Contractual Imperfections, Credit Markets and Vertical Integration: Theory and Cross-Country Evidence

Rocco Macchiavello*

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Abstract

Anecdotal evidence, as well as theoretical considerations, suggest the possibility of important cross-country differences in the organization of production in general, and in the degree of vertical integration in particular. This paper examines the institutional determinants of vertical integration, asking, in particular, whether contractual frictions in input and financial markets have a differential impact on the degree of vertical integration across industries and countries. I discover new patterns in cross country differences in vertical integration. First, contrary to conventional wisdom, I find some evidence of higher vertical integration in developed countries. Second, I show that industries that are more dependent on external finance tend to be relatively more vertically integrated in developed countries. These facts are not consistent with existing theories of vertical integration and suggest that contractual frictions in input and in financial markets have a radically different impact on vertical integration across industries. I develop an industry equilibrium model of vertical integration and imperfect contracting in input and financial markets. Fewer contractual imperfections in input markets unambiguously lead to less vertical integration while fewer contractual imperfections in financial markets are associated with lower degrees of 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.

Keywords: Vertical Integration, Credit Constraints, Contracts Enforcement, Developing Countries, Industry Equilibrium.

JEL Codes: D23, L11, L22, O14.

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1 Introduction

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. Despite the importance of understanding the determinants of these differences and their implications for the observed cross-country differences in productivity, there has been no systematic analysis of cross-country determinants of vertical integration. This paper studies the institutional determinants of vertical integration, asking, in particular, whether contractual frictions in input and financial markets have a differential impact on the degree of vertical integration across industries and countries. Novel patterns in cross-country differences in the extent of vertical integration are revealed, and an industry equilibrium model of vertical integration and imperfect contracting in input and financial markets is developed. Finally, the predictions of the model are tested using cross-country-industry data.

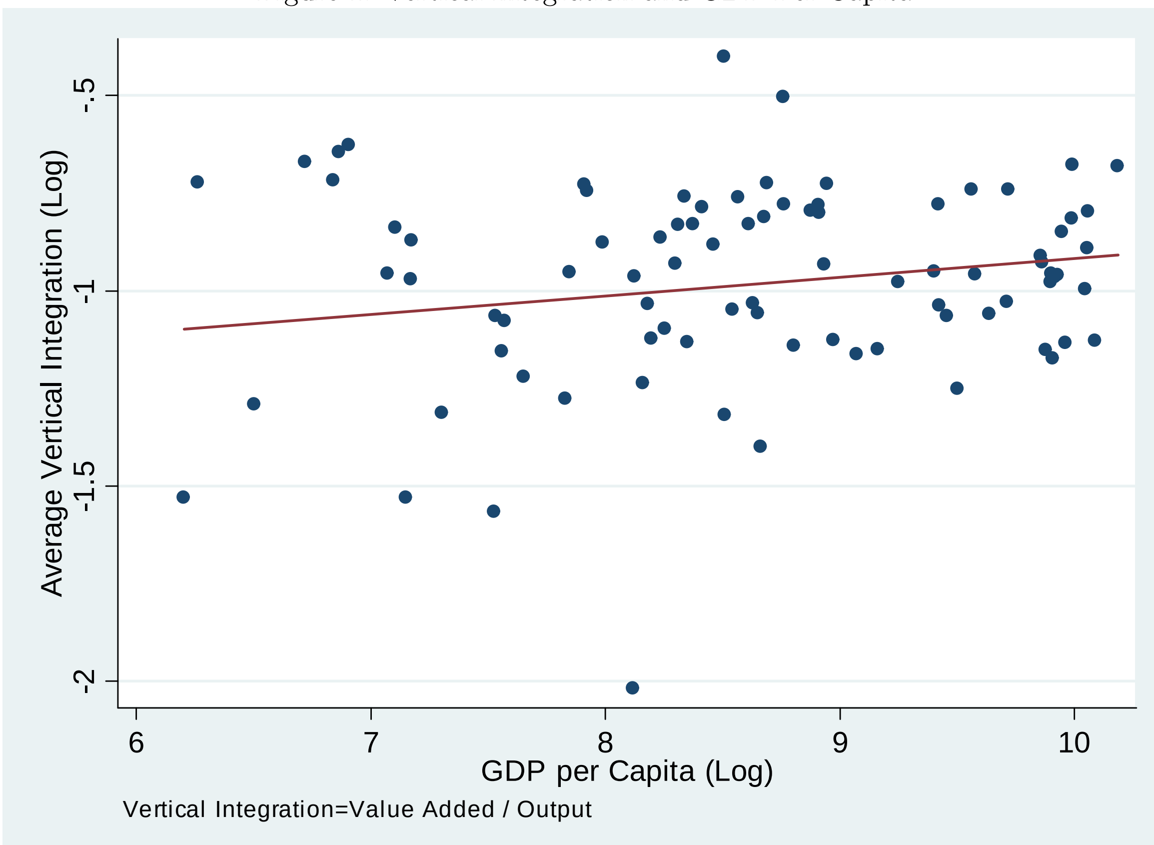
Existing theories of the firm suggest that the more prevalent the imperfections in input markets, the more firms tend to be vertically integrated (see e.g. Williamson (1971, 1975, 1985), Carlton (1979)). Since imperfections such as poor contractual enforcement or low quality and productivity of suppliers characterize the economies of less developed countries, firms in those countries are often thought to be larger and more vertically integrated (see e.g. Khanna and Palepu (1997, 2000)).

Figure 1 casts some doubts on these conventional views. Figure 1 plots (the log of) an average measure of vertical integration against the (log of the) GDP per capita of each country. For each country in my sample I compute the unweighted average of the ratios of value added over output (a commonly used proxy of vertical integration in the industrial organization literature) across 25 industries in the manufacturing sector. Figure 1 does not support the view that there is a higher propensity for firms to vertically integrate in poorer countries.[1] The absence of a negative relationship is instead consistent with anecdotal evidence suggesting that subcontracting arrangements are fairly extensive in the developing world, and have played an important role in the industrialization of late industrializing countries.[2]

[1] As the index is an unweighted average, Figure 1 conveys the same information of a regression of vertical integration in industry i and country c on GDP per capita in country c and industry fixed effects. In the Appendix I discuss results from regressions of this form, in which the effect of country level variable is assumed to be the same across all the industries. While Figure 1 provides interesting motivating evidence for this work, this paper is mostly concerned with the identification of the differential effects of institutions across industries.

[2] See, for example, the experience of Italian industrial districts or the clusters in the early computer industry in

Figure 1: Vertical Integration and GDP Per Capita



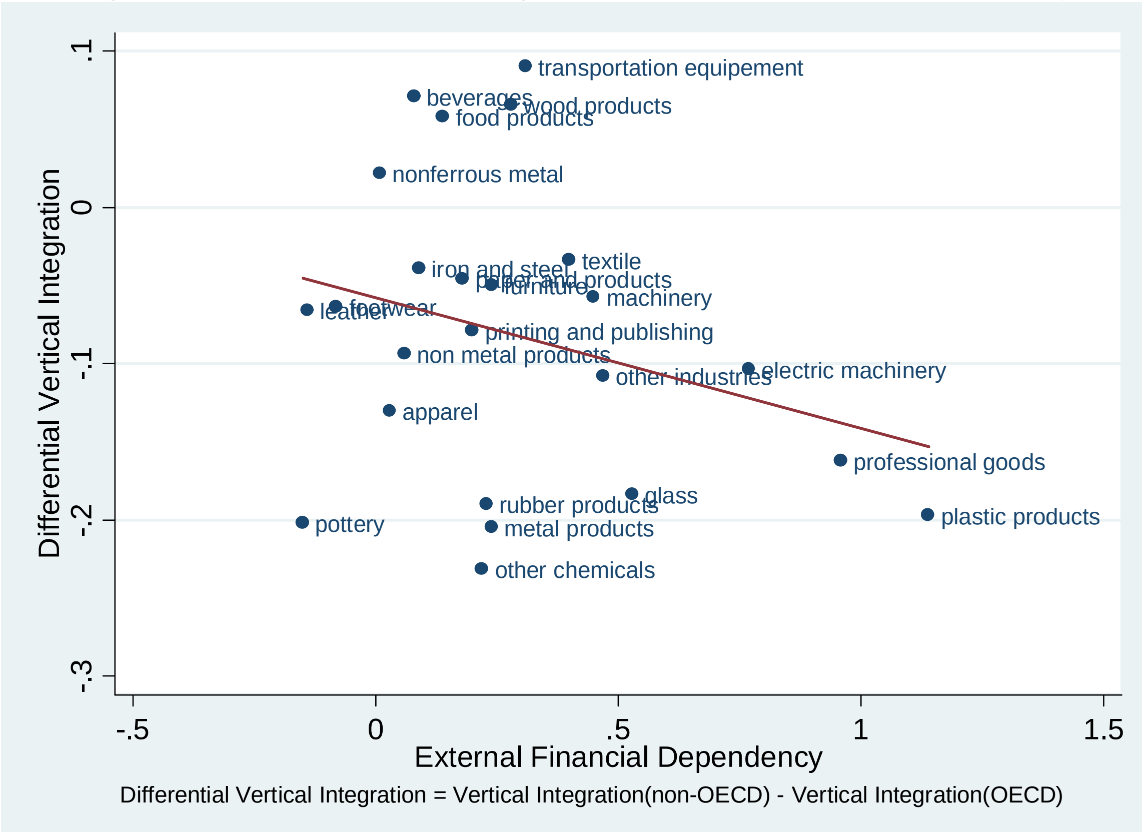
The transaction cost approach to vertical integration (see e.g. Williamson (1975, 1985)) argues that when it is difficult to write detailed contracts, trading at arm's length results in excessive transaction costs. Vertical integration reduces the costs of arm's length transactions by replacing the bargaining process with authority. In the presence of weak contract enforcement institutions, the transaction costs associated with the use of markets increase, and vertical integration becomes (relatively) more appealing.

On the other hand, contractual imperfections severely affect the efficiency of transactions in financial markets.[3] When applied to financial markets, transaction costs theories argue that, 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] An extensive cross-country literature documents how the degree of financial development is strongly associated with its legal origin (see e.g. LaPorta et al. (1998)). There is also a substantial amount of evidence that firms are financially constrained in developed and developing countries as well (see e.g. Banerjee and Munshi (2004), Banerjee,

Figure 2: Differential Vertical Integration and External Financial Dependency



the presence of financial market imperfections, firms vertically integrate and create internal capital markets to substitute for the lack of (efficient) external capital markets.

Figure 2 reveals a second puzzling pattern in the relationship between financial market imperfections and vertical integration. For each of the 26 industries in the sample, I construct an index of "Differential Vertical Integration" as the difference between the average index of vertical integration across non-OECD countries and the average index of vertical integration in OECD countries. I then plot this index against the measure of external financial dependency at the industry level in the U. S., a proxy for technological needs for external finance.[4]

Duflo and Munshi (2003) for firms in India). Moreover, financial development has been shown to be a key determinant of cross country differences in industry growth and productivity (see e.g. Rajan and Zingales (1998), and the survey in Levine (2005)).

[4]It is important to stress that Figure 2 does not tell us anything on the *levels* of vertical integration across industries. The measure of external financial dependency is from Rajan and Zingales (1998). As in their seminal paper, the key assumption underlying Figure 2 is that industry characteristics in the United States proxy for technological characteristics at the industry level. Results are not driven by the comparison between OECD and non-OECD

Figure 2 shows that industries that rely more on external finance are not relatively more vertically integrated in less developed countries. This is not consistent with the transaction costs view applied to imperfections in financial markets. Figure 2 suggests that poor contract enforcement may have a very different impact on vertical integration through imperfections in specific (intermediate) versus non-specific (capital) input markets.[5]

To shed some light on the stylized facts reported above, I develop a theoretical framework to study the relationship between vertical integration and contractual imperfections in input and financial markets. Building on Grossman and Helpman (2002), I assume that vertical integration centralizes the control over non-contractible investments in the production of intermediate inputs, and thus mitigates hold-up problems arising from contractual imperfections. However, since additional investments are required to effectively acquire control over non-contractible investments, vertical integration essentially comes at the cost of higher financial requirements. 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). Under these assumptions, the model generates a natural sorting of firms into organizational forms. More productive firms become larger both in terms of revenue and size. For this reason more productive firms gain relatively more from solving contractual imperfections, and thus become vertically integrated.

I introduce contractual frictions in the intermediate input market and in the financial market and show that these imperfections have radically different implications for the extent of vertical integration in the industry. Fewer contractual frictions in the intermediate input market mitigate the hold-up problem associated with arm's length transactions. Better contractual institutions in intermediate input markets reduce the relative returns of vertical integration and hence unambigously increase the degree of non-integration in the industry. In other words, the benefits of vertical integration are particularly strong in industries that rely more heavily on contracts, and in countries with poor contract enforcement institutions.

countries. Identical results are obtained if the average for non-OECD countries is compared with the average for the U.S. or if the index of "Differential Vertical integration" for industry i is computed as the coefficient β_i of the regression $INT_{ic} = \alpha + \eta_i + \gamma GDPpc_c + \beta_i * GDPpc + \varepsilon_{ic}$.

[5] This intuition is confirmed by the contrast with Figure 9, in which the index of differential vertical integration is plotted against a measure of contractual intensity (described in the text). At this point, a natural question is whether contract enforcement and external financial dependency are truly the crucial factors driving the correlations in Figures 2 and 9. Section 3 provides further econometric evidence on this. For reasons of space, this paper does not focus on other institutional variables, such as openness to trade, labor market regulation, antitrust institutions and social capital.

Frictions in financial markets are introduced through a simple moral hazard problem between the entrepreneur and the external investors. Contractual imperfections in financial markets impact the degree of vertical integration in the industry through two conceptually distinct channels. On one hand there is an "investment", or partial equilibrium, effect. Since vertical integration implies higher financial needs, more developed financial markets allow more firms to become vertically integrated. On the other hand, there is an "entry", or industry equilibrium, effect. Better financial markets favor entry, and thus destroy the profit base that allows firms to vertically integrate. Since the "investment" and "entry" effects have opposite sign the net impact is shown to be ambiguous, and to depend crucially on the shape of the distribution of firm productivity (and hence size) in the industry. In industries in which technology is such that the equilibrium industry structure displays a large number of relatively small firms, the entry effect dominates and better financial markets lead to less vertical integration. In industries in which technology is such that the equilibrium industry structure displays a large number of relatively large firms, the opposite is true. Thus, the model shows that contractual frictions in the input markets and in the capital markets have very different impact on the incentives to vertically integrate, and provides a candidate explanation for the puzzling pattern in Figure 2.[6]

The model delivers clear-cut predictions on the differential impact of better credit markets across industries. In section 3, I use cross-country-industry data to provide econometric evidence supporting those predictions, showing that the patterns in Figures 1 and 2 are robust to the inclusion of additional controls. I find strong evidence supporting the prediction of the model with respect to the differential impact of better financial markets on vertical integration across industries. I also find some evidence of better contract enforcement being associated with lower vertical integration in industries that extensively rely on contracts.

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

[6] A further extension shows how credit markets development may further reduce the incentives for vertical integration, by fostering the development of input markets. I allow the baseline model to accommodate for some search for potential upstream suppliers. The possibility of bottlenecks in the backward industries, due to worse financial markets or low quality of potential supplier implies, ceteris paribus, higher vertical integration in the industry.

