industry for the two groups $g \in \{i, o\}$. An increase in financial market depth (higher μ) or a reduction in contractual imperfections (higher λ) will have subtle effects on the productivity at the industry level. Consider the case of a decrease in λ. A first effect will be that more firms of the outsiders will be able to enter the industry. These firms are less productive than the average outsider firm, implying that $\overline{\theta}_o$ will go down. On the other hand, more outsiders firms will be in the industry, and hence M_o will go up. On the other hand, insider firms will face higher competition, implying that some of the least productive firms will exit the industry. This implies that $\overline{\theta}_i$ will go up, and M_i will go down. Since we know that $\overline{\theta}_o > \overline{\theta}_i$, it is possible that, if the effect on total entry in the industry $M_i + M_o$ is small, average productivity goes up.[3]

We conclude summarizing the results as follows,

Proposition 1.3 *Fewer contractual imperfections for the outsiders (lower λ)*

i) increase entry ($\frac{\partial M_e}{\partial \lambda} < 0$),

ii) conditional on entry, decrease firm's size ($\frac{\partial x(\theta)}{\partial \lambda} > 0$)

iii) have ambiguous effects on industry productivity ($\frac{\partial \overline{\theta}}{\partial \lambda} \lesseqgtr 0$)

Higher "financial depth" (higher μ)

i) increase entry ($\frac{\partial M_e}{\partial \mu} > 0$),

ii) conditional on entry, decrease firms size ($\frac{\partial x(\theta)}{\partial \mu} < 0$)

iii) have ambiguous effects on industry productivity ($\frac{\partial \overline{\theta}}{\partial \mu} \lesseqgtr 0$)

1.4 Conclusions

In this introductory chapter, we have presented a simple framework that helps in understanding the effects of financial markets on industrial structure. In particular we have focussed on the effects of financial market imperfections on entry levels, firms' size and industry productivity levels, in a context in which firms differ in terms of productivity. The analytical framework disentangles several aspects of financial market imperfections.

While I have shown that financial market imperfections tend to increase firm's size by reducing entry and competition in the industry, the model also emphasized that it is

[3] It turns out that, under the assumption of a Pareto distribution however, total entry always increases, and this effect always dominates.

important to distinguish how financial market imperfections are conceptualized. I have proposed a distinction between financial constraints at the entry stage and at the production stage. Financial market imperfections at the entry stage reduce the number of firms that enter the industry **and** survive in the industry, increase the probability of surviving in the industry conditional on entry and decrease the average productivity in the industry. In contrasts, financial market imperfections at the production stage increase the number of firms entering the industry **but** reduce the number of firms surviving in the industry, reduce the probability of surviving in the industry conditional on entry and increase the average productivity in the industry conditional on survival. The difference between the two forms of financial constraints is that in the former case financial constraints act as a barrier to entry, while in the latter case financial constraints increase the competitive pressure - the harshness of the selection process - in the industry.

We have also emphasized a second important distinction in the way financial market imperfections are conceptualized. In the presence of contractual frictions in the financial market, accumulated wealth and access to informal networks are important determinants of access to finance. Thus, financial market imperfections can be conceptualized as the frictions in the contractual environment as well as the "depth" of the local financial system, i.e. the proportion of firms that access to external finance. If firms are heterogeneous in terms of financial market access, the selection process in the industry implies that those that have privileged access will tend to be relatively less productive. An improvement of financial market access for these groups can end up hurting, through increased competition, the firms that have worse access to financial markets: i.e. precisely those firms that are relatively more productive. It seems that these considerations are important in evaluating the role of financial markets imperfection in situations in which an important part of the production is carried on in the informal sector of the economy, where access to finance may be difficult.

The framework of this chapter could be enriched in several dimensions. First of all, it would be interesting to consider general equilibrium implications of financial market imperfections. Secondly, it would be interesting to consider the effects of financial market imperfection in constraining firms growth and technology choice. In the next chapter, I consider the jointly determination of market structure and vertical integration. The framework can also be used to think about the effects of financial market imperfections on technology choice. In the appendix to this chapter I sketch a model in which financial constraints directly affect firms' size. The model is analytically more challenging, nevertheless it underlines some other important aspects of financial market imperfections.

1.5 Appendix: Credit Constraints and Distortions in Firms Size

In this appendix I consider the case in which potential entrants in the market do not have initial wealth to pay the fixed costs and a part of the variable costs. In order to produce they need an initial disbursement of

$$f + \mu\frac{x}{\theta}$$

where $\mu \in [0,1]$ is the proportion of variable costs that have to be paid up-front. When $\mu = 0$, only fixed costs have to be paid up-front. In this case credit constraints affects entry decisions, but conditional on entry there is no distortion with respect to the optimal size of a firm. This case is the one analyzed in the first section of the chapter. The analysis of the general case, while more cumbersome, delivers some additional implications on the effects of credit constraints, and it is sketched in this Appendix.

Denoting by $\frac{x(\theta)}{\theta}$ the labour used by firms with productivity θ to produce $x(\theta)$ units of output, and recalling the expression for the revenue function, the financial constraint for a firm with productivity θ is now given by

$$A\left(x(\theta)\right)^{\alpha} - \frac{x(\theta)}{\theta} - f \geq \lambda\left(f + \mu\frac{x(\theta)}{\theta}\right)$$

Profits are increasing and concave in $x(\theta)$, while the financial constraint is linearly increasing in θ. This implies that,depending on θ, the firm can be in one of the following three situation. Consider first the optimal $x(\theta)$ chosen by the firm in the absence of financial constraints on firm's size (i.e. $\mu = 0$). Under this scenario, we know that

$$x(\theta) = (\alpha A\theta)^{\varepsilon}$$

while variable profits are given by

$$\Pi(\theta) = \alpha^{\alpha\varepsilon}(1-\alpha)A^{\varepsilon}\theta^{\alpha\varepsilon}$$

It follows that if

$$\alpha^{\alpha\varepsilon}(1-\alpha)A^{\varepsilon}\theta^{\alpha\varepsilon} \geq (1+\lambda)f + \lambda\mu\left(\alpha A\right)^{\varepsilon}\theta^{\alpha\varepsilon}$$

the firm can choose the optimal size. This happens if

$$\theta \geq \theta^{*} = \left(\frac{1}{\alpha^{\alpha\varepsilon}A}\frac{(1+\lambda)f}{1-\alpha(1+\lambda\mu)}\right)^{\frac{1}{\alpha\varepsilon}}$$

An increase in competition, that is an exogenous decrease in A, raises the number of firms that are credit constrained, since $\frac{\partial \theta^*}{\partial A} > 0$.

Second, it can happen that a firm has a productivity θ such that the firm is constrained in size. This happens for intermediate values of $\theta \in [\theta^c, \theta^*)$. When this is the case, the financial constraint holds as an equality, and the size of the firm $x(\theta)$ is implicitly defined by it. The value of θ^c is implicitly defined by the two conditions,

$$\begin{aligned} A\left(\widetilde{x}(\theta^c)\right)^{\alpha} &= (1+\lambda)\left(f + \mu\frac{\widetilde{x}(\theta^c)}{\theta^c}\right) \text{ and} \\ \alpha A\left(\widetilde{x}(\theta^c)\right)^{\alpha} &= (1+\lambda)\frac{\mu\widetilde{x}(\theta^c)}{\theta^c} \end{aligned}$$

Solving the two equations, implies that

$$\theta^c = \frac{\mu}{\alpha\varepsilon}\frac{\left((1+\lambda)f\right)^{\frac{1}{\alpha\varepsilon}}}{\left((1-\alpha)A\right)^{\frac{1}{\alpha}}}$$

Finally, firms with productivity below θ^c can not enter the industry. We thus have that the size of a firm with productivity θ follows

$$x(\theta) = \begin{cases} (\alpha A\theta)^{\varepsilon} \text{ if } \theta \geq \theta^* \\ \widetilde{x}(\theta) \text{ if } \theta \in [\theta^c, \theta^*) \\ 0 \text{ if } \theta < \theta^c \end{cases}$$

Some properties deserve a comment. First, as stated in the following Lemma, the interval $[\theta^c, \theta^*)$ is never empty, that is there are always some firms that are constrained in size.

Lemma 1.1 *In any equilibrium the less productive firms are always credit constrained*

Proof. *Suppose not. For a given level of A, the least productive firm active on the market (with productivity level θ^c) is such that it earns operational profits equal to f, i.e. $\Pi(x(\theta^c)) = f$. This contradicts $A\left(\widetilde{x}(\theta)\right)^{\alpha} = (1+\lambda)\left(f + \mu\frac{\widetilde{x}(\theta)}{\theta}\right)$.* ■

Second, mark-ups are not constant anymore: firms that are constrained in size are smaller and charges higher mark-ups. Thus the model endogeneize the degree of price competition in the industry. Consumers willingness to pay for the products of size constrained firms being higher, the capital n the industry is misallocated. Finally, consider two firms with productivity $\theta_1 > \theta_2$. When the two firms are not constrained in size it is easy to show that the ratio of their sizes only depends on the ratio of their productivity levels, i.e.

$$\rho(\theta_1, \theta_2) = \frac{\widetilde{x}(\theta_1)}{\widetilde{x}(\theta_2)} = \frac{\theta_1^{\varepsilon}}{\theta_2^{\varepsilon}}$$

When both firms are constrained instead we will have that

$$\rho^c(\theta_1, \theta_2) = \phi(\mu, \lambda, A)$$

The relative size of firms is affected by the industry equilibrium and by the degrees of financial market imperfections. In this sense, the model endogeneizes the distribution of firm sizes. It is possible to show that

Proposition 1.4 *Assume $f > \varepsilon$. Then:* $\frac{\partial \rho^c(\theta_1,\theta_2)}{\partial \lambda} > 0$, $\frac{\partial \rho^c(\theta_1,\theta_2)}{\partial \mu} > 0$ *and* $\frac{\partial \rho^c(\theta_1,\theta_2)}{\partial A} < 0$

Proof. *First note that, since $\widetilde{x}(\theta)$ is implicitly defined as a solution to the equation $A\left(\widetilde{x}(\theta)\right)^{\alpha} = (1+\lambda)\left(f + \mu\frac{\widetilde{x}(\theta)}{\theta}\right)$, the implicit function theorem implies that*

$$\frac{\partial \widetilde{x}(\theta)}{\partial \theta} = \frac{(1+\lambda)\mu\theta^{-2}\widetilde{x}(\theta)}{(1+\lambda)\mu\theta^{-1} - \alpha A \widetilde{x}(\theta)^{\alpha-1}} > 0$$

since $(1+\lambda)\mu\theta^{-1} - \alpha A\widetilde{x}(\theta)^{\alpha-1} > 0$ is implied by the fact that $\widetilde{x}(\theta)$ is a solution to the equation defined by the credit constraint. Take $\theta_1 > \theta_2$, $\frac{\partial \widetilde{x}(\theta)}{\partial \theta} > 0$ implies that $\widetilde{x}(\theta_1) > \widetilde{x}(\theta_2)$. Using the financial constraint, this also implies that $\frac{\widetilde{x}(\theta_1)}{\theta_1} > \frac{\widetilde{x}(\theta_2)}{\theta_2}$. Moreover the implicit function theorem together with the financial constraint implies that

$$\frac{\partial \widetilde{x}(\theta)}{\partial \lambda} = -\frac{f + \mu\frac{\widetilde{x}(\theta)}{\theta}}{(1+\lambda)\mu\theta^{-1} - \alpha A \widetilde{x}(\theta)^{\alpha-1}} < 0$$

Since

$$sign\left[\frac{\partial \rho^c(\theta_1,\theta_2)}{\partial \lambda}\right] = sign\left[\frac{\partial \widetilde{x}(\theta_1)}{\partial \lambda}\widetilde{x}(\theta_2) - \frac{\partial \widetilde{x}(\theta_2)}{\partial \lambda}\widetilde{x}(\theta_1)\right]$$

we have

$$sign\left[\frac{\partial \rho^c(\theta_1,\theta_2)}{\partial \lambda}\right] = sign\left[\frac{\partial \widetilde{x}(\theta_1)}{\partial \lambda}\widetilde{x}(\theta_2) - \frac{\partial \widetilde{x}(\theta_2)}{\partial \lambda}\widetilde{x}(\theta_1)\right]$$

and substituting the expression for $\frac{\partial \widetilde{x}(\theta)}{\partial \lambda}$, we obtain

$$sign\left[\frac{\partial \rho^c(\theta_1,\theta_2)}{\partial \lambda}\right] = sign\left[-\frac{f + \mu\frac{x_1}{\theta_1}}{(1+\lambda)\mu\frac{x_1}{\theta_1} - \alpha A x_1^{\alpha}} + \frac{f + \mu\frac{x_2}{\theta_2}}{(1+\lambda)\mu\frac{x_2}{\theta_2} - \alpha A x_2^{\alpha}}\right]$$

From the budget constraint we can substitute $Ax^{\alpha} = (1+\lambda)\left(f + \mu\frac{x}{\theta}\right)$, *implying*

$$sign\left[\frac{\partial\rho^{c}(\theta_1,\theta_2)}{\partial\lambda}\right] = sign\left[-\frac{f+\mu\frac{x_1}{\theta_1}}{\mu\frac{x_1}{\theta_1}-\alpha\left(f+\mu\frac{x_1}{\theta_1}\right)}+\frac{f+\mu\frac{x_2}{\theta_2}}{\mu\frac{x_2}{\theta_2}-\alpha\left(f+\mu\frac{x_2}{\theta_2}\right)}\right] = sign\left[f(1-\alpha)-1\right] >$$

Since $\frac{x_1}{\theta_1} > \frac{x_2}{\theta_2}$. *The proofs for* $\frac{\partial\rho^{c}(\theta_1,\theta_2)}{\partial A}$ *and* $\frac{\partial\rho^{c}(\theta_1,\theta_2)}{\partial\mu}$ *are identical.* ■

The Lemma proves that, if we omit the feedback effect that λ has on the equilibrium level of A, when credit markets get better smaller firms receive relatively more capital than bigger firms. Improving credit market conditions improves the relative allocation of capital. Higher competition in the industry also shifts capital to the smaller firms, and in this sense improves the allocation of capital in the industry.

It is possible to show that there is a unique equilibrium, although an explicit solution is hard to obtain. The comparative statics with respect to λ is in general ambiguous, and depends on the shape of the underlying distribution of θ. In general, improving financial markets (lower λ) has a direct positive impact on the size of firms with $\theta \in [\theta^{c}, \theta^{*})$ and a negative effect on the size of firms that have $\theta \geq \theta^{*}$. There is also a direct effect that tend to increase the entry level, i.e. lower θ^{c}. This is however not a general property of the equilibrium. Since better financial markets allow some firms to become larger, competition in the industry increase. This effects makes it harder for firms to borrow, and hence finance entry. If the distribution of θ is such that an important mass of firms has productivity in the interval $\theta \in [\theta^{c}, \theta^{*})$, entry may actually decrease with better financial markets. In other words, financial market imperfections, by constraining the growth of productive firms, allow inefficient firms to survive in the industry.

In the absence of financial market imperfections, if θ is drawn from a Pareto distribution, than the distribution of firm's size would also be Pareto. In the presence of financial market imperfections however, the distribution in firms size will be distorted. Large firms will be even larger, while some firms that would have middle size are smaller. In this sense, financial market imperfections provide in this model a rationale for the so called "missing middle" feature of the firms size distribution in developing countries.

Chapter 2

Contractual Institutions, Financial Development and Vertical Integration: Theory and Evidence

2.1 Introduction

This chapter analyzes the different implications of contractual imperfections with suppliers of specific inputs and with external investors on the degree of vertical integration at the industry level. The main results are that contractual imperfections with specific input suppliers and with external investors have different effects on vertical integration. In particular, financial market imperfections affect vertical integration through two opposing channels: a direct negative, investment, effect and an indirect positive, entry, effect. I develop an industry equilibrium model with heterogeneous firms that combines a simple theory of vertical integration with a convenient parametrization of contractual frictions in specific input and financial markets. The model provides guidance on how to disentangle the opposing effects empirically. Using cross-country-industry data, I find robust correlations which are consistent with the predictions of the theoretical model. In particular, I show that countries with more developed financial systems are relatively more vertically integrated in industries that are dominated by large firms. This work presents novel evidence on international differences in the organization of production and their institutional determinants, complements the existing literature on the determinants of vertical integration, and raises new theoretical questions on the long standing issue of what determines firm boundaries.

Anecdotal evidence, as well as theoretical considerations, suggests the possibility of important cross-country differences in the organization of production in general, and in the degree of vertical integration in particular. For instance, the transaction cost approach to vertical integration (see e.g. Williamson (1975, 1985)) argues that when it is difficult to write detailed contracts, trading at arm's length results in excessive transaction costs. Vertical integration, by replacing the bargaining process with authority, reduces transaction costs and becomes, *ceteris paribus*, more likely when contracts are hard to write and enforce. Since less developed countries are characterized by poor contractual enforcement, firms in those countries are often thought to be larger and more vertically integrated (see e.g. Khanna and Palepu (1997, 2000)).

In a recent paper, Acemoglu et al. (2005) provide evidence on the cross country determinants of vertical integration and cast some doubts on these views. They show that countries with worse contractual institutions have higher degrees of vertical integration but these findings are entirely driven by industrial composition. Within industries, there is no evidence that countries with worse contractual institutions have higher degrees of vertical integration. Figure 1 confirms Acemoglu et al. (2005) findings using an alternative measure of vertical integration. It plots (the log of) the unweighted average of the ratios of value added over output[1] across 25 industries in the manufacturing sector against the (log of the) GDP per capita of each country. Figure 1 does not support the view that there is a higher propensity for firms to vertically integrate in poorer countries, and is instead consistent with anecdotal evidence suggesting that subcontracting arrangements are fairly extensive in the developing world and in late industrializing countries.[2]

Motivated by this evidence, this chapter investigates whether contractual insitutions, and in particular financial markets imperfections, affect vertical integration differently across industries. Since contractual imperfections severely affect the efficiency of transactions in financial markets[3], contractual imperfections with specific input suppliers and with external investors may be highly correlated requiring an analysis that disentangles their different roles.

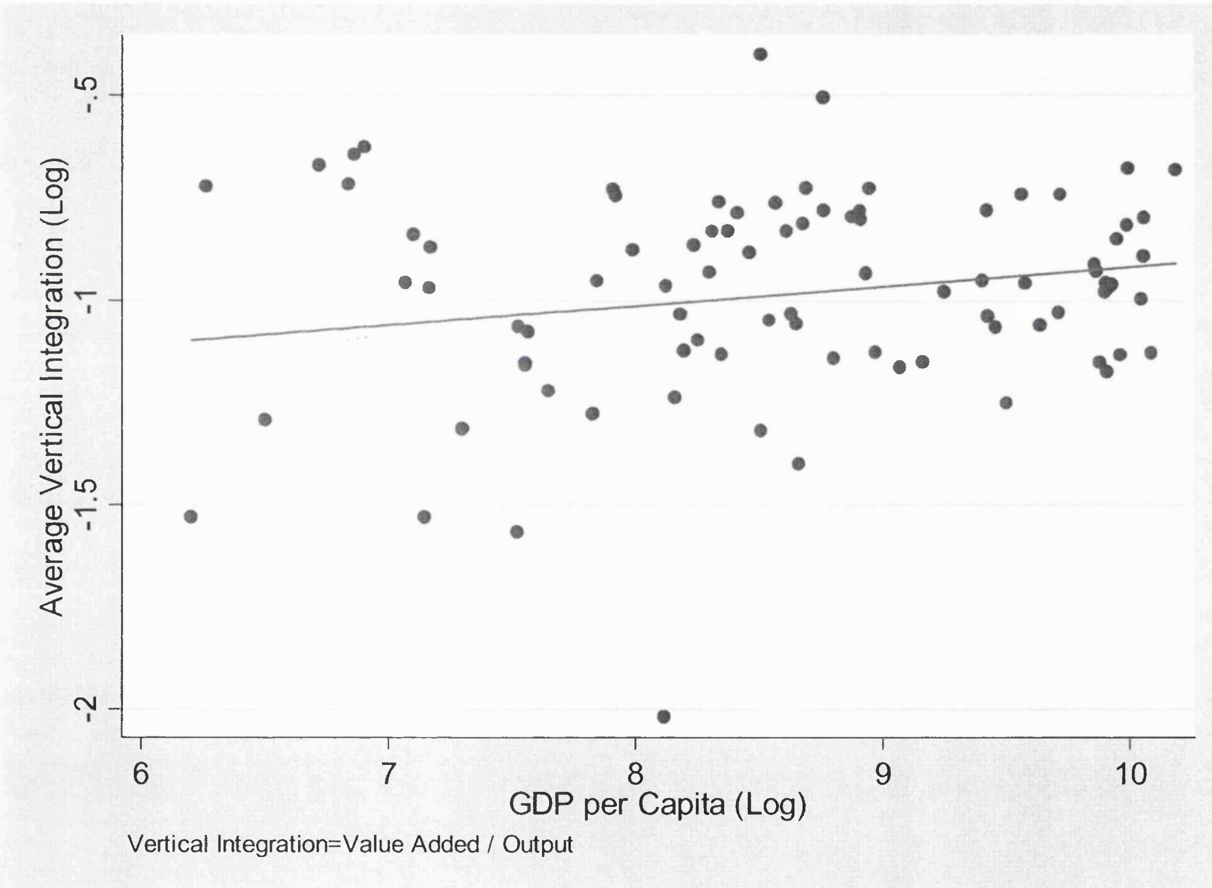
To provide such an analysis, I develop an industry equilibrium model of vertical integration with contractual imperfections in specific input and financial markets. I make one key

[1]Since Adelman (1955), a commonly used proxy of vertical integration in the industrial organization literature.

[2]See, for example, the experience of Italian industrial districts or the clusters in the early computer industry in Taiwan (Levy (1990)). Further examples from developing countries are given by the cotton industry in Tiruppur in southern India, the Guadalajara shoe cluster in Mexico (Woodruff (2002)), or the Sinos Valley in Brazil (Schmitz (1996)). Andrabi et al. (2004) provide an insightful analysis of the subcontracting arrangements of a large tractor producer in Pakistan.

[3]Cross-country studies show that measures of financial development are strongly correlated with legal origin and other aspects of the legal system (see e.g. LaPorta et al. (1998)).

Figure 2.1: Vertical Integration and GDP Per Capita



assumption: vertical integration economizes on the needs for contracting with specific input suppliers at the cost of higher contractual needs with external investors. I embed this model of vertical integration in an industry equilibrium model in which firms are heterogeneous with respect to their productivity levels, as in Melitz (2003).

The model shows that contractual frictions in the intermediate input market and in the financial market have radically different implications for the extent of vertical integration in the industry. Since fewer contractual frictions in the intermediate input market mitigate the hold-up problem associated with arm's length transactions, the first part of the assumption implies that better contractual institutions reduce vertical integration in the industry.

The second part of the assumption nicely captures the fact that contractual frictions in financial markets affect vertical integration in the industry through two conceptually distinct and opposed channels and is consistent with acnedotal evidence from case studies from developing countries and American business history that suggest that external finance availability is an important determinant of vertical integration. For instance, Porter and Livesay (1971) document how only (entrepreneurs linked by various ties to) rich merchants where able to pursue a strategy of backward integration into the production stages.[4] Financial market imperfections thus have a *direct (investment)* impact on vertical integration: since vertical integration implies higher financial needs, less developed financial markets allow less firms to become vertically integrated. The industry equilibrium of the model naturally captures a second *indirect (entry)* effect of financial markets on vertical integration. Contractual frictions in financial markets deter entry, and thus increase the profit base that allows firms to vertically integrate. This second effect is also consistent with acnedotal evidence from the ninetheenth century texitle industry. For instance, Temin (1988) and Brown (1992) shows that firms in less competitive environments created by financial underdevelopment and / or trade barriers were significantly more vertically integrated. Haber (1991) convincingly demonstrate that financial market imperfections have been an important barrier to entry in ninetheenth century texitle industry.[5]

Since the "investment" and "entry" effects have opposite sign the net impact of financial

[4]In a similar context, in a very detailed study of the Tiruppur cotton industry, Banerjee and Munshi (2004) analyze the effects of better access to local capital markets by different groups of entrepreneurs and conclude that entrepreneurs with better access to local finance are more vertically integrated and have greater control over the production process.

[5]These evidence is conssistent with the historical experience of other industries. For instance, Helper (1996) and Langlois and Robertson (1989)) discuss the case of the early American car industry. The absence of a positive trend in vertical integration in American manufacturing industries during the nineteenth century (a period that also witnessed the gradual development of capital markets and contract laws) is also consistent with the mechanics of the model (see, e.g., references in Perry (1989)).

market frictions on vertical integration is ambiguous. One of the key contributions of the model is to clarify in which industries the investment or the entry effect should be expected to be relatively stronger. The model implies that the "investment" effect is relatively more important, and hence better financial markets lead to higher vertical integration, in industries dominated by large firms, in which financial constraints are not a primary source of entry barriers. On the contrary, the "entry" effect is stronger, and hence better financial markets lead to lower vertical integration, in industries dominated by small firms, where financial market imperfections are more likely to be a powerful barrier to entry.

In section 3, I use cross-country-industry data to provide econometric evidence on the relationship between contractual imperfections and vertical integration. I find some evidence that better contract enforcement institutions affect vertical integration at the industry level consistently with the theoretical predictions. Most importantly, I show that countries with more developed financial markets are relatively more vertically integrated in industries that are dominated by large firms, as predicted by the theory.

This work is closely related to several strands in the literature. On the theoretical side there is a large literature on vertical integration and firm boundaries. The two dominant theories of firm boundaries are the transaction costs theory (TC) developed by Williamson (1971, 1975, 1985) and the property rights theory (PR), developed by Grossman and Hart (1986) and Hart and Moore (1990). The model in the theoretical section is most closely related to the former.[6]

While most of the theoretical work on firm boundaries presents partial equilibrium models, a new and rapidly growing literature analyzes models of firm boundaries and organization in industry equilibrium. The model in this chapter is more closely related to this literature, and in particular to Grossman and Helpman (2002). With respect to their framework, I introduce firm heterogeneity and credit market imperfections. The heterogeneity of firms is essential in generating the predictions on the differential effects of credit market imperfections on vertical integration across industries.[7] In his classical analysis of vertical integration and market imperfections, Williamson (1971) informally argued that in the

[6]While the two theories are conceptually different and have different empirical content (see e.g. Whinston (2003) and Gibbons (2004)), the adoption of a TC framework is not essential for our main results. In a PR tradition, Aghion and Tirole (1994), Legros and Newman (2004), and Acemoglu et al. (2006) consider settings in which ex-ante transfers are banned, an extreme form of financial markets imperfections.

[7]Antras (2003) and especially Antras and Helpman (2004) are also closely related. The latter in particular, analyzes an industry equilibrium model in which heterogeneous firms choose between FDI and outsourcing in a property rights framework. Other important recent contributions analyzing the internal organization of firms in industry equilibrum are Grossman and Helpman (2004, 2005) and Marin and Verdier (2002). Acemoglu et al. (2006) analyze an industry equilibrium model of the division of labor, while Acemoglu et al. (2003) analyze vertical integration in a Shumpeterian endogenous growth model.

presence of financial market imperfections, vertical integration may be used as a barrier to entry. The model in this chapter takes a different angle on the relationship between credit constraints, entry barriers and vertical integration and leads to different conclusions.

On the empirical side, Acemoglu et al. (2005) is a parallel and independent study that is most closely related to this chapter. In contrast to their work, the theoretical model in my chapter allows to separate different opposing channels through which financial development affects the degree of vertical integration across industries and countries. To do so, I focus in the empirical part on relative differences across industries within countries, while they mostly focus on industrial composition and within industries propensities towards vertical integration. The two works are thus highly complementary.

Antras (2003), Acemoglu et al (2004) and Aghion et al. (2006) are recent examples of cross-industry studies of vertical integration. Antras (2003) links firm boundaries to trade flows while Acemoglu et al (2004) exploit a very rich dataset on British manufacturing establishments to investigate the links between technological intensity and vertical integration. In a similar context, Aghion et al. (2006) analyze the relationship between vertical integration and competition.[8]

The rest of the chapter is organized as follows. Section 2 analyzes the theoretical model. Section 3 presents empirical evidence on the cross-country determinants of vertical integration using country-industry data. Section 4 provides some concluding remarks. Proofs and details about the main variables in the empirical analysis are in the Appendix.

