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ABSTRACT

Trade Policy and Firm Boundaries*

We study how trade policy affects firms' ownership structures. We embed an incomplete contracts model of vertical integration choices into a standard perfectly-competitive international trade framework. Integration decisions are driven by a trade-off between the pecuniary benefits of coordinating production decisions and the managers' private benefits of operating in preferred ways. The price of output is a crucial determinant of this choice, since it affects the size of the pecuniary benefits: higher prices lead to more integration. Because tariffs increase domestic product prices, this effect provides a novel theoretical channel through which trade policy can influence firm boundaries. We then examine the evidence, using a unique dataset to construct firm-level indexes of vertical integration for a large set of countries. In line with the predictions of our model, we obtain three main results. First, higher tariffs lead to higher levels of vertical integration. Second, differences in ownership structure across countries, measured by the difference in sectoral vertical integration indexes, are smaller in sectors with similar levels of protection. Finally, ownership structures are more alike among members of regional trade agreements.

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1 Introduction

Over the past two decades, the theory of the firm has stressed contractual incompleteness as the key to understanding what a firm is and how it operates. Property rights over assets, which define firm boundaries, and allocations of control over production decisions within and across those boundaries are central elements of organizational design. They are chosen to mediate the way firm stakeholders trade off their collective goals and private interests.[1] For instance, in a highly integrated firm, in which a single decision maker has authority over multiple links in the supply chain, major production decisions can be well-coordinated to accomplish organizational goals such as profit. But this may come at the expense of imposing high costs on subordinates. Less integrated enterprises, in which decision making is spread among several firm heads, may economize on private costs, but may also leave the decisions ill-coordinated, harming profit.

Although the literature has identified a considerable number of trade-offs involving firm boundaries, it has largely left open the question of how such trade-offs are resolved in the market. A few recent papers have addressed the issue.[2] Our paper contributes to this recent literature by examining theoretically and empirically the impact of trade policies on firms' ownership structures.

We consider a perfectly competitive environment, where the influence of the market on firm boundaries can be studied in its simplest form. Building on earlier work by Legros and Newman (2009) and Conconi, Legros and Newman (2009), we show that there is systematic relationship between firm boundaries and the equilibrium price in the product market. In its starkest form, the prediction is that the higher the market price, the more integrated firms will be. The reason for this relationship is that the primary decision makers — the "managers"— have not only a stake in the organizational goal (revenue, profit), but also a private, noncontractible benefit from the organization (doing things their way, or more precisely the way most consonant with the assets and workforce they manage).[3] When different parts of the organization are not integrated,

[1]The significance of firm boundaries was, of course, first pointed out by Coase (1937). The formal incomplete contracts approach begins with Grossman and Hart (1986) and Hart and Moore (1990), which emphasize the hold-up problem. The trade-off described in this paper is the focus of Hart and Holmström (2009). In all these papers, firm boundaries are identified with the extent of decision rights over assets and associated operations. Hart (1995) provides a summary and discussion of earlier as well as more modern approaches.

[2]Theoretical contributions include McLaren (2000) on hold-up and market thickness, Legros and Newman (2008) on control structures and the terms of trade in supplier markets, and Marin and Verdier (2008) on delegation and product demand elasticity. Another literature has examined the question of whether goods are sold within or across firm boundaries in the global economy (see, for example, Antras (2003), Antras and Helpman (2004), and Helpman (2006) for an overview).

[3]As pointed out by Hart and Holmström (2009), private benefits may arise from various sources. For example, employees' human capital is often tied to particular technologies, with which they are familiar and like to work. Also, future career prospects may depend on how well human capital fits firms' needs, so strategic choices concerning technology will have significant private consequences. Differences in ways of doing things (e.g., engineers and marketing departments) can make coordination difficult. In a similar vein, Van den Steen (2005) stresses the importance to organization design of conflicting private benefits that stem from different corporate cultures or managerial visions.

managers make decisions independently, taking more account of their private benefits and less of the organization's, and this results in poor coordination and low output. Integration puts decisions in the hands of a single headquarters with strong incentives to coordinate, so as to maximize benefits to the organization. Non-integration is thus associated with high private benefits and low coordination, integration with high coordination and high private costs.