(1990). The model in the theoretical section builds on these contributions.[7]

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 paper is more closely related to this literature, and in particular to Grossman and Helpman (2002), as mentioned before. 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. Other recent related contributions are Antras (2003) and Antras and Helpman (2004). The latter in particular, analyzes an industry equilibrium model in which heterogeneous firms choose between FDI and outsourcing in a property rights framework.[8] My focus on financial market imperfections brings this work close to an extensive literature on the relationship between credit markets, development and occupational choice pioneered by Banerjee and Newman (1993).[9]

On the empirical side, Acemoglu et al. (2005b) is a parallel and independent study that is most closely related to this paper. It also provides evidence on the cross countries determinants of vertical integration exploiting a large dataset of firms around the world. In contrast to their work, the theoretical model I develop in section 2 allows me to separate, and identify, different opposing channels through which financial development differentially affects the degree of vertical integration across industries and countries. On the other hand, they estimate regressions without industry fixed effects, and show that less developed countries are concentrated in industries that have higher propensity for vertical integration. Dispite differences in the measure and data sources to proxy for

[7] As it is now clear (see e.g. Whinston (2003)) the two theories are conceptually very different in the analysis of the costs and benefits of vertical integration, and have different empirical content. The PR theory has been refined and developed in several papers. Aghion and Tirole (1994), Legros and Newman (2004), and Acemoglu et al. (2005a) consider settings in which ex-ante transfers are banned, and thus the organizational form may not be chosen optimally. For an excellent survey and discussion of existing theories of the firm, see Gibbons (2004). There is also an extensive industrial organization literature on vertical integration, that, however, does not focus on the institutional determinants of vertical integration (for a survey see e.g. Perry (1989)). Finally, at the end of section 2 I discuss how this work relates to recent contributions in the corporate finance literature.

[8] 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. (2005a) analyze an industry equilibrium model of the division of labor.

[9] Gershenkron (1962) provides arguments and some anecdotal evidence on why industries in late industrializing countries seemed to be more vertically integrated. Acemoglu et al. (2003) formalizes similar arguments in a Shumpeterian endogenous growth model. Stigler (1951) noted that developing industries tend to be more vertically integrated since they are not able to rely on established and well developed supplier networks. These contributions share with this work an interest in the relationship between the stage of development and vertical integration.

vertical integration, we obtain very similar results in the subset of overlapping specifications.[10]

Antras (2003) and Acemoglu et al (2004) are recent examples of cross-industry studies of vertical integration. The first links firm boundaries to trade flows. Interestingly, it finds that the share of intrafirm imports in total US imports is significantly higher the higher the capital-labor ratio of the exporting country, a finding that echoes our Figure 1. The second exploits a very disaggregated dataset on British manufacturing establishments to explore within-country determinants of vertical integration. Instead, I emphasize country level determinants of vertical integration.[11]

The rest of the paper is organized as follows. Section 2 analyzes the model and a simple extension to accommodate a third effect of credit market development on vertical integration working through the development of upstream industries. Section 3 presents empirical evidence on the cross-country determinants of vertical integration using country-industry data, and discusses further evidence from case studies and business history. Section 4 provides some concluding remarks. All the proofs are in the Appendix.

2 Model

In this section I develop an industry equilibrium model of the relationship between vertical integration and contractual frictions in input and credit markets. I model vertical integration in a similar way to Grossman and Helpman (2002) and introduce firm heterogeneity as in Melitz (2003). This section is divided into four subsection. I first set up the model and introduce the contractual imperfections in input and financial markets as well as the distinction between vertical integration and non-integration. I then derive the industry equilibrium. In the third part I discuss the effect of contractual imperfections on the degree of vertical integration in the industry. Finally, I present a simple extension of the model that disentangles a further effect of credit market imperfections on the degree of vertical integration.

[10] This work is also related to institutional determinants of cross country-industry analysis of trade flows (e.g. Nuun (2005)), and industry growth (e.g. Rajan and Zingales (1998), and the survey in Levine (2005)). The present study shares with these studies data and methods, however the focus on vertical integration is new.

[11] 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. In the empirical section I discuss some evidence on the links between financial markets and vertical integration, available from case studies and business history. Fee et al (2005) analyze corporate equity ownership in vertical relationships in the United States.

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 paper, 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

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

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

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

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

$$y(\theta) = \theta I \tag{2}$$

where I is a specialized component described below.[12] 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

$$I = \exp\left(\int_0^1 \ln x(i) di\right) \tag{3}$$

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 the collaborating parties, but cannot be verified by a court. The lack of verifiability precludes contracts between input suppliers and customers stipulating a given price for an agreed quantity. If such a contract were signed, the supplier could raise its net profits by reducing the

[12] 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 $y = \theta(\frac{L}{1-\eta})^{1-\eta}(\frac{I}{\eta})^{\eta}$. See the appendix for details.

investment in some task i. The buyer would be obliged to buy the lower quality input with no contractual protection.[13]

Legal institutions vary greatly across countries. In order to capture the effects of different contractual institutions on vertical integration, I follow Acemoglu et al. (2005) 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. Since industries can be treated in isolation, higher μ has to be interpreted as a decrease in the industry-country specific degree of contractual frictions in input markets.[14]

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

[13] While a rich literature has developed discussing alternative solutions to this form of contractual incompleteness (see e.g. Maskin and Tirole (1999) and Aghion et al. (1994)), I do not dwell on the micro-foundations of the assumption, and simply take incomplete contracts as a fact of commercial life.

[14] The Cobb-Douglas aggregate formulation for the production of the intermediate input I implies that the elasticity of substitution between elementary investments is equal to 1. It is possible to use a general CES production function for the production of the intermediate input. It would then be possible to parametrize the contractual needs of the industry with the elasticity of substitution across investments, with higher elasticity parametrizing lower contract needs. Should labor be used to produce the final good, contractual needs could also be parametrized by η, as in footnote 12.

i.[15]

I assume that the marginal cost of investment $x(i)$ is equal to $c = 1$ in both vertically integrated firms and independent suppliers.[16]

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

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. 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.

I assume for now 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.[17]

Fixed costs and financial constraints

In order to start production, firms incur fixed costs, such as the costs of entering the market

[15] 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)).

[16] 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.

[17] 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. In subsection 2.4 I consider a setting in which specialized assemblers do not always find a supplier.

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. For our purposes, it is irrelevant 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.[18]

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 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.). 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

[18] 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.

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.[19] This describes the borrowing process of a vertically integrated firm.

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 a third party, the independent supplier. For simplicity, I focus on bilateral contracts. The restriction on bilateral contracts can be justified by the fact that the fixed costs f have to be financed before the specific match with the supplier is realized, and contracts involving investors, suppliers and assemblers cannot be signed simultaneously. The sequence of events is as follows. First the final assembler finances the fixed costs f borrowing from the external investors. Once these fixed costs have been paid she is matched with an upstream supplier. Since the assembler has *ex-ante* bargaining power she can ask for an *ex-ante* transfer from the supplier. *Ex-ante* competition, drives suppliers profits to zero. I assume that external investors hold claims on the assembler's *ex-post* profits and on the *ex-ante* transfer from the supplier.

I denote with $\Pi_v(\theta)$ and $\Pi_o(\theta)$ the variable (i.e. net of fixed costs) profits of vertically integrated and specialized assembler firms respectively, when the entrepreneur has productivity θ. Similarly, I denote with $F_v = f + k$ and $F_o = f$ the financial requirements of vertical integration and outsourcing respectively. We have

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 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[20].

[19] I assume for simplicity that all the fixed costs have to be paid in order for production to take place, so that the entrepreneur never finds it profitable to divert only a fraction of the borrowed cash.

[20] The formulation relies on a form of *ex-ante* moral hazard. However one could imagine that, once firms realize

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. Note that, under the assumptions specified above, for a given level of financial requirements and variable profits, the form of the credit constraints inequality is the same for vertically integrated and non-integrated firms. In other words, I present a setting in which the organizational form of the firm only affects the financial position of the firm through the associated financial needs.[21] Since vertical integration requires higher financial needs, higher contractual frictions in the financial market, i.e. a higher λ, make vertical integration more difficult.

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 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

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.

[21] The assumptions are made for the sake of simplicity, and do not alter the logic of the results. The Appendix discusses a setting in which suppliers are also financially constrained. Under certain conditions, it is also possible to assume that λ is different across organizational forms, without affecting any of the results. From a theoretical point of view, however, it is not obvious whether vertical integration increases or reduces λ.

productivity θ, and define the industry equilibrium. The derivation of profit functions and proofs of all the results are reported in the Appendix.

I first consider a vertically integrated firm. Since the elementary tasks in the production of the intermediate input are symmetric, I can restrict attention to the case in which a vertical integrated firm invests x_v in each task. The production function of a vertically integrated firm thus becomes

$$q_v(\theta) = \theta x_v$$

Moreover, from the demand equation it is clear that firms charge a constant mark up determined by the elasticity of substitution of consumer demand. For a vertically integrated firm we have

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

By substitution in the demand equation, we obtain the variable profits of a vertically integrated firm as

$$\Pi_v(\theta) = \alpha^{\alpha\varepsilon} A \theta^{\alpha\varepsilon}(1-\alpha) \tag{4}$$

I now turn to the profits of a specialized assembler. In the proof of Lemma 1 in the Appendix I show that *ex-ante* competition among suppliers that are not financially constrained implies that we can restrict attention to the total surplus generated by a match between an assembler and a supplier.

Since elementary tasks in the production of the intermediate input are symmetric, we can restrict attention to the case in which an *ex-ante* contractually specified x_c is invested in the fraction μ of contractible tasks, and x_n is invested in the fraction $(1-\mu)$ of non-contractible tasks, and is independently decided *ex-post* by the supplier.

For a non-integrated firm, the production function becomes

$$q_o(\theta) = \theta x_c^{\mu} x_n^{1-\mu}$$

The sequence of events is as follows. First, the assembler and the supplier sign a contract specifying investments x_c. Then, for a given x_c, the supplier undertakes investments x_n, anticipating that, because of *ex-post* bargaining, she will only retain a fraction β of the revenues. In the

Appendix, I show that under this configuration the optimal pricing policy for a non-integrated firm is given by

$$p_o(\theta) = \frac{1}{\alpha\omega(\beta,\mu)\theta}$$

and $\omega(\beta,\mu) = \beta\left(\frac{1}{\beta}\frac{1-(1-\mu)(\alpha\beta)}{1-\alpha(1-\mu)}\right)^{\mu}$. If $\mu = 1$ contractual institutions are perfect. Since all the tasks are contractible, there is no hold-up problem and a non-integrated firm behaves as a vertically integrated firm, i.e. $\omega(\beta,1) = 1$. Alternatively, when $\mu = 0$, the hold up problem is extremely severe, and $\omega(\beta,0) = \beta$. In the Appendix, I show that $\frac{\partial\omega(\beta,\mu)}{\partial\mu} \geq 0$, implying that better contractual institutions allow non-integrated firms to reduce their marginal costs, and hence charge lower prices.

This pricing rule implies that the profits of a non-integrated firm can be written as

$$\Pi_o(\theta) = \alpha^{\alpha\varepsilon}\Omega(\beta,\mu)A\theta^{\alpha\varepsilon}(1-\alpha) \tag{5}$$

From the properties of $\omega(\beta,\mu)$, it is intuitive that $\Omega(\beta,1) = 1$, while $\Omega(\beta,0) = \left(\frac{1-\alpha\beta}{1-\alpha}\right)$. Finally, $\frac{\partial\Omega(\beta,\mu)}{\partial\mu} \geq 0$. Under both organizational forms, profits are increasing in the productivity index θ, and increasing in the index A, i.e. 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

$$\Pi_v(\widehat{\theta}_v) - (f+k) = \Pi_o(\widehat{\theta}_v) - f \Longleftrightarrow \widehat{\theta}_v = \left(\frac{k}{A\alpha^{\alpha\varepsilon}(1-\alpha)}\frac{1}{(1-\Omega(\beta,\mu))}\right)^{\frac{1}{\varepsilon-1}} \tag{6}$$

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. The sorting of firms with heterogeneous productivity into different organizational forms is illustrated in Figure 3. On the x-axis I report the underlying source of heterogeneity, firm unobserved productivity, while on the y-axis I report the profits of firms with

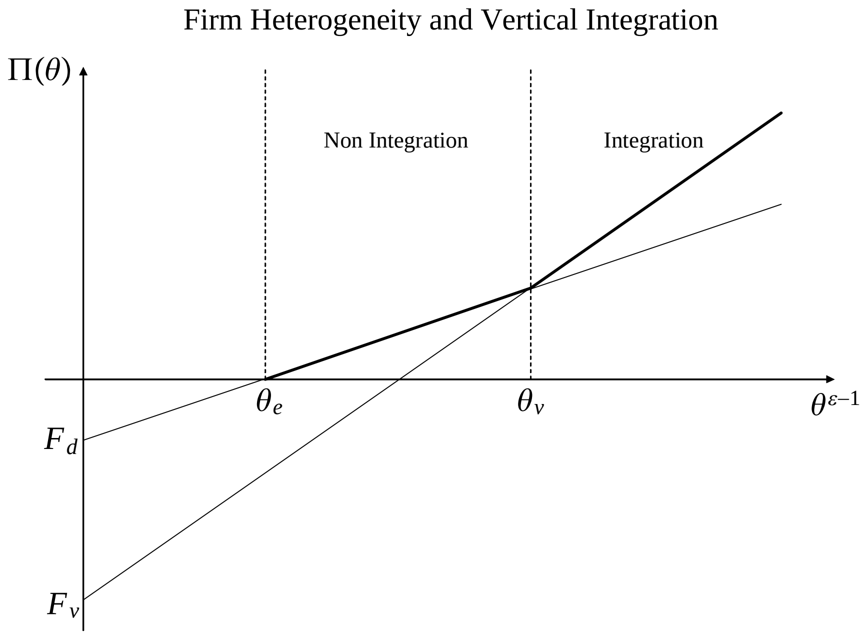


Figure 3: Sorting of Firms into Organizational Forms

productivity θ under the two organizational forms.

Vertical integration reduces inefficiencies caused by contract incompleteness, and thus becomes relatively more attractive in the presence of high quasi rents. Since the specialized component is useless outside the relationship, rents are entirely determined by the scale of operation of the firm. Entrepreneurs with higher θ have lower marginal costs and choose a bigger scale of operations, and thus have higher quasi-rents: for this reason they become vertically integrated.

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

$$\Pi_v(\theta) \geq (1+\lambda)(f+k) \Longleftrightarrow \theta \geq \theta_v = \left(\frac{(k+f)\,(1+\lambda)}{A\alpha^{\alpha\varepsilon}(1-\alpha)}\right)^{\frac{1}{\varepsilon-1}} \tag{7}$$

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 paper 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

$$\Pi_o(\theta) \geq (1+\lambda)f \Longleftrightarrow \theta \geq \theta_e = \left(\frac{f(1+\lambda)}{A\alpha^{\alpha\varepsilon}(1-\alpha)\Omega(\beta,\mu)}\right)^{\frac{1}{\varepsilon-1}} \tag{8}$$

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.*

As noted above, 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 particular form of the endogenous sorting of firms into organizational forms in the model is particularly appealing since it implies a positive correlation between firm's size and vertical integration. This is consistent with anecdotal as well as more formal evidence (see e.g. Acemoglu et al. (2005)). Consistently with the model, in the cement industry in the U.S., Hortacsu and Syevrson (2005) find that vertically integrated firms are larger, more productive and charge lower prices[22]. In the model the specialized component is useless outside the relationship, and hence 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. 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).[23]

Large, and perhaps vertically integrated firms, are often believed to have easier access to financial markets.[24] These considerations transposed into the model would 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 to this extension, 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 in a model in which vertical integration *reduces* the pleadgeable income, and worsen the access of firms to external finance, i.e. when $\lambda_v > \lambda_o$. Interestingly, this possibility has been suggested in Williamson (1971), where it is suggested that it is more difficult to monitor large and complex organizations, and for this reason investors may require higher expected returns

[22] The implication that more productive firms are vertically integrated however does not need to hold for the logic of the main results to be valid, and could be easily mitigated by assuming that firms are also heterogeneous in their access to capital markets.

[23] The theory of vertical integration in this paper is different from the property rights theory of the firm and is close in spirit to transaction costs theories of firm boundaries (see footnote 15). Under certain assumptions, it is possible to extend the property rights framework and derive the same sorting of heterogeneus firms into organizational forms as in the current model without affecting the results (see e.g. Antras and Helpman (2004)).