2.2 Model

In this section I develop an industry equilibrium model of the relationship between vertical integration and contractual frictions with suppliers of specific inputs and external investors. The model shows that the two types of contractual frictions have different effects on vertical integration, that contractual frictions with external investors have an ambigous impact on vertical integration, and clarifies in which industries we should expect better financial markets to lead to more vertical integration.

This section is divided into three subsections. I first set up the model and introduce the contractual imperfections in input and financial markets as well as the distinction between

[8]There is a large literature on the determinants of vertical integration in specific industries in the United States (see Whinston (2003)). A large part of this literature focussed on testing the TC theory of the firm. I am not aware of empirical papers that systematically examine the relationship between vertical integration, and credit markets. Fee et al (2005) analyze corporate equity ownership in vertical relationships in the United States.

vertical integration and non-integration, and discuss the main assumptions. I then derive the industry equilibrium. In the third part I derive the effect of contractual imperfections on the degree of vertical integration in the industry and discuss the main results.

2.2.1 Set Up

Environment

I consider an economy with population L that produces goods using only labor. There are $J+1$ sectors. One sector provides a single homogeneous good. This good is used as the numeraire, and its price is set equal to 1. It is produced under constant return to scale, with a technology employing 1 unit of labor to produce 1 unit of the homogeneous good. Provided that the economy produces the homogeneous good, the wage will be $w = 1$. In the remaining of the chapter, I will assume that this is true. The other J sectors supply a continuum of differentiated goods. In each of these sectors there is a fixed set of potential entrepreneurs described later. Each firm is a monopolist over the variety it produces.

The workers are the only consumers, each endowed with 1 unit of labor. They all have the same CES preferences over the differentiated goods. A consumer that receives q_0 units of the homogeneous good, and $q(\theta)$ of each variety $\theta \in \Theta_j$ (to be determined in equilibrium) of the differentiated goods produced by industry $j \in \{1, ..j, ..J\}$, gets a utility U

$$U \equiv q_0^{1-J\varphi} \prod_{j=1}^{J} \left(\int_{\theta \in \Theta_j} q(\theta)^{\alpha_j} d\theta \right)^{\frac{\varphi}{\alpha_j}} \tag{2.1}$$

where $\varepsilon_j = \frac{1}{1-\alpha_j} > 1$ is the elasticity of substitution between two varieties of the differentiated goods in industry j.

If all varieties in the set Θ_j are available at a particular price $p(\theta)$ these preferences yield aggregate demand functions

$$q(\theta) = A_j p(\theta)^{-\varepsilon_j}$$

where $p(\theta)$ is the price of a particular variety θ and

$$A_j = \frac{\varphi L}{\left(\int_{\theta \in \Theta_j} p(\theta)^{-\alpha_j \varepsilon_j} d\theta \right)}$$

The monopolist of variety θ in industry j treats A_j as a constant, and so perceives a constant elasticity of demand ε_j. I denote $P_j = \left[\int_{\theta \in \Theta_j} p_j(\theta)^{-\alpha_j \varepsilon_j} d\theta \right]^{-\frac{1}{\alpha_j \varepsilon_j}}$ as the price index in industry j. The price index is inversely related to the "competitiveness" in the industry.

Competitiveness is, *ceteris paribus*, increasing in the number of varieties produced in the industry, and decreasing in the (average) price charged by competitors.

Production and Firm Organization

I now turn to the description of firms' technology and modes of organization in the industry. Since the set of potential entrepreneurs in each industry is exogenously given, and production of the homogeneous good in the economy implies $w = 1$, industries can be treated independently. Therefore, I suppress the subscript j from industry variables. With a slight abuse of notation, I assume that each differentiated final product $y(\theta)$ is produced under a constant marginal cost technology according to

$$y(\theta) = \theta I \tag{2.2}$$

where I is a specialized component described below.[9] I also assume that the specialized component must be exact in its specifications, and that different final goods require distinct components. An input must also be of suitably high quality in order to be useful in the production of the final output. Furthermore, I assume that there are fixed costs associated with entering the market.

Final goods may be produced by vertically integrated firms, or by specialized producers that purchase their inputs at arm's length from external suppliers (outsourcing). In either case I assume that an intermediate input of low quality can be produced at no cost.

The intermediate specific input is produced undertaking specific investments in a unit measure of (symmetric) tasks, each entailing a constant marginal cost c. The (quality of) the intermediate input is then a Cobb-Douglas aggregate

$$I = \exp\left(\int_0^1 \ln x(i)di\right) \tag{2.3}$$

where $x(i)$ denotes the level of investment in task i.

I consider a setting with incomplete contracting where investments in some tasks i can be observed by suppliers and the customers, but cannot be verified by a court. Because of this lack of verifiability, contracts specifying a certain price for a given quantity cannot be enforced since the supplier would have strong incentives to reduce her investment in some task i. Because of the contract however, the buyer would be forced to buy the input at the stipulated price.[10]

[9] It is straightforward to extend the model to allow for labor as an additional factor in the production of y, by having a production function of the form $y = \theta(\frac{L}{1-\eta})^{1-\eta}(\frac{I}{\eta})^{\eta}$.

[10] The literature however discusses alternative solutions to contractual incompleteness (see e.g. Maskin

Legal institutions vary greatly across countries. In order to capture the effects of different contractual institutions on vertical integration, I follow Acemoglu et al. (2006) in parametrizing the quality of the contract enforcement institutions in the following intuitive way. I assume that a measure μ of the tasks necessary to complete the intermediate input can be perfectly contracted upon, while a measure $(1-\mu)$ can not be contracted upon. While product and industry characteristics certainly affect the degree of contractual incompleteness in intermediate inputs transactions, contract enforcement institutions also affect the degree of incompleteness of contracts. In countries with better contracting institutions μ tends to be higher, i.e. it is relatively easy to enforce contracts that give appropriate incentives to undertake *ex-ante* investments.

There are two alternative ways of organizing the firm. Under vertical integration the entrepreneur retains control over all non contractible investments. Vertical integration entails centralized control, and thus the entrepreneur (efficiently) decides all the relevant investments $x(i)$.

Alternatively, the entrepreneur may decide to outsource to an independent supplier the production of the intermediate input. Under outsourcing the independent supplier retains control over the non-contractible investments. The absence of *ex-ante* enforceable contracts exposes parties to a hold-up problem. Once a supplier specializes its inputs to a particular final product, these inputs have higher value within the relationship than in any alternative uses. Assuming for simplicity that the value in alternative uses is zero, the downstream producer can then threaten to refuse the transaction with the upstream supplier, unless the price, negotiated once the investments are sunk, is low enough. This leaves the upstream supplier in a relatively weak position. Anticipating this situation, the upstream supplier has insufficient incentives to invest in the non-contractible tasks i.[11]

I assume that the marginal cost of investment $x(i)$ is equal to $c = 1$ in both vertically integrated firms and independent suppliers.[12]

The price for the intermediate input among two independent firms is negotiated *ex-post.*

and Tirole (1999) and Aghion et al. (1994)). I do not provide micro-foundations and take imperfect contracting as description of real commercial life.

[11] As in the property rights theory of the firm (Grossman and Hart (1986) and Hart and Moore (1990)) I assume that (some) tasks $x(i)$ are not contractible. However, in contrast to the property rights framework, I assume that control over tasks is contractible and transferrable, as in Baker et al. (2004). This brings the theory of the firm in this model closer to Transaction Costs theories of the firm (see e.g. Williamson (1975, 1985) and Grossman and Helpman (2002)).

[12] When labor is an additional factor of production the results in the model can be obtained regardless of the contractibility of L. It would also be possible to allow differences in marginal costs of investment in task $x(i)$ across organizational form, and in particular $c < 1$ for specialized suppliers, without affecting the results. Specialized suppliers may be more efficient than vertically integrated firms due to diseconomies of scope, or the excessive bureaucratic costs associated with a more complex, vertically integrated firm.

Ex-post, once the non contractible investments have been undertaken and the specific input produced, the two parties bargain over appropriable quasi rents which are given by the amount of profits that can be obtained using the specific input to produce the final good. To simplify, I assume that in the *ex-post* bargaining process the downstream firm retains a share $(1-\beta)$ of the revenues derived from the transaction, while the upstream firm retains the remaining share β. Treating industries in isolation, it is correct to interpret a higher μ as better contractual enforcement in the country, while a lower β parametrizes the extent to which the industry relies on contracts with suppliers. If β is high, the hold up problem is not particularly severe, while if β is low the hold up problem is very severe and significant underinvestment in the non-contractible tasks results as a consequence of contractual imperfections.

I assume that in each industry there is a fixed pool of potential entrepreneurs that are heterogenous with respect to their productivity θ. Each entrepreneur draws her productivity level θ from a distribution with associated continuous cumulative function $G(\theta)$ and observe her productivity before deciding whether to start production. To simplify, I also assume that the mass of potential entrepreneurs is equal to L in each industry. I take the distribution of the productivity parameter θ as exogenous.[13]

I assume that there is a large supply of homogenous external suppliers. This assumption implies that a firm deciding to "buy" the intermediate input always find a partner.[14]

Fixed costs and financial constraints

In order to start production, firms incur fixed costs, such as the costs of entering the market and setting up the organization and of designing the differentiated product, as well as those fixed costs associated with the equipment necessary to perform assembly operations. These costs have to be paid by all firms, regardless of the organizational form, and are denoted by f. In addition, firms that decide to become vertically integrated have to acquire control over the extra equipment needed to produce the intermediate inputs. I assume that the cost of this additional machinery is equal to k, and that both f and k are strictly positive. It is crucial that $k > 0$. This assumption introduces a trade-off between the two organizational forms which is central for the results. Vertical integration reduces the distortions associated with imperfect contracting in input markets, but comes at the cost of higher financial requirements for the firm. For our purposes, it is irrelevant

[13] However the marginal cost of producing one unit of the final good depends on the organizational form. Since firms with different θ choose different organizational forms, the distribution of measurable productivity is endogenous and is determined by the same forces shaping the organizational form choice.

[14] The assumption that suppliers are homogeneous implies that there are no matching / sorting issues between heterogeneous (in terms of θ) downstream and homogeneous upstream units, and is made for the sake of analytical tractability.

whether a firm deciding to become vertically integrated incurs the extra cost k in order to acquire one of the existing suppliers, or instead builds at cost k the necessary equipment from scratch.[15]

I assume that fixed costs have to be paid up-front, i.e. before production takes place and that firms have no liquidity and need to borrow from external investors in order to finance the fixed cost investment. I assume for simplicity that the risk free interest rate in the economy is equal to zero, and that a large supply of risk neutral investors lend capital at this interest rate. I model credit constraints in a rather crude, but simple, way. I assume that the fixed costs f and k need to be financed in advance, and are in fact composed of a continuum of small investments. I assume that a fraction $1 - \lambda$ of this investments is contractible: external investors can easily make sure that the capital is effectively invested in the project (for instance renting corporate buildings, acquiring specific machines, etc.). In contrast, the remaining fraction λ is not contractible, in the sense that the external provider of finance can not make sure that the capital is effectively invested in production (e.g. hiring the appropriate product designer, purchase of some specific services, etc.), and can be poketed by the entrepreneur.[16]

Denote with $\Pi_i(\theta)$ and F_i the variable profits and financial requirements of firms under organizational form $i \in \{v, o\}$.[17] In the Appendix I proove

Lemma 1

An entrepreneur with productivity θ obtains funding to set up a firm with organizational form $i \in \{v, o\}$ if and only if $\Pi_i(\theta) \geq (1 + \lambda)F_i$.

Lemma 1 describes the effects of the contractual frictions in the financial market associated with the two different organizational forms. If λ is equal to zero, credit markets are perfect, and all projects that generate (variable) profits in excess of the fixed costs (i.e. with positive net present value), are financed. However, if λ is positive, some projects

[15] The assumption that vertical integration entails higher fixed costs is common in the literature (see e.g. Williamson (1971), Grossman and Helpman (2002), Antras and Helpman (2004)). The assumption can be justified on different grounds such as, for example, "managerial" diseconomies of scales. Here I emphasize that in order to effectively acquire control over the production of the intermediate input a firm has to build its own plant, or must acquire an upstream supplier. In either case, these operations are assumed to be relatively more costly than dealing with an already established external supplier whose fixed costs are at least partially sunk.

[16] The case of a specialized assembler is slightly more complicated, since the relationship between the external investors and the entrepreneur is also affected by the presence of the independent supplier. Since fixed costs f have to be financed before the specific match with the supplier is realized, I focus on bilateral contracts.

[17] $F_v = f + k$ and $F_o = f$ are the financial requirements of vertical integration and outsourcing respectively.

that would generate positive net present value cannot be financed because of the form of moral hazard introduced by contract incompleteness in the capital markets[18].

To summarize, the timing of events is as follows. Entrepreneurs with heterogenous productivity θ decide whether to enter the market, as a vertically integrated firm or as a specialized manufacturer of final goods. Those that choose vertical integration as the organizational form of their firm and find external investors willing to finance them, borrow from external investors and pay the corresponding fixed costs, f and k and undertake production decisions. Those that decide to enter as assemblers of final good and find external investors willing to finance them, are matched to a supplier. Suppliers can make *ex-ante* transfers to attract assemblers. The assembler and the supplier write an *ex-ante* contract specifying an initial transfer from the supplier to the assembler, and investments on the fraction μ of contractible tasks. After this contract is signed, the supplier undertakes non-contractible investments i. Finally, bargaining over the surplus takes place, the final goods are produced and sold, and external investors are repaid.

2.2.2 Industry Equilibrium

I now turn to the determination of the industry equilibrium. In order to solve the industry equilibrium, I first compute the profit functions for a vertically integrated and for a non-integrated firm respectively. I then analyze the organizational form and entry decision of entrepreneurs with productivity θ, and define the industry equilibrium. The derivation of profit functions and proofs of all the results are reported in the Appendix.

In the Appendix I show that the variable profits of a vertically integrated firm are given by

$$\Pi_v(\theta) = \alpha^{\alpha\varepsilon} A \theta^{\alpha\varepsilon}(1-\alpha) \tag{2.4}$$

while the profits of a non-integrated firm are equal to

$$\Pi_o(\theta) = \alpha^{\alpha\varepsilon}\Omega(\beta,\mu) A \theta^{\alpha\varepsilon}(1-\alpha) \tag{2.5}$$

where $\Omega(\beta,1) = 1$, $\Omega(\beta,0) = \left(\frac{1-\alpha\beta}{1-\alpha}\right)$ and $\frac{\partial\Omega(\beta,\mu)}{\partial\mu} \geq 0$. Under both organizational forms, profits are increasing in the productivity index θ, and increasing in the index A, i.e.

[18] The formulation relies on a form of *ex-ante* moral hazard. However one could imagine that, once firms realize revenues, the owner of the firm can hide (a share of) profits at some per unit cost $\lambda \leq 1$, avoiding to repay the external investors. This form of *ex-post* moral hazard would generate a form of credit constraints equivalent to the one introduced in the text.

decreasing in the number of firms active in the industry.

We have

Lemma 2

There exists a unique threshold $\widehat{\theta}_v$ such that a firm with productivity $\theta \geq \widehat{\theta}_v$ earns higher profits choosing vertical integration rather than non integration. The opposite is true for $\theta < \widehat{\theta}_v$.

In particular the unique threshold $\widehat{\theta}_v$ is determined by the equality

$$\Pi_v(\widehat{\theta}_v) - (f+k) = \Pi_o(\widehat{\theta}_v) - f \Longleftrightarrow \widehat{\theta}_v = \left(\frac{k}{A\alpha^{\alpha\varepsilon}(1-\alpha)} \frac{1}{(1-\Omega(\beta,\mu))}\right)^{\frac{1}{\varepsilon-1}} \tag{2.6}$$

Note that the threshold θ_v is decreasing in A. This implies that, ceteris paribus, in more competitive markets θ_v is higher, i.e. fewer firms find it profitable to integrate vertically. This is simply due to the fact that in order for vertical integration to be profitable, a firm must generate enough profits to repay the additional fixed costs. Vertical integration reduces inefficiencies caused by contract incompleteness, and is relatively more attractive for entrepreneurs with higher θ (lower marginal costs): as a result vertical integrated firms are larger and more productive.

Firms however, are not unconstrained in their choice of organizational form. When $\lambda > 0$ financial constraints prevent some firms from adopting the optimal organizational form. Substituting the profit function of a vertically integrated firm into the respective financial constraint, we obtain that a firm with productivity θ can enter the industry as a vertically integrated firm if and only if

$$\Pi_v(\theta) \geq (1+\lambda)(f+k) \Longleftrightarrow \theta \geq \theta_v = \left(\frac{(k+f)(1+\lambda)}{A\alpha^{\alpha\varepsilon}(1-\alpha)}\right)^{\frac{1}{\varepsilon-1}} \tag{2.7}$$

The relative position of the two thresholds θ_v and $\widehat{\theta}_v$ determines whether financial constraints affect the vertical integration decision of firms. If $\theta_v \leq \widehat{\theta}_v$, financial constraints are irrelevant when making a vertical integration. However, if $\theta_v > \widehat{\theta}_v$ instead some entrepreneurs who would like to enter the industry as vertically integrated firms are prevented from doing so by the existence of financial constraints. In the remaining part of this chapter I will focus on the case in which $(1+\lambda)(1-\Omega(\beta,\mu)) > \frac{k}{(k+f)}$, and hence $\theta_v > \widehat{\theta}_v$, so that some entrepreneurs are constrained in their organizational form decision. A first implication of lower contractual frictions in the financial markets is that more entrepreneurs will be able to vertically integrate. Financial market imperfections thus impact vertical integration through a direct "investment" effect.

Finally, in order to solve for the industry equilibrium of the model I have to derive the thresholds determining whether an entrepreneur can enter the industry as a non-integrated firm. Combining the financial constraint inequality for a non-integrated firm with its respective profit function, it is obvious that an entrepreneur with productivity θ can enter the industry with a non-integrated firm if and only if

$$\Pi_o(\theta) \geq (1+\lambda)f \Longleftrightarrow \theta \geq \theta_e = \left(\frac{f(1+\lambda)}{A\alpha^{\alpha\varepsilon}(1-\alpha)\Omega(\beta,\mu)}\right)^{\frac{1}{\varepsilon-1}} \tag{2.8}$$

The following proposition characterizes the equilibrium in the industry.

Proposition 3

If $\frac{f}{(k+f)} \leq \Omega(\beta,\mu)$ *there exists a unique equilibrium defined by two thresholds* θ_e *and* θ_v*, such that entrepreneurs with* $\theta < \theta_e$ *do not enter the industry, entrepreneurs with* $\theta \in [\theta_e, \theta_v)$ *enter the industry as specialized assemblers, and entrepreneurs with* $\theta \geq \theta_v$ *enter the industry as vertically integrated firms.*

If $\frac{f}{(k+f)} > \Omega(\beta,\mu)$ *there exists a unique equilibrium defined by the threshold* θ_v*, such that entrepreneurs with* $\theta < \theta_v$ *do not enter the industry, and entrepreneurs with* $\theta \geq \theta_v$ *enter the industry as vertically integrated firms.*

The model generates an endogenous sorting of firms with heterogeneous productivity into organizational forms: only relatively more productive firms generate enough variable profits to cover the extra financial requirements necessary to vertically integrate. When $\frac{f}{(k+f)} \leq \Omega(\beta,\mu)$, the distortions associated with outsourcing are relatively mild, and both organizational forms coexist in equilibrium. On the other hand, when $\frac{f}{(k+f)} > \Omega(\beta,\mu)$, the inefficiencies caused by incomplete contracting are so strong that the industry only displays vertically integrated firms. A firm trying to enter the industry as a non-integrated firm would not generate enough profits to credibly commit to repay external investors.

The endogenous sorting of firms into organizational forms implies a positive correlation between firm's size and vertical integration. Moreover, since the specialized component is useless outside the relationship, quasi-rents are entirely determined by the scale of operation of the firm. The model thus predicts a positive correlation between quasi-rents and vertical integration. These predictions are consistent with anecdotal as well as more formal evidence.[19]

Large, and perhaps vertically integrated firms, are often believed to have easier access to financial markets, suggest the possibility that λ may vary with the organizational form of the firm, and in particular $\lambda_v < \lambda_o$. The main predictions of the model would be robust as far as $\frac{1+\lambda_o}{1+\lambda_v}\frac{f}{f+k} < \Omega(\beta,\mu)$. The model, however, suggests an alternative explanation for the presumption that vertically integrated firms, being larger, find easier access to finance. The underlying heterogeneity in productivity implies that vertically integrated firms are larger, and, while vertical integration requires more external finance, in a cross-section of firms vertically integrated firms are less likely to be financially constrained. This would also be true if instead of $k > 0$ we assumed that it is more difficult to monitor large and complex organizations, i.e. $\lambda_v > \lambda_o$ (as argued in Williamson (1971)).[20]

2.2.3 Main Predictions of the Model

I now turn to the analysis of the role that the institutional variables μ and λ play in determining the extent of vertical integration in the industry.

Following the seminal contribution in Adelman (1955), the empirical literature has often measured vertical integration as the ratio of valued added over sales. Intuitively, the ratio tells us the percentage of the value of production that is carried on within firm boundaries. In our model, the ratio of valued added over sales is equal to 1 for vertically integrated firms, and is instead equal to $(1-\beta)$ for non-integrated firms.

At the industry level, a convenient index of vertical integration is given by the average index of vertical integration of firms active in the industry. Denoting by N_v and N_o the number (measure) of vertically integrated and non-integrated firms respectively, the

[19] Acemoglu et al. (2005b) report positive correlation between size and vertical integration. The implication that vertically integrated firms are more productive, while not necessary for the results, is also consistent with empirical evidence (see e.g. Hortacsu and Syevrson (2005) on the cement industry in the U.S.). It is a common finding in empirical work in the transaction costs literature that higher quasi-rents are associated with higher vertical integration (see e.g. Whinston (2003) for a survey).

[20] While common in the literature, assuming $k > 0$ does not provide a satisfactory explanation of firm boundaries (see e.g. Gibbons (2004)) . On the other hand, assuming $\lambda_v > \lambda_o$ raises the interesting question of why vertical integration makes the monitoring by external investors more difficult. Macchiavello (2006) argues that vertical integration, by bringing the bargaining process inside the firm, reduces the amount of information that can be used by external investors to monitor the firm. Inderst and Mueller (2004), Faure-Grimaud and Inderst (2005) analyze models in which the organizational form of the firm affects the financial constraint of the firm. (see also the survey in Stein (2004)).

industry level index of vertical integration is given by

$$INT = \frac{N_o(1-\beta) + N_v \cdot 1}{N_o + N_v} = 1 - \beta\frac{N_o}{N_o + N_v} \tag{2.9}$$

I focus on the more interesting case $\frac{f}{(k+f)} \leq \Omega(\beta, \mu)$, in which both organizational forms coexist in the industry. When this is the case, in the industry equilibrium there is a mass of non-integrated firms equal to $G(\theta_v) - G(\theta_e)$, and a mass of vertically integrated firms equal to $1 - G(\theta_v)$. The average index of vertical integration in the industry is then given by

$$INT = 1 - \beta\frac{G(\theta_v) - G(\theta_e)}{1 - G(\theta_e)} \tag{2.10}$$

As is clear from this expression, the industry level index of vertical integration critically depends on the shape of the underlying distribution of productivity, $G(\theta)$. I make the following assumption

Assumption

θ is distributed in the population according to a generalized Pareto distribution, i.e.

$$G(\theta) = 1 - (1 + \frac{\sigma}{(1-\sigma)}\frac{(\theta-1)}{\overline{\theta}-1})^{-\frac{1}{\sigma}} \tag{2.11}$$

with $\theta \geq 1$, $\overline{\theta} \geq 1$ and $\sigma \in (0,1)$.[21]

The average productivity of the potential pool of entrepreneurs is parametrized by $\overline{\theta}$, while the shape of the distribution is conveniently parametrized by σ. For a given $\overline{\theta}$, the effect of different σ is depicted in 2.2.

When $\sigma = 1 - \frac{1}{\overline{\theta}}$, the distribution is a standard Pareto distribution. For $\sigma < 1 - \frac{1}{\overline{\theta}}$, the distribution has relatively lower density at low levels of θ, and higher density for large θ. The opposite is true for $\sigma > 1 - \frac{1}{\overline{\theta}}$. Proxying the size of the firm with revenues, equations 2.4 and 2.5 show that more productive firms (higher θ) are larger. Industries with low σ are dominated by (relatively) large firms, while industries with high σ are dominated by small firms.

[21] The density of a generalized Pareto is given by $g(\theta) = \frac{1}{\zeta}(1 + \sigma\frac{(\theta-1)}{\zeta})^{-1-\frac{1}{\sigma}}$. In order to perform comparative statics on ths shape parameter σ without simultaneously changing average productivity $\overline{\theta}$, I have fixed $\overline{\theta} = \int_1^{\infty} \theta dG(\theta) = \left(1 + \frac{\zeta}{1-\sigma}\right)$ substituting for the scaling parameter ζ to obtain the expression in the assumtpion.

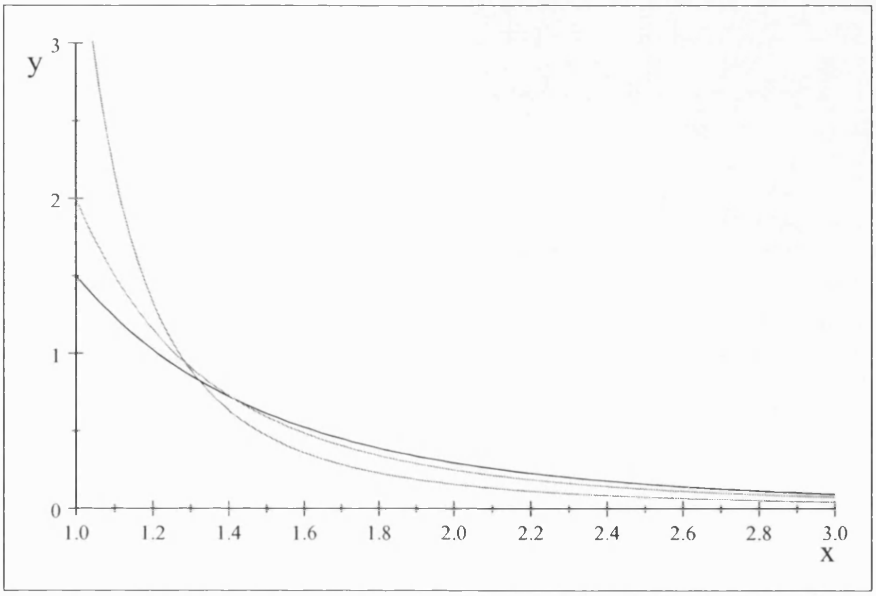


Figure 2.2: Generalized Pareto Distribution, for $\overline{\theta} = 2$, and $\sigma \in \{\frac{1}{3}, \frac{1}{2}, \frac{2}{3}\}$

Since this chapter is mainly concerned with identifying the role of contractual institutions on vertical integration, Propositions 4 and 5 provides comparative statics results with respect to contractual imperfections with input suppliers (μ) and external investors (λ).[22]

[22] With respect to industry parameters, it can be shown that vertical integration is increasing in $\overline{\theta}$ and decreasing in β and σ.