Market price enters the trade-off because it directly affects the organizational objective — profit — but has relatively little impact on private costs. When enterprise profitability (market price) is high, this trade-off is made in favor of integration, since the organizational goal is relatively more valuable than private goals. At low prices, the trade-off goes the other way, in favor of non-integration. Thus, anything that affects equilibrium prices will have an indirect effect on the degree of integration.

Of course, in an industry in which several enterprises face this organizational design trade-off, market quantity and price will depend on their choices of ownership structure: if integration is more productive and all enterprises integrate, there may be too much produced to be taken up by existing demand; price would then need to fall, encouraging some firms to switch to non-integration, thus reducing the quantity supplied. Product-market clearing will therefore jointly determine quantity, price, *and* ownership structures.

Trade policy provides an ideal proving ground for a model that links price levels to organizational design, since it generates a plausibly exogenous source of equilibrium price variation: the degree of trade protection will obviously affect equilibrium prices; however, as we argue below, it is likely to be independent of firms' boundary choices. The first-order effect of the imposition of a tariff is to raise the price of the imported good. Thus, all else equal, the higher the tariff, the more integrated firms in the industry should be.[4]

By the same token, if two countries' tariffs for the same industry are close, equilibrium prices and ownership structures should be similar. Thus, the theory predicts convergence in ownership structure between countries with similar levels of protection. Moreover, if two countries are members of a regional trade agreement, all else equal, enterprises in those two economies should have similar organizational structures. This effect should be more pronounced for customs unions, since the elimination of internal trade barriers and the adoption of common external tariffs should lead to price and organizational convergence between member countries.

Absence of an international dataset sufficiently comprehensive to support studies of firm organization across a wide range of countries has limited empirical analysis on the effects of trade policy on organizational choices. We overcome this limitation by using a new dataset from Dun and Bradstreet (D&B) that contains both listed and unlisted plant-level observations for a large set of countries and territories in 2004. For each plant, the dataset includes information

[4]This can be interpreted as a statement about intensive margins — more parts of the supply chain should be part of a single firm as the price for the final good increases, or about extensive margins — a greater fraction of firms are integrated at higher prices, assuming some heterogeneity among them.

about its primary and secondary activities, as well as about ownership (e.g., its domestic or global parent). By combining this information with U.S. input-output tables, we are able to construct firm-level vertical integration indexes.[5] Despite its limitations, this methodology enables us to analyze a large set of countries and industries, and thus to overcome an important constraint in the literature (we also do not have to worry about the value of intra-firm activities being affected by transfer pricing).

Our empirical analysis relies on exogenous price variation induced by trade policy. In particular, we exploit the cross-country and cross-sectoral variation in most-favored-nation (MFN) tariffs. We obtain data on applied MFN tariffs at the 4 digit SIC level for all WTO members for which this information is available. MFN tariffs negotiated at the GATT/WTO level over long periods of time are less "political" than administrative measures for the regulation of imports (e.g., anti-dumping and countervailing duties).[6] Firms' ownership structures are unlikely to have a systematic impact on trade policy in general, and on MFN tariffs in particular. Our empirical analysis controls, however, for firm size and industry concentration, which could be correlated with both firms' vertical integration decisions and the level of tariffs.[7] We also collect systematic information on all regional trade agreements (RTAs) in force in 2004. Free trade areas and customs unions are regulated by GATT/WTO rules and their establishment is unlikely to be driven by firm's ownership decisions.[8]

We examine first the relation between tariffs and organizational structure. In line with the predictions of our theoretical model, we find that higher tariffs lead to more vertical integration at the firm level. The impact of tariffs on vertical integration is sizable. In our preferred estimation, a 100 percent tariff increase leads to a 2.15 percent increase in the vertical integration index, which implies that increasing tariffs from 1 percent to their mean level of around 5 percent increases vertical integration by more than 8 percent. Our results are robust to different specifications and subsamples.