[24] If suppliers are also financially constrained, vertical disintegration tends to reduce pleadgeable income, since the assembler is not a full residual claimant of revenues. I refer the reader to discussion after the proof of Lemma 1 in the Appendix for details.

as finance requirements become progressively greater. In this case, even in the absence of the higher financial requirements of vertical integration, the sorting pattern of the model would be obtained, since only more productive firms generate enough profits to afford vertical integration.[25]

2.3 Main Predictions of the Model

I now turn to the analysis of the role that the industry specific institutional variables μ and λ play in determining the extent of vertical integration in the industry.[26]

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 industry level index of vertical integration is given by

$$INT = \frac{N_o(1-\beta) + N_v \cdot 1}{N_o + N_v} = 1 - \beta \frac{N_o}{N_o + N_v} \tag{9}$$

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

$$INT = 1 - \beta \frac{G(\theta_v) - G(\theta_e)}{1 - G(\theta_e)} \tag{10}$$

[25] Inderst and Mueller (2004), Faure-Grimaud and Inderst (2005) analyze models in which the organizational form itself affects the financial constraint of the firm. Recent work on internal capital markets also sheds some light on the relationship between firm boundaries and financial constraints (see the excellent review in Stein (2004)). In Macchiavello (2004, 2005) I consider settings in which the assembler and the supplier jointly contract with the external investor. The two papers provide a microfoundation for $\lambda_v > \lambda_o$. The key intuition is 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. For a related point, in the literature on trade credit, see Bukart and Ellingsen (2004).

[26] Since $\frac{\partial \omega(\beta,\mu)}{\partial} \geq 0$, an increase in β reduces vertical integration. Artificial barriers to entry could be conceptualized as an exogenously given threshold $\widehat{\theta}_e$, i.e. as a restriction on the number of firms in the industry. In this case, artificial barriers to entry reduce competition in the industry, and imply lower vertical integration.

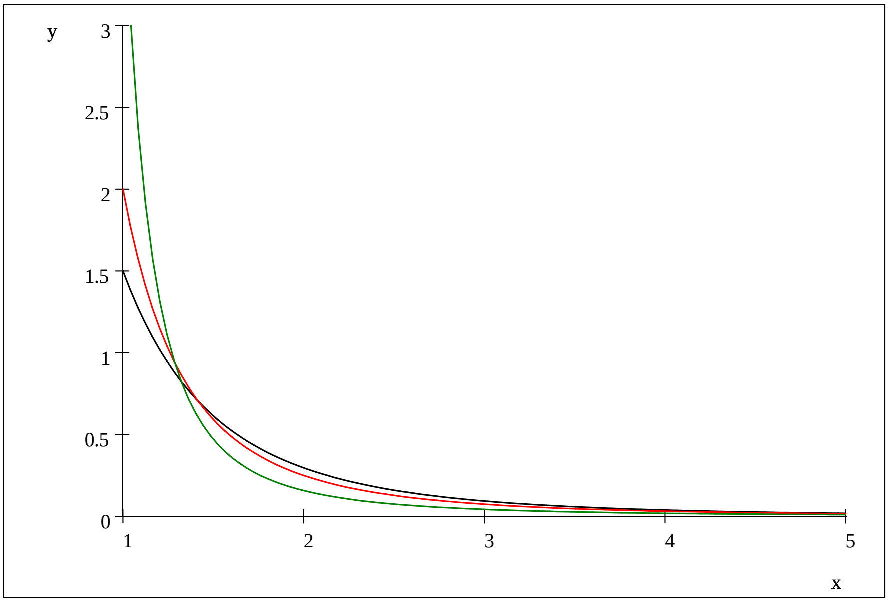


Figure 4: Generalized Pareto Distribution, for $\overline{\theta} = 2$, and $\sigma \in \{\frac{1}{3}, \frac{1}{2}, \frac{2}{3}\}$

As is clear from this expression, the industry level index of vertical integration critically depends on the shape of the underlying distribution of productivity, $G(\theta)$. In order to derive clear cut comparative statics, it is useful to suppose that θ is distributed in the population according to a generalized Pareto distribution, i.e.

$$g(\theta) = \frac{1}{\zeta}(1 + \sigma\frac{(\theta - 1)}{\zeta})^{-1-\frac{1}{\sigma}}$$

with $\theta \geq 1$, $\zeta \in \mathbb{R}^2_+$, and $\sigma \in (0, 1)$. The average θ in the pool of potential entrepreneurs is given by $\overline{\theta} = \int_1^\infty \theta dG(\theta) = \left(1 + \frac{\zeta}{1-\sigma}\right)$. In order to perform comparative statics on the shape parameter σ without changing the average productivity in the pool of entrepreneurs $\overline{\theta}$, I substitute ζ as a function of $\overline{\theta}$ and work with the corresponding cumulative function

$$G(\theta) = 1 - (1 + \frac{\sigma}{(1-\sigma)}\frac{(\theta - 1)}{\overline{\theta} - 1})^{-\frac{1}{\sigma}} \tag{11}$$

The average productivity of the potential pool of entrepreneurs is thus easily 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 Figure 4.

When $\sigma = 1 - \frac{1}{\theta}$, the distribution is a standard Pareto distribution. For $\sigma < 1 - \frac{1}{\theta}$, the distribution has relatively lower density at low levels of θ, and higher density for large θ. The opposite is true for $\sigma > 1 - \frac{1}{\theta}$. Proxying the size of the firm with revenues, equations 4 and 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. We can thus state

Proposition 4

i) Higher average productivity in the pool of potential entrepreneurs (higher $\overline{\theta}$) unambiguously increases vertical integration in the industry,

ii) Better contractual institutions in input markets (higher μ) unambiguously reduces vertical integration in the industry,

iii) Better contractual institutions in financial markets (lower λ)

- *increase vertical integration in industry dominated by large firms ($\sigma < 1 - \frac{1}{\theta}$) and*
- *decrease vertical integration in industry dominated by small firms ($\sigma > 1 - \frac{1}{\theta}$).*
- *When $\sigma = 1 - \frac{1}{\theta}$ vertical integration is independent of λ.*

I first consider 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 5.[27] *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 vertical integration[28]

Next, I consider the case of better capital markets (i.e. lower λ). As in the case of better

[27] 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.

[28] 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.

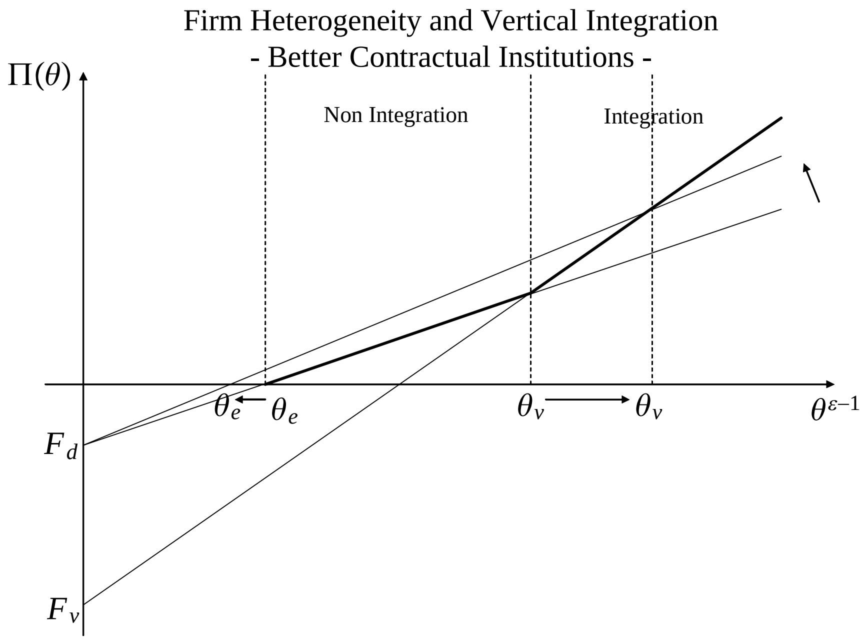


Figure 5: Comparative Statics and Industry Equilibrium (1)

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 6. 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.[29]

This second effect differentiates the mechanics of the response of vertical integration to bet-

[29] In the Appendix I show that for a general distribution $G(\theta)$ the net effect of better financial markets (lower λ) depends on whether $\frac{d\ln(1-G(\theta))}{d\ln(\theta)} \lesseqgtr 0$. See equation 24 for details.

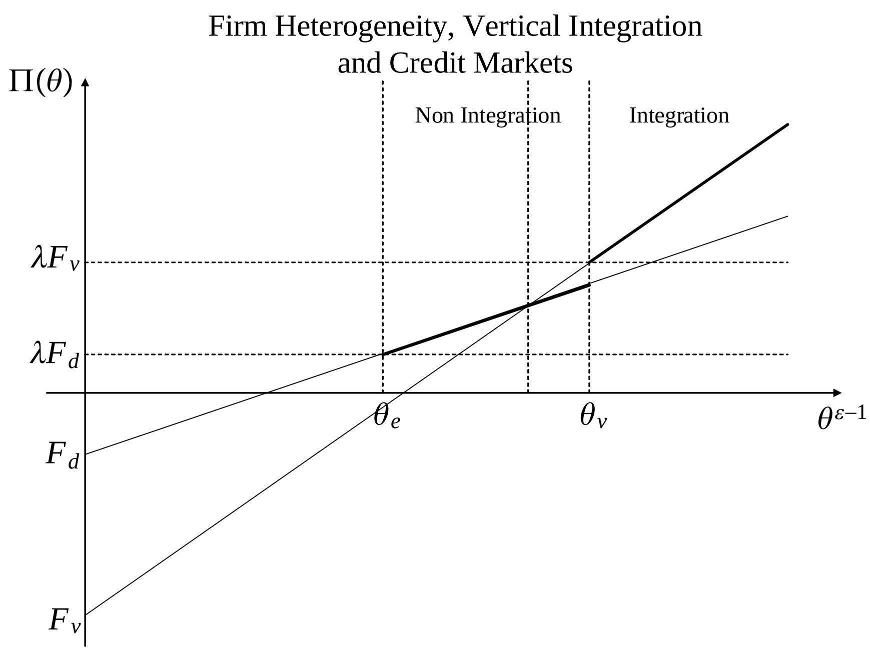


Figure 6: Comparative Statics and Industry Equilibrium (2)

ter 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 net impact of better financial markets on the degree of vertical integration is thus *a priori* ambiguous, and depends on additional industry characteristics. 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.[30]

[30] I have solved the model without considering labor as additional factor of production. Introducing labor would establish a closer link between the prediction of the model and the empirical test in section 3. In the Appendix I

2.4 Entry in the Upstream Industry

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. I now 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.

The analysis for a vertically integrated firm is as described in the previous subsection. The case for non-integration needs to be modified. In particular I assume that after the fixed costs f have been paid, the downstream entrepreneur searches for an upstream supplier. Let Δ denote the mass of downstream firms in the market, and Υ the mass of upstream firms in the market. To keep the analysis simple I assume that the probability that a downstream firm finds an upstream supplier is given by

$$P_d = \min\{\frac{\Upsilon}{\Delta}, 1\}$$

while the probability that an upstream supplier finds a downstream customer is given by

$$P_u = \min\{\frac{\Delta}{\Upsilon}, 1\}$$

Firms on the short side of the market always find a partner. If a firm does not find a partner it is forced to exit the market, and the fixed costs are lost. Since we are interested in analyzing the effects that the development of backward industries has on vertical integration, I restrict attention to equilibria in which $\Delta > \Upsilon$, so that upstream firms are now on the short side of the market.

Upstream firms enter the industry paying the fixed costs k. In order to keep the model simple, I assume that upstream firms are homogenous in terms of their productivity, and are randomly matched with a downstream unit. At the time of entry, the upstream supplier faces uncertainty with respect to the productivity of the final assembler she matches. This uncertainty translates into uncertainty regarding the profits of entering the industry.

I introduce contractual imperfections in the financing of the entry of upstream suppliers. Since,

show that the amount of labor employed by the firm is proportional to $\theta^{\alpha\varepsilon}$.

as in the previous subsection, the degree of financial market frictions is industry specific, I parametrize the degree of contractual imperfections with the share of the fixed investment of upstream suppliers k that is not contractible, $\widetilde{\lambda}$.[31]

Before entry, in order to satisfy the (expected) zero profit condition for upstream firms, the following condition has to be satisfied

$$\Pi_u = \mathbf{E}_{\theta\in\Delta}[\beta\Pi_o(\theta)] - k = \widetilde{\lambda}k \tag{12}$$

where the $\widetilde{\lambda}k$ term on the right hand side follows from the fact that upstream firms face some borrowing constraints originating from contractual imperfections in financial markets. In equilibrium Δ is proportional to $G(\theta_v) - G(\theta_e)$, where the two thresholds θ_v and θ_e are determined in an analogous manner as in the previous subsection. In an equilibrium in which upstream firms are on the short side of the market, the thresholds θ_e and θ_v adjust in order to satisfy the zero profits constraint of upstream firms. In particular, note that higher contractual imperfections in the financial market (higher $\widetilde{\lambda}$) imply that the expected productivity of specialized assemblers must be higher. A similar argument applies to downstream firms. The expected profits of the marginal downstream firm entering the market with productivity θ_e must satisfy

$$\Pi_o = (1-\beta)\frac{\Upsilon}{\Delta}\Pi_o(\theta_e) - f = \lambda f \tag{13}$$

It is clear from this last equation that tighter intermediate input markets, i.e. smaller Υ, imply that the productivity level of the marginal firm entering the industry, θ_e must be higher. Finally, restricting attention to equilibria in which downstream firms are constrained in their organizational form decision, the marginal (least productive) firm that can afford vertical integration as organizational mode is defined as before by the productivity threshold θ_v given by

$$\theta_v = \frac{(k+f)(1+\lambda)}{A\alpha^{\alpha\varepsilon}(1-\alpha)}$$

Since the threshold θ_v does not depend on the thickness of the input market, the only way through which Δ can appropriately adjust to a higher $\widetilde{\lambda}$ is through an increase in the threshold

[31] I also assume that the match is specific and firms do not negotiate ex-ante transfers. This assumption simplifies the analysis without affecting the results.

θ_e that implies a higher expected productivity of downstream assemblers. This movement in θ_e in turns implies a higher degree of vertical integration in the industry. I summarize this discussion with the following

Proposition 5

Better contractual institutions in the financing of upstream industries (lower $\widetilde{\lambda}$) reduce vertical integration in the downstream industry.

In the presence of credit market imperfections, the effective fixed costs that have to be covered by the upstream firm are given by $k(1+\widetilde{\lambda})$. A direct implication of higher $\widetilde{\lambda}$ is that the input market become tighter, and it is thus more difficult to find a supplier for a non-integrated downstream assembler (lower $\frac{\Upsilon}{\Delta}$). 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.

3 Empirical Evidence

In this section, I use data on value added and output for 26 industries in the manufacturing sector across a sample of 89 countries to test the empirical validity of the theoretical arguments relating institutions and vertical integration developed in the previous session. This can be thought of as a more robust illustration of the patterns in Figures 1, 2 and 9.

I measure vertical integration in industry i in country c as the ratio of value added over output, i.e.

$$INT_{ic} = \frac{VA_{ic}}{Y_{ic}} \tag{14}$$

This measure was first introduced in a classical study on vertical integration in Adelman (1955). 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. In section 3.4 I discuss in more detail some concerns arising from how the index aggregates up at the industry level.

This section is divided into three subsections. In the first subsection I describe the data used. The second subsection investigates whether country level institutions have differential impact across industries and whether those differences are captured by the specific channels emphasized in section

2. The third subsection discusses some further issues arising from the aggregation of data at the industry level. Finally, the last subsection discusses some further evidence from case studies and American business history on the link between credit markets and vertical integration. The Appendix contains a discussion on whether measures of institutions at the country level are correlated with the average degree of vertical integration and a description of the main variables used in the analysis.

3.1 Data

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 3-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 95 countries using the years from 1990 to 1999 inclusive.

In the analysis I compute the index of vertical integration for every industry, country and year. Since most of the analysis does not exploit time variation, I use only the average of the variable of interest for the period between 1990 and 1999.