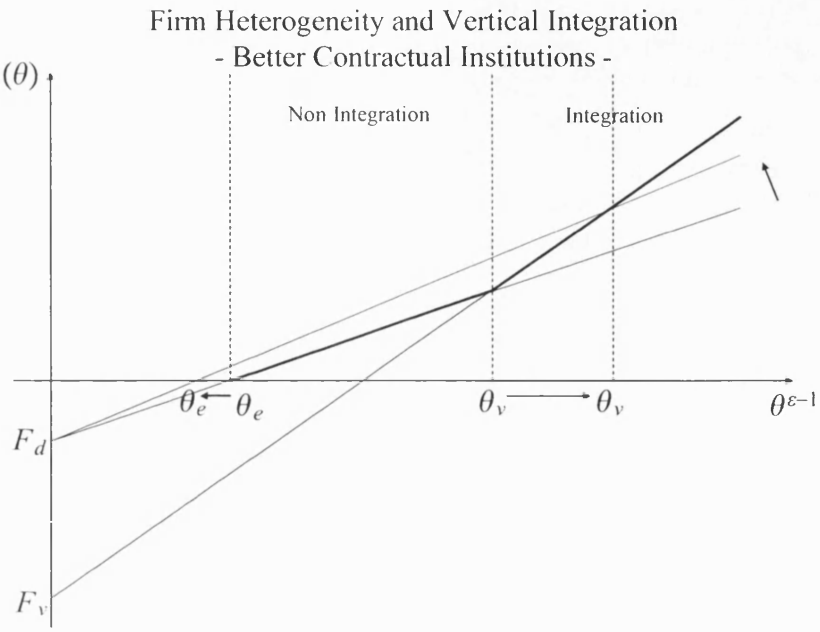


Figure 2.3: Comparative Statics and Industry Equilibrium (1)

Proposition 4

Assume $\frac{f}{(k+f)} < \Omega(\beta, \mu)$. *Better contractual institutions in input markets (higher* μ*) unambiguously reduces vertical integration in the industry.*

Proposition 4 considers the effects of changes in contractual institutions μ on the degree of vertical integration in the industry. There are two effects: a partial equilibrium effect and an industry equilibrium effect. The partial equilibrium effect is that the profits of a non-integrated firm increase, thus making non-integration relatively more profitable. This effect is illustrated in figure 2.3.[23] The figure reports the profits of firms with productivity θ under integration and non-integration. *Ceteris paribus*, better contract enforcement leads to a decrease in vertical integration in the industry, in the sense that fewer firms are vertically integrated. The industry equilibrium effect is due to the fact that, since non-integrated firms are relatively more efficient because of better contractual institutions, vertically integrated firms face higher competition. This implies that the profits of each firm with productivity $\theta \geq \widehat{\theta}_v$ decrease and this further shifts towards the right the threshold $\widehat{\theta}_v$. The industry equilibrium effect thus pushes further away from

[23]Since the industry equilibrium effect goes in the same direction as the partial equilibrium effect, it is not illustrated in Figure 5 in order to keep the analysis simpler.

vertical integration.[24]

Note that an implication of the model is that countries with better contract enforcement (higher μ) are *relatively more* vertically integrated in industries that heavily rely on contracts (low β). When β is very low the hold-up problem is so severe that non-integrated firms can not survive in the industry (remember that when β is too low, $\frac{f}{(k+f)} > \Omega(\beta, \mu)$). The vertical integration index is very high (in the model equal to one) regardless of contract enforcement μ. Industries with higher β instead will not be completely vertically integrated, and, as stated in proposition 4, will be more vertically integrated in countries with worse contract enforcement.

Proposition 5

Assume $\frac{f}{(k+f)} < \Omega(\beta, \mu)$. *Better contractual institutions in financial markets (lower* λ*) increase vertical integration if* $\sigma < 1 - \frac{1}{\theta}$ and *decrease vertical integration if* $\sigma > 1 - \frac{1}{\theta}$.

Proposition 5 considers the case of better capital markets (i.e. lower λ) and delivers the main prediction that I will test in the empirical section. As in the case of better contractual enforcement there are two different effects: a partial equilibrium effect, and an industry equilibrium effect.

The effects of imperfect financial markets are illustrated in figure 2.4. First, whenever $\lambda > 0$ some firms are credit constrained and cannot integrate vertically. Because of the sorting effect, only firms with productivity above a certain threshold are vertically integrated. When capital markets improve, the threshold moves towards the left, as it becomes easier to raise external funds. Since lack of financial resources is the only constraint on vertical integration, better financial markets have a positive (partial equilibrium) "investment" effect on the degree of vertical integration. However, better financial markets also favor the entry of new competitors in the industry. First of all, the marginal entrant is a non-integrated firm, an effect that counterbalances the previous effect. More importantly, new competitors in the industry implies that each firm earns fewer profits. This effect implies that fewer firms can become vertically integrated.

Proposition 5 states that the effect of better financial markets on vertical integration, while *a priori* ambiguous, crucially depend on the shape of the underlying distribution of productivity in the industry and thus clarifies when we should expect the "investment"

[24] This can be easily shown for the case in which θ follows a Pareto distribution in the industry. Under this circumstance the index of vertical integration only depends on the ratio $\widehat{\theta}_e/\widehat{\theta}_v$, it is easy to show that an increase in μ, raising $\Omega(\beta, \mu)$, reduces $\widehat{\theta}_e$ and thus implies lower vertical integration.

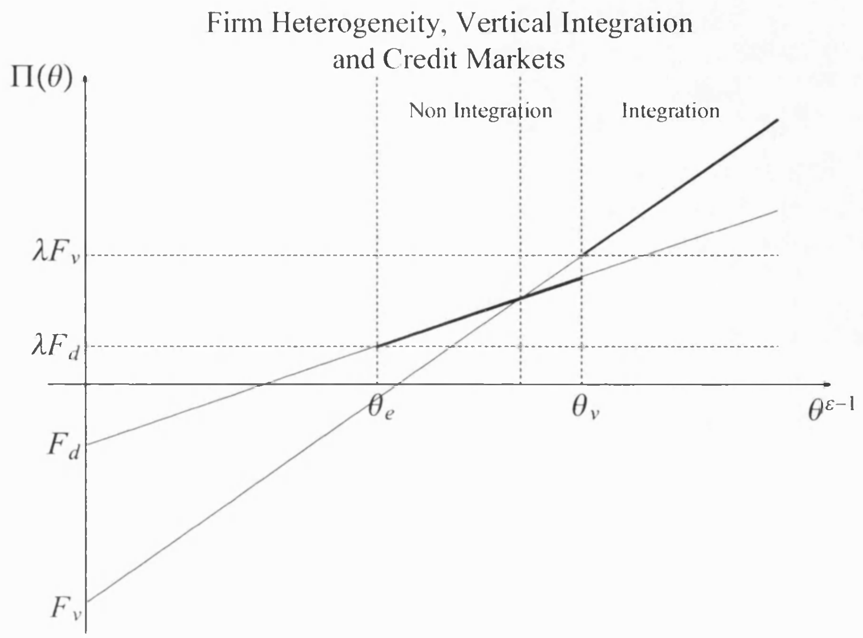


Figure 2.4: Comparative Statics and Industry Equilibrium (2)

or the "entry" effect to be stronger. Better financial markets increase vertical integration in industries that have relatively high densities at high θ, since the "investment" effect is relatively stronger in such industries. These industries are, for technological reasons, dominated by large firms, in the sense that a large share of output is produced in large firms. On the other hand, better financial markets reduce vertical integration in industries that have relatively high densities at low θ, since in those industries the "entry" effect is relatively stronger. These industries are instead dominated by relatively small firms, in the sense that a large share of output is produced by such firms.

This second effect differentiates the mechanics of the response of vertical integration to better contractual institutions in the capital markets compared with the effect of better contractual institutions in the specific input market. In the specific input market the industry equilibrium effect works in the same direction as the partial equilibrium effect, and the total effect is thus unambiguous. The model clarifies why contractual imperfections with suppliers of specific inputs, and with external investors impact vertical integration in radically different ways and provides a candidate explanation for why we do not find evidence that countries with better contractual institutions have lower degrees of vertical integration within industries (see Acemoglu et al. (2005)).

The fact that the relationship between credit constraints and vertical integration depends on other determinants of the firms size distribution in the industry is reminiscent of older informal arguments in the literature. In his pioneering paper on vertical integration and market failures, Williamson (1971) argues that, if borrowers are confronted by increasingly adverse rates as they increase their finance requirements, costs may not be independent of vertical structure. He goes on arguing that "established firms may use vertical integration strategically to increase finance requirements and thereby discourage entry if potential entrants feel compelled, as a condition of successful entry, to adopt the prevailing structure - as they may if the industry is highly concentrated" (Williamson (1971), pp. 119). The formal argument in the model reverses the perspective on vertical integration as a barrier to entry in the presence of financial markets imperfections and leads to different predictions. Since financial markets act as powerful barriers to entry, I show that poor functioning financial markets can lead to higher vertical integration if the industry is not highly concentrated.[25]

It is often argued that vertical integration may be a response to the difficulties of finding suitable and reliable suppliers. To the extent that institutional failures in developing countries hinder the development of upstream industries, it is expected that firms in the developing world are relatively more vertically integrated. The model developed so far assumed that a downstream firm always finds a potential supplier in the market. It is straightforward to relax this assumption in order to consider the effects of contractual imperfections in financial markets on the degree of vertical integration by examining the effect on the development of upstream industries. In the presence of credit market imperfections input markets become tighter, and it is more difficult to find a supplier for a non-integrated downstream assembler. This effect reduces the relative returns of non-integration in the industry, and is thus equivalent to a reduction in $\Omega(\beta, \mu)$ in the model in the previous subsection. We can state[26]

Proposition 6

Better contractual institutions in the financing of upstream industries reduce vertical integration in the downstream industry

In the next section I exploit cross-country variation in contractual institutions and cross-industry variation in contractual needs with specific input suppliers and with external investors to provide some evidence on the relationship between vertical integration and

[25] In the model the size of a firm is determined by the productivity parameter θ. Qualitatively similar results would be reached if wealth, instead of productivity, was the source of heterogeneity in firms size.

[26] A variation of the model presenting this argument formally is available upon request.

contractual imperfections. I mostly focus on the theoretical results in Proposition 5, which predicts that

1. Fewer contractual imperfections with external investors (lower λ) increase vertical integration in industries dominated by large firms, and decrease vertical integration in industries dominated by small firms.

   Since contractual imperfections with external investors (λ) and with input suppliers (μ) are likely to be highly correlated across countries, Proposition 4 suggest that we need to control for the additional effects of contractual imperfections with input suppliers. When we do so, we expect that

2. Countries with better contract enforcement are relatively more vertically integrated in industries with high contractual needs

   Finally, proposition 6 suggests that we also need to control for the additional impact that financial market development has on vertical integration through the development of upstream industries. In other words, we also expect that

3. Better credit markets reduce vertical integration by allowing more firms to enter upstream industries.

2.3 Empirical Evidence

In this section I use data on cross-country-industry differences in vertical integration in the manufacturing sector to provide formal empirical evidence on the relationship between financial market development and vertical integration. This section is divided into three subsections. I first describe the data, and in particular the indexes of vertical integration. I than discuss the specification used to test the main prediction of the model. I finally presents the main results and robustness checks. An Appendix contains details on the construction of the industry level variables used in the regressions, as well as further robustness checks.

2.3.1 Data

The main measure of vertical integration in industry i in country c comes from the UNIDO database. Following the industrial organization literature (see e.g. Adelman (1955)), I measure vertical integration in industry i in country c as the ratio of value added over output, i.e.

$$INT_{ic} = \frac{VA_{ic}}{Y_{ic}} \tag{2.12}$$

At the firm level, the measure captures the proportion of the production process that is carried out within firm boundaries. A higher value of the index is therefore associated with a higher degree of vertical integration.[27]

The data used to compute the index of vertical integration are from the 2001 edition of the UNIDO Industrial Statistics Database. Data are available for the manufacturing sector, and are aggregated at the three-digit level of the second revision of the ISIC Code classification system. This gives a total of 29 manufacturing industries. The data were supplied by national statistical offices and supplemented with estimates generated by UNIDO whenever necessary. The 2001 edition of the database covers 175 countries for the period 1963-1999. However, since period coverage as well as item coverage differ from country to country, I focus on a sample of 88 countries using the years from 1990 to 1998 inclusive. Since the analysis does not exploit time variation, I use only the average of the variable of interest for the period between 1990 and 1998. In the entire sample the index of vertical integration spans essentially all the unit interval. Table 1.a shows the average degree of vertical integration for each industry in the sample, and Table 1.b lists the countries used in the analysis.

In order to check for the robustness of the results, Table 6 reports results using a second measure of vertical integration in industry i and country c. This second measure is constructed from firm level information provided in Worldbase, a database maintained by Dun & Bradstreet, and follows the procedure in Acemoglu et al. (2005a). It exploits firm level information on primary 4-digit SIC code, and up to five other 4-digit SIC codes of secondary product lines for the firm, combined with input-output data from the United States. I describe in Appendix B the construction of this alternative measure in greater detail. I also restrict attention to the manufacturing sector and to the same sample of countries as for the UNIDO measure. The main advantages of the first measure are that it is a well known index of vertical integration and that data come from industrial statistics relying on Census information. While issues of comparability across countries and aggregation may introduce measurement error, the data are overall representative. The second measure instead has the advantage of being constructed from a very large firm level database, and exploit information on firms activities. Moreover, the industry classification allows me to consider two-digit input-output classification system, i.e. to break

[27] Because of data availability, I am constrained to use the index at the industry level. This aggregation may introduce measurement error. For example, the index is sensitive to the degree of intra-industry trade between vertically disintegrated firms within the industry.

up the manufacturing sector in 52 industries. However, the construction of the firm level index hinges on the use of input-output information from the United States, and large countries tend to be over represented in the sample.

I use two main different types of right-hand-side variables.[28] A first set of variables are various industry characteristics in the United States. The main ones are external financial dependency (Rajan and Zingales (1998) and author's calculations), importance of small firms, measured by the share of employees working in establishments with less than 100 or 500 employees (author's calculations from 1992 US census of industries), contractual needs, as proxied by the Herfhindal index of input shares (author's calculations) and external financial dependency of upstream industries (author's calculations). The Appendix describes the construction of these variables.

The second set of variables are country level measures of financial development and contractual institutions. The preferred measure of financial development is the average ratio of bank credit over GDP during the nineties, and it is taken from Levine (2005). Levine (2005) also provides alternative measures of financial development that I use in Table 5. Finally, I proxy contractual institutions with suppliers of specific inputs with (minus) the number of procedures mandated by law or court regulation demanding interactions between the parties or between them and the judge. I take this measure from the Doing Business database at World Bank available online, which follows the methodology in Djankov et al. (2003).

Table 1.c provides basic summary statistics for the industry level variables at the 3-digit ISIC level as well as for the country level variables in the sample.

2.3.2 Specification

I test the hypothesis that more developed financial markets increase vertical integration in industries dominated by large firms and decrease vertical integration in industries dominated by small firms. Since the model treats industries in isolation, the parameter for contractual imperfections in financial markets λ_{ic} can be thought as industry-country specific. Since I do not have data on exogenous variations in the supply of credit to industry i in country c, I follow Rajan and Zingales (1998) and proxy for λ_{ic} using an interaction between the degree of external financial dependency of industry i in the United States ED_i and a variable capturing the level of financial markets development FD_c in

[28] Whenever possible, I control for other variables at the industry country level (such as average firm size, number of establishment, average mark-up). Results are never affected by the inclusion or exclusion of these additional controls. Henceforth, I omit to discuss them in the remaining of the text.

country c.

The model predicts that the effect of λ_{ic} should be allowed to depend on other technological determinants of firm's size distribution in the industry, and in particular on the relative importance of small and large firms. In the main specification, I proxy the degree to which industry i relies on small firms with the share of employees working in establishments with less than 500 employees in industry i in the United States, SF_i.

Denoting by INT_{ic} the degree of vertical integration in industry i and country c, the baseline specification is given by

$$INT_{ic} = \beta_0 + \beta_1 (ED_i \times FD_c) + \beta_2 (ED_i \times SF_i \times FD_c) + \beta_3 (SF_i \times FD_c) + \eta_i + \mu_c + \varepsilon_{ic} \tag{2.13}$$

which can be rewritten in compact notation as

$$INT_{ic} = \beta_0 + \widehat{\beta} X_{ic} + \eta_i + \mu_c + \varepsilon_{ic} \tag{2.14}$$

where η_i and μ_c are a set of industry and country dummies and $\widehat{\beta} X_{ic}$ is a compact notation for the interactions of interest. I also include as controls a measure of average size and the number of firms in the industry. Since the regression includes country fixed effects, the estimate of the vector of coefficient β identifies relative propensity towards vertical integration. The coefficient β_1, for instance, tells wether countries with more developed financial markets are relatively more or less vertically integrated in industries that depend on external finance. Whether industries in countries with better financial markets are on average more or less vertically integrated can not be identified in the regression, because of the inclusion of the country fixed effects μ_c. In other words, the specification tests the empirical validity of the main predictions of the model by exploring whether country level measures of contractual imperfections have a differential impact across industries.

The use of industry characteristics from the United States to differentiate industries along technological characteristics deserves some comment. The interaction term proxing for λ_{ic} captures the specific channels through which it is reasonable to expect financial market development to affect vertical integration in a given industry (external financial dependency). The results reported below on the baseline specification and on a number of robustness checks document robust correlations which are consistent with the predictions of the model, and that show that financial markets impact vertical integration differently across industries. The use of industry characteristics in the United States can be thought as a convenient device to describe correlation patterns in the data.

The use of industry characteristics in the United States, introduced in the influential work by Rajan and Zingales (1998), has been extensively used in the literature on industrial development and finance (see for a survey Levine (2005)), and in recent papers on the determinants of trade (e.g. Nunn (2005)). This literature claims that under two distinct sets of assumptions, the use of industry characteristics from the U.S. allow for a causal interpretation of the coefficients estimated with equation 2.13. First, to the extent that markets in the United States are unregulated and well functioning, equilibrium variables in the U.S. can be taken as good proxies of technological characteristics inherent to the production process of a given industry. Second, if the ranking of industry characteristics in the United States is the same than in other countries, the technological characteristics of industry i in the U.S. are representative of technology in other countries. Under those two assumptions, the effect of financial development works through the specific channel of financial needs, thus increasing the likelihood of capturing a causal impact of financial markets development on vertical integration.[29] Since the validity of those two "identification assumptions" is hard to test empirically, I hope that the several robustness checks I include in the analysis will neverthless convince the reader that the correlation patterns I document in the data are robust to different specifications.[30]

In light of the theoretical predictions, I expect $\beta_1 > 0$ and $\beta_2 < 0$. When the technology of industry i is such that only a small fraction of employees work in small firms, the model predicts that better financial markets will lead to more vertical integration, and hence $\beta_1 + \beta_2 SF_i > 0$. When instead the technology of industry i is such that a big fraction of employees work in small firms, the model predicts that better financial markets will lead to less vertical integration, and hence $\beta_1 + \beta_2 SF_i < 0$.

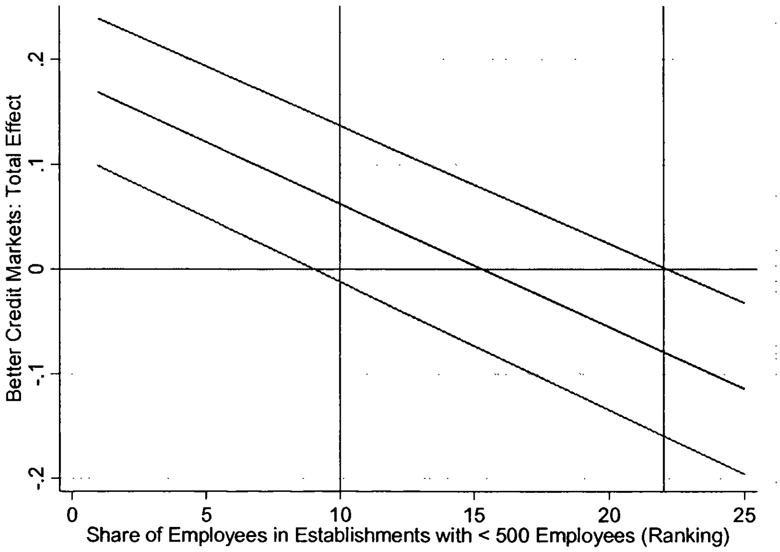
2.3.3 Results

Table 2 presents the main results. Column I reports the coefficient on the interaction of financial development and external financial dependency. As argued above, the model has ambiguous predictions on this coefficient, since better financial markets in industry i and country c can lead to higher or lower degrees of vertical integration depending on whether the industry is dominated by large or small firms. While the positive coefficient indicates that, on average, countries with better financial systems are relatively more vertically

[29] Note also that, even if measures of external financial dependency and firm's size distribution were available for industry i in country c, these measures should not be used in the analysis because these are likely to be endogenously determined and to be dependent on vertical integration.

[30] In line with the spirit of the main identification assumption, I run the regressions using the ranking of the industry level variables in the United States. Moreoever, I use the natural logarithm for the left-hand-side variables, and for all the country level variables used in the analyis.

Figure 2.5: Differential Effect of Better Credit Markets



integrated in industries that heavily depends on external finance, the relationship is not statistically different from zero.

As argued in the theoretical section, the effect of better financial markets on the degree of vertical integration should be allowed to depend on some proxy of other determinants of the size distribution of firms in the industry. Column II reports the results of estimating equation 2.13, in which I proxy the degree to which industry i relies on small firms with the share of employees working in establishments with less than 500 employees in the United States. In light of the theoretical predictions, I expect $\beta_1 > 0$ and $\beta_2 < 0$.[31] Consistently with the theoretical predictions, I find that in industries that rely on small firms, better financial markets have a negative impact on the degree of vertical integration ($\beta_1 + \beta_2 SF_i < 0$), while in industries that rely on large firms, better financial markets have a positive impact on the degree of vertical integration ($\beta_1 + \beta_2 SF_i > 0$). In other words, Columns II finds a positive, direct effect of financial development on vertical integration (the first coefficient increases with respect to Column I and becomes statistically significant). However, because the second coefficient is negative, larger, and statistically significant, the total effect is weaker (and for some industries negative), for industries that employ a large share of workers in relatively small establishments.

Figure 2.5 explains the differential impact of better credit markets on vertical integration. For any given industry, the total effect of the interaction between financial development

[31] Regressions in Columns II to VI in Tables 2 include the interaction between the variable SF_i and financial development to saturate the equation. I omit β_3 from the Table.

and external financial dependency is given by the sum of the coefficient in the first line of Table 2, plus the coefficient in the second line multiplied by the ranking of the industry with respect to the share of employees working in establishments with less than 500 employees. The y-axis reports the appropriate linear combination of the estimated parameters, while the x-axis reports the corresponding ranking. The Figures also reports the appropriate interval of confidence on the estimated total effect of better financial markets. The total effect is positive and statistically different from zero for the ten industries with the highest share of employees working in establishments with more than 500 employees. These industries include, for example, tobacco, iron and steel, transportation equipment and glass. The effect is instead negative only for the 4 industries for which the share of employees working in establishments with less than 500 employes is highest (wood manufacturing, leather, metal and non-metal products).

Columns III to VI present a first sequence of robustness checks.

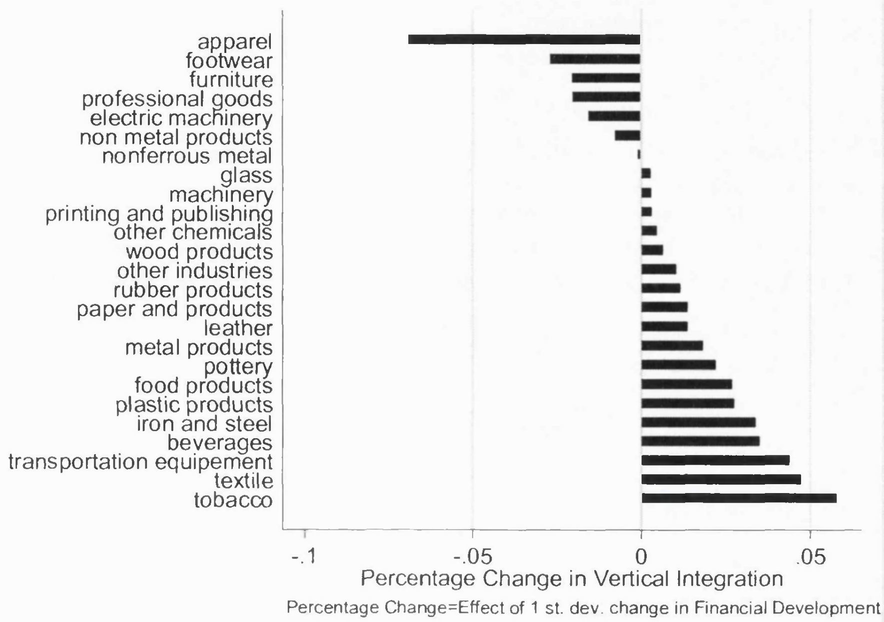
A first concern is that, as discussed at the end of the theoretical section, countries with better financial markets may have industries which are less vertically integrated, since financial market development fosters the development of input markets. Financial market frictions could thus induce more vertical integration through this separate channels. The inclusion of country fixed effects in the regressions controls for the possibility that better financial markets reduce vertical integration through the development of upstream industries only if these effects are the same across all the industries. However, industries largely differs in terms of their input requirements, and these differences may be correlated with the external financial dependency or the importance of small firms in the industry. Omitting to control for this additional channel would result in the coefficients of interest being biased.

In order to control for the possibility that financial market development impacts vertical integration through the development of upstream industries, I compute for each industry i a weighted average of the external financial dependency of the industries that sell inputs to industry i. I construct the weights using information from the input-output table of the United States. Denoting by ED_j the external finance dependency in industry j and by v_{ij} the share of use of input j in the production of i from the input-output table, the measure of external financial dependency of upstream industries for industry i is given by

$$EDU_i = \Sigma_{j \neq i} v_{ij} \times ED_j$$

The intuition is that, ceteris paribus, better financial markets should affect vertical integration relatively more in those industries that purchase inputs from industries that are,

Figure 2.6: Quantitative Effect



on average, highly dependent on external finance.[32]

In column III I add to the specification in Column II the interaction between financial market development in country c and the external financial dependency of upstream industries. The inclusion of this further interaction reinforces the results in Column II, since the absolute values of the coefficients β_1 and β_2 go up. Moreover, the coefficient on the interaction between financial market development in country c and the external financial dependency of upstream industries (β_4) confirms the intuition informally discussed at the end of the theoretical section. I find that countries with more developed financial systems are relatively less vertically integrated in industries that use inputs from industries that are more externally financial dependent.

What is the magnitude of the effects we are identifying? Figure 2.6 provides an answer to this question. In Column III the country level measure of financial development affects vertical integration through four different, and opposing, channels (estimated by the vector of coefficients $\beta = [\widehat{\beta}\ \beta_4]$). Figure 2.6 reports, for each industry, the average percentage change induced in the index of vertical integration by an increase in the index of financial

[32] Similarly to the identification strategy discussed above, the use of U.S. Input-Output table is justified by concerns that, because of various sources of input markets imperfections correlated with financial markets imperfections, industries in country c may substitute inputs in ways which are correlated with other determinants of vertical integration. I further describe the construction of the average external financial dependency of upstream industries in the data Appendix.

development of one standard deviation. In our sample, a difference of one standard deviation in the index of financial development is equivalent to the difference between the index of financial development in Algeria and South Korea. Figure 2.6 identifies that for some industries the net effect is positive (e.g. textile and transport equipment) while for other industries is negative (e.g. footwear), and is in the order of 3-5% points.[33]

An important concern with the regressions in Columns I to III is that, *within* industries, countries at different stages of the development process produce goods that differ in terms of factor intensities and value added. If those "within" industries product mixes differs systematically across industries with the level of financial development, the results in Columns I to III could be capturing those differences along with the effect of financial development on vertical integration.

Related to this concerns, since financial development is highly correlated with GDP per capita and with broader institutional quality it is possible that the coefficients in Columns I to III are also picking up the effects of other institutions on vertical integration that work differently across industries in a way which is correlated with the industry variables (external financial dependency and importance of small firms) included in the regression. While the relatively high level of aggregation makes it difficult to control for these within-industry compositional effects, Columns IV to VI try to address some of this concerns.

In Column IV I add the interaction between the degree of vertical integration in the United States in industry i and GDP per capita in country c. The idea of the interaction is to directly control for the possibility that richer countries produce goods that are relatively more similar to the goods produced in the United States, and should tend to be relatively more vertically integrated in the industries that are integrated in the US. Column IV shows that the results on the effects of financial development on vertical integration are stable to the inclusion of this further control, and moreover confirm the intuition that richer countries are relatively more vertically integrated in industries that are more vertically integrated in the United States, consistently with the idea that product mixes within industries changes systematically with respect to their degree of vertical integration as countries achieve different development stages.