The theoretical framework also suggests that trade policy should, through its effect on prices, affect the degree of organizational convergence across countries. That is, convergence in corporate organization — the tendency of industries to be characterized by the same ownership structure across countries — may result not only from global cultural transmission or technological diffusion, but also from standard neoclassical market forces, namely, the law of one price (see

[5]We build on the methodology of Acemoglu, Johnson and Mitton (2009), who use the 1992 U.S. input-output tables to produce an "ingredients list" for each industry, which they combine with 2002 WorldBase plant-level data to derive a measure of vertical integration. Section 3.3 describes the empirical methodology in detail.

[6]This is the reason why most empirical papers on the political economy of trade policy focus on non-tariff barriers rather than MFN tariffs. For example, Goldberg and Maggi (1999) and Gawande and Bandyopadhyay (2000) use data on 1983 non-tariff barrier coverage ratios for the U.S. manufacturing sector to test Grossman and Helpman (1994)'s lobbying model.

[7]Some studies find that firm size and industry concentration affect U.S. non-tariff barriers through their impact on lobbying contributions (e.g., Mitra, 1999; Bombardini, 2008).

[8]Other studies consider RTAs as being exogenous to firms' decisions. See, for example, Bustos (2010) on the impact of the Southern Common Market (MERCOSUR) on Argentinean firms' technology upgrading.

also Conconi, Legros and Newman, 2009). In line with our predictions, we find that for a given country-pair differences in sectoral vertical integration indexes are significantly larger (at least at the 5 percent level) in those sectors in which differences in MFN-tariffs are larger.

We then examine the relation between the degree of sectoral organizational convergence and common membership in a regional trade agreement. As it is possible that countries that are more similar are more likely to form RTAs, we use a number of controls for common relationship. Our theoretical model suggests that, everything else equal, liberalization of product markets between two countries should lead to more similar product prices and, thus, more similar ownership structures within industries. Our empirical results show that ownership structures are, indeed, more alike for members of RTAs. We find the difference in vertical integration indexes to be around 9 percent smaller for country pairs engaged in RTAs. In line with the predictions of our model, this effect is found to be stronger for older trade agreements, which are more likely to have fully eliminated trade barriers among member countries. Our model also suggests that price and organizational convergence should be stronger for customs unions, in which members impose common external tariffs vis-à-vis non-members, than for free trade areas. Indeed, we find that customs unions are characterized by a lower difference (approximately 18.5 percent) in vertical integration indexes.

Our paper contributes to an emerging literature on general equilibrium models with endogenous organizations and, in particular, to a nascent stream of empirical work that examines firms' organizational choices in a global economy. Like this paper, part of that literature focuses on integration (i.e., firm boundaries/ownership structure). Acemoglu, Johnson, and Mitton (2009) (henceforth AJM) study the determinants of vertical integration using D&B data for 93 countries, focusing on the role of contracting costs. The authors find that individually, these costs have little significant impact on vertical integration. However, they find evidence of an interaction effect (i.e., more vertical integration in countries with greater contracting costs and greater financial development) and that contracting costs have a stronger impact on more capital-intensive industries. Acemoglu, Aghion, Griffith, and Zilibotti (2009) use data on all British manufacturing plants to study the relationship between vertical integration and rates of innovation. Aghion, Griffith and Howitt (2006) investigate whether the propensity for firms to vertically integrate varies systematically with the extent of competition in the product market. None of these papers focus specifically on how industry price levels affect integration. Breinlich (2008) finds a significant increase in the level of M&A activity in Canada (but not the U.S.) following CUSFTA, but does not examine mechanisms.[9]

Another stream of the literature focuses on within-firm delegation (for a given ownership structure). Guadalupe and Wulf (2009) investigate the effects of the 1989 CUSFTA agreement

[9]Single-industry studies on vertical integration include Hortaçsu and Syverson (2007) on U.S. ready-mix concrete and Woodruff (2002) on Mexican footwear. The former specifically emphasizes that market power plays little role in determining the extent of vertical integration.

that eliminated tariffs and other barriers between the U.S. and Canada and find that competition led large U.S. firms to flatten their hierarchies. Bloom, Sadun and Van Reenen (2010), using data on nearly 4,000 medium sized (100 to 5,000 employees) manufacturing firms across a dozen countries, find that greater product market competition increases decentralization.