Two sets of variables are added. I use data from the Census Bureau and from the input-output table of the United States to construct data on industry characteristics in the United States. In addition to these data, I use several institutional variables at the country level. Most of these variables are from the Doing Business database at WorldBank and have been developed by Djankov et al. (see e.g. (2002) and (2003)). The preferred measures of financial development come from the dataset discussed in Levine (2005).

Table 1 shows descriptive statistics of the main variables used in the analysis. The sample includes 89 countries.

3.2 Differential Cross-Country Propensities to Vertical Integration: Specific Channels

3.2.1 Basic Results

This subsection tests the empirical validity of the main predictions of the model by exploring whether country level variables have a differential impact across industries. In doing so, I look for specific channels through which institutions affect vertical integration. Linking country institutions to organizational form through specific channels also provides better grounds for establishing a causal relationship between institutions and organizational form. I run regressions of the following form

$$INT_{ic} = \alpha + \beta I_i \times Z_c + \eta_i + \mu_c + \varepsilon_{ic} \tag{15}$$

where η_i and μ_c are a set of industry and country dummies, I_i are industry characteristics in the United States and Z_c are country level variables. Since the regression includes country fixed effects, the estimate of the coefficient β identifies relative propensity towards vertical integration. For example, the regression interacting external financial dependency with financial development tells us whether countries with more developed financial systems are relatively more or less integrated in industries that require more external finance. It is important to stress that results should be interpreted in terms of relative degrees of vertical integration across industry within countries, and not in terms of differential level of vertical integration across countries.

The identification strategy is closely related to the influential work of Rajan and Zingales (1998).[32] The key assumption is that characteristics of industries in the United States are representative of the same technological characteristics of industries in other countries. To clarify the assumption, consider a measure of external financial dependency. I assume that the measure of external financial dependency in the United States reflects technological features of the industries. These technological features do not need to be equal in other countries, although the ranking across industries does. For example, I do not require the financial needs of the textile industry in India to be the same as in the United States, but I require that if the textile industry is less dependent on external finance than the glass industry in the United States, this relationship is also valid (on

[32] The same identification strategy is extensively used in the rapidly growing literature on industry performance and credit markets development as summarized in Levine (2005), and in more recent papers on the institutional determinants of trade (e.g. Nunn (2005)).

average) in India. For this reason I run regressions in this subsection substituting the industry level variable with its ranking in the United States.

Since the model treats industries in isolation the contractual imperfections parameters μ and λ can be thought as industry-country specific. I proxy for contractual imperfections in industry i and country c using an interaction between an industry variable computed in the U.S. (capturing the need for contracts in either input or financial markets) and a country variable (capturing the development of specific contractual institutions).

With respect to the effects that contractual imperfections in the credit market have on the degree of vertical integration, the model predicts that

- Better credit markets allow more firms to undertake the necessary investments to integrate vertically;

- However, better credit markets allow more firms to enter the industry, and hence increase competition, and make vertical integration more difficult;

- Finally, better credit markets allow more firms to enter upstream industries. Since input markets become thicker, this reduces the incentives to integrate vertically.

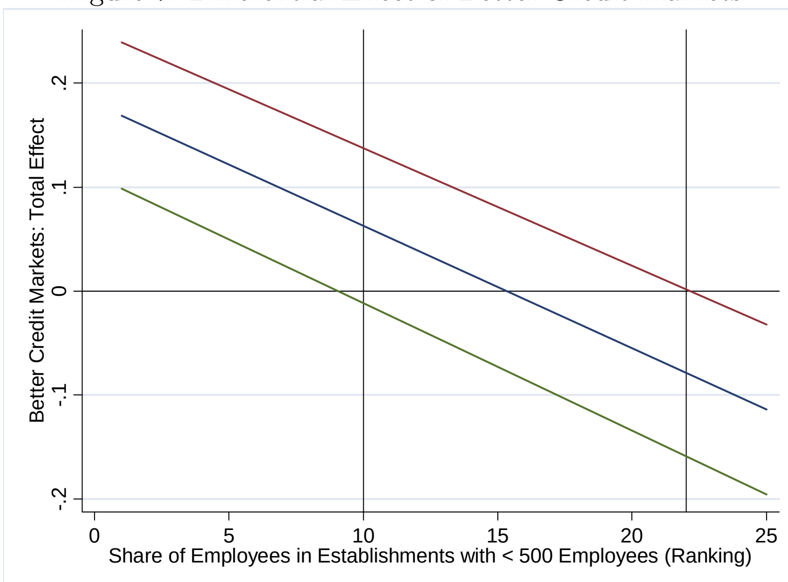
While the first effect is positive, the second and third effects are negative. However, the model predicts that the first effect dominates the second in industries that for technological reasons employ a large share of workers in relatively large establishments, while the second effect dominates the first one in industries that, for technological reasons, employ a large share of workers in relatively small establishments. Finally, for a generic industry i, the third effect should work through the (average degree of) external financial dependency of all industries $j \neq i$ supplying inputs to industry i. With the appropriate interactions between financial development and suitable industry characteristics in the United States, it is possible to disentangle the three different effects.

Table 2 focuses on credit markets, and disentangles the three effects emphasized by the model. I proxy financial market development with the ratio of credit to the private sector over GDP.

Column 1 shows that financial development has no differential impact. This is consistent with the model, since the first and second effects go in opposite directions.

Column 2 and Column 3 capture the three effects, and further confirm the prediction of the model. The second effect is captured in column 2 by further interacting external financial develop-

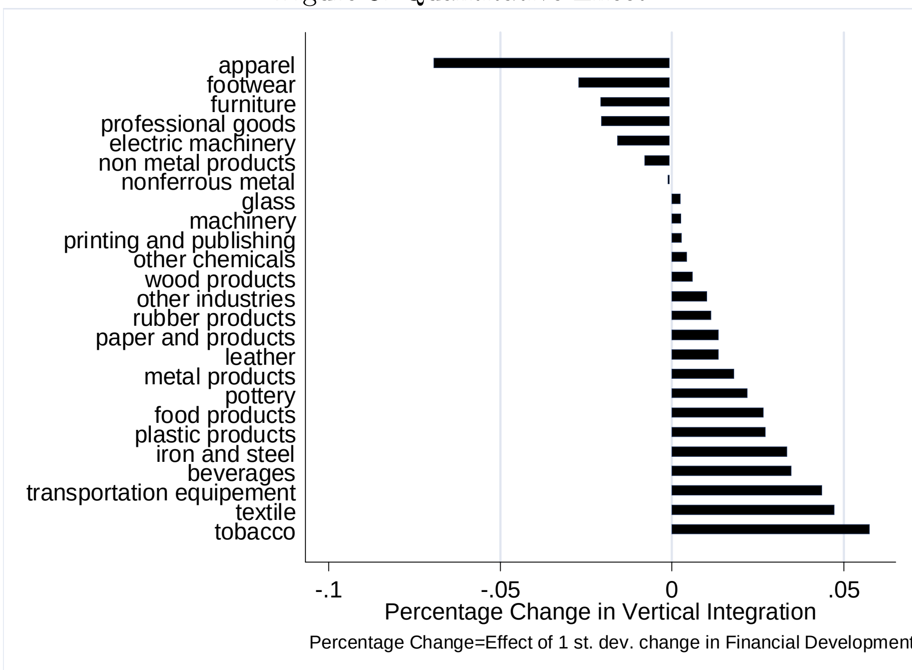
Figure 7: Differential Effect of Better Credit Markets



ment with a measure of the relative importance of small firms in the industry (the share of workers in establishments with less than 500 employees). I find a positive, direct effect of financial development on vertical integration (the first coefficient increases and becomes statistically significant). However, the net effect is weaker (and for some industries negative), for industries that employ a large share of workers in relatively small establishments. The coefficient of the second interaction is negative, and statistically significant.

Figure 7 explains the differential impact of better credit markets on vertical integration. For any given industry, the total effect of the interaction between financial development 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

Figure 8: Quantitative Effect



employees working in establishments with less than 500 employes is highest (wood manufacturing, leather, metal and non-metal products).

Column 3 investigates whether financial institutions affect vertical integration through a differential impact on backward industries. Industries are different with respect to the input mix, i.e. use the products of other industries in differential proportion. Using data from the Input-Output table in the United States, I construct for each industry in the sample an index of the average external financial dependency in industries from which the industry under consideration purchases inputs. If bad financial institutions are particularly detrimental to the development of industries that rely heavily on external finance, I may expect higher degrees of vertical integration in industries that use a relatively high proportion of inputs from financially dependent industries.[33] The third effect emphasized by the model, is thus captured in column 3: industries that purchase inputs from industries that require more external finance are relatively less vertically integrated in countries with higher financial development. The coefficient is negative, and statistically significant.

[33] The use of Unites States Input-Output table is justified by concerns that, because of various sources of input markets imperfections, industries in country c may substitute inputs in ways which are correlated with other determinants of vertical integration specific to country c.

What is the magnitude of the effects we are identifying? Figure 8 provides an answer to this question. In Column 3 the country level measure of financial development affects vertical integration through four different, and opposing, channels (three reported, plus the unreported interaction of the variable "small firms" with financial development). Figure 8 reports, for each industry, the average percentage change induced in the index of vertical integration by an increase in the index of financial 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 (two standard deviation is somewhat smaller than the difference between Algeria and France). Figure 8 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.[34]

Columns 4 and 5 perform some preliminary robustness checks. Since financial development is strongly correlated with the country development stage, a first concern is whether the patterns in columns 2 and 3 are really due to financial institutions, or are instead capturing the effects of other institutional characteristics correlated with development. To control for this possibility, Column 4 includes interactions of the industry variables with GDP per capita, a proxy of broader institutions. The relationship is robust, and GDP has no impact at all. It thus seems that financial development is not capturing the effects of broader institutional context, as proxied by GDP per capita.

Another concern is that, within industries, richer countries produce goods which are more similar to those produced in the US. In order to control for this possibility, Column 5 adds an interaction of vertical integration in the US and GDP per capita. This further interaction should partially account for the fact that, because of more similar technologies, richer countries tend to be relatively more vertically integrated in industries that are more vertically integrated in the United States. Column 5 shows that this further interaction is not significant and does not affect the results[35].

[34] The effect identified in Figure 8 is the net effect of four coefficients working in different directions. This implies that each single effect has a larger magnitude. Moreover, the inclusion of country fixed effects prevents the identification of the average effect of financial development on vertical integration, which, as we have shown in table 1, is negative and quite large. The total effect of a change of one standard deviation in the index of financial development implies a change in the ranking of industries in terms of vertical integration (for the average country) for 6 industries (footwear, machinery, professional goods, textile, iron and steel and metal products).

[35] I have repeated the exercise using an index of investor's rights as alternative measure of financial development. Statistical significance is reduced, but the economic interpretation (the ratio of the coefficient in line 2 and 1), and the magnitudes of the coefficient, are not changed. Results available upon request.

3.2.2 Further Results

The results in Table 2 are not driven by omitted country characteristics that affect vertical integration equally in all industries, or by industry characteristics that affect vertical integration equally in all countries, since country and industry fixed effects are included in the specification. However, there may be omitted country characteristics that affect vertical integration in some industries more than in others, and the interactions in the regressions are simply picking up these effects. As noted above, one important concern regards cross-country differences in product mixes within industries. Better financial markets may favor a switch towards products that require higher vertical integration, and this compositional effect may be stronger in industries that rely more heavily on external finance. Alternatively, financial development could simply be picking up the effects of economic development, or other broader characteristics that happen to be correlated with it. Consider as an example how bad enforcement of contracts at the country level may push firms towards vertical integration relatively more in industries that would otherwise rely on subcontracting. To the extent that our credit measures are correlated with contract enforcement, and our measure of technology at the industry level are correlated with reliance on subcontracting, our results could be biased.

Moreover, the model emphasizes the differential impact of better contractual institutions in specific versus generic (capital) input markets. For all these reasons, it is important to consider the role of contract enforcement institutions. This is done in table 3, in which I explore the robustness of the evidence in favor of the credit market story to the inclusion of additional controls considering contractual institutions. In particular, I ask whether the potential correlation between external financial development with contractual needs is responsible for the patterns in table 2. Table 3 shows that this is definitively not the case. I proxy contract enforcement with the number of procedures mandated by law or court regulation demanding interactions between the parties or between them and the judge, from Djankov et al. (2003). I interact this measure of contractual enforcement with measures of contractual intensity at the industry level in the U.S.

I construct two measures to proxy for the contractual intensity of the industry (contractual needs and Herfindahl index of input use) and use three different specifications. The first measure is a weighted average of the degree of specificity of inputs used by the industry. I have combined information from the input-output table in the United States with the commodity classification in Rauch (1999). Rauch (1999) classifies goods according to the thickness of markets to procure goods. At one extreme there are goods for which referenced markets exist. At the other extreme there are goods that are normally procured through specific contractual arrangements. I assume that industries that use higher shares of inputs classified by Rauch (1999) as "differentiated" rely more heavily on contracts, since these inputs are not readily available on markets. A higher value for the index represents higher contractual needs. I compute an index of specificity at the 4-digit NAICS classification industry level. I then use this specificity index to compute a weighted average of input specificity for each industry, at the same level of aggregation. I then take the median level of input specificity within each industry classification in the sample to obtain an index of contractual needs for the 26 industries in our sample.

The second measure of contractual needs is the (negative of the) Herfindahl index of input use. Starting from the input-output table in the United States, I construct for each 4-digit NAICS industry the Herfindahl index of input use, in order to capture how heavily an industry depends on a (small) set of suppliers. Letting s_{ij} be the share of input use of industry i from industry j, the index is given by $HI_i = \Sigma_j s_{ij}^2$. 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, and thus require more contractual provisions to mitigate hold-up problems.[36]

Columns 1 and 4 show that the interactions with financial development are not simply picking up the effects of contractual institutions. The results of table 2 are robust to the introduction of the interaction between contractual intensity and contract enforcement institutions. Moreover, better contract enforcement has a relatively stronger positive impact in industries that have higher contractual needs, when contractual needs are proxied with the Herfindahl index of input use.

In Columns 2 and 5, I add the cross-interactions between financial dependency and contractual enforcement, and financial development with contractual intensity. This is done in order to check whether financial markets development works through the appropriate channel, i.e. through external financial dependency. This is indeed the case. Interestingly, contract enforcement does not seem to work particularly through contractual needs, while instead the interaction with financial

[36] With respect to the first measure of contractual needs, a similar procedure has been used by Nunn (2005). There is a positive correlation between the index of vertical integration and the variables contractual needs and Herfindahl in input use for the 26 industries in our sample in the United States.

dependency is statistically significant.[37]

Finally, in Columns 3 and 6, I test whether financial development and contract enforcement are picking up the effects of broader institutions simply by interacting contractual intensity and external financial dependency with the GDP per capita. Results are again robust to this alternative specification.[38]

Evidence is however mixed with respect to the role of contractual institutions interacted with contractual needs in the input markets. The model has an unambiguous prediction on the role of contractual institutions. Columns 1 to 3 support the prediction of the model, while columns 4 to 6 do not. Results thus hinge on the particular way contractual needs are measured. One possible interpretation for these findings goes as follows: firms in countries with worse contract enforcement institutions may self-select into the production of simpler goods that require lower degrees of vertical integration. This unobserved substitution then reduces the effect of poor contractual institutions on observed organizational form. This interpretation is consistent with the fact that the results for the contractual interaction improve when the interaction of contractual needs with GDP per capita is included in columns 3 and 6.[39]

Finally Table 4 investigates the relevance of further controls, in particular skills. There are several concerns here. A first concern is that higher financial needs could be correlated with higher skill intensity of the industry, and financial development with the availability of a skilled labor force. Besides that, our measure of vertical integration is quite closely related to value added, and could be influenced by factor intensity or other determinants of productivity. Finally, these additional controls may be of some interest on their own, in providing some evidence on the relationship between human capital and vertical integration.[40]

[37] This result makes sense since, as emphasized in the introduction, an important component of credit markets development relates to the development of contract enforcement institutions.