Column V is more directly concerned with the possibility that financial development is capturing the effect of broader institutional quality on vertical integration. I control for the possibility that financial development is simply picking up the effects of broader

[33]While the effect identified in Figure 2.6 is the net effect of four coefficients working in different directions, each single effect has a larger magnitude. The inclusion of country fixed effects prevents the identification of the average effect of financial development on vertical integration. The effect depicted in the figure imply a change in the ranking of industries in terms of vertical integration (for the average country) for 9 out of the 26 industries in the sample.

institutional quality by controlling for the interaction between GDP per capita, a proxy of institutional quality, and all the industry level interactions used in Column III. Results are once again very robust, suggesting that financial development is not picking up the effects of the higher quality of other institutions on vertical integration. Moreover, none of the (unreported) interactions between the industry level variables and GDP per capita is statistically significant from zero, suggesting that the industry variables proxy for the appropriate channels through which financial development impacts vertical integration.

Finally, Column VI adds interactions between industry dummies and GDP per capita. This is done to capture the fact that industries are engaged in different production across countries, and more broadly that there may be broader omitted institutional factors that have differential impact across industries working through specific channels which are different from, but correlated to, external financial dependency. I find that the results are robust to the inclusion of these additional twenty-six controls. Quite remarkably the magnitude as well as the statistical significance of the coefficients are virtually unchanged.

The theoretical model emphasizes the differential impact of better contractual institutions in specific input markets versus contractual imperfections in financial markets. Table 3 investigates empirically the relevance of this distinction. Beyond exploring the robustness of the evidence in favor of the credit market story to the inclusion of additional controls considering contractual institutions, Table 3 presents some results that are of separate and independent interest.

I proxy better contract enforcement in country c (the parameter μ in the model) with (minus) the number of procedures mandated by law or court regulation demanding interactions between the parties or between them and the judge. I take this measure from the Doing Business database at World Bank, which construct the measure following the methodology in Djankov et al. (2003). I interact this measure of contractual enforcement with a measure of contractual intensity at the industry level in the U.S. I use as measure of contractual needs in industry i the (negative of the) Herfindahl index of input use. The rationale for using the Herfindahl index instead of the number of inputs used is that the number of inputs used would overestimate the importance of inputs that contribute only marginally to the production process. Instead I assume that industries that rely on a less concentrated set of suppliers are more exposed to hold-up problems (lower β in the model), and thus require more contractual provisions to mitigate hold-up problems.[34]

Column I shows that countries with better contractual enforcement are relatively more

[34] I describe the details for the construction of this measure in the data Appendix. This measure of contractual dependency has been previously used in the literature (see e.g. Levchenko (2005) and Blanchard and Kremer (1997).

vertically integrated in industries that have higher contractual needs. The coefficient between contractual enforcement and contractual needs is positive, large and statistically significant. This result is in line with the theoretical prediction of the model. Industries that have very high contractual intensity (low β) are so severely exposed to the hold-up problem that non-integrated firms can not survive in the industry (remember that when β is too low, $\frac{f}{(k+f)} > \Omega(\beta, \mu)$). The vertical integration index is very high (in the model equal to one) regardless of contract enforcement μ. Industries with lower contractual intensity (higher β) instead will not be completely vertically integrated, and will be more vertically integrated in countries with worse contract enforcement. It follows that countries with better contract enforcement are *relatively more* vertically integrated in industries that heavily rely on contracts.

Before re-introducing financial markets interactions to control for the robustness of the insights gained with Table 2 and separate the role of contractual imperfections with input suppliers and external investors, Column II checks that the relationship in Column I does not depend on the size distribution of firms, as the model predicts. I add further interactions with the variable proxing for the importance of small firms and find no statistically significant effect.

Column III reintroduces the interactions linking financial development and vertical integration through the two opposite and distinct channels emphasized in the theoretical section.[35] Results are again highly robust, and the coefficients clearly identify the different role of contractual imperfections with input suppliers and external investors in shaping vertical integration.

Since financial development and contract enforcement are highly correlated, Column IV adds the cross-interactions between financial dependency and contractual enforcement, and financial development with contractual intensity in order to check that the two measures of contractual imperfections with suppliers and investors are indeed working (exclusively) through the appropriate channels.[36] Once again, Column IV shows that the results are highly robust both in terms of magnitudes and statistical significance. Moreover, the coefficients on the cross interactions are small and not statistically significant, suggesting that the main interactions of interest are indeed disentangling the role of contractual imperfections with input suppliers and external investors, instead of simply picking up the effects of broader contractual environment.

[35] I also include, but do not report, the interaction between financial market development in country c and the external financial dependency of upstream industries for industry i. The coefficient is always negative and statistically significant as in Table 2.

[36] I also include, but do not report, interaction between contract enforcement and importance of small firms, and the corresponding triple interaction with external financial dependency to saturate the equation. None of these interactions is statistically significant.

Finally, Columns V and VI add the same set of controls than the corresponding columns in Table 2. Column V adds interaction between the industry level variables and GDP per capita, while column VI adds interactions of industry dummies with GDP per Capita. Results are once again highly robust to those two alternative specifications.[37]

To summarize, the available data recommended the use of interactions of industry variables in the United States with country level variables proxing financial development to investigate the effects of contractual imperfections with external investors on vertical integration at the industry level, in a cross-country perspective. While this methodology requires strong identification assumptions to interpret the resulting evidence as causal, the results presented in this section and the further robustness checks reported in the Appendix, present very robust cross-country-industry correlations that are consistent with the main predictions of the model and shed some light on the ambiguous role of contractual institutions in general, and financial development in particular, in shaping international differences in vertical integration.

2.4 Conclusion

This chapter shows that contractual imperfections with suppliers of specific inputs and with external investors have radically different effects on the degree of vertical integration at the industry level. The main result is that financial market imperfections affect vertical integration through two opposing channels: a direct negative, investment, effect and an indirect positive, entry, effect. Using cross-country-industry data I find that countries with more developed financial systems are relatively more vertically integrated in industries that are dominated by large firms, consistently with the predictions of the theoretical model. This work thus presents novel evidence on international differences in the organization of production and their institutional determinants, complements the existing literature on the determinants of vertical integration, and raises new theoretical questions on the long standing issue of what determines firm boundaries.

Much work remains to be done, both on the theoretical and on the empirical side. With respect to the theory, an important avenue for future research is to explore the general

[37] Contractual enforcement may also be measured with the percentage costs needed to enforce a debt contract. When this is done, the statistical significance of the contract enforcement channel is significantly reduced, while credit market variables improve their statistical significance. I have also checked whether (minus) ethnic fragmentation and average level of trust in the society are substitutes for poorly functioning judicial systems by running the same set of regressions interacting the measures of contractual needs with social trust and ethnic fragmentation. The results have the expected sign, but are not strongly statistically significant and are available upon request.

equilibrium implications of the different mechanisms underlined in the model of this paper, and their implications for cross-country patterns of industrial structure.

On the empirical front more effort should be devoted to the exploration of interactions between the institutional characteristics considered in this paper and the role of other institutional variables such as, for example, trade openness, informal networks and human capital. While the current analysis may improve our understanding of institutional determinants of vertical integration across countries, it is eventually of crucial importance to understand how differences in organizational forms affect productivity.

2.5 Appendix A

2.5.1 Proof of Lemma 1

Let us first consider the case of an entrepreneur borrowing K units of capital and signing a contract in which she commits to repay B out of her (variable) profits $\Pi(\theta)$. Of the K units of capital, a fraction $1-\lambda$ has to be invested in the project, since the investors can perfectly monitor such investments. The remaining amount λK can either be invested, or it can be diverted by the entrepreneur. If the entrepreneur invests, she generates revenues $\Pi(\theta)$, and she repays B. If instead she diverts cash, she obtains λK. She abstains from diversion if and only if $\lambda K \leq \Pi(\theta) - B$. When this inequality is satisfied, the entrepreneur repays the external investors with probability equal to one, since there is no uncertainty in production. Since external investors are risk neutral and on the long side of the market, $B = K$. The former inequality can be rewritten as

$$(1+\lambda)K \leq \Pi(\theta)$$

In this environment, an entrepreneur does not have the incentive to borrow more than what is required to finance the fixed costs to start production, and hence without loss of generality one can consider $K = f + k$ for a vertically integrated firm and $K = f$ for a firm entering the market as assembler. This proves the result for a vertically integrated firm. I now turn to the case of a non-integrated firm.

The sequence of events is as follows. First the final assembler finances the fixed costs f borrowing from the external investors, issuing an amount of debt equal to $B = f$. Then she is matched with an upstream supplier. Since suppliers are on the long side of the market, they compete in order to attract customers. Since they have deep pockets, they offer an *ex-ante* transfers $T(\theta)$ to an assembler with productivity θ. *Ex-ante* competition among suppliers, implies that the *ex-ante* transfers drive their profits to zero. *Ex-post*, the match realizes revenues $R(\theta)$, and the supplier retains a fraction β of these revenues. Denoting by $C(I)$ the costs of producing the intermediate input, *ex-ante* competition among suppliers implies that $T(\theta) + C(I) = \beta R(\theta)$. External investors hold claims on the assembler's *ex-post* profits $(1 - \beta)R(\theta)$ and on the *ex-ante* transfer $T(\theta)$, i.e. on $(1 - \beta)R(\theta) + T(\theta) = R(\theta) - C(I) = \Pi_o(\theta)$. Applying the same reasoning as for the case of a vertically integrated firm completes the proof of the Lemma.

2.5.2 Derivation of Profit Functions and Proof of Lemma 2

Under vertical integration, the firm chooses investments I to maximize profits

$$\Pi_v(\theta) = A^{1-\alpha}\theta^{\alpha}I^{\alpha} - C(I) \tag{2.15}$$

Since all elementary investments $x(i)$ are symmetric, and profits are a concave function of $x(i)$, the firm optimally sets $x(i) = \overline{x}$, for all $i \in [0, 1]$. The intermediate input becomes $I = \exp\left(\int_0^1 \ln \overline{x} di\right) = \overline{x}$, and hence profits can be rewritten as

$$\Pi_v(\theta) = A^{1-\alpha}\theta^{\alpha}\overline{x}^{\alpha} - \overline{x}$$

The first order condition with respect to $\overline{x}$ yields

$$\overline{x}(\theta) = \alpha^{\varepsilon}A\theta^{\alpha\varepsilon}$$

Substituting into the profit function yields $\Pi_v(\theta) = \alpha^{\alpha\varepsilon}A\theta^{\alpha\varepsilon}(1 - \alpha)$, which is the expression in the text.

I now turn to the profits of a non-integrated firm. Denoting x_c the contractible investment, and x_n the non contractible investments, profits can be written as

$$\Pi_o(\theta) = A^{1-\alpha}\theta^{\alpha}x_c^{\alpha\mu}x_n^{\alpha(1-\mu)} - \mu x_c - (1 - \mu)x_n \tag{2.16}$$

The sequence of events is as follows. First, firms contract on contractible tasks. Second, the upstream firm take the non contractible investements decision as given, and, anticipating *ex-post* bargaining, maximizes with respect to x_n her share of profits. I solve for the subgame perfect equilibrium.

The first order condition for the upstream firm gives

$$x_n = (\alpha\beta)^{\frac{1}{1-\alpha(1-\mu)}} A^{\frac{1-\alpha}{1-\alpha(1-\mu)}} \theta^{\frac{\alpha}{1-\alpha(1-\mu)}} x_c^{\frac{\alpha\mu}{1-\alpha(1-\mu)}}$$

Substituting this expression back into the profit function yields

$$\Pi_o(\theta) = A^{\frac{1-\alpha}{1-\alpha(1-\mu)}} \theta^{\frac{\alpha}{1-\alpha(1-\mu)}} x_c^{\frac{\alpha\mu}{1-\alpha(1-\mu)}} (\alpha\beta)^{\frac{\alpha(1-\mu)}{1-\alpha(1-\mu)}} \left(1 - (1-\mu)(\alpha\beta)\right) - \mu x_c \tag{2.17}$$

The contract, anticipating the choice of x_n picks up the optimal x_c. The first order condition is gives

$$x_c = \left(\frac{\alpha}{1-\alpha(1-\mu)}\right)^{\varepsilon(1-\alpha(1-\mu))} A\theta^{\alpha\varepsilon} (\alpha\beta)^{\alpha(1-\mu)\varepsilon} \left(1-(1-\mu)(\alpha\beta)\right)^{\varepsilon(1-\alpha(1-\mu))} \tag{2.18}$$

and by further substitution in the profits function, I obtain

$$\Pi_o(\theta) = A\theta^{\alpha\varepsilon}\alpha^{\alpha\varepsilon}(1-\alpha)\beta^{\varepsilon}\left(\frac{1}{\beta}\frac{1-\alpha\beta(1-\mu)}{1-\alpha(1-\mu)}\right)^{\varepsilon\alpha\mu+1} = A\theta^{\alpha\varepsilon}\alpha^{\alpha\varepsilon}(1-\alpha)\Omega(\beta,\mu) \tag{2.19}$$

When $\mu \to 0$ we obtain

$$\lim_{\mu\to 0} \Pi_o(\theta) = A\theta^{\alpha\varepsilon}(1-\alpha\beta)(\alpha\beta)^{\alpha\varepsilon}$$

while when $\mu \to 1$ we obtain

$$\lim_{\mu\to 1} \Pi_o(\theta) = A\theta^{\alpha\varepsilon}\alpha^{\alpha\varepsilon}(1-\alpha)$$

which are the profits of a vertically integrated firm.

I finally prove that profits are monotonically increasing in μ. Taking the logarithm of the profit function, I obtain

$$sign\left|\frac{\partial \log \Pi_o(\theta)}{\partial\mu}\right| = sign\left|\frac{\partial \log\left(\frac{1-(1-\mu)\alpha\beta}{1-\alpha(1-\mu)}\right)^{\varepsilon\alpha\mu+1}}{\partial\mu}\right|$$

Denoting $\Lambda(\beta,\mu) = \left(\frac{1-(1-\mu)\alpha\beta}{1-\alpha(1-\mu)}\right)^{\varepsilon\alpha\mu+1}$, and taking the derivative with respect to μ, gives

$$sign\left|\frac{d(\log\Lambda(\beta,\mu))}{d\mu}\right| = sign\left|\left(\ln\frac{1-\alpha\beta(1-\mu)}{1-\alpha(1-\mu)}\right) - \frac{(1-\beta)}{1-\alpha\beta(1-\mu)}\right| \geq 0$$

where the inequality follows from the fact that

$$sign\left|\frac{\partial^2 \log \Lambda(\beta,\mu)}{\partial\mu\partial\beta}\right| = sign\left|1 - \frac{1}{1-\alpha\beta(1-\mu)}\right| < 0$$

Note in fact that $\frac{\partial^2 \log \Lambda(\beta,\mu)}{\partial\mu\partial\beta} < 0$ implies that $\frac{d\log\Lambda(\beta,\mu)}{d\mu}$ reaches a minimum in $\beta = 1$, i.e. when $\frac{d(\log\Lambda(\beta,\mu))}{d\mu} = 0$, and thus is positive everywhere else. I have proved that $\frac{\partial \Pi_o(\theta)}{\partial\mu} \geq 0$. Combining this observation with the fact that $\lim_{\mu\to 1}\Pi_o(\theta) = A\theta^{\alpha\varepsilon}\alpha^{\alpha\varepsilon}(1-\alpha)$ proves Lemma 2 in the text.

2.5.3 Proof of Proposition 3

The condition $\frac{f}{(k+f)} \leq \Omega(\beta,\mu)$ ensures that $\theta_v > \theta_e$, and hence that the equilibrium is interior. Since A is in equilibrium a function of θ_v and θ_e, the two thresholds θ_v and θ_e defines a system of two equations in two unknown. Unicity of the equilibrium follows from the fact that the ratio $\frac{\theta_v}{\theta_e} = \frac{k}{f}\frac{(1-\alpha\beta)\beta^{\alpha\varepsilon}}{(1-\alpha)-(1-\alpha\beta)\beta^{\alpha\varepsilon}} > 1$ is constant, and that, by totally differentiating the expression for θ_e, we obtain

$$\begin{aligned}
\theta_e &= \left[\frac{f}{A(\theta_e,\theta_v)\,(\alpha\beta)^{\alpha\varepsilon}\,(1-\alpha\beta)}\right]^{\alpha\varepsilon} \Longleftrightarrow \qquad (2.20)\\
d\theta_e &= -\alpha\varepsilon\left(\frac{f}{(\alpha\beta)^{\alpha\varepsilon}\,(1-\alpha\beta)}\right)^{\alpha\varepsilon} A(\theta_e,\theta_v)^{-\varepsilon}[\frac{\partial A(\theta_e,\theta_v)}{\partial\theta_v}d\theta_v + \frac{\partial A(\theta_e,\theta_v)}{\partial\theta_e}d\theta_e]
\end{aligned}$$

which can be rewritten as

$$\frac{d\theta_e}{d\theta_v} = -\frac{KA(\theta_e,\theta_v)^{-\varepsilon}\frac{\partial A(\theta_e,\theta_v)}{\partial\theta_v}}{(1+KA(\theta_e,\theta_v)^{-\varepsilon}\frac{\partial A(\theta_e,\theta_v)}{\partial\theta_e}} < 0 \qquad (2.21)$$

since $\frac{\partial A(\theta_e,\theta_v)}{\partial\theta_v} > 0$ and $\frac{\partial A(\theta_e,\theta_v)}{\partial\theta_e} > 0$, if $\frac{dG(\theta)}{d\theta} > 0$.

When $\frac{f}{(k+f)} > \Omega(\beta,\mu)$ instead $\theta_v < \theta_e$, and only vertically integrated firms enter the industry. The unicity of the equilibrium follows from the fact that θ_v is decreasing in A, and that A is instead an increasing function of θ_v.

2.5.4 Proof of Proposition 4

Consider the (unweighted) average level of vertical integration in the industry given by the index

$$INT = 1 - \beta\left(1 - \frac{1-G(\theta_v)}{1-G(\theta_e)}\right) \tag{2.22}$$

Note that by taking the derivative w.r.t. μ we obtain

$$sign\left|\frac{\partial INT}{\partial \mu}\right| = -sign\left|\frac{g(\theta_v)\frac{\partial \theta_v}{\partial \mu}}{[1-G(\theta_e)]} - \frac{g(\theta_e)\frac{\partial \theta_e}{\partial \mu}}{[1-G(\theta_e)]}\frac{[1-G(\theta_v)]}{[1-G(\theta_e)]}\right| < 0$$

since $\frac{\partial \theta_v}{\partial \mu} > 0$ and $\frac{\partial \theta_e}{\partial \mu} < 0$.

2.5.5 Proof of Proposition 5

Taking the derivative of INT w.r.t. λ we obtain

$$\frac{\partial \widehat{INT}}{\partial \lambda} \geq 0 \Longleftrightarrow \frac{\frac{d\theta_e}{d\lambda}}{\frac{d\theta_v}{d\lambda}}\frac{g(\theta_e)}{g(\theta_v)} \leq \frac{1-G(\theta_e)}{1-G(\theta_v)} \tag{2.23}$$

since $\frac{d\theta_v}{d\lambda}$ (to see this, note that in equilibrium the ratio $\frac{\theta_e}{\theta_v}$ is constant and does not depend on λ). First we note that $\frac{d\theta_e}{d\lambda} = \frac{\partial \theta_e}{\partial \lambda} + \frac{\partial \theta_e}{\partial A}\frac{\partial A}{\partial \lambda}$ implies $\frac{d\theta_e}{d\lambda} = \left(\frac{1}{\alpha} - 1\right)\theta_e\left(\frac{1}{1+\lambda} - \frac{1}{A}\frac{\partial A}{\partial \lambda}\right)$ and similarly $\frac{d\theta_v}{d\lambda} = \frac{\partial \theta_v}{\partial \lambda} + \frac{\partial \theta_v}{\partial A}\frac{\partial A}{\partial \lambda}$ implies $\frac{d\theta_v}{d\lambda} = \left(\frac{1}{\alpha} - 1\right)\theta_v\left(\frac{1}{1+\lambda} - \frac{1}{A}\frac{\partial A}{\partial \lambda}\right)$, hence

$$\frac{\frac{d\theta_e}{d\lambda}}{\frac{d\theta_v}{d\lambda}} = \frac{\theta_e}{\theta_v}$$

Moreover, imposing that $G(\theta)$ is distributed according to a generalized Pareto distribution with mean $\overline{\theta}$ and shape parameter κ, i.e. $G(\theta) = 1 - (1 + \frac{\sigma}{(1-\sigma)}\frac{(\theta-1)}{\overline{\theta}-1})^{-\frac{1}{\sigma}}$, we obtain

$$\frac{\partial INT}{\partial \lambda} \geq 0 \Longleftrightarrow \theta_e(1 - \frac{\sigma}{(1-\sigma)}\frac{1}{\overline{\theta}-1}) \leq (1 - \frac{\sigma}{(1-\sigma)}\frac{1}{\overline{\theta}-1})\theta_v \tag{2.24}$$

Since $\theta_v > \theta_e$, the inequality is satisfied if and only if $1 - \frac{\sigma}{(1-\sigma)}\frac{1}{\overline{\theta}-1} > 0$, i.e. if $\left(1 - \frac{1}{\overline{\theta}}\right) > \sigma$.

2.6 Appendix B

2.6.1 Data Description

Vertical Integration from Dun&Bradstreet

The Wordbase dataset reports for each firm the primary 4-digit SIC code, and up to five other codes of secondary product lines for the firm. I only have access to information at the industry level, constructed in the following way. For each firm f in industry i in country c let V_{fic} the index of vertical integration,

$$V_{fic} = \frac{1}{2}\frac{1}{|I_{fic}|}\Sigma_i \Sigma_j v_{ij}$$

where v_{ij} is the input-output coefficient between industry i and industry j in the U.S., and $|I_{fic}|$ is the cardinality of the set of industries in which firm f is active, I_{fic}. Vertical integration at the industry level is given by the unweighted average of the indexes of vertical integration of firms in industry i and country c, i.e.

$$INT_{ic} = \frac{1}{N_{ic}}\Sigma_f V_{fic}$$

where N_{ic} is the number of firms in industry i and country c.

External Financial Dependency

I rely on the data provided in Rajan and Zingales (1998) for the regresssions using UNIDO database. For results in Table 6, I have computed the external financial dependency of 52 two-digit Input-Output industries. Starting from Compustat data, I have followed the methodology in Rajan and Zingales (1998) to compute the external financial dependency of 4-digit SIC industries. I have matched 4-digits codes with IO 2-digits codes and taken median values.

Small Firms

The variable "Small firms" is the share of employees working in establishments with less than 500 (or 100, in Table 4) employees in the United States. Data are from the 1992 Census of Industries. I have matched 4-digit SIC codes with 3-digit ISIC codes in order to provide aggregate figures at the 3-digit ISIC level in Tables 1 to 5. For Table 6 I have matched 4-digits codes with IO 2-digits codes.

External Financial Dependency of Upstream Industries

From the 1992 input-output table for the US, I construct an average measure of External Financial Dependency of upstream industries as follows. I construct input-output shares at the 3-digit ISIC level, using only flows within the manufactring sector. Denoting by ED_j the external financial dependency in 3-digit ISIC industry j and by v_{ij} the share of inputs purchased by (3-digit ISIC code) industry i from other (3-digit ISIC code) industries j, the measure is given by

$$EFDU_i = \Sigma_{j \neq i} v_{ij} \times ED_j$$

I use the same procedure in Table 6, at the 2-digit IO level.

Contractual Needs

Starting from the 1992 input-output table in the United States, I construct for each 6-digit IO industry the Herfindahl index of input use. Letting s_{ij} be the share of input use of industry i from industry j, the index is given by $HI_i = \Sigma_j s_{ij}^2$. I then match the 6-digit IO industry codes with 3-digit ISIC codes, and take the median value within industry groups to generate the measure of contractual needs in Table 3. For Table 6, I perform the same excercise at the IO 2-digit level.

2.6.2 Further Robustness Checks

In this subsection I check the robustness of the results to alternative measures of the main variables used in Table 2.

Table 4 presents results when I use different measures to proxy for the importance of small firms in the industry. Columns I, II and III present results from the same specifications of Columns III, V and VI from Table 2 when the importance of small firms is proxied by the share of employees working in establishments with less than 100, instead of 500, employees. Results are broadly robust, even if the statistical significance is somewhat reduced.

Columns IV, V and VI of Table 4 repeat the exercise when the importance of small firms in the industry is proxied by the share of employees working in establishment with less than 500 employees in the United Kingdom, and thus checks that the main results do not depend on the use of industry variables in the United States, and that the importance of small firms is really capturing technological features of the industry. Results for these specifications are very robust, and the magnitude of the coefficients of interest is somewhat increased.

Other concerns may arise with respect to the use of the ratio of bank credit over GDP as a measure of financial development. Table 5 presents results for the baseline specification using alternative measures of financial development. Column I uses the ratio of bank assets over GDP per capita. Results are robust to the use of this alternative measure of financial development. Column II proxies financial development with (the inverse of) bank concentration, as measured by the share of deposits of the three largest banks. Unfortunately this measure is available only for a smaller set of countries, significantly reducing the number of observations. On the other hand, this variable is closer in spirit to the anecdotal evidence on the relationship between financial markets and vertical integration in XIX century New England discussed in the introduction, since it proxies for the structure of the financial system. I find once again the main results to be robust to this specification. Finally column III reports results when financial development is measured by an index of legal rights of investors (from Doing Business database at World Bank). The advantage of this type of measure over measures of bank credit is that they are less directly an outcome variable related to the availability of credit. On the other hand, it is plausible that the index captures availability of credit with higher measurement error. I do not take the logarithm of the index to run the regression, and hence the coefficients are not directly comparable to the coefficients in Columns I and II. The main message of the analysis is consistent, even if statistical significance is reduced, possibly due to higher measurement error in the measure of credit availability.

The last two Columns of Table 5 instead present results for the baseline specification when I break the sample between OECD and non OECD countries. The results are once again robust, and I find evidence consistent with the theoretical predictions in both sets of countries, although the magnitude and statistical significance of the coefficients for the within non OECD countries are reduced. This can be due to the fact that vertical integration is measured with greater measurement error in poorer countries, and that there is less variation in financial development among those countries. Results are improved when I pool the sample, and impose the same industry fixed effects for OECD and non-OECD countries (results are available upon request).

In order to check for the robustness of the results, Table 6 reports results using a second measure of vertical integration in industry i and country c. This second measure is constructed from firm level information provided in Worldbase, a database maintained by Dun & Bradstreet, and follows the procedure in Acemoglu et al. (2005a). As noted above, the main advantages of the UNIDO measure are that it is a well known index of vertical integration and that data come from industrial statistics relying on Census information and are thus overall representative. The Worldbase measure has the advantage of being constructed from a large firm level database exploiting information on firms activities. The industry classification allows me to consider two-digit input-output classification system, i.e. to break up the manufacturing sector in 52 industries. On the other hand, the construction of the firm level index hinges on the use of input-output information from the United States, and large countries tend to be over represented in the sample.

Table 6 performs the same exercise of Table 2 with the second measure of vertical integration. Column I presents results from the baseline specification which are highly consistent with the theoretical predictions. Column II includes the interaction with external dependency of upstream industries, and Column III further introduces the interaction between contractual intensity and contractual enforcement. The magnitude and statistical significance of the coefficients β_1 and β_2 is virtually unchanged, but in contrast to the results in Table 2 and Table 3, the two further interactions in the third and fourth lines have the appropriate sign, but are not statistically significant.

Finally, Columns IV to VI repeat the exercise of the corresponding Columns in Table 2, by adding the interaction of vertical integration in the United States with GDP per capita (Column IV), the interaction of industry variables with GDP per capita (Column V) and interactions of fifty two industry dummies with GDP per capita (Column VI). While the statistical significance of the results is somewhat reduced, the magnitude and interpretation of the coefficients are once again unchanged.

TABLE 1A

Average Vertical Integration by Industry in the Sample

industry	Code ISIC	Vertical Integration	Industry	Code ISIC	Vertical Integration
food products	311	0.29	rubber prductus	355	0.39
beverages	313	0.48	plastic products	356	0.36
tobacco	314	0.56	pottery	361	0.52
textile	321	0.38	glass	362	0.45
apparel	322	0.41	non metal products	369	0.42
leather	323	0.33	iron and steel	371	0.31
footwear	324	0.39	nonferrous metal	372	0.28
wood products	331	0.38	metal products	381	0.38
furniture	332	0.40	machinery	382	0.41
paper and products	341	0.35	electric machinery	383	0.38
printing / publishing	342	0.47	transportation equip.	384	0.36
other chemicals	352	0.38	professional goods	385	0.44
petroleum raffineries	353	0.29	other industrries	390	0.41

TABLE 1B

List of Countries in the Sample

Algeria	Costa Rica	Indonesia	Namibia	Singapore
Argentina	Cote d'Ivoire	Iran	Nepal	Slovakia
Australia	Croatia	Ireland	Netherlands	Slovenia
Austria	Czech	Israel	New Zeland	South Africa
Bangladesh	Denmark	Italy	Nigeria	Spain
Belgium	Ecuador	Jamaica	Norway	Sri Lanka
Bolivia	Egypt	Japan	Oman	Sweden
Bosnia	El Salvador	Jordan	Pakistan	Syria
Botswana	Ethiopia	Kenya	Panama	Tanzania
Brazil	Fiji	South Korea	Paraguay	Thailand
Bulgaria	Finland	Kuwait	Peru	Tunisia
Burundi	France	Latvia	Philippines	Turkey
Cameroon	Ghana	Macedonia	Poland	Unit. Kingdom
Canada	Greece	Malawi	Portugal	Venezuela
Centr. African Rep.	Honduras	Malaysia	Romania	Zambia
Chile	Hong Kong	Mexico	Russian	Zimbabwe
China	Hungary	Mongolia	Senegal	
Colombia	India	Morocco	Sierra Leone	

TABLE 1C

Descriptive Statistics

	Observations	Mean	St. Dev	Min	Max
Main Industry Variables					
Vertical Integration	28	0.50	0.12	0.17	0.75
External Financial Dependency	28	0.24	0.33	-0.45	1.14
Share of Small Firms	28	0.38	0.16	0.06	0.64
External Financial Dependency of Upstream Industries	28	0.33	0.10	0.11	0.55
Contractual Needs	28	0.17	0.04	0.12	0.33
Main Country Level Variables					
GDP per Capita (Log)	89	8.61	1.04	6.2	10.18
Bank Credit / GDP	89	0.37	0.29	0.03	1.45
Number of Procedures	89	29.29	11.32	11	58

TABLE 2: FINANCIAL MARKETS AND VERTICAL INTEGRATION

Vertical Integration: UNIDO Measure	I	II	III	IV	V	VI
External Financial Dependency × Financial Development	0.040	0.178***	0.191***	0.173***	0.173**	0.168**
	[0.030]	[0.063]	[0.064]	[0.066]	[0.089]	[0.087]
External Financial Dependency × Financial Development × Empl. in Small Firms		-0.264***	-0.285***	-0.256***	-0.245**	-0.240**
		[0.091]	[0.094]	[0.097]	[0.113]	[0.109]
External Financial Dependency of Upstream Industries × Financial Development			-0.049**	-0.041*	-0.061*	-0.059*
			[0.021]	[0.022]	[0.034]	[0.034]
Vertical Integration in U.S. × GDP per Capita				0.086*	0.088*	0.067
				[0.045]	[0.046]	[0.086]
Industry Dummies	yes	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes	yes
Vertical Integration U.S. × GDP Per Capita				yes	yes	
Industry Characteristics × GDP Per Capita					yes	
Industry Dummies × GDP Per Capita						yes
Observations	1734	1734	1734	1734	1734	1734
R-squared	0.52	0.52	0.52	0.53	0.53	0.54

***, ** and * mean statistically significant at 1%, 5% and 10% respectively. Robust standard errors clustered at the country level are reported in parenthesis. Vertical Integration is the (log of the) ratio of Value Added over Output at the Industry level (source: UNIDO 2001 database). Financial Development is the (log of the) ratio of Bank Credit over GDP (source: Levine (2003)). External Financial Dependency (source: Rajan and Zingales (1998)). Employment in small firms is the share of employees in establishment with less than 500 employees (source: author's calculations). External Financial Dependency of Upstream Industries (source: author's calculations). I use the ranking of the industry level variables.

TABLE 3: DISENTANGLING CONTRACTS WITH INVESTORS AND INPUT SUPPLIERS

Vertical Integration: UNIDO Measure	I	II	III	IV	V	VI
Contractual Needs × Quality of Contract Enforcement	0.210***	0.393**	0.220***	0.273***	0.249***	0.272***
	[0.056]	[0.181]	[0.060]	[0.111]	[0.070]	[0.082]
Contractual Needs × Qual. of Contr. Enforc. × Empl. in Small Firms		-0.415				
		[0.333]				
External Financial Dependency × Financial Development			0.170***	0.163**	0.149*	0.156*
			[0.064]	[0.071]	[0.085]	[0.085]
External Financial Depend. × Financ. Developm. × Empl. in Small			-0.274***	-0.261**	-0.225**	-0.236**
			[0.094]	[0.109]	[0.110]	[0.109]
Contractual Needs × Financial Development				0.025		
				[0.033]		
External Financial Dependency × Quality of Contract Enforcement				-0.09		
				[0.118]		
Industry Dummies	yes	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes	yes
Industry Characteristics × GDP Per Capita					yes	
Industry Dummies × GDP Per Capita						yes
Observations	1734	1734	1734	1734	1734	1734
R-squared	0.52	0.52	0.53	0.53	0.53	0.55

***, ** and * mean statistically significant at 1%, 5% and 10% respectively. Robust standard errors clustered at the country level are reported in parenthesis. Vertical Integration is the (log of the) ratio of Value Added over Output at the Industry level (source: UNIDO 2001 database). Financial Development is the (log of the) ratio of Bank Credit over GDP (source: Levine (2003)). Quality of Contract Enforcement is (minus the log of) the number of procedures to enforce a contract (source: Doing Business Database at World Bank). External Financial Dependency (source: Rajan and Zingales (1998)). Employment in small firms is the share of employees in establishment with less than 500 employees (source: author's calculations). External Financial Dependency of Upstream Industries (source: author's calculations). Contractual Needs is the Herfindahl index of input use (source: author's calculations). I use the ranking of the industry level variables.

TABLE 4: ALTERNATIVE MEASURES FOR SMALL FIRMS

Vertical Integration: UNIDO Measure	I	II	III	IV	V	VI
External Financial Dependency × Financial Development	0.198***	0.135	0.141*	0.230***	0.205***	0.205***
	[0.064]	[0.088]	[0.085]	[0.072]	[0.082]	[0.084]
External Financial Dependency × Financial Development × Empl. in Small Firms	-0.303***	-0.182	-0.190*	-0.342***	-0.298***	-0.299***
	[0.098]	[0.117]	[0.114]	[0.104]	[0.115]	[0.117]
External Financial Dependency of Upstream Industries × Financial Development	-0.060***	-0.065*	-0.061*	-0.044*	-0.059	-0.055
	[0.022]	[0.034]	[0.034]	[0.024]	[0.037]	[0.038]
Industry Dummies	yes	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes	yes
Industry Characteristics × GDP Per Capita		yes			yes	
Industry Dummies × GDP Per Capita			yes			yes
Observations	1734	1734	1734	1734	1734	1734
R-squared	0.52	0.53	0.54	0.52	0.53	0.55

***, ** and * mean statistically significant at 1%, 5% and 10% respectively. Robust standard errors clustered at the country level are reported in parenthesis. Vertical Integration is the (log of the) ratio of Value Added over Output at the Industry level (source: UNIDO 2001 database). Financial Development is the (log of the) ratio of Bank Credit over GDP (source: Levine (2003)). External Financial Dependency (source: Rajan and Zingales (1998)). Employment in small firms is the share of employees in establishment with less than 100 employees in the US in Columns I, II, III, and share of employees in establishment with less than 100 employees in the UK in Columns IV, V, VI. (source: author's calculations). External Financial Dependency of Upstream Industries (source: author's calculations). I use the ranking of the industry level variables.

TABLE 5: ALTERNATIVE SAMPLES AND MEASURES OF FINANCIAL DEVELOPMENT

Vertical Integration: UNIDO Measure	I	II	III	IV	V
External Financial Dependency × Financial Development	0.194***	0.420*	0.044*	0.253***	0.085
	[0.073]	[0.222]	[0.026]	[0.096]	0.065
External Financial Dependency × Financial Development × Empl. in Small Firms	-0.294***	-0.670**	-0.053	-0.322**	-0.185*
	[0.104]	[0.305]	[0.034]	[0.161]	[0.107]
External Financial Dependency of Upstream Industries × Financial Development	-0.042*	0.048	-0.008	-0.059	-0.038
	[0.024]	[0.131]	[0.009]	[0.056]	[0.036]
Industry Dummies	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes
Observations	1734	1059	1734	561	1147
R-squared	0.52	0.55	0.54	0.65	0.5

***, ** and * mean statistically significant at 1%, 5% and 10% respectively. Robust standard errors clustered at the country level are reported in parenthesis. Vertical Integration is the (log of the) ratio of Value Added over Output at the Industry level (source: UNIDO 2001 database). Financial Development is the (log of the) ratio of Bank Assets over GDP in Column I, the (log of the) share of the deposit of the three largest banks in Column II (source: Levine (2003)) and the index of investor's rights in Column III (source: Doing Business Database at World Bank). External Financial Dependency (source: Rajan and Zingales (1998)). Employment in small firms is the share of employees in establishment with less than 500 employees (source: author's calculations). External Financial Dependency of Upstream Industries (source: author's calculations). I use the ranking of the industry level variables. Columns IV and V present results from separate regressions for OECD and Non OECD countries respectively.

TABLE 6: ALTERNATIVE MEASURE OF VERTICAL INTEGRATION

Vertical Integration: Dun & Bradstreet Measure	I	II	III	IV	V	VI
External Financial Dependency × Financial Development	0.710***	0.706***	0.696***	0.559**	0.623**	0.646*
	[0.234]	[0.238]	[0.238]	[0.241]	[0.324]	[0.347]
External Financial Dependency × Financial Development × Empl. in Small Firms	-1.545***	-1.537***	-1.515***	-1.196**	-1.029	-1.128
	[0.581]	[0.593]	[0.593]	[0.599]	[0.792]	[0.855]
External Financial Dependency of Upstream Industries × Financial Development		-0.037	-0.038	-0.004	-0.118	-0.11
		[0.169]	[0.170]	[0.169]	[0.192]	[0.209]
Contractual Needs × Quality of Contract Enforcement			0.554			
			[2.256]			
Industry Dummies	yes	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes	yes
Vertical Integration U.S. × GDP Per Capita				yes	yes	
Industry Characteristics × GDP Per Capita					yes	
Industry Dummies × GDP Per Capita						yes
Observations	2417	2417	2417	2417	2417	2417
R-squared	0.55	0.55	0.55	0.55	0.55	0.58

***, ** and * mean statistically significant at 1%, 5% and 10% respectively. Robust standard errors clustered at the country level are reported in parenthesis. Vertical Integration is the (log of the) ratio of the index of vertical integration from the Dun & Bradstreet Worldbase (source: author's calculations). Financial Development is the (log of the) ratio of Bank Credit over GDP (source: Levine (2003)). Quality of Contract Enforcement is (minus the log of) the number of procedures to enforce a contract (source: Doing Business Database at World Bank). External Financial Dependency (source: Rajan and Zingales (1998)). Employment in small firms is the share of employees in establishment with less than 500 employees (source: author's calculations). External Financial Dependency of Upstream Industries (source: author's calculations). Contractual Needs is the Herfindahl index of input use (source: author's calculations). I use the ranking of the industry level variables. Industries are classified as in Table 6.a.

TABLE 6A

List of Industries: IO Code

13	Ordnance and accessories	39	Metal containers
14	Food and kindred products	40	Heating, plumbing and fabric. Struct. Mat.
15	Tobacco products	41	Screw machine products and stampings
16	Broad and narrow fabrics, yarn and mills	42	Other fabricated metal products
17	Miscellaneous textile goods	43	Engines and turbines
18	Apparel	44+45	Farm, construction and mining machinery
19	Miscellaneous fabricated textile products	46	Materials handling machinery and equip.
20+21	Lumber and wood products	47	Metalworking machinery and equipment
22+23	Furniture and fixtures	48	Special industry machinery and equipment
24	Paper and allied products	49	General industrial machinery and equipment
25	Paperboard containers and boxes	50	Miscellaneous machinery and equipment
26A	Newspapers and periodicals	51	Computer and office equipment
26B	Other printing and publishing	52	Service industry machinery
27A	Industrial and other chemicals	53	Electrical industrial equip. and apparatus
27B	Agricultural fertilizers and chemicals	54	Household appliances
28	Plastics and synthetic materials	55	Electric lighting and wiring equipment
29A	Drugs	56	Audio, video and communication equipment
29B	Cleaning and toilet preparation	57	Electronic components and accessories
30	Paints and allied products	58	Misc. electrical machinery and supplies
31	Petroleum refining and related products	59A	Motor vehicles passangers cars and trucks
32	Rubber and miscellaneus plastics products	59B	Motor vehicles parts
33+34	Footwear, leather, and leather products	60	Aircraft and parts
35	Glass and glass products	61	Other transportation equipment
36	Stone and clay products	62	Scientific and controlling instruments
37	Primary iron and steel manufacturing	63	Ophthalmic and photographic equipment
38	Primary nonferrous metals manufacturing	64	Miscellaneous

Part II

Financial Constraints and the Theory of the Firm

Chapter 3

Pledgeable Income and the Costs and Benefits of Vertical Integration

Introduction

There is substantial evidence that firms are constrained in their investment decisions in developing and developed countries as well.[1] In order to improve our understanding of the organization and performance of industries (and vertical relationships in particular) in environments in which financial constraints are likely to be binding, this paper asks whether vertical integration reduces or increases transaction costs with external investors. In doing so, it investigates the circumstances under which firms become a valid instrument to facilitate the financing of assets which are linked by input-output transactions.

To analyze these questions, I build a simple model in which a seller produces a good that can be used by a buyer, or sold on a spot market. The buyer and the seller have no cash, need to finance the investments for production, and can not foresee in advance whether the input is most efficiently traded on the spot market or with each other (contracts are incomplete).

I make two key assumptions. First, I assume that ownership of physical assets gives control over contracting rights to those assets, i.e. it determines who has the right to sign trade

[1] See Banerjee and Munshi (2004), Banerjee and Duflo (2004), Banerjee, Duflo and Munshi (2004) for firms in India, Fazzari et al. (1998) for the U.S. and Hubbard (1998) for a review of the literature.

contracts. I focus for simplicity on two different configurations. Under *non-integration* both sides can veto internal trade. In the absence of a previous enforceable contract, two independent firms trade with each other if and only if the two managers agree, possibly after a bargaining process. Under (buyer) *vertical integration* instead the buyer can decide the trade configuration by fiat, i.e. she can impose internal trade between the two divisions of the integrated firms or impose to both units to trade on the spot market. Second, I assume that financial streams get transferred with ownership. (Complete) Separation between the return streams of the productive assets and the decision rights may not be entirely feasible because (part of) the returns can not be verified. This is likely to be the case if, for example, control rights entails the right to sign contracts with third parties, and contracts can be used to generate private benefits for the party in control, as it is assumed here.

I compare vertical integration against non integration in terms of their pledgeable income, i.e. the highest expected returns that can be delivered to external investors. I show that the net balance of the costs and benefits of vertical integration in terms of pledgeable income depends on the relative intensities of two opposing effects. On the one hand vertical integration ensures that the investor faces fewer holdups and that profits can be collectively pledged as collateral ensuring more financing. In contrast, since financial streams get transferred with ownership and returns can not be completely verified, non-integration multiplies the sources of opportunism and makes the financing process harder. I label this first positive effect of vertical integration *profits-pooling* effect. On the other hand, under non-integration, when the two firms trade with each other, they need to bargain to determine the price associated with the input transaction. When the course of action that generates private benefits for one trading partner at the expenses of profits requires cooperation from the other trading partner, the bargaining process becomes an indirect source of information from the point of view of investors. In particular, the seller might refuse to trade with the buyer when such trade produces low joint profits, even if the buyer would privately benefit from such trade.[2] In contrast, vertical integration, by centralizing control rights suppresses the bargaining process and allow the manager of the integrated firm to implement the course of action yielding higher private benefits but lower profits relatively more often. I label this second negative effect of vertical integration "*de-monitoring*" effect.[3] Highlighting, and exploring the consequences of this trade-off

[2] The fact that the two managers do not have cash is important, as it prevents the buyer from bribing the seller to accept trade.

[3] In other words, the "profits-pooling" effect reduces the sources of opportunism related to the possibility of hiding profits while the "control-rights-pooling" (or "de-monitoring") effect increases the sources of opportunism related to the possibility of implementing a course of action that yields private benefits at the cost of lower profits. Since financial streams are transferred with ownership, the vertical integration decision weights the benefits of the pooling-profits effect against the costs of the control-rights-pooling effect.

on the decision to vertically integrated is the main focus of this paper.

Factors affecting the net balance of this trade-off are likely to be important determinants of vertical integration. A higher likelihood that internal trade yields high joint profits, i.e. a higher degree of specificity linking the two projects, favours vertical integration. In other words, assets that are likely to be used together should also be managed and financed together. The main reason is that when the two units are likely to trade together, the monitoring role of bargaining is reduced, and the benefits of non-integration do not compensate for the costs. Larger projects (in terms of investment, profits and quasi-rents) are more likely to be financed under the umbrella of a single firm. Non-integration multiplies the scope for opportunistic behavior by giving to multiple managers the possibility of hiding (part of the) profits. The higher the profits, the costlier this decentralization in the opportunities of stealing profits, and hence the more likely is vertical integration to ensure higher returns to the investors. By the same logic, vertical integration becomes relatively more likely in environments with low investor protection.

As defined above, vertical integration implies joint liability between the two projects while non-integration implies separate liability for the two firms. While contractual externalities among investors may prevent joint liability contracts to be signed among two independent firms, I show that the partial verifiability of profits prevents joint liability contracts to completely remove the higher costs of non-integration associated coming from the multiplication of the centers of opportunism. Related to these issues, I also show how contractual externalities among investors at the financing stage lead to relatively more vertical integration or to underinvestment.

The analysis of the determinants of vertical integration has been a central theme in the modern literature on the theory of the firm.[4] In contrast to the property rights theory of the firm developed in Grossman and Hart (1986), Hart and Moore (1990) and Hart (1995), I de-emphasize the importance of the assignment of control rights in shaping incentives to undertake ex-ante non contractible investments, and instead focus on the consequences that firm's boundaries have on transaction costs with external investors.[5]

The assumption that control rights can not be (entirely) separated from financial streams brings the model close to Holmstrom and Tirole (1987, 1991), although these papers focus on how control rights shape incentives provision (see also Holmstrom and Milgrom (1994)).

[4] For an excellent discussion see Gibbons (2004).

[5] The property right approach has been applied to the analysis of the financial structure of firms (see Hart and Moore (1994), Aghion and Bolton (1992) and Bolton and Sharfstein (1992)). These contributions treat the firm as a single entrepreneur and hence can not ask what determines firm's boundaries. The property right approach has also been extended to consider cash constrained agents (Aghion and Tirole (1994, 1997), Legros and Newman (2004), Acemoglu et al. (2006)). The general theme emerging from this literature is that control rights may be exchanged for cash.

The model in this chapter is mostly related to Holmstrom (1999) from which it borrows the notion that control over physical assets gives control over contracting rights to those assets, and from such notion derives the costs and benefits of vertical integration in terms of pledgeable income. This chapter is also related to transaction costs theories of the firm (see e.g. Williamson (1975)). In an important paper, speculating on why investors may require higher interest rates on the larger investments required for vertical integration, Williamson argued that " (...) unable to monitor the performance of *large, complex* organizations in any but the crudest way (...) investors demand larger returns as finance requirements become progressively greater, *ceteris paribus*" (Williamson (1971)). This chapter suggests that vertically integrated firms are more complex and inherently more difficult to monitor because they bring the bargaining process within firm's boundaries.[6]

The two main assumptions of our model are motivated by the work of legal scholars and business historians. As in Hausmann and Kraakman (2001), the model in this chapter defines the firm as an organization with centralized allocation of control rights *and* joint liability of the financed investments.[7] The angle emphasized here is one in which the firm is a "nexus of contracts" (see e.g. Cheung (1983)) across multiple transactions (the intermediate input supply, and the financing of the two projects). This has two major implications. First, the firm centrally organizes the nexus of contracts, greatly reducing the extent of contractual externalities, at the cost of suppressing valuable sources of information. Second, the input transaction (i.e. the make-or-buy decision), is not anymore the exclusive focus of the analysis. The organization of one particular transaction between two contracting parties depends on the nexus of contracts linking these parties to other economic actors.

Finally, this work is also related to the literature on the working of internal capital markets which explores the implications of different organizational forms (typically conglomerates versus stand alone firms) on the allocative efficiency of given financial resources (see Stein (1997), Sharfstein and Stein(2000), Rajan et al. (2000), Stein (2004) for a survey). In this strand of literature Inderst and Mueller (2003) and Faure-Grimaud and Inderst (2005)

[6] On the positive role of disagreement in organizations see also Landier et al. (2006).

[7] Hausmann and Kraakman (2001) argue that "To serve effectively as a nexus of contracts, a firm must generally have two attributes. The first is well defined decision-making authority. More particularly, there must be one or more persons who have ultimate authority to commit the firm to contracts" ... "The second attribute a firm must have, ... is the ability to bond its contracts credibly .... Bonding commonly requires that there exist a pool of assets that the firm's managers can offer as satisfaction for the firm obligations". Similarly, in an analysis of organizational forms in the United States in the nineteenth century, Lamoreaux (1998) argued that "no clear economic boundary distinguished ordinary contracts from those considered by the law to be firm (...) business people could choose from a range of contractual forms that offered varying degrees of firmness". Firmness in turn, is defined along two main dimensions: liability and firm's autonomy, the latter referring to the extent to which the firm had legal existence, - the possibility of writing binding contracts - beyond that of its members. Similar issues are discussed in the debate on "piercing the corporate veil" (see e.g. Posner (1976) and Landers (1976)).

compare the pledgeable income of conglomerate vs. stand alone firms and are closest in spirit to the present framework. They emphasize how pooling cash flows of independent projects facilitates or hinders the financing process, while I focus on projects which are vertically related.[8]

The chapter is organized as follows. Section 2 presents the model and the main assumptions. Section 3 derives the pledgeable income under vertical integration and under non-integration. Section 4 compares the pledgeable income under the two organizational forms, and presents the main results on the determinants of vertical integration. Section 5 discusses joint liability contracts between non integrated firms and how contractual externalities among investors make integration relatively more likely. Section 6 offers some concluding remarks.

3.1 The Model

Set up: Technology and Private Benefits

Consider two managers, a buyer and a seller, $j \in \{d, u\}$ respectively in charge of two different projects: a downstream (d) unit and an upstream (u) unit. The upstream unit produces a good that can be used by the downstream unit, or sold to an external market. The two managers are aware of the possibility that certain features of the input may make the input best suited to be traded on the spot market or with each other, but they can not foresee in advance the nature of these features, and hence can not write an ex-ante contract which is contingent on the nature of ex-post trade.

Trade between the two units (henceforth "internal trade") generates joint profits V_i while trade on the input spot market generates joint profits V_m. Whether internal trade or trade on the input spot market is more profitable depends on the state of nature. Let $V \in \{\underline{V}, \overline{V}\}$ denote the joint profits of the two units and $\Delta V = \overline{V} - \underline{V} > 0$ be the difference between the two levels of joint profits. I assume that with probability π internal trade generates joint profits $V_i = \overline{V}$ while trading on the spot market generates joint profits $V_m = \underline{V}$. With the complementary probability $(1 - \pi)$ joint profits from internal trade are $V_i = \underline{V}$ while joint profits from trade on the spot market are equal to $V_m = \overline{V}$. I assume that whenever the two units trade on the market, the downstream unit realizes profits equal to βV_m and the upstream unit realizes profits equal to $(1 - \beta)V_m$. The parameter π captures the specificity of the relationship. When π is close to one, the input is very

[8] The fact that projects are vertically related greatly reduces the coinsurance motive to pool projects together (see e.g. Diamond (1984)).

specific to the needs of the buyer, and internal trade almost always generates higher surplus than trade on the spot market. It is instead useful to think of the parameter β as determined by industry conditions. High β is more likely if, when the buyer purchases the input on the spot market, she realizes relatively high profits, perhaps because many firms compete in the upstream industry driving down input's price on the spot market. When β is relatively small instead, the seller can easily sell the input on the spot market at a fairly high price, perhaps because competition among several potential buyers drives input's price up.

Finally, I assume that with probability σ the buyer derives private benefits b from the trade configuration that yields low joint profits $\underline{V}$. These private benefits are inalienable and unverifiable. For instance, in designing a product, the buyer may find ex-post profitable (e.g. a reduction in non monetary costs) to tailor the good on the specification of an existing good readily available on the market even when the seller produces an input that would generate higher profits if used in the production process. Alternatively, the buyer may find out that her capabilities have a better fit, e.g. in terms of acquiring certain skills, with the specifications of the input produced by the seller, even if trading on the input market would generate higher joint profits. Another example, would be the possibility of trading with relatives or other members of a network that generates benefits that can not be transferred to third parties, instead of trading with the partner (possibly on an anonymous market) that would guarantee higher joint profits.

Four states of nature can be realized, depending on whether internal trade or trade on the spot market yields high joint profits, and on whether the buyer derives private benefits from the trade configuration yielding low joint profits. The realization of the state of nature is perfectly observed by the buyer, while the seller only observes whether internal trade generates high of low joint profits if she has control rights over some assets. Finally, I assume that third parties, such as investors and courts, do not observe the state of nature. I assume for simplicity that private benefits are completely unspecific to the relationship, i.e. that the realizations of private benefits and joint profits from the two trading configurations are independent. I also assume that the seller never derives private benefits from the trade configuration that generates low joint profits. It is possible to relax these two assumption without gaining much further intuition.[9]

Ownership

[9] The level and realization of private benefits is exogenous: they could be affected by factor as diverse as technology, belonging to social networks, or legal environment. They are not, however, affected by the allocation of control rights. This may not be the case if the allocation of control rights shapes incentives to generate private benefits or if private benefits are specific to the organization, in which case the matching between the two managers may not be random.

Ownership determines who has the right to decide on whether trade takes place between the two units or on the spot market. I focus for simplicity on two different configurations. Under *non-integration* both sides can veto internal trade. In the absence of a previous enforceable contract, two independent firms trade with each other if and only if the two managers agree. Under (buyer) *vertical integration* instead the manager of the downstream unit can decide the trade configuration by fiat, i.e. she can impose internal trade between the two divisions of the integrated firms or impose to both units to trade on the spot market.[10]

One key difference between vertical integration and non integration is that in an integrated firm there is no bargaining (one party unilaterally decides the trade configuration) while under non integration when the two firms trade with each other they need to bargain to determine the price P for the transaction. For the bargaining process, I assume that the buyer has the right to make a take-it-or-leave-it offer with probability α, while with the complementary probability the seller has the right to make a take-it-or-leave-it offer.[11]

A second important difference between vertical integration and non integration is related to financial streams. In contrast to Grossman and Hart (1986) original contribution on the costs and benefits of vertical integration, I assume that the financial streams get transferred with ownership. While it is true that parts of the financial streams and decisions rights can be transferred through contracts, in reality there is typically a connection between the right to decide and the financial responsibility for the outcome of the decision. This assumption is consistent with the idea that separating the return streams of the productive assets from the decision rights is not entirely feasible, because (part of) the returns can not be verified. For example, control rights typically entails the right to sign contracts with third parties, and these contracts can be used to generate private benefits for the party in control. To formalize these ideas, I assume that whenever a manager has control, she can hide profits making them unverifiable and keep a fraction ϕ of those profits for herself. I interpret the parameter ϕ as a proxy for the degree of external investor protection in the economy.[12] Under vertical integration, the downstream manager has control over the entire profits V, while under non integration the buyer and the seller

[10]Since the upstream manager never derives private benefits from the trade configuration that generates low joint profits, giving him ownership would be best from the point of view of external investors. To make the problem simple and interesting, I assume that this arrangement is not feasible. It is straightforward to relax these assumptions (see Macchiavello (2005)).