[38] Contractual enforcement may also be measured with a measure of percentage costs needed to enforce a debt contract. When this is done, the contractual channel disappears, and the credit market variables improve their statistical significance in all the specification in Table 3. I have checked whether ethnic fragmentation and average level of trust in the society acted as 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. As expected, we find a strong positive effect of average level of social trust. Countries with higher level of social trust are relatively more vertically integrated in industries with higher contractual needs. The coefficient on the interactions with ethnic fragmentation is negative, but not statistically significant. Results are available upon request.

[39] The theoretical section presents a transaction-costs-like theory of vertical integration. In a property rights framework however it is not clear that better contractual institutions would necessarily lead to lower integration. The prediction would depend on the relative improvement in investment incentives at the margin.

[40] Vertical integration may require higher coordination of tasks, and this in turn may need workers with higher degrees of human capital.

I proxy skill intensity of the industry with the ratio of employees (non production workers) over total workers. Results are robust to the inclusion of these further controls. Moreover the interactions with the measure of skill intensity are significant. Countries with higher levels of higher education are relatively more vertically integrated in industries that require a higher level of skills. I again perform the checks introducing the interactions of industry variables with GDP per capita and the cross interactions. Once more, results are robust to these alternative specifications.

Interestingly, the effect of skill intensity is not entirely captured by higher education.[41] I also find that countries with higher financial development are relatively less integrated in industries that require higher skills. This points towards interesting interaction effects of institutional variables, to be explored in further research.[42]

3.3 Further Robustness Checks and Measurement Issues

In this subsection I discuss some further robustness checks, and some issues relating to measurement error.

The index of vertical integration suffers from some limitations arising from being computed at the industry level. In particular, I have not ruled out the possibility that our results are partially picking up the fact that, within industries, rich and poor countries are engaged in the production of different mixes of goods. Institutional variation could than be correlated with "*what*" is produced, and not only with "*how*" production is carried out. This concern may be particularly relevant to explain the lack of a strong relationship between the index of vertical integration and measures of contract enforcement in the data. Because of poor contract enforcement, within industries, firms in less developed countries specialize in the production of goods that rely less on contractual enforcement. If this is the case, firms in those countries may not be more vertically integrated simply because they engage in the production of goods for which non-integration does not reduce efficiency.[43] With more disaggregated data, one way of partially addressing this concern, would be

[41] The interaction with GDP per capita is significant, possibly due to the fact that higher education is strongly correlated with GDP pc., and in fact when skill intensity is measured with R&D expenditures, the interaction with GDP per capita eliminates the interaction with higher education.

[42] Acemoglu et al. (2005) also finds similar results.

[43] Acemoglu et al. (2005b) however find that poorer countries have disproportionately more firms in sectors that are *more* vertically integrated in the U.S. On the other hand, since their data include firms in the service sector, their evidence does not rule out the possibility that within manufacturing sectors firms substitute away from productions of good that require, for technological reasons, higher degrees of vertical integration. Another related problem of our data is that data are collected at establishment, rather than firm, level.

to restrict attention to industries in which the product mix is relatively similar across countries. Since the manufacturing sector is classified in only 26 industries, the choice of the sectors for which product mixes are not too different would be rather arbitrary.

I pursue another route in Table 5. In Column 1 I add as additional controls the interactions of all the industry level variables used to estimate the coefficients of interest, with GDP per capita. This is done in order to check whether results are driven by broader institutional characteristics correlated with financial development. Column 2 repeats the exercise, including all the previous industry variables with the square of the GDP per capita in case omitted institutional characteristics are not captured linearly by GDP. Results are robust. The magnitude of the coefficients does not change significantly, and statistical significance is only marginally reduced.

In Column 3, I add 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, and that work through specific channels which are different from, but correlated to, external financial dependency. Results are again quite robust both in terms of statistical significance, magnitude and interpretation of the coefficients.

Another concern with the index is its sensitiveness to the degree of intra-industry trade between vertically disintegrated firms in the industry.[44] Within industries, countries may differ in their product mixes. If the degree of intra-industry trade is correlated with other characteristics affecting vertical integration through specific institutions, the coefficients may be biased. In order to partially account for this issue, I further include interactions of industry dummies with GDP per capita and the industry level measure of intra-industry trade in the United States, which I compute from the input-output table. Results are again robust to the inclusion of these further interactions.

Finally Columns 5a and 5b present the results for a pooled regression in which I allow the coefficients that identify the credit channel to differ across two separate samples of countries. In

[44] It can easily be shown that the extent to which intra industry trade generates measurement error depends on the dispersion of firm size in the industry, but that if firms use inputs in fixed proportions within the industry, intra-industry trade is not a source of measurement error. With a mild abuse of notation, assume that each firm i in the industry purchases a proportion β_{ij} from firm $j \neq i$ in the industry, and uses inputs $\mathbf{I}_i$ from other industries. The index of vertical integration in industry ι and country c can be expressed as $\widehat{INT}_{\iota c} = 1 - \frac{1}{N}\Sigma_i(\frac{\Sigma_{j \neq i}\beta_{ij}Y_j}{Y_i}) - \frac{1}{N}\Sigma_i(\frac{\mathbf{I}_i}{Y_i})$ while the observed index is given by $INT_{\iota c} = 1 - \frac{1}{N}\frac{\Sigma_i \Sigma_{j \neq i}\beta_{ij}Y_j}{\Sigma_i Y_i} - \frac{1}{N}\frac{\Sigma_i \mathbf{I}_i}{\Sigma_i Y_i}$. The measurement error thus depends on the distribution of relative propensity to use inputs from the same industry. Assuming $\mathbf{I}_i = \gamma Y_i$ and $\Sigma_{j \neq i}\beta_{ij}Y_j = \eta Y_i$, it is easy to show that the two indexes give identical results.

particular, I split the sample into two groups: countries with GDP per capita above the median of the distribution of GDP per capita and countries below. The sample indicator is then interacted with all the credit markets channels. Results are again very robust, and coefficient are larger for the group of richer countries.

A second measurement issue is that the index is a weighted average (weighted by output) of the ratios of value added over output at the firm level, i.e. it is not strictly speaking the measure of the average degree of vertical integration within an industry that was used to derive comparative statics from the model. In the Appendix, I show that the observed index of vertical integration can be written as

$$\widehat{INT}_{ic} = INT_{ic} + \Delta_{ic}$$

where INT_{ic} is the index used to derive comparative statics in the model, while Δ_{ic} is an error term related to the within-industry correlation between firm size and vertical integration. Empirical studies find a positive correlation between vertical integration and measures of firm size in the manufacturing sector, after controlling for industry fixed effects. This source of measurement error biases our results if, the determinants of the within-industry correlation between firm size and vertical integration in industry j and country c are correlated with our right hand side variables.

The model in the previous section helps us to understand whether we should expect this source of measurement error to be (strongly) correlated with the independent variables related to credit markets or contractual enforcement. An explicit solution for the "weighted" index of vertical integration $\widehat{INT}_{jc}$ can be derived under the assumption that $G(\theta)$ is a Pareto distribution. When this is the case, we can show that

Proposition 6
Assume $G(\theta) = 1 - \theta^{-\frac{1}{\sigma}}$. Then i) Δ_{ic} does not depend on λ, and ii) $\frac{\partial \Delta_{ic}}{\partial \mu} < 0$

Proposition 6 has two important implications for the empirical analysis in the previous section. Under the assumption that firm productivities are n from a Pareto distribution, the difference between the weighted and the unweighted indexes of vertical integration depends on the relative efficiency of non-integration versus vertical integration, $\Omega(\beta, \mu)$, and on the ratio of the thresholds θ_v and θ_e. First of all, the measurement error does not depend on λ, the degree of contractual imperfection in the credit markets. In other words, the model itself suggests that the bias arising from the correlation between the error term and the independent variables is likely to be very small.[45]

The second part of the proposition yields that the measurement error is instead systematically associated with the degree of contractual imperfections in input markets: higher contractual imperfections amplify measurement error. This suggests that the estimated coefficient is likely to be biased upward, and the magnitude of the effect in Table 3 should be interpreted with caution. The precise form of the bias due to measurement error does not explain why we do not find an effect of contractual institutions when we measure contractual needs at the industry level with the index proxying input specificity.

Some of the issues raised by measurement error (at least those that have a more structural component, e.g. within industry composition of product mixes) could be accounted for by regressions including country-industry fixed effects. I use data for several years (1990 - 1999). This enables me to run a panel specification in which industry-country dummies are included. Some results from this specification are reported in Table 6. In particular, I focus on the interaction of financial development, external financial dependency and the proxy for firm's size distribution. This is done since the measure of financial development, the ratio of bank credit over GDP, varies over time.

The sign and economic interpretation of the interactions between the industry characteristics and financial development are highly robust to the inclusion of industry-country fixed effects. The main concern with these specifications, are time trends in the variables. Column 1 does not include any specific trend. Columns 2 and 3 instead include industry and country trends separately. The coefficients are smaller when industry trends are added. Finally, Column 4 includes the interactions of the industry variables with GDP per capita. While the coefficients are barely unaffected, statistical significance is reduced.[46] Overall, Table 6 shows that, while the statistical inference that can be n from the inclusion of industry-country fixed effects depends on the treatment of the time component of the error term, the economic interpretation of the coefficients is unaffected.[47]

[45] Moreover, it should be noted that, at least for the regressions investigating the role of institutions through specific channels, the identification comes from the interaction between institutions and industry level variables in the United States. This should further reduce the correlation between the component of the error terms given by Δ_{jc}, and our independent variables.

[46] However, it would be hard to imagine that changes from one year to the next in the country level variables contain high frequency variation predicting changes in vertical integration. For this reason I focus on what can be identified through cross-sectional variation.

[47] Finally, if value added is a nonlinear function of output, the index could simply pick up the effects of institutions (and specific channels) on output. To partially address this concern I run all the regressions in the table 1 to 6

3.4 Further Evidence from Case Studies and Business History

Case studies from developing countries and American business history provide some micro level evidence on the subject. Here I focus on the evidence on the relationship between credit markets development and vertical integration. For ease of exposition and comparability I focus mainly on the textile industry.[48]

Banerjee and Munshi (2004) provide a very detailed study of the Tiruppur cotton industry. They analyze the effects of better access to local capital markets by different groups of entrepreneurs on capital investment and vertical integration. Because of connections with the local elite, one social group has better access to local informal capital markets than newly migrated entrepreneurs. They conclude that differences in credit market access translate into a clear difference in the extent of vertical integration. The group of entrepreneurs with better access to local finance are more vertically integrated and therefore have greater control over the production process.[49] Porter and Livesay (1971) argue that in the early phase of industrialization, backward integration of rich merchants into the production stage represented an essential form of finance. While their analysis includes a rich set of industries and business stories, the experience of the cotton textile industry in New England is especially informative. Porter and Livesay (1971) describe an environment which is very similar to that described by Banerjee and Munshi (2004).[50]

Imperfect credit markets can constitute a powerful barrier to entry, and may thus reduce com-

replacing the index of vertical integration with the residual of a regression of vertical integration over interactions of industries and countries dummies with output. This set of interactions takes care of the possibility that our index of vertical integration simply picks up non-linearities in output, and I allow these non linearities to be industry specific. Results are not affected by these robustness checks, and sometimes standard errors are improved.

[48] The focus on the historical experience of the textile industry is not casual. As Haber (1991) pointed out, the cotton textile industry is a good setting to analyze the effects of credit market imperfections on market concentration and vertical integration. In his comparative analysis of the textile sector in America, Brazil and Mexico, he notes that in the early textile cotton industry "the usual mechanisms by which firms obtain market control were lacking" since "capital equipment was easily divisible" and "no significant barriers to entry existed" in the industry. Moreover this is an industry with relatively simple production processes making it especially relevant for developing countries today.

[49] Banerjee and Munshi (2004) find large differences in productivity across the two groups of entrepreneurs: firms in the credit constrained group, while less vertically integrated, they are more productive. While our model predicts that more productive firms are larger and vertically integrated, it is possible to extend our theoretical framework to include heterogeneity in firms access to credit. When this is done, the model perfectly matches Banerjee and Munshi (2004) findings.

[50] Porter and Livesay (1971) interpret these findings as indicating that backward vertical integration may substitute for the lack of developed credit markets. The main problem with this conclusion is that the nineteenth century also witnessed the gradual development of capital markets and contract laws. At the same time no significant trend towards a reduction in vertical integration has been observed, as, among others, Laffer (1969) and Tucker and Wilder (1977) have pointed out (quoted in Perry (1989)).

petition. This effect can in turn reduce vertical integration, since firms lose rents that can be used to integrate vertically.[51] Beyond the cited work of Porter and Livesay (1971), further evidence on this point comes from a comparison of the textile industry in the nineteenth century England, United States and Germany. Temin (1988) notes that the large and vertically integrated firms of the textile industry in New England were by no means more efficient than the British textile industry. Interestingly, he notes that powerful interest groups in New England ensured very effective trade protection to the textile industry. One can therefore argue that with respect to firms in the relatively less concentrated and more competitive market in England, large American firms enjoyed rents and market power. These rents may have been used to integrate vertically and acquire more control over the production process.[52]

Similar evidence can be found for the historical evolution of the automobile industry in the United States. Helper (1996) reports evidence that credit was a substantial problem in the organization and expansion at early stage of the industry, and therefore while the degree of vertical integration varied from firm to firm, virtually all automobile companies began as assemblers rather than manufacturers, implying a lower degree of vertical integration. Langlois and Robertson (1989) compare years immediately before and after the Depression, during which credit availability is likely to have changed significantly. They report that in years before the big depression the industry was on an upward trend with respect to vertical integration, while during the depression the share of intermediate inputs purchased from external suppliers went up.

4 Conclusion

This paper uncovers novel patterns in cross-country differences in the extent of vertical integration and on their institutional determinants, by focussing on the relative role of contract enforcement and financial market development. Contrary to conventional wisdom, I find some evidence of higher

[51] There is evidence linking credit market imperfections to the concentration of industries, and more broadly on entry and firm size (see references in Levine (2005)). One very interesting historical analysis is provided by Haber (1991). He provides a comparative analysis of the cotton textile industry in the nineteenth century United States, Brazil and Mexico. He finds that Mexico and Brazil, with far less developed and more segmented capital markets, exhibited very high levels of concentration in the industry. At the turn of the century Brazil passed reforms which improved the working of the financial system. This led to a rapid growth of the textile industry in Brazil, and a reduction in the level of concentration.

[52] Similarly Brown (1992) reports that the German textile industry, which in the late 19^{th} century enjoyed a very high level of protection, was far more concentrated and integrated than its counterpart in England. Despite the high level of integration, the industry did not appear to be more productive.

vertical integration in developed countries. Furthermore, industries that are more dependent on external finance tend to be relatively more vertically integrated in developed countries. I argue that these facts suggest that contractual imperfections in input and financial markets have radically different impact on vertical integration across industries, and that they are not consistent with existing theories of vertical integration.

To explore these issues, I develop an industry equilibrium model of vertical integration with heterogeneous firms. I introduce in this framework imperfect contracting in input and financial markets. The model predicts that better contract enforcement in specific input markets unambiguously leads to lower vertical integration. More interestingly, better contract enforcement in financial markets is associated with higher degrees of vertical integration in industries that are dominated by large firms and lower degrees of vertical integration in industries that are dominated by small firms.

I test the predictions of the model using cross-industry-country data. The econometric evidence provides strong support for the predictions of the model with respect to the differential impact of better financial markets on vertical integration across industries. I also find some evidence of better contract enforcement being associated with lower vertical integration in industries that are contract intensive.

Much theoretical and empirical 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 equilibrium implications of the different mechanisms underlined in the model of this paper, and their implications for cross-country patterns of industrial structure. In particular, the intra-industry effects of institutions emphasized here (how institutions affect "*how*" things are produced) may be offset by inter-industry effects of institutions ("*what*" is produced). Along the same lines, it should be useful to consider the role of other institutional characteristics. For example, the theoretical prediction on the effects of the average productivity of potential entrepreneurs on vertical integration, and the empirical findings on the interactions between proxies of human capital, skill intensity and financial development, suggest that the skills of the labor force may be a key determinant of organizational form decisions.