[11]Another difference between integration and non integration is that the seller observes which trade configuration yields high joint profits only if the two firms are non integrated. This assumption, while not essential for the analysis, is reasonable if one assumes that in practice the state of the world is at least in part learned through the exercise of contracting rights (e.g. negotiating input prices, hiring consultants, etc...).

[12]External investors' protection from expropriation is the single most important factor explaining large cross-countries differences in the access of firms to external finance (see e.g. La Porta et al. (1997)). An alternative interpretation would link ϕ to the extent to which firm's investments are "tangible".

have control over the profits of their respective firm ($\beta \ V_m$ and $(1-\beta)V_m$ respectively when they trade on the input market, and $V_i - P$ and P when they trade with each other). Subject to the limits imposed by the possibility of "stealing", profits are contractible, and payments to external investors can be made contingent on their realization.

Initial Contract and Timing of Events

I assume that the two managers are essential for production, but have no cash. The downstream units has a fixed set up cost k_d while the upstream unit has a fixed set up cost k_u. The two managers hence need to borrow in order to start the (two) firm(s). I assume that the two managers have an outside option equal to zero. There is a unique investor that contracts with both managers and that has all the ex-ante bargaining power.[13] Contracts are thus designed to maximize the pledgeable income of the two projects.

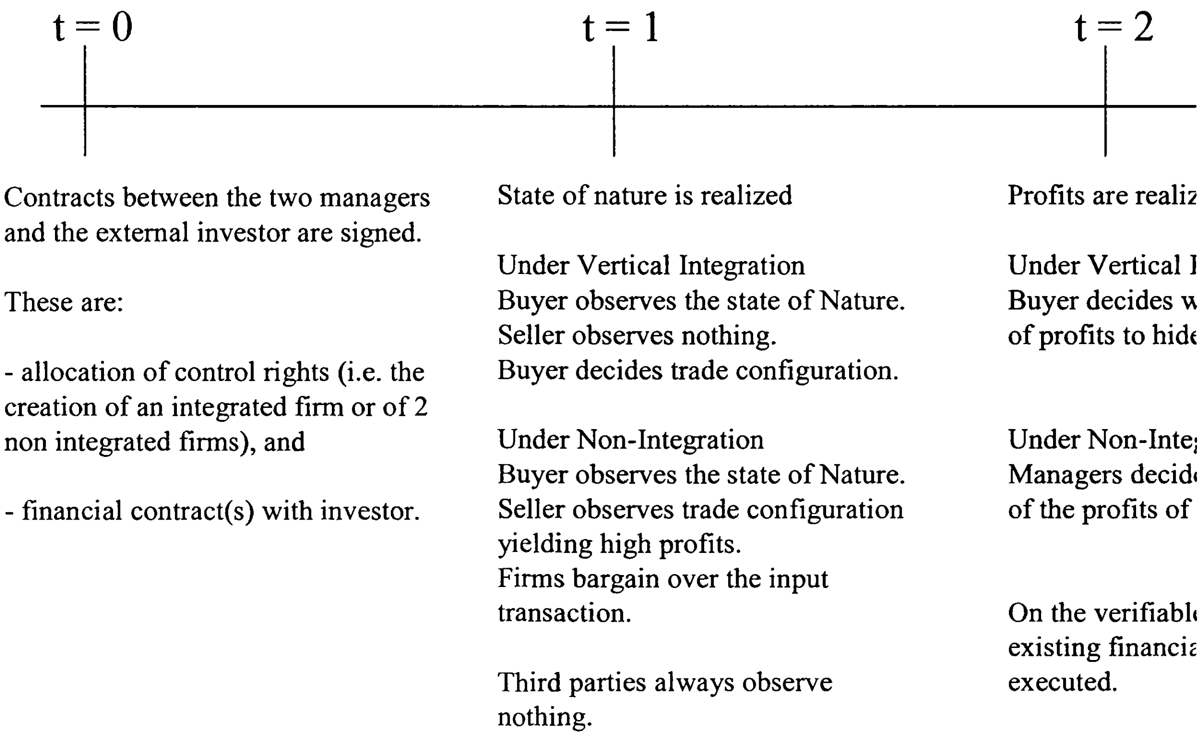
Given the simplicity of the pay off structure, I focus on simple debt-like contracts. In particular I assume that the bank holds a debt-like claim B over the profits of a firm. When the firm is integrated there is a unique B. When the two firms are not integrated, the investor holds claims B_d and B_u on the profits of the downstream and upstream firm respectively. When the two firms are non integrated, I assume for now that the repayment of each firm is not made contingent on the repayment of the other firm, i.e. I rule out joint liability contracts.[14]

To summarize, the timing of events is as follows. At date 0 all the feasible contracts are signed. These are the financial contracts signed with the external investor, and the creation of an integrated firm or of two separate firms (the allocation of control rights). At date 1, the state of nature is realized and observed by the buyer. If the seller has control rights over its unit, she observes which trade configuration yields high joint profits, otherwise she observes nothing. Third parties always observe nothing. If the firm is integrated, the buyer decides whether the two divisions should trade the input with each other or on the spot market. Under non integration instead the two separate firms bargain over the price, according to the process specified above. At date 2 profits are realized. If the firm is integrated the buyer decides which fraction of profits to hide. If the firm is not

[13] I discuss the implications of allowing for multiple investors in section 5. Note however that the two units might also try to maximize the cash that they can raise from external investors in order to use this money to transfer rents according to the initial distribution of bargaining power.

[14] I discuss the implications of relaxing this assumption in Section 5. I also assume that the investor can not holds claims which are contingent on the identity of the trading partners. When the firm is integrated it seems natural to assume that the investors can not easily distinguish whether the input was traded between the two divisions of the firm, or on the spot market. When the two firms are non integrated instead, the investor could hold different claims on the profits of the two firms depending on whether the two firms trade with each other or not. The two managers may find profitable to sign contracts with third parties that would undo these provisions.

Figure 3.1: Timing of Events



integrated, each manager decides which fraction of the profits of her firm to hide. Finally, on the verifiable part of profits, existing financial contracts are executed. The timing of the game is illustrated in Figure 1.

3.2 Organizational Form and pledgeable Income

In order to focus on the main results, and to avoid a long taxonomy of cases that do not add further intuition, I introduce the following assumptions on the parameters of the model.

Assumptions

A1: $k_u = K - k_d$ and $\underline{V} < \frac{K}{1-\phi} < \overline{V}$,

A2: $\max\{2 - \frac{1}{\beta}, 0\}\Delta V \leq \phi\Delta V < b < \beta\Delta V$

A3: $\beta\overline{V} < \Delta V$

A4: $\pi \leq \frac{\beta\overline{V}}{\Delta V + \beta\underline{V}}$

The first part of the assumption implies that the two projects have a joint positive net present value ($K < (1-\phi)\overline{V}$), but that it is not possible to finance both projects by assuring an expected return equal to $(1-\phi)\underline{V} \leq K$, which the investor can always guarantee for himself.

The second part of the assumption implies that the private benefits that the buyer obtains from the low joint profits configuration are larger than the private benefits that it is possible to create by hiding the difference in the joint profits ΔV, so that the separate agency conflict with the buyer has potentially some bite. On the other hand, the private benefits b are sufficiently small so that if the low joint profits trade configuration is implemented, not only transferrable profits are lower, but also aggregate surplus is reduced. The second part of the assumption also implies that the transaction costs associated with hiding profits ϕ are bounded, and in particular that $\phi \in [2 - \frac{1}{\beta}, \beta]$, and it is made to simplify the analysis.

The third part of the assumption introduces an upper bound on the share of profits that the buyer can realize by trading on the spot market and implies that the downstream firm can not convince the upstream firm to undertake internal trade whenever it generates low joint profits $(1-\beta)\overline{V} > \underline{V}$.

Finally, the fourth part of the assumption puts an upper bound on the ex-ante likelihood that internal trade yields high joint profits. These last two assumptions simplify the exposition without affecting the main results.

Before I determine the pledgeable income under the two organizational forms, let consider the trading configuration implemented if the two managers have deep pockets.

Lemma 3.1 *Integration generates total surplus $\overline{V} - K$. Non integration generates total surplus $\overline{V} - \pi\sigma(1-\alpha)(\Delta V - b) - K$ if $\sigma\Delta V < b$ and $\overline{V} - K$ otherwise.*

Under integration, the buyer is the residual claimant of the profits of the firm, and the second part of the assumption makes sure that $\overline{V} > \underline{V} + b$. The unique residual claimant of firm's profits would always implement the high profits action, which also maximizes social surplus. Under non integration instead the two firms have to bargain over the price P. As a benchmark, it is useful to consider the case $\alpha = 1$. Under this scenario, the buyer always has the right to make a take-it-or-leave-it offer and the ex-post bargaining process is efficient. When this is the case, in the absence of non contractible investments, the organizational form does not matter for efficiency. When $\alpha < 1$ instead the ex-post bargaining process occurs under asymmetric information with probability $(1 - \alpha)$, and it is thus, in general, not efficient. In particular, if $\sigma\Delta V > b$ the seller bargains too aggressively to extract the highest possible price at the expense of total efficiency. The simple model thus captures the original intuition of the transaction cost literature (see e.g. Williamson (1971), (1975)) that vertical integration by replacing the bargaining process with fiat reduces the inefficiencies caused by contract incompleteness.[15] In this context, α is a measure of the degree of inefficiency in the ex-post bargaining process, as well as a measure of the bargaining power of the buyer.

In the next subsections I analyze the situation when the buyer and the seller do not have deep pockets and need to finance the initial investments k_d and k_u. I first derive the highest joint pledgeable income under vertical integration and under non-integration. In the next section I compare the two organizational forms in terms of pledgeable income.

3.2.1 Vertical Integration

Under vertical integration, the buyer decides whether trade should take place internally and moreover has control over the joint profits generated by the two units. Conditional on implementing the action that yields high joint profits, she will repay debt B if the payoff from repaying the debt $\max\{\overline{V} - B, 0\}$ is larger than the payoff from hiding profits $\overline{V}$ realizing private benefits of value $\phi\overline{V}$. In other words, she will repay debt if $B \leq (1-\phi)\overline{V}$. Suppose instead that she decides to implement the action that yields low joint profits. In this case, she will repay the debt B if and only if $B \leq (1-\phi)\underline{V}$. If this condition is satisfied however, she will never find it profitable to implement the low joint profits action since the payoff from the high joint profits action would always be higher as $\Delta V > b$. Denoting by $\mathbf{I} \in \{0, 1\}$ an indicator function taking value equal to one when the buyer has private benefits b from the low cash flow action, and zero otherwise, if $B \in ((1 - \phi)\underline{V}, (1 - \phi)\overline{V})$ the buyer will implement the high profits action if and only if $\overline{V} - B > \mathbf{I}b \geq \phi\underline{V}$. This inequality is always satisfied if $\mathbf{I} = 0$. If instead $\mathbf{I} = 1$, the inequality is satisfied if and only if $B \leq \widetilde{B} = \overline{V} - b - \phi\underline{V}$, and $\widetilde{B} \in ((1 - \phi)\underline{V}, (1 - \phi)\overline{V}$ since $b > \phi\Delta V$ by assumption.

The investors hence maximizes pledgeable income by trading off an higher debt B with

[15] If the upstream managers also derives non observable private benefits from the trade configuration that yields low joint profits, integration would always dominate. Schmitz (2006) and Matouschek (2003) are examples of models of vertical integration with inefficient ex-post bargaining.

a lower probability that the debt is paid back. Denoting by B_{int} the solution of the investor's problem, the linearity of the problem implies that the solution to the investor problem will either be $B_{int} = (1-\phi)\overline{V}$ or $B_{int} = \widetilde{B}$. Denoting by P_{int} the solution to the investor's problem, i.e. the highest pledgeable income of a vertically integrated firm, I can summarize the previous discussion with the following proposition.

Proposition 3.1 *Under Assumption A2,* $P_{int} = \max\{(1-\phi)(1-\sigma)\overline{V}, \overline{V} - b - \phi\underline{V}\}$.

The investor can choose a relatively low level of debt $B_{int} = \overline{V} - b - \phi\underline{V}$ that leaves to the manager rents equal to the private benefits $b + \phi\underline{V}$ that can be acquired exercising the control rights over the financial streams and the trading decisions, or she can instead set an higher level of debt $B_{int} = (1-\phi)\overline{V}$, knowing that whenever private benefits b from the low profits action are realized the debt will not be repaid.

As expected, the pledgeable income of an integrated firm is decreasing in the level of private benefits b (weakly) and in the likelihood of the agency conflict (higher σ). Moreover, the pledgeable income of an integrated firm is increasing in the degree of investor protection (decreases in ϕ) and in the joint profits generated by the two firms (higher $\overline{V}$). However, it is decreasing in $\underline{V}$, a direct measure of the importance of taking the right trading decision, but also an inverse measure of the cost of opportunism for the manager.

The pledgeable income does not depend on π, β and α. P_{int} does not depend on π since the buyer is the full residual claimant of the firm's profits, and depending on the level of debt B_{int}, will chose the appropriate trade configuration with either probability 1 or $(1-\sigma)$. This is a direct consequence of the fact that under integration, the two trading configurations become symmetric from the point of view of the borrower. The same logic also explain why P_{int} does not depend on β. The buyer, being the residual claimant, does not care about the distribution of profits between the two divisions of the firm. Finally, P_{int} does not depend on α as vertical integration eliminates all bargaining process between the two units.

It is also clear that $P_{int} < (1-\phi)\overline{V} < \overline{V}$, and hence there exist profitable investment opportunities that can not be financed because of the agency conflict. Note also that if, contrary to Assumption A2, I assumed $b < \phi\Delta V$, I would have that $P_{int} = (1-\phi)\overline{V}$ and the only agency conflict that would have some bite is the possibility of hiding profits.

3.2.2 Non-Integration

Under non-integration the two units are two independent firms managed by two separate managers. Before I present the main result, I describe the investor's problem. The investor chooses debts levels B_d and B_u in order to maximize the joint pledgeable income of the two non integrated firms. The problem has to be solved backward. For a given vector of debt levels B_d and B_u, I first analyze the bargaining game between the two managers depending on whether

- internal trade or trade on the spot market produces high joint profits,
- the buyer derives private benefits or not from the low cash flow action, and
- the buyer or the seller has the right to make a take-it-or-leave-it offer for the price of the input.

In any state s (there are eight, i.e. $2 \times 2 \times 2$, states), the bargaining process determines the profits of the two firms, and because of the possibility of hiding profits, B_u and B_d may or may not be repaid. Let $\mathbf{I}_d(s \mid B_d, B_u) \in \{0,1\}$ and $\mathbf{I}_u(s \mid B_d, B_u) \in \{0,1\}$ be two indicator functions taking values equal to one if, given B_u and B_d, in state s the outcome of the bargaining process is such that B_d and B_u are respectively repaid. Let π_s be the probability that state s is realized. The investor solves

$$\max_{B_d, B_u} \Sigma_s \pi_s \left(\Sigma_{j \in \{d,u\}} B_j \cdot \mathbf{I}_j(s \mid B_d, B_u)\right)$$

As for the case of vertical integration, the investor will have to trade-off a higher debt levels B_d and B_u, with a higher probability that the debt is repaid. The main difference with respect to the case if vertical integration, is that the profits of the two firms, and hence the maximum debt levels that firms can credibly commit to repay, are determined by the bargaining process between the two managers.

In order to focus on the main intuition, I present the results for the two polar cases $\alpha = 1$ and $\alpha = 0$. Denote with $P_{ni}(\alpha)$ the highest joint pledgeable income of two non integrated firms as a function of α: We can prove the following result

Proposition 3.2 *Under Assumptions A2-A4,*

$$P_{ni}(1) = (1-\phi)\left[\beta \overline{V} + (1-\beta)\max\{\underline{V}, \overline{V}(1-\pi)\}\right]$$

and

$$P_{ni}(0) = (1-\phi)\left[\beta \max\{\underline{V}, \overline{V}(1-\pi)\} + \max\{(\overline{V} - \beta\underline{V})\pi(1-\sigma), (1-\beta)\overline{V}\}\right]$$

As for the case of vertical integration, the highest joint pledgeable income of the two non integrated firms is increasing in the level of investor protection (lower ϕ) and in the level of joint profits $\overline{V}$. However, certain important differences can be noted with respect to the case of vertical integration.

Consider first the case $\alpha = 1$. In this case the buyer always makes a take-it-or-leave-it offer, and the bargaining process is efficient. To gain some intuition on how the bargaining process influences the choice of debt levels B_d and B_u, consider, as an illustration, the case of the seller. The investor can choose a debt level $B_u = (1-\phi)(1-\beta)\underline{V}$ which will always be repaid by the seller, since any offer made by the buyer has to be greater than $(1-\beta)\underline{V}$, which is the minimum outside option for the seller in the bargaining process. Alternatively, the investor can set an higher debt $B_u = (1-\phi)(1-\beta)\overline{V}$, but whenever trade should take place internally, the buyer offers such a low price that the seller accepts, but does not find it profitable to repay the debt B_u (this happens with probabilityπ).

As a consequence of this logic, in contrast to the case of vertical integration, when $\alpha = 1$, P_{ni} is (weakly) increasing in $\underline{V}$. While under vertical integration the profits from the low joint profits action are rents that have to be given to the borrower to induce her to repay the debt ($\phi\underline{V}$), under non integration a fraction of these profits becomes the outside option of the party that does not have bargaining power, and can guarantee a minimum level of debt repayment.

P_{ni} depends on the degree of input specificity π and on the industry structure, as summarized by β. Consider again the case $\alpha = 1$. P_{ni} is (weakly) decreasing in π. The decentralized allocation of control rights over whether the two firms should trade internally or on the spot market, creates a basic trade-off under non integration. On the one hand, the buyer does not have enough money to "bribe" the seller to trade internally when trade on the spot market produces higher joint profits but the buyer has private benefits from trading internally. On the other hand, when internal trade generates high joint profits but the buyer has private benefits from trading on the spot market, she has the right to impose trade on the spot market. The higher π, the less valuable is the option of having the seller block a low joint profit trade configuration.

When the buyer has high bargaining power she can extract higher profits from the seller if β is high. This increases the pledgeable income of the buyer, reducing the pledgeable income of the seller. The seller's pledgeable income however is reduced proportionally to the seller outside option, and not to the joint profits. In other words, the higher bargaining power of the buyer, helps the investor in pumping out money from the two firms.

The discussion so far focussed on the case in which the buyer has all the bargaining power. What happens if the seller has all the bargaining power? Before I discuss the result in Proposition 3 for the case $\alpha = 0$, I present a direct consequence of the discussion above.

Corollary

Assume that the seller observes the realization of b. Then

$$P_{ni}(0) = (1-\phi)\left[(1-\beta)\overline{V} + \beta \max\{\underline{V}, \overline{V}(1-\pi)\}\right]$$

If the seller has all the power in the bargaining game, and observes the realization of the private benefits b, the bargaining game is completely symmetric to the case $\alpha = 1$, with the exception that the role played by industry structure β is inverted. We than see that, under efficient bargaining, $P_{ni}(1)$ is increasing in β, while $P_{ni}(0)$ is decreasing in β, and the pledgeable income is higher when the buyer has full bargaining power if $P_{ni}(1) > P_{ni}(0)$, i.e. if $\beta > \frac{1}{2}$. From the point of view of the investor, α and β are hence complements, in the sense that higher bargaining power of the buyer is good news in industries in which most of the value is kept or produced downstream.

When $\alpha = 0$ and the seller *does not* observes the realization of b the intuitions presented above still hold, but a new effect has to be taken into account. In this case the seller makes a take-it-or-leave-it offer, and the bargaining process may be inefficient. The seller may end up bargaining too aggressively, in order to extract an high price from the buyer. With probability $\pi\sigma$ however the buyer derives private benefits from trading on the spot market and rejects the offer of the seller, which is then left with low profits and does not repay the debts. This further effect explains why $P_{ni}(0)$ is potentially non monotonic in π and β and why it is increasing in $(1-\sigma)$. It is interesting to note the following

Corollary

If $\alpha = 0, \pi \rightarrow \frac{\beta\overline{V}}{\Delta V + \beta\underline{V}}$ *and* $(1-\sigma) \rightarrow 1$, *the pledgeable income under inefficient bargaining is higher than the pledgeable income under efficient bargaining if* $\beta < \frac{1}{2}$.

The Corollary makes clear that the inefficiency of the bargaining process between the buyer and the seller is not necessarily bad news from the point of view of the investor. If the likelihood of internal trade yielding high joint profits is high (high π), and the chances that aggressive bargain still lead to debt repayment (low σ), then the aggressive behavior of the seller in the bargaining game allows the investor to set a higher B_u and to "pump" money out of the two firms more easily. This effect will be stronger the lower β. When this is the case, the aggressive bargaining induced by asymmetric information reinforces the complementarity between low β and $\alpha = 0$.

So far I have compared the pledgeable income under non integration with respect to different configurations of the bargaining process (buyer vs. seller bargaining power, and efficient vs. inefficient bargaining). In the next section I compare the highest pledgeable income under integration and under non integration, and derives the main results of the chapter.

3.3 Determinants of Vertical Integration

In this section I compare the pledgeable income under two alternative organizational forms: vertical integration and non integration. The primary objective of the analysis is to shed some light on the determinants of vertical integration. The focus on the pledgeable income is relevant since, in environments in which investors have ex-ante bargaining power, the organizational form that generates higher pledgeable income is more likely to be chosen to organize the tow projects.

The next proposition provides necessary and sufficient conditions under which vertical integration has higher pledgeable income than non integration for the case in which $\alpha = 1$.

Proposition 3.3 *Under Assumption A2-A4 $P_{ni}(1) < P_i$ if and only if $\pi > \frac{1}{1-\beta}\min\{\frac{b-\phi\Delta V}{(1-\phi)\overline{V}}, \sigma\}$.*

The next proposition provides necessary and sufficient conditions under which vertical integration has higher pledgeable income than non integration for the case in which $\alpha = 0$ and bargaining takes place under asymmetric information.

Proposition 3.4 *Under Assumption A2-A4 $P_{ni}(0) < P_i$ if and only if $\pi > \frac{1}{\beta}\min\{\frac{b-\phi\Delta V}{(1-\phi)\overline{V}}, \sigma, \frac{\beta(1-}{(1-\sigma)(}$*

Despite the differences between the two cases analyzed in Proposition 4 and 5, some factors affect vertical integration in the same way under the two alternative scenarios

$\alpha = 0$ and $\alpha = 1$. The next proposition summarizes those factors.[16]

Proposition 3.5 *Under Assumption A2-A4 vertical integration is more likely*

1. *the higher the level of quasi-rents (higher π),*
2. *the higher the level of profits (higher $\overline{V}$) and the losses associated with the low profits trade configuration (lower $\underline{V}$),*
3. *the lower the quality of investor's protection (higher ϕ)*
4. *the lower the likelihood (lower σ) and the size of buyer's private benefits (lower b),*

A first key determinant of vertical integration is π, the likelihood that internal trade yields high joint profits, i.e. the degree of specificity linking the two projects. When π is high, vertical integration becomes more likely, i.e. assets that are likely to be used together should also be managed and financed together. The intuition for this result directly follows from the analysis of the pledgeable income under non integration. Non integration grants control rights over the trade configuration to multiple firms, inducing bargaining. This bargaining process generates useful information from the point of view of the investors, since the seller can prevent a low profit action to be taken when profits are higher if trade takes place on the spot market. The positive monitoring effect of non integration is stronger when π is low, that is when the optimal trade configuration from the point of view of the investors is likely to be trade on the input spot market.[17]

This result echoes the property rights results that complementary assets should be jointly owned. However here the source of complementarity does not derive from the incentives to undertake non contractible investments, but is instead determined by the likelihood that the two assets should trade together. As an example, we expect that firms that use specific inputs that are geographically localized and costly to transport should be jointly owned and financed, i.e. vertically integrated. This seems to be consistent with anecdotal as well as formal evidence (see the evidence discussed in Whinston (2003)).

[16] The proofs of propositions 6 and 7 (as well as the corollary in this subsection) follow from straightforward differentiation, and are therefore omitted.

[17] As noted above, in this environment seller integration would be optimal. The model can be extended to consider the case in which with some probability σ_u the seller also derives private benefits b_u from the action yielding low cash flows. When this is done, seller integration is not unambiguously optimal anymore. Moreover, it can be shown that an higher degree of correlation in private benefits realizations reduces pleadgeable income and favors vertical integration (see Macchiavello (2005)).

A consequence of this result is also that in a cross-section of firms, vertically integrated firms will be more likely to trade internally, instead that on the market. There are two effects that reinforce each other that explain this fact. First of all, Proposition 6 suggests that assets with high π will be owned and managed together. In other words, vertically integrated firms are inherently different from non integrated firms since they tend to use assets that are likely to trade together relatively more often. We can think of this first effect as a "*selection*" effect. The second effect derives from the fact that under vertical integration trade takes place internally with probability $\pi(1-\sigma)+(1-\pi)\sigma$ if $(1-\sigma) > \frac{\overline{V}-b-\phi V}{(1-\phi)\overline{V}}$, and with probability π otherwise. Under non integration instead, the two firms trade together with a probability equal toπ when the bargaining process is efficient, and with even lower probability when the bargaining process occurs under asymmetric information. Since the allocation of control rights directly influences the likelihood of internal trade, we can think of this effect as a "*governance*" effect. Mullainhathan and Sharfstein (2001) find evidence which is consistent with these predictions, although, by treating the integration decision as exogenous, they do not disentangle the two effects emphasized by the model.[18]

A second important determinant of vertical integration is the size of the two projects, as summarized by $\overline{V}$. Non integration multiplies the scope for opportunistic behavior by giving to multiple agents the possibility of hiding (part of the) profits. The higher the profits, the costlier this decentralization in the opportunities to steal profits, and hence the more likely is vertical integration to ensure higher returns to the investors. This result suggests that in a cross-section of firms, vertically integrated firms will tend to be larger, an observation which seems to be consistent with empirical evidence (see e.g. Macchiavello (2006) and the references therein).

The positive relationship between $\overline{V}, \pi$ and vertical integration, also suggest that vertical integration positively depends on the *level* of quasi-rents on which the two firms bargain. A useful measure of quasi-rents in our environment is the ex-ante difference in expected profits between internal trade and trade on the input spot market, which is proportional to $R = (2\pi - 1)\,\Delta V$, and hence $\frac{\partial R}{\partial \overline{V} \partial \pi} > 0$. In an influential paper Whinston (2003) noted that the transaction cost and the property right theory of the firm are conceptually different, and that, while the former predicts a positive relationship between vertical integration and the level of the quasi-rents generated by specificity and incomplete contracts, the property rights theory of the firm does not have predictions on the relationship between the level of quasi-rents and vertical integration. Moreover, he noted that virtually all empirical work support the transaction cost intuition that higher quasi-rents are associated with

[18] Vertical integration might require more specific assets with lower resale (or collateral) value, making financing more difficult.

either long term contracts or with vertical integration. Our model is also coherent with this evidence.

A third prediction of the model is that vertical integration becomes relatively more likely in environments with low investor protection (higher ϕ). It has been noted that, because of widespread input and market failures, firms in developing countries are often thought to be larger and more vertically integrated (see e.g. Palepu and Khanna (2000)). While further empirical work is needed in this area, the model provides a rationale for this anecdotal evidence.[19]

We have noted in the previous section that the inefficiency caused by asymmetric information in the bargaining game between the buyer and the seller is not necessarily a bad news from the point of view of external investors. A direct consequence of propositions 4 and 5 is the following corollary.

Corollary

Assume that the seller observes the realization of b. Under Assumption A2-A4 $P_i(0) < P_{ni}(0)$ *if and only if* $\pi < \frac{1}{\beta}\min\{\frac{b-\phi\Delta V}{(1-\phi)V}, \sigma\}$.

The corollary clarifies that the cases in which inefficiencies in the bargaining process are likely to increase the pledgeable income of two non integrated firms are precisely the cases in which vertical integration becomes more likely. Despite the observation in the previous section, in a cross-section of firms, the model has the standard prediction that higher bargaining costs make vertical integration more likely.

The results in Proposition 6 do not depend on the distribution of bargaining power between the seller and the buyer. In contrast, the next proposition shows that the relationship between industry structure and vertical integration crucially depends on the distribution of bargaining power between the seller buyer.

Proposition 3.6 *Under Assumption A2-A4, higher competition in the upstream market (high* β*) makes vertical integration more likely if the seller has bargaining power (*$\alpha = 0$*) and less likely if the buyer has bargaining power (*$\alpha = 1$*).*

[19] However recent cross-country-industry empirical evidence on the institutional determinants of vertical integration do not fully support this view (see Acemoglu et al. (2005) and Macchiavello (2006)).

This result shows that industry structure might affect vertical integration in the presence of financial constraints. Unfortunately I am not aware of empirical studies linking industry structure, vertical integration in the presence of financial constraints.[20]

3.4 Discussion and Extensions

3.4.1 Joint Liability

In the model in the previous section a firm is an organization with centralized ownership of physical assets and centralized (i.e. joint) financial liabilities. Non integrated firms instead suffer from the fact that in the bargaining process the price might be set at a level that induces either the seller or the buyer to default on the loan (by hiding the profits). Because of this, parties are induced to bargain too aggressively from the point of view of external investors. This effect is absent in the case of a vertically integrated firm, where the manager is jointly responsible for both projects (what I have labeled the *profits-pooling* effect of vertical integration).[21]

While useful to analyze the dichotomy between "markets and hierarchies" from a theoretical perspective, the perfect correlation between centralized ownership and joint financial liabilities typical of the firm is far from being the only organizational form observed in practice. "Hybrid" organizational forms are indeed relatively common. In this subsection I ask whether the negative effect of non integration can be undone by imposing some form of joint liability for the two firms. In doing so I analyze the scope for an "hybrid" organizational form in which ownership of assets is decentralized, while financial liabilities are (partially) centralized.[22]

In particular, I assume that the financial contracts that the investor offers at the financing stage specify that if the upstream firm does not repay the debt B_u the downstream firm is liable for an amount L_d, and similarly if the downstream firm does not pay back the debt

[20] In a recent paper, Aghion et al (2006) reports the existence of a U-shaped relationship between vertical integration and the degree of product market competition, a result that could be consistent with an extensions of the current model that allow for separate agency conflict with the seller and considered also seller integration (see also Acemoglu et al. (2005)). We feel that further theoretical and empirical work is needed on this subject.

[21] In an integrated firm the manager of the firm can not easily "move" money across units avoiding to repay the investors. Under non integration instead the outside options in the bargaining game are essentially given by the rents that can be gained by hiding profits. This implicitely introduces a form of collusion between the buyer and the seller against the investors.

[22] An interesting example is given by micro-finance contracts. In micro-finance arrangements however, financed projects are rarely vertically related with each other. We conjecture that needs for diversification is at the heart of this practice.

B_d, the upstream firm is liable for an amount B_u. Letting $\mathbf{B} = [B_d, B_u]$ and $\mathbf{L} = [L_d, L_u]$ be the vectors of debt and joint liability contracts respectively, the investor problem can be written as

$$\max_{B_d, B_u, L_d, L_u} \Sigma_s \pi_s \left(\Sigma_{j\in\{d,u\}, j\neq j'} \mathbf{I}_j(s \mid \mathbf{B}, \mathbf{L}) \cdot (B_j + L_j \cdot (1 - \mathbf{I}_{j'}(s \mid \mathbf{B}, \mathbf{L})))\right)$$

As for the case without joint liability contracts, the investor will have to trade-off a higher debt levels B_d and B_u, with a higher probability that the debt is repaid. The investor however has two additional instruments to extract money from the two firms. Joint liabilities make sure that if one of the two debts is not paid back, the investor still can potentially recover some money from the other firm. Moreover, joint liability becomes an important tool in the hands of the external investor to affect the bargaining process among the two units.

The following proposition derives the optimal contract when joint liability is allowed.

Proposition 3.7 *Assume* $\alpha = 1$. *Under Assumptions A2-A3 the optimal financial contracts are given by* $B_u^* = (1-\phi)(1-\beta)\overline{V}$, $B_d^* = (1-\phi)\beta\overline{V}$, $L_u^* = B_d^*$ *and* $L_d^* = (1-\phi)(1-\beta)\Delta V$ *if* $(1-\sigma) > \frac{\Delta V + \beta(1-\phi)\underline{V} - b}{(1-\phi)(\Delta V + \beta\underline{V})}$ *and* $L_d^* = (1-\beta(1-\phi))\Delta V - b$ *otherwise.*

The maximum pledgeable income of two non integrated firms under joint liability $P_{ni}^{JL}(1)$ *is given by*

$$P_{ni}^{JL}(1) = (1-\phi)(1-\pi)\overline{V} + \pi\max\{(1-\phi)(1-\sigma)(\Delta V + \beta\underline{V}), \Delta V + \beta(1-\phi)\underline{V} - b\}$$

The proposition implies the following corollary.

Corollary

1. *The optimal joint liability contract displays* $B_d^* \geq L_u^* > 0$ *and* $B_u^* > L_d^* > 0$.
2. *There exist a unique* $\pi^* < 1$ *such that* $P_{ni}^{JL}(1) > P_{ni}(1)$ *if and only if* $\pi < \pi^*$.

The first part of the corollary is obvious and implies that the pledgeable income of two non integrated firms always increases when joint liability contracts are allowed. The optimal contract displays positive levels of joint liability. Moreover, the two joint liability amounts L_d and L_u play very different roles. L_d^* is used to increase repayments in those states in which the upstream firm defaults. Those states occur with probability π. From the point of view of the investor it is better to let the upstream firm defaults in those states, as having both firms repaying their debts multiplies the rents that have to be left, as the price P has to compensate more than proportionally the debt level B_u. L_u^* is instead used to decrease the value of default for the downstream seller. By increasing L_u^* the investor makes default for the downstream firm extremely costly, as the price offer P has to compensate for the joint liability amount L_u^*.[23]

The second part of the corollary instead implies that joint liability is not sufficient to make non integration always preferred to integration. It shows that, because of the possibility of hiding profits, joint liability contracts are not sufficient to create a complete *profits-pooling* effect under non-integration. This happens because the price P has to compensate more than proportionally the debt B_u in for the joint liability L_d to be repaid. In environments with high external investors protection, ϕ is close to zero and non-integration always achieves higher pledgeable income than integration. The source of the *profits-pooling* effect is therefore the combination of poor investor protection and joint liability typical of an integrated firm. In summary, the intuition and results of the previous section continue to hold true even when joint liability contracts between two non integrated firms are allowed.[24]

3.4.2 Contractual Externalities

In section 3, I have solved the model assuming that investors maximize the sum of the pledgeable incomes of the two separate firms, thus removing all contractual externalities

[23] On the ground that the state is not verifiable by third parties, we assumed that agents are restricted to contracts that allocates decisions rights over the optimal action to be taken, i.e. we assumed that the feasible contracts are highly incomplete. In principle however parties could design an ex-ante mechanism in which they report to the mechanism designer messages on the realization of the state of the world, and actions are taken accordingly to the reported messages. In Macchiavello (2005) I consider a similar model in which $\phi = 0$ but in which also the seller can derive private benefits from the low joint profit action. I show that under Nash implementation, Coalitional Rationality, and Limited Liability, the optimal mechanism is equivalent to a simple allocation of control right (integration and non-integration as explored here, and external control). The optimal contract always displays joint liability. As in the present contaxt, joint liability would however create a negative externality across the two units: opportunistic behavior of one unit compromizes the financial returns of the other units and could lead to lower effort. The reader can check that Proposition 7 implies that if $\phi \to 0$ non integration with joint liability does always better than integration in terms of pleadgeable income.

[24] It is possible to imagine the symmetric hybrid organizational form, in which the two units are jointly managed but not jointly liable from the financial point of view. This seems to be the case in business groups and pyramids (see Bianco and Nicodano (2002) and Almeida and Wolfenzon (2006) for recent theoretical treatement of these hybrids from a financial perspective). I conjecture that this analysis could shed some light on tunneling.

that could originate from separate financing.[25] However, it has been argued by legal scholars (Kraakman and Hausmann (2001), Cheung (1983)) as well as business historians (see e.g. Lamoreaux (1998)) and economists (Holmstrom (1999)) that one important role of firms could be to eliminate contractual externalities associated with various sources of financing.[26]

In this subsection I explore within the framework of the model analyzed in the previous section circumstances under which a particular form of contractual externalities between investors results "too often" in the creation of an integrated firm or in underinvestment, and briefly discuss other potential forms of contractual externalities.

Before I turn to the formal analysis of the financing decisions, I illustrate the fundamental source of externalities across the to projects. When the upstream firm does not exist, the net present value of the downstream firm is given by

$$\mathcal{V}_d^0 = (1-\pi)\beta\overline{V} + \pi\beta\underline{V} - k_d$$

while the net present value when the upstream firm is financed is given by

$$\mathcal{V}_d = (1-\pi)\beta\overline{V} + \pi\alpha\Delta V + \beta\underline{V} - k_d$$

implying that the financing of the upstream firm increases the value of downstream firm of an amount equal to $\Delta\mathcal{V}_d = \mathcal{V}_d - \mathcal{V}_d^0 = \alpha\pi\Delta V$. Obviously, a similar reasoning applies for the positive externality that the financing of the downstream firm has on the net present value of the upstream firm. It is obvious that $\Delta\mathcal{V}_u = \mathcal{V}_u - \mathcal{V}_u^0 = (1-\alpha)\pi\Delta V$, where the notation is adapted from the previous expressions to the case of the upstream firm. It is thus possible to have parameters configurations in which none of the two projects has positive present value, unless the other project is also financed. As the previous expression shows, this is more likely to happen when π is high.

To explore how contractual externalities interact with the decision to finance an integrated firm as opposed to two non-integrated firms, consider the following modification to the model presented in section 2. Suppose that there are two investors, $\mathcal{D}$ and $\mathcal{U}$. I assume that $\mathcal{D}$ can only finance the operations of the buyer, i.e. downstream firm, while $\mathcal{U}$ can only finance the operations of the seller. By this I mean that whenever the buyer has control over the firm, only $\mathcal{D}$ can recover a positive fraction of the profits. Similarly, when

[25] Note that in the model presented above under non-integration, the decisions on the optimal debt levels B_d and B_u are separable (see proof of Proposition 3).

[26] That the firm could be a valuable financial intermediary has been argued by the recent literature on the working of internal capital markets (see Gertner, Scharfstein and Stein (1994) and the following work reviewed in Stein (2004)). This work sheds important light on incentivs and allocative efficiency of internal capital markets.

the seller has control over the upstream firm, only $\mathcal{U}$ can recover a positive fraction of the upstream firm's profits. I formalize this intuition assuming that the parameter ϕ is specific to the investor-borrower relationship. In particular I assume $\phi(\mathcal{U}, u) = \phi(\mathcal{D}, d(= \phi$ as in Assumption A2, while $\phi(\mathcal{U}, d) = \phi(\mathcal{D}, u(= 1$. Although this assumption is presented under an extreme form, specific human capital in the monitoring of certain kinds of economic activities, past business relationships, reputation, belonging to a common network, and other factors imply that investors may not be perfect substitutes in lending relationships.

This assumption implies that $\mathcal{D}$ can finance two kind of projects: a small (non-integrated) buyer or a large vertically integrated firm managed by the buyer, that produces its own inputs. $\mathcal{U}$ instead can only finance a (non-integrated) seller. To keep the analysis simple, I assume that the two investors get a payoff equal to zero if they do not invest and that if $\mathcal{U}$ invests when $\mathcal{D}$ finances a vertically integrated firm the nature of competition in the industry implies negative returns L on $\mathcal{U}$'s investment, while $\mathcal{D}$ receive a fraction δ of the returns to vertical integration such that $\delta P_{int} - K \geq 0$.[27]

Finally, I assume that the two investors $\mathcal{D}$ and $\mathcal{U}$ takes their financing decisions independently and non cooperatively. As a justification for this assumption, we can think that, for instance, at the financing stage investors do not know the realization of the specific match between the buyer and the seller. If initial contracts are hard to renegotiate, multilateral contracts will not be effectively signed.[28] The two investors $\mathcal{D}$ and $\mathcal{U}$ simultaneously decide whether to finance a firm, and in the case of $\mathcal{D}$ whether to finance a large vertically integrated firm, or a smaller non integrated firm. They also choose the appropriate debt levels that maximizes their expected returns. I focus on pure strategy Nash equilibria of this game.[29]

Since this analysis is meant to be purely illustrative, the next proposition presents results for a particular parametric configuration of the model presented above. To draw a starker connection between contractual externalities and integration I focus on the particular case in which the pledgeable income of vertical integration is minimal.

Proposition 3.8 *Assume $\alpha = \frac{1}{2}$, $\sigma \to 1$, $b = \Delta V$ and $\pi < \frac{\Delta V}{V}$. Under Assumption A2-A4,*

[27] This could be the case if an additional entry in the upstream industry significantly lowers the profits of non-integrated firms, and if the seller can be replaced without incurring eccessive costs.

[28] It would be interesting to explore how these considerations interact with the financing of (generic) human capital.

[29] Formally, a strategy for investor $\mathcal{D}$ is a two dimensional vector: an action $a_{\mathcal{D}} \in \mathcal{A}_{\mathcal{D}} = \{0, \mathbf{D}, \mathbf{I}\}$ and a debt level $B_{\mathcal{D}} \times \Re^{+}$, where $\mathbf{0}, \mathbf{D}, \mathbf{I}$ denote respectively no financing, financiang of a (small) downstream firm, and financing of an integrated firms. Similarly for investor $\mathcal{U}$ is a two dimensional vector: an action $a_{\mathcal{U}} \in \mathcal{A}_{\mathcal{U}} = \{0, \mathbf{B}\}$.

1. $\max\{P_{ni}, K\} > P_i$ *is a necessary but not sufficient condition for non-integration to be a Nash equilibrium of the financing game, and*

2. $P_{ni} < \max\{P_i, K\}$ *is a sufficient condition for integration to be the unique Nash equilibrium of the financing game.*

As emphasized above, the source of the externality is that the financing of the downstream firm improves the net present value of the upstream firm and viceversa. When the two investors $\mathcal{D}$ and $\mathcal{U}$ simultaneously decide whether to finance a firm they do not take into account these effects. Instead they focus on the individual returns of each firm, and as a result vertical integration becomes more likely. First of all, it could be that $\mathcal{D}$ prefers to finance an integrated firm than a smaller downstream firm, even if $\mathcal{U}$ finances an upstream firm. This in turn induces $\mathcal{U}$ to abstain from investing in the first place. Note that this can happen even if the joint financial return of two non-integrated firms is higher than the one offered by an integrated firm. Under these circumstances however, vertical integration is not necessarily inefficient (in fact, under the assumptions in Proposition 8, vertical integration increases efficiency). Integration simply increases the rents of the coalition formed by the buyer and $\mathcal{D}$, at the expenses of the seller and $\mathcal{U}$. Another scenario happens when the financial requirements of the two units are highly asymmetric (k_u is high relative to $(1-\beta)$, while k_d is low relative to β), in which case either vertical integration or underinvestment will occur. Underinvestment in turn, can take two forms: no firms being financed, or only a small, non integrated firm, being financed.

Note that the contractual externalities emphasized here operate at the moment of setting up the two firms. While I have shown that those contractual externalities make integration more likely, it is clear from the preceding analysis that integration does not remove those contractual externalities. In practice, integration could instead remove contractual externalities that arise once the two projects have been financed.[30]

[30] It would be interesting to consider richer environments in which external investors can seize control over firm's assets and even force liquidation in certain states of the world (see e.g. Aghion and Bolton (1992) and Bolton and Sharfstein (1992)). We conjecture that in the presence of costly renegotiation, integration is less likely to lead to excessive liquidation than non integration, since the value of the entire supply chain as opposed to the value of a single firm should be taken more easily into account by external investors (for a related point, see XXX (JFinEc. 1981/82)). It has been noted that the financial position of a firm may affects the position of the firm vis à vis (potential) competitors. It would be interesting to perform similar analysis for the case of vertical relationships.

3.5 Conclusions

In this chapter I ask whether vertical integration reduces or increases transaction costs with external investors. I build a model in which a seller produces a good that can be used by a buyer, or sold on a spot market. The buyer and the seller have no cash, need to finance investments for production, and can not foresee in advance whether the input is most efficiently traded on the spot market or among each other. I assume that ownership of physical assets gives control over contracting rights to those assets, that financial streams get transferred with ownership and that returns can not be perfectly verified. The net balance of the costs and benefits of integration in terms of pledgeable income depends on the relative intensities of a positive "*profits-pooling*" effect against a negative "*de-monitoring*" effect. I find that larger projects, more specific assets, and low investors protection are determinants of vertical integration. I discuss joint liability contracts between non integrated firms and how contractual externalities among investors favor integration.

Several dimensions need further theoretical scrutiny. In particular the model could be extended to consider the role of trade credit and supply credit. Moreover, non contractible investments should be reintroduced in the model in order to make it more suitable for the analysis of industries in which skills and human capital are important determinants of efficiency. The ambiguous prediction on the role of the distribution of bargaining power and industry structure should motivate further theoretical as well as empirical effort. The exploration of these and other questions constitutes a promising avenue for future research.

3.6 Appendix: Proofs

Proof of Lemma 1

The case of integration is obvious since $b < \beta\Delta V$ and $\beta < 1$ imply $\overline{V} > \underline{V} + b$.

For the non integration case we have to analyze the bargaining game. With probability α the downstream manager makes a take-it-or-leave-it offer P for internal trade. Under non integration, with probability π internal trade generates high joint profits. She will choose P to maximize $\max\{\overline{V} - P, \beta\underline{V} + \mathbf{I}b\}$ subject to the constraint $P \geq (1-\beta)\underline{V}$, where $\mathbf{I} \in \{0, 1\}$ depending on whether the downstream manager has private benefits b from the low joint profits action. The solution to this program is $P = (1-\beta)\underline{V}$, and assumption 2 guarantees that $\max\{\overline{V} - P, \beta\underline{V}\} = \Delta V + \beta\underline{V} > \beta\underline{V} + \mathbf{I}b$ and hence internal trade takes place. The argument is similar for the case in which trade on the spot market generates high joint profits.

With probability $(1 - \alpha)$ the upstream manager makes a take-it-or-leave-it offer P. With probability π internal trade generates high joint profits. The upstream manager faces uncertainty with respect to the realization of b, and hence the offer P is made to maximize the expected profits $\max \mathbf{E}_\sigma \max\{P, (1-\beta)\underline{V}\}$. If $P \leq \overline{V} - \beta\underline{V} - b$ the offer is always accepted, if $P \in (\overline{V} - \beta\underline{V} - b, \overline{V} - \beta\underline{V}]$ the offer is accepted with probability $(1 - \sigma)$, and finally if $P > \overline{V} - \beta\underline{V}$ the offer is always rejected. It follows that the optimal P is $P \leq \overline{V} - \beta\underline{V} - b$ if $\overline{V} - \beta\underline{V} - b > (1-\sigma)(\overline{V} - \beta\underline{V}) + \sigma(1-\beta)\underline{V}$, i.e. if $b < \sigma\Delta V$ and $P = \overline{V} - \beta\underline{V}$ otherwise. In the latter case, the two firms trade on the market with probability σ and generate surplus equal to $\underline{V} + b$. With probability $1 - \pi$ trade on the market generates high joint profits. Even the most profitable offer $P = \underline{V} - \beta\overline{V} + b$ makes internal trade unprofitable for the upstream manager since $\underline{V} - \beta\overline{V} + b < (1-\beta)\overline{V}$.[31]

Under non integration, the high joint profits trade configuration is implemented with probability $1 - \pi\sigma(1-\alpha)$ while with the complementary probability the low joint profits trade is implemented and the realized surplus is given by $\underline{V} + b$.■

Proof of Proposition 2

In order to prove proposition 3, we have to solve the game backward. We start by proving the following Lemma.

Lemma

[31] Since managers have deep pockets, P can be larger than $\underline{V}$.

Denote with B_d^* and B_u^* the solution to the investor's problem, then $\frac{B_d^*}{(1-\phi)} \in \{\beta\underline{V}; \beta\overline{V}; (\Delta V - b)(1-\phi) + \underline{V}; (\Delta V + \beta\underline{V})\}$ *and* $\frac{B_u^*}{(1-\phi)} \in \{(1-\beta)\underline{V}; (1-\beta)\overline{V}; (\overline{V} - b - \beta\underline{V}); (\overline{V} - \beta\underline{V})\}$

Proof:

Denote with V_i and V_m the joint profits realized with internal trade and with trade on the input market respectively, and let $\mathbf{I} \in \{0,1\}$ be an indicator of whether the buyer derives private benefits b from the trade configuration that yields low joint profits.

With probability α the buyer has the right to make a take-it-or-leave-it offer. We have to analyze four different cases, depending on the realizations of the private benefits and joint profits.

Case 1: With probability $\pi(1-\sigma)$ we have $V_i = \overline{V}$ and $\mathbf{I} = 0$.

The buyer makes an offer P in order to $\max_P\{\overline{V} - P - B_d, \phi(\overline{V} - P)\}$. The offer is accepted by the seller if $\max\{P - B_u, \phi P\} \geq \max\{(1-\beta)\underline{V} - B_u, \phi(1-\beta)\underline{V}\}$. The buyer makes the offer if and only if the solution to the bargaining problem gives him an final payoff larger than her outside option $\overline{D} = \max\{\beta\underline{V} - B_d, \phi\beta\underline{V}\}$.

Assume first that $B_u \leq (1-\phi)(1-\beta)\underline{V}$. The outside option of the upstream firm is to trade on the input market realizing profits $\overline{U} = (1-\beta)\underline{V} - B_d$. The best price the buyer can offer is hence $P = (1-\beta)\underline{V}$, realizing profits $D^* = \max\{\Delta V + \beta\underline{V} - B_d, \phi(\Delta V + \beta\underline{V})\}$. If $B_d < (1-\phi)\beta\underline{V}$ then Assumption 1 implies $D^* > \overline{D}$. The offer is made and accepted in equilibrium, the two firms trade with each other, $V_i = \overline{V}$ is realized and debts B_u and B_d are fully repaid. Suppose instead that $B_d > (1-\phi)\beta\underline{V}$. Then again $D^* > \overline{D}$, the offer is made and accepted, firms trade with each other, B_u is fully repaid, while B_d is repaid if and only if $B_d < (1-\phi)(\Delta V + \beta\underline{V})$.

Assume instead that $B_u > (1-\phi)(1-\beta)\underline{V}$. Take $\varepsilon_d \geq 0$ and $\varepsilon_u \geq 0$ such that $B_u = (1-\phi)(1-\beta)\underline{V} + \varepsilon_u$ and $B_d = (1-\phi)(\Delta V + \beta\underline{V}) - \varepsilon_d$. If $P = \frac{B_u}{1-\phi}$ the offer is accepted and B_u is repaid, and the buyer gets payoff $\widehat{D} = \phi(\Delta V + \beta\underline{V}) + \varepsilon_d - \frac{\varepsilon_u}{1-\phi}$ and repays the debt. However $\widehat{D} < \phi(\Delta V + \beta\underline{V}) + \varepsilon_d$, which is the payoff she can guarantee herself offering $P = (1-\beta)\underline{V}$ and repaying her debt. The two firms hence trade with each other, however B_u is not repaid and B_d is repaid as long as $\varepsilon_d \geq 0$, i.e. if and only if $B_d < (1-\phi)(\Delta V + \beta\underline{V})$.

Case 2: With probability $(1-\pi)(1-\sigma)$ we have $V_m = \overline{V}$ and $\mathbf{I} = 0$.

For the tow firms to trade with each other, the offer P must be such that $\max\{P - B_u, \phi P\} > \max\{(1-\beta)\overline{V} - B_u, \phi(1-\beta)\overline{V}\}$ and moreover $P \leq \underline{V}$. Suppose first that $B_u \leq (1-\phi)(1-\beta)\overline{V}$, then it must be $P \geq (1-\beta)\overline{V}$ which is impossible because of

Assumption 1. Assume instead that $B_u > (1-\phi)(1-\beta)\overline{V}$, then again $P \geq (1-\beta)\overline{V}$, which is impossible. We conclude that the two firms always trade on the input market, realizes joint profits $V_m = \overline{V}$, debt B_u is repaid if $B_u \leq (1-\phi)(1-\beta)\overline{V}$and B_d is repaid if $B_d \leq (1-\phi)\beta\overline{V}$.

Case 3: With probability $\pi\sigma$ we have $V_i = \overline{V}$ and $\mathbf{I} = 1$.

The buyer makes an offer P in order to $\max\limits_{P}\{\overline{V}-P-B_d, \phi(\overline{V}-P)\}$. The offer is accepted by the seller if $\max\{P-B_u, \phi P\} \geq \max\{(1-\beta)\underline{V}-B_u, \phi(1-\beta)\underline{V}\}$. The buyer makes the offer if and only if the solution to the bargaining problem gives him a final payoff larger than her outside option $\overline{D} = \max\{\beta\underline{V} - B_d, \phi\beta\underline{V}\} + b$.

Assume first that $B_u \leq (1-\phi)(1-\beta)\underline{V}$. The outside option of the upstream firm is to trade on the input market realizing profits $\overline{U} = (1-\beta)\underline{V} - B_d$. The best price the buyer can offer is hence $P = (1-\beta)\underline{V}$, realizing profits $D^* = \max\{\Delta V + \beta\underline{V} - B_d, \phi(\Delta V + \beta\underline{V})\}$. Analogously to Case 1, it is easy to see that the buyer repays her debt if and only if $B_d < \Delta V + \beta(1-\phi) - b$.

Assume instead that $B_u > (1-\phi)(1-\beta)\underline{V}$. Take $\varepsilon_d \geq 0$ and $\varepsilon_u \geq 0$ such that $B_u = (1-\phi)(1-\beta)\underline{V} + \varepsilon_u$ and $B_d = \Delta V - b + \beta(1-\phi)\underline{V} - \varepsilon_d$. If $P = \frac{B_u}{1-\phi}$ the offer is accepted and B_u is repaid, and the buyer gets payoff $\widehat{D} = \phi\beta\underline{V} + b + \varepsilon_d - \frac{\varepsilon_u}{1-\phi}$ and repays the debt. However this proposal is always dominated by offering $P = (1-\beta)\underline{V}$ and repaying her debt, obtaining a payoff equal to $\beta\phi\underline{V} + b + \varepsilon_d$ which is also larger than the payoff she obtains from trading on the outside market. As before, she offers $P = (1-\beta)\underline{V}$, the offer is accepted, the two firms trade with each other and realize joint profits $V_i = \overline{V}$, B_u is not repaid and B_d is repaid as long as $\varepsilon_d \geq 0$, i.e. if and only if $B_d = \Delta V - b + \beta(1-\phi)\underline{V}$.

Case 4: With probability $(1-\pi)\sigma$ we have $V_m = \overline{V}$ and $\mathbf{I} = 1$

Analogously to Case 2, the two firms always trade on the input market, realizes joint profits $V_m = \overline{V}$, debt B_u is repaid if $B_u \leq (1-\phi)(1-\beta)\overline{V}$and B_d is repaid if $B_d \leq (1-\phi)\beta\overline{V}$.

With probability $1-\alpha$ the seller has the right to make a take-it-or-leave-it offer. We have to analyze two different scenarios, depending on the whether she observes $V_i = \overline{V}$ or not.

With probability $(1-\pi)$ the seller observes that $V_m = \overline{V}$. Analogously to Cases 2 and 4 above Assumption 1 ensures that there does not exists a price $P \leq \underline{V}$ that makes both the buyer and the seller willing to trade with each other.