These considerations immediately point towards the need for further work 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 and informal networks. Moreover, while the analysis of institutional determinants of differential organizational forms across countries is interesting *per se* from the point of view of organizational economics, eventually it is of crucial importance to understand what can be learnt about the relationship between differential organizational forms and productivity.

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5 Appendix A

5.1 Proof of Lemma 1 and Discussion of Financial Constraints

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 $M(\theta)$, i.e. on $(1-\beta)R(\theta) + T(\theta) = R(\theta) - C(I) = \Pi_o(\theta)$. This completes the proof for a non-integrated firm.

I now briefly consider the case in which suppliers are also financially constrained. Consider the following timing of events. First the final assembler finances the fixed costs f borrowing from the external investors, issuing an amount of debt equal to $B = f$. Once these fixed costs have been paid she is matched with an upstream supplier. The assembler has *ex-ante* bargaining power and asks for an *ex-ante* transfer M from the supplier. The supplier is liquidity constrained and thus needs to borrow M from external investors. The upstream supplier borrows an amount of cash M, issuing debt $\widetilde{B}$. She can either transfer M to the final assembler, in which case she enters a relationship with the assembler, and she will receive a share β of the *ex-post* surplus $R - B - \widetilde{B}$. Alternatively, she can divert the cash M. The upstream supplier abstains from diversion if $\beta \left(R - f - \widetilde{B} \right) \geq M$. In any subgame perfect equilibrium the latter inequality is satisfied, and the supplier repays her debt with probability equal to one, implying $\widetilde{B} = M$. The supplier can thus borrow up to $M \leq \overline{M} = \frac{\beta}{1+\beta}(R - f)$. Since the assembler has *ex-ante* bargaining power, in equilibrium the supplier borrows up to her limit $\overline{M}$. The first implication is that in a subgame perfect equilibrium in which the assembler repays the debt $B = f$, the final payoff $V_d(\theta)$ of an assembler with productivity θ and generating revenues $R(\theta)$ is equal to $V_d(\theta) = (1 - \beta)(R(\theta) - f - \widetilde{B}) + M$, and since $M = \widetilde{B} = \overline{M}$ we obtain $V_d(\theta) = \frac{1}{1+\beta}(\Pi_o(\theta) - f)$. The final assembler effectively is the residual claimant of a share $\frac{1}{1+\beta} < 1$ of the total profits generated by the relationship. The credit constraint takes the form $\frac{1}{1+\beta}(\Pi_o(\theta) - f) > \lambda f$. Contractual imperfections in financial markets are amplified by the fact that the final assembler is effectively the residual claimant of only a fraction $\frac{1}{1+\beta}$ of the total profits, due to financial constraints of upstream suppliers.

Finally, I have framed the discussion using the premise that in order to integrate vertically, a firm must acquire a new machine. However, results are qualitatively similar if the firm acquires a supplier. Under this scenario, the supplier could agree to be paid once revenues have been generated, thus relaxing the financial constraint of the firm. The formulation in the text is equivalent to a case in which the supplier has no monitoring advantage over external investors. While recent contributions in the trade credit literature (see e.g. Bukart and Ellingsen (2004)) have emphasized different reasons for why suppliers may have a monitoring advantage over external investors, results would not be affected by allowing for these differences in our framework.

5.2 Derivation of Profit Functions and Related Results

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

$$\Pi_v(\theta) = A^{1-\alpha}\theta^{\alpha}I^{\alpha} - C(I) \tag{16}$$

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 $\Pi_v(\theta) = \alpha^{\alpha\varepsilon}A\theta^{\alpha\varepsilon}\left(1-\alpha\right)$, 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

$$\Pi_o(\theta) = A^{1-\alpha}\theta^{\alpha}x_c^{\alpha\mu}x_n^{\alpha(1-\mu)} - \mu x_c - (1-\mu)x_n \tag{17}$$

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

$$\Pi_o(\theta) = A^{\frac{1-\alpha}{1-\alpha(1-\mu)}}\theta^{\frac{\alpha}{1-\alpha(1-\mu)}}x_c^{\frac{\alpha\mu}{1-\alpha(1-\mu)}}(\alpha\beta)^{\frac{\alpha(1-\mu)}{1-\alpha(1-\mu)}}\left(1-(1-\mu)(\alpha\beta)\right)-\mu x_c \tag{18}$$

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

$$x_c = \left(\frac{\alpha}{1-\alpha(1-\mu)}\right)^{\varepsilon(1-\alpha(1-\mu))} A\theta^{\alpha\varepsilon}(\alpha\beta)^{\alpha(1-\mu)\varepsilon}\left(1-(1-\mu)(\alpha\beta)\right)^{\varepsilon(1-\alpha(1-\mu))} \tag{19}$$

and by further substitution in the profits function, I obtain

$$\Pi_o(\theta) = A\theta^{\alpha\varepsilon}\alpha^{\alpha\varepsilon}(1-\alpha)\beta^{\varepsilon}\left(\frac{1}{\beta}\frac{1-\alpha\beta(1-\mu)}{1-\alpha(1-\mu)}\right)^{\varepsilon\alpha\mu+1} = A\theta^{\alpha\varepsilon}\alpha^{\alpha\varepsilon}(1-\alpha)\Omega(\beta,\mu) \tag{20}$$

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

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

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.

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

$$\begin{aligned} \theta_e &= \left[\frac{f}{A(\theta_e,\theta_v)\,(\alpha\beta)^{\alpha\varepsilon}\,(1-\alpha\beta)}\right]^{\alpha\varepsilon} \Longleftrightarrow \\ d\theta_e &= -\alpha\varepsilon\left(\frac{f}{(\alpha\beta)^{\alpha\varepsilon}\,(1-\alpha\beta)}\right)^{\alpha\varepsilon} A(\theta_e,\theta_v)^{-\varepsilon}[\frac{\partial A(\theta_e,\theta_v)}{\partial \theta_v}d\theta_v + \frac{\partial A(\theta_e,\theta_v)}{\partial \theta_e}d\theta_e] \end{aligned} \tag{21}$$

which can be rewritten as

$$\frac{d\theta_e}{d\theta_v} = -\frac{KA(\theta_e,\theta_v)^{-\varepsilon}\frac{\partial A(\theta_e,\theta_v)}{\partial \theta_v}}{(1+KA(\theta_e,\theta_v)^{-\varepsilon}\frac{\partial A(\theta_e,\theta_v)}{\partial \theta_e}} < 0 \tag{22}$$

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.

5.4 Proof of Proposition 4

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

$$INT = 1 - \beta\left(1 - \frac{1-G(\theta_v)}{1-G(\theta_e)}\right) \tag{23}$$

To prove the first part of the proposition, simply note that by taking the derivative of INT w.r.t. M and denoting $(1-\sigma)(M-1)=\zeta$, we obtain

$$
\begin{aligned}
& sign\left|\frac{\partial INT}{\partial\overline{\theta}}\right| \\
= \quad & -sign\left|\frac{\left((1-\sigma)+\sigma\frac{\partial\theta_v}{\partial\overline{\theta}}\right)[\zeta+\sigma(\theta_e-1)]-[\zeta+\sigma(\theta_v-1)]\left((1-\sigma)+\sigma\frac{\partial\theta_e}{\partial\overline{\theta}}\right)}{[\zeta+\sigma(\theta_e-1)]^2}\right|
\end{aligned}
$$

Hence

$$
sign\left|\frac{\partial INT}{\partial\overline{\theta}}\right|\geq 0\Longleftrightarrow\frac{1-\sigma\left(\left(\frac{1}{\alpha}-1\right)\theta_v\frac{1}{A}\frac{\partial A}{\partial\overline{\theta}}+1\right)}{1-\sigma\left(\left(\frac{1}{\alpha}-1\right)\theta_e\frac{1}{A}\frac{\partial A}{\partial\overline{\theta}}+1\right)}\leq\frac{1-(1-\sigma)\overline{\theta}-\sigma\theta_v}{1-(1-\sigma)\overline{\theta}-\sigma\theta_e}
$$

It is easy to check that $\lim_{\sigma\to 0}\frac{1-\sigma\left(\left(\frac{1}{\alpha}-1\right)\theta_v\frac{1}{A}\frac{\partial A}{\partial\overline{\theta}}+1\right)}{1-\sigma\left(\left(\frac{1}{\alpha}-1\right)\theta_e\frac{1}{A}\frac{\partial A}{\partial\overline{\theta}}+1\right)}=\lim_{\sigma\to 0}\frac{1-(1-\sigma)\overline{\theta}-\sigma\theta_v}{1-(1-\sigma)\overline{\theta}-\sigma\theta_e}=1$. On the other hand $\lim_{\sigma\to 0}\frac{1-\sigma\left(\left(\frac{1}{\alpha}-1\right)\theta_v\frac{1}{A}\frac{\partial A}{\partial\overline{\theta}}+1\right)}{1-\sigma\left(\left(\frac{1}{\alpha}-1\right)\theta_e\frac{1}{A}\frac{\partial A}{\partial\overline{\theta}}+1\right)}=\frac{\theta_v}{\theta_e}<\lim_{\sigma\to 0}\frac{1-(1-\sigma)\overline{\theta}-\sigma\theta_v}{1-(1-\sigma)\overline{\theta}-\sigma\theta_e}=\frac{\theta_v-1}{\theta_e-1}$

To prove the second part of the propostition simply 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 $\frac{\partial\theta_e}{\partial\mu}<0$.

To prove the third part of the proposition, note that taking the derivative w.r.t. λ we obtain

$$
\frac{\partial\widehat{INT}}{\partial\lambda}\geq 0\Longleftrightarrow\frac{\frac{d\theta_e}{d\lambda}}{\frac{d\theta_v}{d\lambda}}\frac{g(\theta_e)}{g(\theta_v)}\leq\frac{1-G(\theta_e)}{1-G(\theta_v)}\tag{24}
$$

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

$$
\frac{\partial INT}{\partial\lambda}\geq 0\Longleftrightarrow\theta_e(1-\frac{\sigma}{(1-\sigma)}\frac{1}{\overline{\theta}-1})\leq(1-\frac{\sigma}{(1-\sigma)}\frac{1}{\overline{\theta}-1})\theta_v\tag{25}
$$

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

5.5 Proof of Proposition 6 and Related Results

I first derive an expression for Δ_{ic} in the text. Consider firm f in industry j in country c, and define the index of vertical integration at the firm level as $int_{fjc} = \frac{VA_{fjc}}{Y_{fjc}}$where VA_{fjc} and Y_{fjc} stem for value added and output respectively. Assuming that the industry is composed of N firms $f \in \{1, 2, ..., N\}$ we would like to measure $INT_{jc} = \frac{1}{N} \cdot \sum_{f=1}^{N} int_{fjc}$. Instead, the observed index of vertical integration is $\widehat{INT}_{jc} = \left(\sum_{f=1}^{N} VA_{fjc} \right) / \left(\sum_{f=1}^{N} Y_{fjc} \right)$.Denoting with $\overline{X}$ the aggregate at the industry level of variable X, we have that $\widehat{INT}_{jc} = \sum_{f=1}^{N} \frac{VA_{fjc}}{Y_{fjc}} \cdot \frac{Y_{fjc}}{\overline{Y}_{jc}}$. Some further simple algebra gives $\widehat{INT}_{jc} = INT_{jc} + (int_{fjc} - INT_{jc}) \cdot (\frac{Y_{fjc}}{\overline{Y}_{jc}} - \frac{1}{N})$. In the text I set $\Delta_{jc} = \Sigma_f \ (int_{fjc} - INT_{jc}) \cdot (\frac{Y_{fjc}}{\overline{Y}_{jc}} - \frac{1}{N})$.

I now turn to the proof of proposition 6.

Assuming a Pareto distribution, i.e. $G(\theta) = 1 - \theta^{-\frac{1}{\sigma}}$, the model implies that the unweighted index of vertical integration in the industry can be computed as

$$INT_{ic} = 1 - \beta \left[1 - \left(\frac{\theta_v}{\theta_e} \right)^{-\frac{1}{\sigma}} \right] \tag{26}$$

The weighted industry level index of vertical integration observed in the data is instead given by

$$\widehat{INT}_{ic} = 1 - \beta \left[1 - \frac{\int_{\theta_v}^{\infty} R_v dG(\theta)}{\int_{\theta_e}^{\theta_v} R_o(\theta) dG(\theta) + \int_{\theta_v}^{\infty} R_v dG(\theta)} \right] \tag{27}$$

Substituting in this equation the expression for the revenue functions of integrated and non-integrated firms, we obtain

$$\widehat{INT}_{ic} = 1 - \beta \left(1 - \frac{\int_{\theta_v}^{\infty} \theta^{\alpha\varepsilon} dG(\theta)}{\Omega(\beta, \mu) \int_{\theta_e}^{\theta_v} \theta^{\alpha\varepsilon} dG(\theta) + \int_{\theta_v}^{\infty} \theta^{\alpha\varepsilon} dG(\theta)} \right)$$

It is well known that if θ is distributed according to a Pareto with shape parameter σ, $\theta^{\alpha\varepsilon}$ is also distributed according to a Pareto with shape parameter $\frac{1}{\sigma} - \alpha\varepsilon$. In this case the index can be rewritten as

$$\widehat{INT}_{ic} = 1 - \beta \left(1 - \frac{\left(\frac{\theta_v}{\theta_e}\right)^{-\frac{1}{\sigma}+\alpha\varepsilon}}{\Omega(\beta,\mu) + (1-\Omega(\beta,\mu))\left(\frac{\theta_v}{\theta_e}\right)^{-\frac{1}{\sigma}+\alpha\varepsilon}} \right)$$

Finally note that

$$\Delta_{ic} = \widehat{INT}_{ic} - INT_{ic} = \beta \left(\frac{\theta_v}{\theta_e}\right)^{-\frac{1}{\sigma}} \left(\frac{\left(\frac{\theta_v}{\theta_e}\right)^{\alpha\varepsilon}}{\Omega(\beta,\mu) + (1-\Omega(\beta,\mu))\left(\frac{\theta_v}{\theta_e}\right)^{-\frac{1}{\sigma}+\alpha\varepsilon}} - 1 \right) \tag{28}$$

which is the expression derived in the text. To prove the second part of the proposition, we have

$$sign \left| \frac{\partial \Delta_{ic}}{\partial \mu} \right| = sign \left| \frac{d\left(\frac{(\Omega)^{-\frac{1}{\sigma}+\alpha\varepsilon}}{\Omega + (1-\Omega)\left(\frac{f+k}{f}\Omega\right)^{-\frac{1}{\sigma}+\alpha\varepsilon}} - 1 \right)}{d\Omega} \frac{d\Omega}{d\mu} \right|$$

which, after some algebra, gives

$$sign \left| \frac{\partial \Delta_{ic}}{\partial \mu} \right| = -sign \left| \Omega^{-\alpha\varepsilon}\left(1 + \frac{k}{f}\right)^{-\alpha\varepsilon} + \frac{(1-\Omega)}{1 - \Omega + \Omega\left(\Omega + \frac{k}{f}\Omega\right)^{\frac{1}{\sigma}-\alpha\varepsilon}} \right| < 0$$

5.6 Derivation of Profit Functions with Labor

I derive the profits functions of both organizational form for the more general production function

$$q(\theta) = \theta\left(\frac{L}{1-\eta}\right)^{1-\eta}\left(\frac{I}{\eta}\right)^{\eta} \tag{29}$$

For simplicity, I focus on the case $\mu = 0$. The corresponding expressions in the text are then derived for the case in which $\eta \to 1$. The demand equation implies that for each firm,

$$q(\theta) = Ap^{-\varepsilon} \Longleftrightarrow \frac{A^{1-\alpha}}{q(\theta)^{1-\alpha}} = p(\theta)$$

The revenue function for each firm θ becomes

$$R(\theta) = \frac{A^{1-\alpha}}{q(\theta)^{1-\alpha}} q(\theta) = A^{1-\alpha} q(\theta)^{\alpha}$$

Let $C(I) = \int_0^1 x(i)di$ be the cost of producing intermediate input I.

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

$$\Pi_v(\theta) = A^{1-\alpha}\theta^{\alpha}(\frac{L}{1-\eta})^{\alpha(1-\eta)}(\frac{I}{\eta})^{\alpha\eta} - L - C(I)$$

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

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

The optimal investment $\overline{x}$ and labor demand are functions of the productivity θ. The system of first order conditions with respect to L and $\overline{x}$ respectively gives

$$F.O.C. = \begin{cases} \alpha A^{1-\alpha}\theta^{\alpha}(\frac{L(\theta)}{1-\eta})^{\alpha(1-\eta)}(\frac{\overline{x}(\theta)}{\eta})^{\alpha\eta-1} = 1 \\ \alpha A^{1-\alpha}\theta^{\alpha}(\frac{L(\theta)}{1-\eta})^{\alpha(1-\eta)-1}(\frac{\overline{x}(\theta)}{\eta})^{\alpha\eta} = 1 \end{cases}$$

implying the standard Cobb - Douglas result

$$\frac{L(\theta)}{\overline{x}(\theta)} = \frac{1-\eta}{\eta}$$

Substituting into the profit function yields

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

and from the first order condition, we obtain $\alpha^{\varepsilon} A\theta^{\alpha\varepsilon} = (\frac{\overline{x}(\theta)}{\eta})$, which finally gives profits

$$\Pi_v(\theta) = \alpha^{\alpha\varepsilon} A\theta^{\alpha\varepsilon}\,(1-\alpha) \tag{30}$$

which is the expression in the text. Note that the firm employs $L(\theta) = (1-\eta)\alpha^{\varepsilon} A\theta^{\alpha\varepsilon}$ units of labor. The size of the firm is thus increasing in the productivity parameter θ.

I now turn attention to the (sum of the) profits generated by a specialized assembler and her supplier. For simplicity, I assume that the decision regarding labor investments is contractible.

The sum of profits is given by

$$\Pi_o(\theta) = A^{1-\alpha}\theta^{\alpha}(\frac{L}{1-\eta})^{\alpha(1-\eta)}(\frac{\overline{x}}{\eta})^{\alpha\eta} - L - \overline{x}$$

With respect to the case of vertical integration there are two differences. The investment decision over $\overline{x}$ is taken by the upstream firm, and can not be specified in an *ex-ante* contract. The upstream supplier, anticipating *ex-post* bargaining, knows that she will only capture a fraction β of the surplus generated by the investments. Secondly, since it is possible to write contracts on L, investments in L will take into account the investment in $\overline{x}$ choosen by the upstream firm.

The first order condition for the upstream firm gives

$$\frac{\overline{x}(\theta, L)}{\eta} = (\alpha\beta)^{\frac{1}{1-\alpha\eta}} A^{\frac{1-\alpha}{1-\alpha\eta}} \theta^{\frac{\alpha}{1-\alpha\eta}} (\frac{L}{1-\eta})^{\frac{\alpha(1-\eta)}{1-\alpha\eta}}$$

where I make explicit the fact that the investment of the supplier depends on the productivity parameter, and on the contractually specified amount of labor. Substituting this expression into the profits function yields

$$\Pi_o(\theta) = (\alpha\beta)^{\frac{\alpha\eta}{1-\alpha\eta}} A^{\frac{1-\alpha}{1-\alpha\eta}} \theta^{\frac{\alpha}{1-\alpha\eta}} (\frac{L}{1-\eta})^{\frac{\alpha(1-\eta)}{1-\alpha\eta}} (1-\alpha\beta) - L$$

Taking the first order condition with respect to L yields

$$\left(\frac{\alpha}{1-\alpha\eta}\right)^{\frac{1-\alpha\eta}{1-\alpha}} (\alpha\beta)^{\alpha\eta\varepsilon} A\theta^{\alpha\varepsilon}(1-\alpha\beta)^{(1-\alpha\eta)\varepsilon} = (\frac{L(\theta)}{1-\eta})$$

and finally yielding profits

$$\Pi_o(\theta) = A\theta^{\alpha\varepsilon}(\frac{1-\alpha\beta}{1-\alpha\eta})^{(1-\alpha\eta)\varepsilon} (\beta)^{\alpha\eta\varepsilon} \alpha^{\alpha\varepsilon}(1-\alpha) \tag{31}$$

Taking the limit for $\eta \to 1$ we obtain the expresion in the text,

$$\lim_{\eta \to 1} \Pi_o(\theta) = A\theta^{\alpha\varepsilon}(1-\alpha\beta)\left(\frac{\alpha\beta}{\rho}\right)^{\alpha\varepsilon}$$

Note that $\frac{\partial \Pi_o(\theta)}{\partial \theta^{\alpha\varepsilon}} = \frac{(1-\alpha\beta)}{(1-\alpha)}(\beta)^{\alpha\varepsilon}\frac{\partial \Pi_v(\theta)}{\partial \theta^{\alpha\varepsilon}} \leq \frac{\partial \Pi_v(\theta)}{\partial \theta^{\alpha\varepsilon}}$, since $(1-\alpha\beta)(\beta)^{\alpha\varepsilon}$ is increasing in β, and is thus bounded above by 1. Moreover, as for the case of vertical integration, the optimal labor demand $L(\theta)$ is increasing in the productivity parameter θ. The distribution $G(\theta)$ induces a distribution in firms size, when firms size is proxied by employees.

6 Appendix B

6.1 Data Description

Data on industries in the manufacturing sector (at the 3-digit code ISIC second revision) are available from UNIDO database. Data at the country level come from different sources. Data on GDP per capita and total GDP are from the World Penn Tables. Institutional variables are from the Doing Business dataset from the World Bank. Measures of financial development are from Levine et al. (2002). Measures of educational level are from the Barro and Lee (2001) dataset.

The measure of external dependency in the United States is taken from Rajan and Zingales (1998). The variable small firms (the share of employees working in establishments with less than 500 employees in the United States) is taken from the US Census of Manufacturing, and are reported in Beck et al. (2004).

External Financial Dependency: is the average over the '80s of the ratio

$$ED_i = \frac{\text{Cap Exp } - \text{Cash Flows}}{\text{Cap Exp}}$$

for the median firm in each industry. Data are from Compustat. I use the values reported in Rajan and Zingales (1998).

Small Firms: is the share of employees working in establishments with less than 500 employees in the United States.

Contractual Needs (1) is a measure of contractual needs computed as follows. From the input-output table in the United States I compute for each (SIC 87 4-digit) industry i the share of inputs purchased from other industries $j \neq i$ in the manufacturing sector, $sh_{ij} = \frac{u_{ij}}{\Sigma_{j \neq i} u_{ij}}$. I use the classification in Rauch (1999) to compute a measure of specificity at the industry level. I match the classification in Rauch (1999) with the input-output table. For each (SIC 87 4-digit) industry i I compute the average degree of specificity as the fraction s_i of products produced in that industry that are classified by Rauch as specific. Contractual needs is than given by

$$CN(1)_i = \Sigma_j sh_{ij} \times s_j$$

I then aggregate at the ISIC code 3-digit level by taking the within industry median value.

Contractual Needs (2): is constructed as Contractual Needs (1), but considers the Herfindhal index for the use of inputs. The index is thus

$$CN(2)_i = \Sigma_j sh_{ij}^2$$

External Financial Dependency of Backward Industries: I construct an average measure of External Financial dependency for the backward industries of industry i. Denoting by ED_j the external financial dependency in (3-digit ISIC code) industry j and by $\widetilde{sh}_{ij}$ 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

$$Ext\_Dep\_Back_i = \Sigma_{j \neq i} \widetilde{sh}_{ij} \times ED_j$$

6.2 Cross-Country Differences in Vertical Integration

In this subsection I discuss the results of estimating regressions of the form

$$INT_{ic} = \alpha + \beta Z_c + \eta_i + \varepsilon_{ic} \tag{32}$$

where INT_{ic} is the index of vertical integration in industry i in country c, Z_c is a vector of country level variables and η_i is a set of industry dummies. Since I am primarily interested in the coefficient β, I correct the standard errors adjusting for clustering by country. To provide a control for the average size of establishments in the industry, a measure of average output per establishment is also included as additional control in the regressions.[53] Results are reported in Table A1.

Column 1 confirms the findings presented in Figure 1. Once industry fixed effects are controlled for, there is no evidence of higher vertical integration in less developed countries. In column 1 the GDP per capita enters positively and is statistically significant.[54] If firms integrate vertically in order to exploit economies of scale, countries with larger markets may have more vertically integrated firms. Column II addresses this issue by including the logarithm of population as proxy for domestic market size. The coefficient is positive, but is not statistically significant.[55]

Columns 3 and 4 explore the relationship between financial development and vertical integration. Financial development may affect vertical integration through several channels. First of all, vertical integration may be considered as an additional investment that has to be financed. Better credit markets would then be associated with higher degrees of vertical integration. However, better financial markets may foster competition, and thus reduce the possibility of firms to integrate vertically. Moreover, better credit markets can also foster the development of certain key backward industries, reducing the need for vertical integration in downstream industries.[56]

I use two measures of financial development. In Column 3 I proxy financial market development with the ratio of credit to the private sector over GDP. The coefficient is negative, large, and highly significant. The coefficient on GDP per capita remains positive, and is statistically significant.[57] In Column 4, I proxy financial market development with an index of the degree of protection of creditors rights, from the Doing Business database at World Bank. Creditor's Legal Rights measures the degree to which collateral and bankruptcy laws facilitate lending.[58] While the sign of

[53] The UNIDO dataset contains information on employees at the industry level. I can thus control for the average size measured as the average number of employees and for output per worker. Results are not affected by the addition of these controls. However, because of pervasive missing values in the employees variable, I focus in the remaining part of the paper on regressions only controlling for average output per establishment. Results for the alternative specification are available upon request.

[54] The relationship between the level of development and the degree of vertical integration could be non-linear. For example, constraints originating from the underdevelopment of backward industries could push towards vertical integration only after a certain level of development. However, I do not find evidence of a non-linear relationship between the income of the country and the average propensity to integrate vertically.

[55] Since in this specification the effect of country level variables is assumed to be identical across industries, β estimates an average country-level propensity to vertically integrate. Since I do not include country fixed effects, I interpret the results as correlations.

[56] Finally, to the extent that firms, at least partially, pursue a strategy of vertical integration to create internal capital markets substituting for poorly functioning (external) capital markets, better capital markets may be further associated with less vertical integration.

[57] Similar results are obtained when financial development is proxied with the ratio of bank assets over total financial assets.

[58] The methodology is developed in Djankov et. al (2005) and adapted from La Porta et. al. (1998).

the coefficient goes in the same direction as the previous measure of financial development, it is not statistically significant. Overall, I find evidence that countries that are more financially developed are less vertically integrated, although the statistical significance of the results depends on the precise way financial development is measured.[59]

Column 5 explores the role of contractual enforcement. As emphasized in the theoretical section, vertical integration is a response to contractual imperfections. Countries with better contract enforcement have relatively less integrated firms, since transactions across firms are mediated by relatively more efficient contracts. I proxy contract enforcement with the number of procedures mandated by law or court regulation demanding interactions between the parties or between them and the judge, from Djankov et al. (2003). I find some evidence that countries with worse enforcement of contracts tend to be more vertically integrated, however the coefficient is not statistically significant.[60]

Finally, in Column 6 I consider both the role of contract enforcement and financial development, and I also include controls for entry barriers and human capital. Artificial entry barriers (e.g. those induced by excessive regulation) may reduce competition, enabling surviving firms with market power to integrate vertically. Using the Doing Business database, I measure entry barriers as the number of entry procedures, following the methodology in Djankov et al. (2002). I find no evidence that entry barriers affect vertical integration. I measure human capital with average years of higher education in the adult population. If vertical integration requires higher coordination, and coordination requires higher skills, firms will tend to be relatively more vertically integrated in countries with higher supply of skilled workers. I find that countries with higher levels of education are more vertically integrated, but the coefficient is not statistically significant. Column 6 also shows that the financial development variables remains highly statistically significant.

I have run similar regressions (results are omitted, but available on request) considering the role of trade openness, labor regulation, ethnic fragmentation and antitrust policies. The degree of openness to trade may affect vertical integration giving firms access to larger inputs markets and increasing competition on domestic markets. Both channels suggest that higher trade openness should be associated with less vertical integration. I find that openness to trade (measured as the

[59] I have tried other measures such as bank concentration and creditor's information indexes, or costs of forming collateral, obtaining very similar results. Acemoglu et al. (2005b) find very similar results on a different dataset.

[60] The Doing Business database contains other measures of contract enforcement. I obtain very similar results with these alternative measures of contracts enforcement.

sum of imports and exports over GDP) is negatively associated with vertical integration.

Strict labor regulation is often considered as one important constraint on firm growth in less developed countries. In order to avoid strict labor regulation, especially with respect to firing workers, firms may decide to operate on a smaller scale. To the extent that firm size is correlated with vertical integration, or that there are technological limits to small scale operation, labor regulation will reduce vertical integration by making commitments to internal supply relatively more costly (e.g. because of lack of flexibility in an uncertain environment). However, the index of labor regulation does not appear to be correlated to vertical integration.

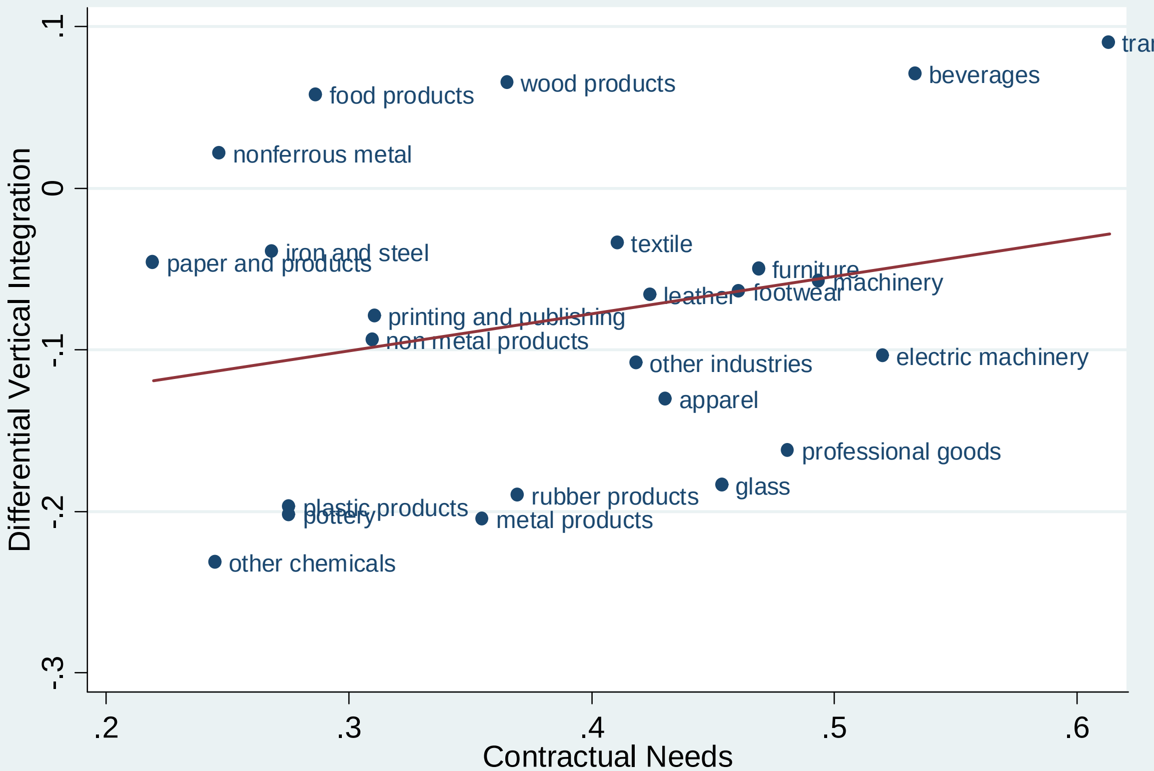
Countries with higher levels of trust may have relatively less integrated firms, if other social networks provide informal ways of enforcing contracts. Where formal contracts cannot provide adequate incentives, fiat or trust may substitute for the lack of enforcement. I find that ethnic fragmentation (which is negatively correlated with trust) is positively associated with vertical integration. On a much smaller sample, worse antitrust institutions are associated with more vertical integration. None of these coefficients, however, is statistically significant. Similarly, a regression simultaneously considering all the institutional variables does not change the main conclusions.