With probability π instead the seller observes that $V_i = \overline{V}$. I start by proving the following

Claim: *Regardless of B_d, the seller offers a price $P \in \{\overline{V} - \beta\underline{V}, \overline{V} - \beta\underline{V} - b\}$.*

Proof: If $B_d \leq \beta\underline{V}$ and $P \leq \overline{V} - \frac{B_d}{1-\phi}$, depending on the realization of b, the buyer accepts an offer $P = \overline{V} - \beta\underline{V} - \mathbf{I}b$. If instead $P > \overline{V} - \frac{B_d}{1-\phi}$, the buyer accept the offer if and only if $P \leq \overline{V} - \frac{\beta\underline{V} - B_d}{\phi} - \frac{\mathbf{I}b}{\phi} \leq \overline{V} - \beta\underline{V} - \frac{\mathbf{I}b}{\phi} \leq \overline{V} - \beta\underline{V} - \mathbf{I}b$. If instead $B_d > \beta\underline{V}$ and and $P > \overline{V} - \frac{B_d}{1-\phi}$, depending on the realization of b, the buyer accepts an offer $P = \overline{V} - \beta\underline{V} - \mathbf{I}b$. Instead if $P \leq \overline{V} - \frac{B_d}{1-\phi}$ the buyer accepts the offer if and only if $P \leq \overline{V} - B_d - \phi\beta\underline{V} - \mathbf{I}b \leq \overline{V} - \beta\underline{V} - \mathbf{I}b$.

The claim established that the bargaining strategy of the seller does not depend on whether $B_d \gtrless \beta\underline{V}$. Given this result, the seller set $P = \overline{V} - \beta\underline{V} - \widehat{\mathbf{I}}b$, with $\widehat{\mathbf{I}} = 1$ if

$$\begin{aligned} & \max\{\overline{V} - \beta\underline{V} - b - B_u, \phi(\overline{V} - \beta\underline{V} - b)\} \\ \geq \; & (1-\sigma)\max\{\overline{V} - \beta\underline{V} - B_u, \phi(\overline{V} - \beta\underline{V})\} + \sigma\max\{(1-\beta)\underline{V} - B_u, \phi(1-\beta)\underline{V} \end{aligned}$$

It follows that if $B_u \leq (1-\phi)(1-\beta)\underline{V}$ or $B_u > (1-\phi)(\overline{V} - \beta\underline{V})$, $\widehat{\mathbf{I}} = 1$ if and only if $\sigma\Delta V \geq b$, if instead $B_u \in ((1-\phi)(\overline{V} - \beta\underline{V} - b), (1-\phi)(\overline{V} - \beta\underline{V})]$ then $\widehat{\mathbf{I}} = 0$, and finally if $B_u \in ((1-\phi)(1-\beta)\underline{V}, (1-\phi)(\overline{V} - \beta\underline{V} - b)]$ then $\widehat{\mathbf{I}} = 1$.

We are now ready to establish the maximum pledgeable income when the two units are independently owned and managed. Let $\mathbf{I}_d(s \mid B_d, B_u) \in \{\mathbf{0}, \mathbf{1}\}$ and $\mathbf{I}_u(s \mid B_d, B_u) \in \{\mathbf{0}, \mathbf{1}\}$ be two indicator functions taking values equal to one if in state s, and given B_u and B_d the outcome of the bargaining process is such that B_d and B_u respectively are repaid. Let π_s be the probability that state s is realized. The investor solves

$$\max_{B_d, B_u} \mathbf{\Sigma}_s\pi_s\left(\mathbf{\Sigma}_{j\in\{d,u\}}B_j \cdot \mathbf{I}_j(s \mid B_d, B_u)\right)$$

Since the indicators $\mathbf{I}_j(s \mid B_d, B_u)$ are piecewise linear in B_d and B_u, the investors solves a linear programming problem. Hence the solution of the program will (generically) be at a corner.■

The proof of the previous Lemma implies that in each state, the repayment of B_d does not depend on B_u and viceversa, i.e. $\mathbf{I}_j(s \mid B_d, B_u)$ can be rewritten as $\mathbf{I}_j(s \mid B_j)$. The investor's problem can thus be decomposed into two simpler problems: for $j \in \{d, u\}$,

$$\max_{B_j} \mathbf{\Sigma}_s\pi_s B_j \cdot \mathbf{I}_j(s \mid B_j)$$

Denote with $P^j(\alpha)$ the solution to this problem, and hence $P_{ni}(\alpha) = P^d(\alpha) + P^u(\alpha)$. From the previous Lemma we have

$$\begin{aligned} P^d(\alpha) &= (1-\phi)\max\{\beta\underline{V}, \beta\overline{V}(1-\pi(1-\alpha)), \\ &\quad (\Delta V + \beta\underline{V})\alpha\pi(1-\sigma), (\frac{\Delta V - b}{1-\phi} + \beta\underline{V})\alpha\pi\} \end{aligned}$$

and

$$\begin{aligned} P^u(\alpha) &= (1-\phi)\max\{(1-\beta)\underline{V}, (1-\beta)\overline{V}(1-\pi\alpha), \\ &\quad (\overline{V} - \beta\underline{V})(1-\alpha)\pi(1-\sigma), (\overline{V} - \beta\underline{V} - b)(1-\alpha)\pi\} \end{aligned}$$

Consider first $\alpha = 1$. To determine $P^d(1)$, note that assumption A2 implies $\frac{\Delta V - b}{1-\phi} + \beta\underline{V} \leq \Delta V + \beta\underline{V}$ and assumption A4 implies $\beta\overline{V} \geq (\Delta V + \beta\underline{V})\pi$. Since $(\Delta V + \beta\underline{V}) \geq \max\{(\Delta V + \beta\underline{V})(1-\sigma), (\frac{\Delta V - b}{1-\phi} + \beta\underline{V})\}$ we conclude that $P^d(1) = \beta\overline{V}$.It is instead obvious that $P^u(1) = (1-\phi)(1-\beta)\max\{\underline{V}, \overline{V}(1-\pi)\}$, and hence

$$P_{ni}(1) = (1-\phi)\left[\beta\overline{V} + (1-\beta)\max\{\underline{V}, \overline{V}(1-\pi)\}\right]$$

Consider now $\alpha = 0$. It is obvious that $P^d(0) = (1-\phi)\beta\max\{\underline{V}, \overline{V}(1-\pi)\}$. To determine $P^u(0)$, note that assumption A2 implies $\overline{V} - \beta\underline{V} - b \leq \overline{V} - \beta\underline{V} - \phi\Delta V$, and assumptions A2 and A4 imply $(1-\beta)\overline{V} \geq \left(\overline{V} - \beta\underline{V} - \phi\Delta V\right)\pi$. We conclude that $P^u(0) = (1-\phi)\max\{(\overline{V} - \beta\underline{V})\pi(1-\sigma), (1-\beta)\overline{V}\}$ and hence

$$P_{ni}(0) = (1-\phi)\left[\beta\max\{\underline{V}, \overline{V}(1-\pi)\} + \max\{(\overline{V} - \beta\underline{V})\pi(1-\sigma), (1-\beta)\overline{V}\}\right]$$

which concludes the proof.■

Proof of Proposition 3

Suppose first that $\pi \geq \frac{\Delta V}{\overline{V}}$. Then $P_{ni}(1) = (1-\phi)(\underline{V} + \beta\Delta V)$. But than note that $P_i(1) \geq \overline{V} - b - \phi\underline{V} \geq P_{ni}(1)$ as $b \leq (1-\beta(1-\phi))\Delta V$ is implied by A2. Suppose instead $\pi < \frac{\Delta V}{\overline{V}}$. Then $P_{ni}(1) = (1-\phi)\overline{V}(1-\pi(1-\beta))$. If $\pi > \frac{\sigma}{1-\beta}$, then $P_i(1) \geq (1-\phi)\overline{V}(1-\sigma) \geq P_{ni}(1)$. If instead $\pi < \frac{\sigma}{1-\beta}$, then $P_{ni}(1) > P_i(1)$ if $(1-\phi)\overline{V}(1-\pi(1-\beta)) > \overline{V} - b - \phi\underline{V}$. Assumption A2 implies that $\overline{V} - b - \phi\underline{V} \geq (1-\beta)\overline{V} + (\beta-\phi)\underline{V}$, and hence $\pi > \frac{(\beta-\phi)}{(1-\phi)(1-\beta)}\frac{\Delta V}{\overline{V}}$ implies $P_{ni}(1) < P_i(1)$. Rearranging terms concludes the proof.■

Proof of Proposition 4

To prove the first part, note that $(\overline{V}-\beta\underline{V})\pi > (1-\beta)\overline{V}$ if $\pi > \frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})\pi}$, however $\beta < \frac{1}{2}$ implies $\frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})\pi} > \frac{\beta\overline{V}}{\Delta V+\beta\underline{V}}$ and hence $(\overline{V}-\beta\underline{V})\pi < (1-\beta)\overline{V}$. If $\pi > \frac{\Delta V}{\overline{V}}$ then $P_{ni}(0) = (1-\phi)[\beta\underline{V}+(1-\beta)\overline{V}]$. However assumption A2 implies $P_i(0) \geq (1-\beta)\overline{V}+(\beta-\phi)\underline{V}$, and $\Delta V > 0$ implies $(1-\beta)\overline{V}+(\beta-\phi)\underline{V} > P_{ni}(0)$. Suppose instead $\pi < \frac{\Delta V}{\overline{V}}$, then $P_{ni}(0) = (1-\phi)(1-\beta\pi)\overline{V}$. The results follows as in the proof of proposition 4, since assumption A2 implies $\frac{b-\phi\Delta V}{(1-\phi)\overline{V}} < \frac{\Delta V}{\overline{V}}$.

The analysis to prove the case $\beta > \frac{1}{2}$ is more involved, as $P_{ni}(0)$ is non-monotonic in π, and hence several cases have to be considered.

<u>Case 1:</u> Suppose first that $\pi < \min\{\frac{\Delta V}{\overline{V}}, \frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})(1-\sigma)}\}$, then $P_{ni}(0) = (1-\phi)(1-\beta\pi)\overline{V}$ and the analysis is as before.

<u>Case 2:</u> Suppose instead $\pi > \max\{\frac{\Delta V}{\overline{V}}, \frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})(1-\sigma)}\}$, and hence $P_{ni}(0) = (1-\phi)[\beta\underline{V} + (\overline{V}-\beta\underline{V})\pi)(1-\sigma)]$. We know that $P_i(0) \geq \overline{V}-b-\phi\underline{V}$ and that $\frac{\partial P_i}{\partial(1-\sigma)} = (1-\phi)\overline{V}$ if $(1-\sigma) > \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$, while $\frac{\partial P_i}{\partial(1-\sigma)} = 0$ if $(1-\sigma) < \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$. Since $(1-\phi)\overline{V} > \frac{\partial P_{ni}}{\partial(1-\sigma)} = (1-\phi)(\overline{V}-\beta\underline{V})\pi > 0$, the condition

$$P_i(0)_{|(1-\sigma)=\frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}} > P_{ni}(0)_{|(1-\sigma)=\frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}} \tag{3.1}$$

is necessary and sufficient to prove $P_i(0) > P_{ni}(0)$ for all values of σ when $\pi > \max\{\frac{\Delta V}{\overline{V}}, \frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})(1-\sigma)}$. Substituting $(1-\sigma) = \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$ in $P_{ni}(0)$, after some algebra we can show that the condition can be rewritten as $\pi < \frac{\overline{V}}{\overline{V}-\beta\underline{V}}\frac{\overline{V}-b-\phi\underline{V}-\beta(1-\phi)\underline{V}}{\overline{V}-b-\phi\underline{V}}$. The right hand side is decreasing in b and increasing in ϕ. Hence a sufficient condition is that the inequality is satisfied when $b = \beta\Delta V$, and when $\phi = \max\{2-\frac{1}{\beta}, 0\} = 0$, where the last equality follows from $\beta > \frac{1}{2}$. After the appropriate substitutions, the inequality becomes $\pi < \frac{\overline{V}}{\overline{V}-\beta\underline{V}}\frac{\overline{V}(1-\beta}{\overline{V}(1-\beta+\beta\underline{V}}$. Assumption A4 ($\pi < \frac{\beta\overline{V}}{\Delta V+\beta\underline{V}}$) implies that the last inequality is always satisfied, since trivial algebra and $\beta > \frac{1}{2}$ imply $\frac{\overline{V}}{\overline{V}-\beta\underline{V}}\frac{\overline{V}(1-\beta}{\overline{V}(1-\beta+\beta\underline{V}} > \frac{\overline{V}}{\Delta V+\beta\underline{V}} > \frac{\beta\overline{V}}{\Delta V+\beta\underline{V}}$.

<u>Case 3:</u> Suppose that π belongs to the non empty interval $(\frac{\Delta V}{\overline{V}}, \frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})(1-\sigma)})$. In this case $P_{ni}(0) = (1-\phi)(\beta\underline{V}+(1-\beta)\overline{V})$ and it is easy to show that assumption A2 implies $P_i(0) \geq \overline{V}(1-\beta)+(\beta-\phi)\underline{V} > P_{ni}(0)$.

<u>Case 4:</u> Suppose that π belongs to the non empty interval $(\frac{(1-\beta)\overline{V}}{(\overline{V}-\beta\underline{V})(1-\sigma)}, \frac{\Delta V}{\overline{V}})$. In this case $P_{ni}(0) = (1-\phi)(\beta\overline{V}(1-\pi)+\pi(1-\sigma)(\overline{V}-\beta\underline{V}))$. As in case 2, $0 < \frac{\partial P_i}{\partial(1-\sigma)} < \frac{\partial P_{ni}}{\partial(1-\sigma)}$ if $(1-\sigma) > \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$ and $\frac{\partial P_i}{\partial(1-\sigma)} > \frac{\partial P_{ni}}{\partial(1-\sigma)} = 0$ if $(1-\sigma) < \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$. To see whether $P_{ni}(0) \gtrless P_i(0)$ we can focus on the case in which $(1-\sigma) = \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$. Let $\Phi = \frac{\overline{V}-b-\phi\underline{V}}{(1-\phi)\overline{V}}$,

condition 3.1 can be rewritten as

$$\Phi > \beta(1-\pi) + \pi\Phi\frac{\overline{V} - \beta\underline{V}}{\overline{V}}$$

which after some algebra becomes

$$\Phi > \frac{\beta(1-\pi)}{1 - \pi\frac{\overline{V}-\beta\underline{V}}{\overline{V}}}$$

since $1 - \pi\frac{\overline{V}-\beta\underline{V}}{\overline{V}}$ for all $\pi < 1$. The right hand side is decreasing in π, while the left hand side is decreasing in b. A sufficient condition for 3.1 to be true is therefore $\frac{\overline{V}(1-\beta)+(\beta-\phi)\underline{V}}{(1-\phi)\overline{V}} > \beta$ which can be rewritten as $\overline{V}(1-\beta(2-\phi)) > -(\beta-\phi)\underline{V}$. Assumption A2 guarantees that this last inequality is always satisfied, completing the proof.■

Proof of Proposition 7

The proof of proposition 7 mimics the proof of proposition 3. I first derive the outcome of the bargaining process in the four states of nature, and then analyze the optimal contract. With a minor abuse of notation, I denote with $\mathbf{I}_j$ an indicator function taking value equal to 1 if firm $j \in \{d, u\}$ defaults. With probability $(1-\pi)$, $V_m = \overline{V}$. Since $\beta\overline{V} < \Delta V$ trade has to take place on the spot input market, and debts are repaid as long as $B_u \leq (1-\phi)(1-\beta)\overline{V}$ and $B_d \leq (1-\phi)\beta\overline{V}$. Note that in these states of the world it is not impssible to do better using joint liability. Suppose the buyer defaults, and $L_u > 0$. The seller will not default if and only if $B_u + L_u \leq (1-\phi)(1-\beta)\overline{V}$.

Let us now consider the case in which $V_i = \overline{V}$ and $\mathbf{I}_b = 0$, which happens with probability $\pi(1-\sigma)$.

Suppose, without loss of generality, $B_u > (1-\phi)(1-\beta)\underline{V}$ and $B_d > (1-\phi)\beta\underline{V}$. This implies that if trade takes place on the input market, the upstream firm does not pay the debt B_u. Suppose the downstream firm offers a price P. If $P < (1-\beta)\underline{V}$, the offer is rejected, and trade takes place on the input market. The payoff of the dowsntream firm is then given by $V_{d,m}^{\cdot,0} = \max\{\beta\underline{V} - B_d - L_d, \phi\beta\underline{V}\} = \phi\beta\underline{V}$. If instead $P \in \{(1-\beta)\underline{V}, \frac{B_u + \mathbf{I}_d L_u}{(1-\phi)})$, the seller accepts the offer, but still defaults on her loan. The payoff of the downstream firm is gven by $V_{d,i}^{\cdot,0} = \max\{\overline{V} - P - B_d - L_d, \phi\left(\overline{V} - P\right)\}$. Since in this case the optimal P is equal to $(1-\beta)\underline{V}$, we have $V_{d,i}^{\cdot,0} > V_{d,m}^{\cdot,0}$. This ensures that the downstream always makes an offer that is accepted. Finally, if $P \geq \frac{B_u + \mathbf{I}_d L_u}{(1-\phi)}$, the payoff of the downstream firm is given by $V_{d,i}^{\cdot,1} = \max\{\overline{V} - P^1 - B_d, \phi(\overline{V} - P^0)\}$, where P^0 is the price that has to be paid if $\mathbf{I}_d = 1$ and P^1 if $\mathbf{I}_d = 0$. Clearly, if $\mathbf{I}_d = 0$ we have $P^1 = \frac{B_u}{(1-\phi)}$ and the downstream firm repays the debt if $\overline{V} - \frac{B_u}{(1-\phi)} - B_d > \phi(\overline{V} - \frac{B_u + L_u}{(1-\phi)})$. By setting

$L_u = (1-\phi)\overline{V} - B_u$ the right hand side becomes equal to zero, and the two debts are repaid if $\overline{V} - \frac{B_u}{(1-\phi)} - B_d > \overline{V} - (1-\beta)\underline{V} - B_d - L_d$. In an optimal contract, the right hand side is equal to $\phi(\Delta V + \beta\underline{V})$. It follows that if $\frac{B_u}{(1-\phi)} + B_d \leq \overline{V}(1-\phi) + \phi(1-\beta)\underline{V}$. If the latter inequality is not satisfied instead, the downstream firm repays debt B_d and liability L_d if and only if $B_d + L_d \leq (1-\phi)(\Delta V + \beta\underline{V})$. Since the problem is linear, we know that the solution will be at a corner. We start by proving the following Lemma.

Lemma: *The optimum is given by* $\frac{B_d^*}{1-\phi} = \beta\overline{V}$, $\frac{B_u^*}{1-\phi} = (1-\beta)\overline{V}$.

First note that the two candidate solution on the line $\frac{B_u}{(1-\phi)} + B_d = \overline{V}(1-\phi) + \phi(1-\beta)\underline{V}$ must have either $\frac{B_u^*}{1-\phi} = (1-\beta)\overline{V}$ or $\frac{B_u^*}{1-\phi} = (1-\beta)\underline{V}$. In the first case, debts are always repaid, which gives a total return to the investor equal to $(1-\phi)\overline{V} - (1-\beta)\phi\Delta V$. This return is always smaller than $(1-\pi)(1-\phi)\overline{V} + \pi(1-\phi)(\Delta V + \beta\underline{V})$ which can be obtained with a contract $\frac{B_d^*}{1-\phi} = \beta\overline{V}$, $\frac{B_u^*}{1-\phi} = (1-\beta)\overline{V}$ and $L_d = (1-\phi)(1-\beta)\Delta V$. To see this, note that the returns associated with this last contract are decreasing in π, and are equal to $(1-\phi)\left[\frac{\Delta V}{\Delta V + \beta\underline{V}}(1-\beta)\overline{V}) + \beta\overline{V}\right]$ at their minimum, i.e. when $\pi = \frac{\beta\overline{V}}{\Delta V + \beta\underline{V}}$. In the second case, the debts are repaid with probability π, and with probability $(1-\pi)$ only the upstream firm repays at most $(1-\phi)(1-\beta)\overline{V}$. Returns are thus given by $(1-\phi)\left[\pi\overline{V} + (1-\beta)(1-\pi)\overline{V}\right]$. Note that the inequality

$$\pi\overline{V} + (1-\beta)(1-\pi)\overline{V} < (1-\pi)\overline{V} + \pi(\Delta V + \beta\underline{V})$$

is always satisfied since the RHS is decreasing in π, the LHS is increasing in π and the inequality is satisfied at $\pi = \frac{\beta\overline{V}}{\Delta V + \beta\underline{V}}$ This implies that the highes repayment that the investor can get out of the two firms is given by the contract The optimum is given by $\frac{B_d^*}{1-\phi} = \beta\overline{V}$, $\frac{B_u^*}{1-\phi} = (1-\beta)\overline{V}$ and $L_d = (1-\phi)(1-\beta)\Delta V$ ■.

Remark: The proof for the case in which $V_i = \overline{V}$ and $\mathbf{I}_b = 1$ is completely analogous, and is therefore omitted. In this case, the highest financial return that can be extracted from the two firms is given by $B_d + L_d = \overline{V} - b - \phi\underline{V} - (1-\beta)(1-\phi)\underline{V} > (1-\phi)\beta\overline{V}$. The last inequality implies that $L_d^* > 0$ and $B_d^* = (1-\phi)\beta\overline{V}$. B_u is set at the highest level consistent with repayment in states in which $V_m = \overline{V}$, i.e. $B_u^* = (1-\phi)(1-\beta)\overline{V}$. As shown above $L_u^* = (1-\phi)\overline{V} - B_u^* = (1-\phi)\beta\overline{V} = B_d^*$.

The highest pledgeable income immediately follows. If $(1-\sigma) > \frac{\Delta V + \beta(1-\phi)\underline{V} - b}{(1-\phi)(\Delta V + \beta\underline{V})}$ it is optimal to set $B_d^* + L_d^* = (1-\phi)(\Delta V + \beta\underline{V})$, otherwise it is optimal to choose $B_d^* + L_d^* = \Delta V + \beta(1-\phi)\underline{V} - b$. With probability $1-\pi$ the firms jointly repay $B_u^* + B_d^*$, while with probability π they repay $L_d^* + B_d^*$. This completes the proof.■

Proof of Proposition 8

To proove the proposition, we start by prooving the followig Lemma:

Lemma: *Assume* $\alpha = \frac{1}{2}$, $\sigma \to 1$, $b = \Delta V$ *and* $\pi < \frac{\Delta V}{\overline{V}}$. *Under Assumption A2-A4* $P_{ni} = (1-\phi)\overline{V}(1-\frac{\pi}{2})$.

Proof. Since, conditional on the two firms having been separatedly financed, the optimal level of debts are determined separatedly, the result in the Lemma presented in the proof of proposition 3 holds. Consider the detrmination of B_u^*. First,$\pi < \frac{\Delta V}{\overline{V}}$ implies $\frac{\pi}{2} < \frac{\Delta V}{\overline{V}}$, ruling out $B_u^* = (1-\phi)(1-\beta)\underline{V}$. Also, $\sigma \to 1$ rules out $B_u^* = (1-\phi)(\overline{V} - \beta\underline{V})$ (which is repaid with probability $\alpha\pi(1-\sigma)$). Hence $B_u^* \in \{(1-\phi)(1-\beta)\overline{V}, (\overline{V} - b - \beta\underline{V})\}$. The first term is repaid with probability $(1-\alpha\pi) = 1 - \frac{\pi}{2}$, the second with probability $\alpha\pi = \frac{\pi}{2}$. Moreover, $b = \beta\Delta V$ implies that $\overline{V} - b - \beta\underline{V} = (1-\beta)\overline{V}$, and since $\pi < 1$, we have $1 - \frac{\pi}{2} > \frac{\pi}{2}$. Clearly, the returns on the upsream firm are given by $P^u = (1-\phi)(1-\beta)(1-\frac{\pi}{2})\overline{V}$.

Consider now the downstream firm. An analogous proof shows that $P^d = (1-\phi)\beta(1-\frac{\pi}{2})\overline{V}$ if, when $b = \beta\Delta V$, the inequality $\left(\overline{V} - b - \phi\underline{V} - (1-\beta)\underline{V}\right)\frac{\pi}{2} < (1-\phi)\beta\overline{V}(1-\frac{\pi}{2})$ is verified. To see that this is the case, take the highest possible $\pi = \frac{\Delta V}{\overline{V}} < \frac{\beta\overline{V}}{\Delta V + \beta\underline{V}}$ (this last inequality implies $\frac{\Delta V^2}{\Delta V^2 + \overline{V}\underline{V}} < \beta < \frac{\Delta V}{\overline{V}}$). The inequality can be rewritten as $2\beta\overline{V}\underline{V}(1-\phi) > (1-\beta(2-\phi))\Delta V^2$. If $\phi \to 0$ this expression is always satisfied. If instead $\phi \to \beta$ the inequality becomes $\frac{\Delta V^2}{\overline{V}\underline{V}} < 2\frac{\beta}{1-\beta}$. The RHS is increasing in β, and the inequality is always satisfied since it is true when $\beta = \frac{\Delta V^2}{\Delta V^2 + \overline{V}\underline{V}}$. This completes the proof of the Lemma.■

Denote by P_d^1 and P_u^1 the returns that investors $\mathcal{D}$ and $\mathcal{U}$ obtain from financing the non integrated buyer and seller respectively when the other investor has also financed the respective non integrated firm. The previous Lemma implies $P_d^1 = (1-\phi)(1-\beta)(1-\frac{\pi}{2})\overline{V}$ and $P_d^1 = (1-\phi)\beta(1-\frac{\pi}{2})\overline{V}$. Similarly, denote by P_d^0 and P_u^0 the returns that investors $\mathcal{D}$ and $\mathcal{U}$ obtain from financing the non integrated buyer and seller respectively when the other investor has not financed the respective non integrated firm.

To proove the first part of the proposition, let's start by considering the case of investor $\mathcal{U}$. With probability π the firm realizes profits $(1-\beta)\underline{V}$, while with probability $1-\pi$ the upstream firm realizes profits $(1-\beta)\overline{V}$. Since $\pi < \frac{\Delta V}{\overline{V}}$, the optimal amount of debt in this case is $(1-\phi)(1-\beta)\overline{V}$ which is repaid with probability $1-\pi$. It follows that $P_u^0 = (1-\phi)(1-\beta)(1-\pi)\overline{V}$ and (symmetrically) $P_d^0 = (1-\phi)\beta(1-\pi)\overline{V}$. Hence $P_j^1 > P_j^0$ for $j \in \{d, u\}$. The fact that non-integration is a Nash equilibrium implies that $P_u^1 > k_u$ (otherwise $\mathcal{U}$ best reply would be to not invest), and $P_d^1 > \max\{k_d, P_{int} - k_u\}$ (if $P_d^1 < k_d$ $\mathcal{D}$ could ensure a higher payoff by not investing, while if $P_d^1 < P_{int} - k_u$ she would improve her payoff by financing an integrated firm). The second inequality implies $k_u > P_{int} - P_d^1$, and hence the first inequality implies $P_u^1 > P_{int} - P_d^1$, which rearranged yields $P_{int} <$

$P_d^1 + P_u^1 = P_{ni}$. This complete the first part of the proof.

Remark 1: To see why $P_{int} < P_{ni}$ is not sufficient to ensure non-integration, consider the case in which $k_d < P_d^1 < P_{int}$ (which happens if β is small), and $k_u \to 0$. Then $\mathcal{D}$ improve her payoff by financing an integrated firm. If she does so, the best response for $\mathcal{U}$ is to not invest as $L < 0$. But $P_{int} > P_d^1$ implies $P_{int} > P_d^0$, and hence the action profile in which $\mathcal{D}$ finances a vertically integrated firm while $\mathcal{U}$ does not invest is an equilibrium.

To proove the second part of the proposition, it is sufficient to prove that $P_{int} > P_{ni} = P_u^1 + P_d^1$ implies that $P_{int} - K < P_d^1 - k_d$ (the best scenario under which $\mathcal{D}$ chooses not to finance a vertically integrated firm) leads to a contradiction. To see this, Suppse that $P_{int} - K < P_d^1 - k_d$, i.e. that $P_{int} < P_d^1 + k_u$. Combining this inequality with $P_{int} > P_u^1 + P_d^1$ implies $k_u > P_u^1$, which means that $\mathcal{U}$ prefers not to invest. A contradiction of the equilibrium with non-integration.■

Remark 2: Suppose instead $P_{int} < K$, and $P_d^1 < k_d$. Than if $k_u \in [P_u^0, P_u^1)$ the only equilibrium is that no firm is financed, despite the fact that $P_d^1 < k_d$ does not rule out $P_{ni} > K$, since $P_u^1 > k_u$.

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