To summarize, with the exception of financial development, the results in this section do not show strong patterns relating country level variables and institutions with the degree of vertical integration. Interestingly, using a different dataset, Acemoglu et al. (2005b) find that less developed countries are more vertically integrated. However they find that this result is entirely driven by industrial composition. Once industry composition is taken into accout (with the inclusion of industry fixed effects, as it is done here), contracting costs, entry barriers and financial market development are not strong predictors of vertical integration patterns.

The model in section 2 and the empirical evidence in section 3 suggest another explanation for the lack of correlation between (most of the) institutional variables at the country level and vertical integration. Institutional characteristics at the country level have differential impacts across industries, which cancel out when the same average effect across industries is imposed.[61]

[61] My data do not allow for a careful decomposition of within industry composition effects. As an example, consider the case of contract enforcement. The lack of a relationship between vertical integration and contractual enforcement may be due to the fact that firms substitute away from production of goods which rely heavily on contracts towards goods that can be produced with more standardized inputs and thus are less dependent on contractual enforcement. For instance, firms in the textile industry in India or Pakistan are mainly engaged in the production of T-shirts, while textile firms in Italy may be mainly engaged in the design of new products. If the latter kind of activity is more exposed to hold-up problems, it is quite natural to think that production at the design and distribution stage

Figure 9: Differential Vertical Integration and Contractual Needs



Differential Vertical Integration = Vertical Integration(non-OECD) - Vertical Integration(OECD)

carried out in Italy may be more vertically integrated than the production activities in India and Pakistan, despite Italy having better contract enforcement institutions.

Table 1: Descriptive Statistics of Main Variables

Country Level Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Vertical Integration Propensity	89	0.39	0.09	0.13	0.67
GDP Per Capita (in Logs)	86	8.61	1.04	6.20	10.18
Bank Credit over GDP Ratio	80	0.37	0.29	0.03	1.45
Legal Rights Index	84	5.10	2.25	0	10
Number of Legal Procedure to Enforce a Contract	89	29.29	11.33	11	58

Industry Level Variables (in U.S.)

Variable	Obs	Mean	Std. Dev.	Min	Max
Vertical Integration	25	0.50	0.10	0.36	0.68
External Financial Dependency	25	0.25	0.35	-0.45	1.14
Contractual Needs	25	0.37	0.12	0.12	0.61
Share of Small Firms	25	0.38	0.15	0.09	0.63
Externnal Financial Dependency of Upstream Industries	25	0.33	0.10	0.10	0.60

Notes: Country Level Variables: Vertical Integration Propensity is computed for each country as the unweighted average of the industry vertical integration indexes across the 25 industries in the sample (Data Source: UNIDO 2001 database). GDP Per capita is from the Penn Database. Bank Credit over GDP Ratio comes from 2000 World Bank data. Legal Rights index and Number of Legal Procedures to Enforce a Contract come from Doing Business Database at World Bank (2004, 2005 and Djankov et al. (2002, 2003))

Industry Level Variables: Vertical Integration is computed with data from UNIDO (2001) database. External Financial Dependency is from Rajan and Zingales (1998). Share of small Firms is the measured as the share of employees working in establishments with less than 500 employees, from the Census Bureau. Contractual Needs and External Financial Dependency of Upstream Industries are from author’s calculations. See Data Appendix for further details. Petroleum and Refineries is omitted. All industry variables are 3-Digit Code Isic, for the manufacturing sector in the United States.

Table 2: Disentangling Credit Markets Effects on Vertical Integration

Dependent Variable: Vertical Integration

	I	II	III	IV	V
External Financial Dependency × Financial Development	0.034	0.181***	0.186***	0.186***	0.185***
	[0.032]	[0.069]	[0.069]	[0.077]	[0.071]
External Financial Dependency × Financial Development × Small Firms		-0.295***	-0.289**	-0.291**	-0.299***
		[0.115]	[0.114]	[0.116]	[0.118]
External Financial Dependency of Upstream Industries × Financial Development			-0.146*	-0.202**	-0.101
			[0.081]	[0.104]	[0.087]
Industry Dummies	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes
Industry Characteristics × GDP Per Capita				yes	
Vertical Integration U.S. × GDP Per Capita					yes
Observations	1734	1734	1734	1734	1734
R-squared	0.52	0.53	0.53	0.54	0.54

*** Statistically significant at 1%, ** at 5%, * at 10%. Robust Standard Errors, corrected for clustering at the country level, reported in parenthesis. All variables are mean for the 1990-1999 years. Vertical Integration is the ratio of Value Added over Output in the Industry, computed from Data from UNIDO 2001 Database. Financial Development is measured as the ratio of Bank Credit over GDP from 2000 World Bank data. External Financial Dependency is for the U.S., from Rajan and Zingales (1998). Small Firms is measured as the share of employees working in establishments with less than 500 employees in the U.S., from the Census Bureau. External Financial Dependency of Upstream Industries is from author's calculations. See Data Appendix for details. Industry characteristics include all the interactions of U.S. variables used to estimate the parameters of interest. Estimated, but unreported, the coefficient of the interaction of Financial Development with Small Firms. The U.S. are excluded from the sample. The regressions are estimated using the ranking of industry variables in the U.S. instead that the original measure. All the other variables are in Logs.

Table 3: Credit Markets and Contractual Enforcement

Dependent Variable: Vertical Integration

	Herfindal Inputs Use			Specificity Inputs Use		
	I	II	III	IV	V	VI
External Financial Dependency × Financial Development	0.152**	0.137*	0.153**	0.165**	0.159**	0.174**
	[0.070]	[0.071]	[0.074]	[0.071]	[0.075]	[0.076]
External Financial Dependency × Financial Development × Small Firms	-0.247**	-0.254**	-0.245**	-0.260**	-0.289**	-0.278**
	[0.115]	[0.116]	[0.117]	[0.118]	[0.124]	[0.117]
External Financial Dependency of Upstream Industries × Financial Development	-0.114	-0.119	-0.141*	-0.147*	-0.143*	-0.155*
	[0.080]	[0.081]	[0.083]	[0.081]	[0.081]	[0.083]
Contractual Needs × Number of Legal Procedures	-0.615**	-0.574	-0.760***	-0.203	-0.117	0.284
	[0.280]	[0.320]	[0.324]	[0.183]	[0.201]	[0.211]
Contractual Needs × Financial Development		-0.021			-0.027	
		[0.134]			[0.090]	
External Financial Dependency × Number of Legal Procedures		-0.046*			-0.058**	
		[0.027]			[0.027]	
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		yes	yes
Industry Characteristics × GDP Per Capita			yes			yes
Observations	1734	1734	1734	1734	1734	1734
R-squared	0.52	0.53	0.53	0.52	0.53	0.53

*** Statistically significant at 1%, ** at 5%, * at 10%. Robust Standard Errors, corrected for clustering at the country level, reported in parenthesis. All variables are mean for the 1990-1999 years. Vertical Integration is the ratio of Value Added over Output in the Industry, computed from Data from UNIDO 2001 Database. Financial Development is measured as the ratio of Bank Credit over GDP from 2000 World Bank data. External Financial Dependency is for the U.S., from Rajan and Zingales (1998). Small Firms is measured as the share of employees working in establishments with less than 500 employees in the U.S., from the Census Bureau. External Financial Dependency of Upstream Industries and Contractual Needs variables are from Author's Calculation. See Data Appendix for details. Industry characteristics include all the interactions of U.S. variables used to estimate the parameters of interest. Estimated, but unreported, the coefficient of the interaction of Financial Development with Small Firms. The U.S. are excluded from the sample. Columns Va and Vb report separately the coefficients estimated from a pooled regressions in which the sample is divided between OECD and non-OECD countries. The regressions are estimated using the ranking of industry variables in the U.S. instead that the original measure. All the other variables are in Logs.

Table 4: Financial Markets, Human Capital and Vertical Integration

Dependent Variable: Vertical Integration

	I	II	III	IV
External Financial Dependency × Financial Development	0.170**	0.170**	0.198***	0.141*
	[0.076]	[0.076]	[0.077]	[0.079]
External Financial Dependency × Financial Development × Small Firms	-0.250**	-0.207*	-0.284**	-0.269**
	[0.127]	[0.128]	[0.128]	[0.128]
External Financial Dependency of Upstream Industries × Financial		-0.184**		
		[0.003]		
Skill Intensity × Higher Education	0.254**	0.262***	0.362***	0.417***
	[0.109]	[0.109]	[0.117]	[0.125]
Skill Intensity of Upstream Industries × Higher Education		-0.518		
		[0.343]		
Skill Intensity × Financial Development			-0.269***	
			[0.0839]	
External Financial Dependency × Higher Education			0.001	
			[0.032]	
Industry Dummies	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes
Industry Characteristics × GDP Per Capita				yes
Vertical Integration U.S. × GDP Per Capita				yes
Observations	1369	1369	1369	1369
R-squared	0.55	0.56	0.56	0.56

*** Statistically significant at 1%, ** at 5%, * at 10%. Robust Standard Errors, corrected for clustering at the country level, reported in parenthesis. All variables are mean for the 1990-1999 years. Vertical Integration is the ratio of Value Added over Output in the Industry, computed from Data from UNIDO 2001 Database. Financial Development is measured as the ratio of Bank Credit over GDP from 2000 World Bank data. External Financial Dependency is for the U.S., from Rajan and Zingales (1998). Small Firms is measured as the share of employees working in establishments with less than 500 employees in the U.S., from the Census Bureau. Skill intensity is measured as the ratio of employees over total workers in the U.S., from the NBER manufacturing database. External Financial Dependency of Upstream Industries is from author's Calculation. See Data Appendix for details. Industry interactions include all the interactions of U.S. variables used to estimate the parameters of interest. Estimated, but unreported, the coefficient of the interaction of Financial Development with Small Firms. The U.S. are excluded from the sample. Columns Va and Vb report separately the coefficients estimated from a pooled regressions in which the sample is divided between OECD and non-OECD countries. The regressions are estimated using the ranking of industry variables in the U.S. instead that the original measure. All the other variables are in Logs.

Table 5: Further Robustness Checks

Dependent Variable: Vertical Integration	I	II	III	IV	Va	Vb
External Financial Dependency × Financial Development	0.157*	0.139*	0.149*	0.149*	0.182***	0.265***
	[0.092]	[0.075]	[0.091]	[0.091]	[0.070]	[0.109]
External Financial Dependency × Financial Development × Small Firms	-0.219	-0.207	-0.212	-0.212	-0.287***	-0.357**
	[0.140]	[0.131]	[0.139]	[0.139]	[0.116]	[0.162]
External Financial Dependency of Upstream Industries × Financial Development	-0.214**	-0.206*	-0.209**	-0.209**	-0.145*	-0.173*
	[0.104]	[0.128]	[0.105]	[0.105]	[0.082]	[0.106]
Industry Dummies	yes	yes	yes	yes	yes	yes
Country Dummies	yes	yes	yes	yes	yes	yes
Industry Interactions × GDP pc.	yes	yes				
Industry Interactions × (GDP pc)².		yes				
Industry Dummies × GDP pc.			yes	yes		
Industry Dummies × Intra Indust × GDP pc.				yes		
Breaking the Sample					yes	yes
Observations	1715	1715	1715	1715	1715	-
R-squared	0.53	0.54	0.55	0.56	0.53	-

*** Statistically significant at 1%, ** at 5%, * at 10%. Robust Standard Errors, corrected for clustering at the country level, reported in parenthesis. All variables are mean for the 1990-1999 years. Vertical Integration is the ratio of Value Added over Output in the Industry, computed from Data from UNIDO 2001 Database. Financial Development is measured as the ratio of Bank Credit over GDP from 2000 World Bank data. External Financial Dependency is for the U.S., from Rajan and Zingales (1998). Small Firms is measured as the share of employees working in establishments with less than 500 employees in the U.S., from the Census Bureau. External Financial Dependency of Upstream Industries and Intra Industry are from author's Calculation. See Data Appendix for details. Industry interactions include all the interactions of U.S. variables used to estimate the parameters of interest. Estimated, but unreported, the coefficient of the interaction of Financial Development with Small Firms. The U.S. are excluded from the sample. Columns Va and Vb report separately the coefficients estimated from a pooled regressions in which the sample is divided between OECD and non-OECD countries. The regressions are estimated using the ranking of industry variables in the U.S. instead that the original measure. All the other variables are in Logs.

Table 6: Panel Specification

Dependent Variable: Vertical Integration

	I	II	III	IV
External Financial Dependency × Financial Development	0.090***	0.089***	0.038**	0.051
	[0.029]	[0.025]	[0.015]	[0.033]
External Financial Dependency × Financial Development × Small Firms	-0.161***	-0.157***	-0.097***	-0.117*
	[0.060]	[0.051]	[0.034]	[0.069]
Industry-Country Dummies	yes	yes	yes	yes
Country Trends		yes		
Industry Trends			yes	
Industry Interactions × (GDP pc)				yes
Clusters	*i-c*	Country	Industry	*i-c*
Observations	9961	9961	9961	9961
R-squared	0.55	0.57	0.63	0.56

*** Statistically significant at 1%, ** at 5%, * at 10%. Robust Standard Errors are reported in parenthesis. Vertical Integration is the ratio of Value Added over Output in the Industry, computed from Data from UNIDO 2001 Database. Financial Development is measured as the ratio of Bank Credit over GDP from 2000 World Bank data. External Financial Dependency is for the U.S., from Rajan and Zingales (1998). Small Firms is measured as the share of employees working in establishments with less than 500 employees in the U.S., from the Census Bureau. Industry interactions include all the interactions of U.S. variables used to estimate the parameters of interest. Estimated, but unreported, the coefficient of the interaction of Financial Development with Small Firms. The U.S. are excluded from the sample. Columns Va and Vb report separately the coefficients estimated from a pooled regressions in which the sample is divided between OECD and non-OECD countries. The regressions are estimated using the ranking of industry variables in the U.S. instead that the original measure. All the other variables are in Logs.

Table A1: Cross-Country Differences in Vertical Integration

Dependent Variable: Vertical Integration

	I	II	III	IV	V	VI
GDP per capita	0.065*	0.082**	0.132***	0.068	0.07	0.125**
	[0.037]	[0.038]	[0.038]	[0.044]	[0.042]	[0.052]
Population		0.003				0.013
		[0.020]				[0.027]
Financial Development			-0.164***			-0.160***
			[0.030]			[0.033]
Investor's Legal Rights				-0.045		
				[0.052]		
Contract Enforc. Procedures					0.022	-0.058
					[0.074]	[0.073]
Entry Procedures						-0.012
						[0.049]
Higher Years of Education						0.038
						[0.039]
Industry Dummies	yes	yes	yes	yes	yes	yes
Observations	1734	1734	1734	1734	1734	1344
R-squared	0.21	0.22	0.29	0.23	0.22	0.32

*** Statistically significant at 1%, ** at 5%, * at 10%. Robust Standard Errors, corrected for clustering at the country level, reported in parenthesis. All variables are mean for the 1990-1999 years. Vertical Integration is the ratio of Value Added over Output in the Industry, computed from Data from UNIDO 2001 Database. Financial Development is measured as the ratio of Bank Credit over GDP from 2000 World Bank data. Investors' Legal Rights and Number of Entry Procedures are from Doing Business Database (World Bank). Years of Higher Education is from Barro and Lee database. All variables are in Logs.