Other studies have stressed the impact of trade liberalization on the reallocation of resources across individual plants and firms (see Goldberg and Pavcnik (2004) for an overview) or in work practices (Schmitz, 2005).

Finally, recent studies have examined how organizational design can explain observed patterns of intra-firm trade and the location of multinational subsidiaries or suppliers (Antras, 2003; Antras and Helpman, 2004; and Grossman and Helpman, 2004). Ornelas and Turner (2008) examine how trade policy affects hold-up problems through its effect on foreign suppliers' investment incentives.

The rest of the paper is organized as follows. Section 2 presents the theoretical framework and discusses the empirical implication of our model. Section 3 describes our data and the methodology used to construct vertical integration indexes. Section 4 presents and discusses the results on tariffs and vertical integration. Section 5 analyzes the effect of trade policy (tariffs and RTAs) on the degree of organization convergence within sectors across countries. Section 6 analyzes the robustness of the results. The last section concludes.

2 Model

Our model is similar to a standard specific-factor model, in which trade among many small countries is driven by differences in endowments of the specific factors. Before looking at international trade and the effects of trade policy, we describe the building blocks of the model in its closed-economy form.

2.1 Setup

There are $K+1$ sectors/goods, denoted by 0 and $k = 1, \ldots, K$; good 0 is a numeraire. The representative consumer's utility can be written as

$$u(c_0, \ldots, c_K) \equiv c_0 + \sum_{k=1}^{K} u_k(c_k), \tag{1}$$

where c_0 is consumption of the numeraire good, and c_k consumption of one of the other goods. The utility functions $u_k(\cdot)$ are twice differentiable, increasing, strictly concave, and satisfy the Inada conditions $\lim_{c_i \to 0} u_k'(c_k) = \infty$ and $\lim_{c_i \to \infty} u_k'(c_k) = 0$. Domestic demand for each good k can then be expressed as a function $D_k(p_k)$ of its own price.

Production of good k requires the cooperation of two types of input suppliers, denoted A and B_k. B_k suppliers generate no value without being matched with an A; A suppliers can either match with any B_k or engage in stand-alone production of the numeraire good 0. Many interpretations of the A and B_k firms are possible. For example, A suppliers may represent light assembly plants or basic inputs, such as energy, or various business services (e.g., IT, retailing, logistics) that can be used to produce basic consumer goods or combined with other inputs (B_k suppliers) to produce more complex goods.

All goods are sold under conditions of perfect competition. There is a continuum of each type of supplier, with a measure n_k of B_k's, and a unit measure of A's. We assume the aggregate supply of A's exceeds that of the B_k's (i.e., $\sum_{k=1}^{K} n_k < 1$) so that a positive amount of good 0 is produced in equilibrium. The price of the numeraire good is normalized to unity.

So far, we have described a standard specific-factor model in which A suppliers represent the mobile factor and B_k suppliers the specific factors of production. The crucial distinguishing feature of the model is that production units are run by managers who trade off the pecuniary benefits of coordinating their decisions with the private benefits of taking decisions that go in their favored direction.

An equilibrium in the supplier market consists of a stable match between each B_k supplier and an A supplier: given the surplus allocation among all the managers, no (A, B_k) pair can form an enterprise that generates payoffs for its two managers that exceed their equilibrium levels.

All A suppliers are equally productive when matched with one of the B_k's. A stand-alone A produces α units of the numeraire good. Since the price of the numeraire is equal to unity, this also pins down the outside option for all A's.

2.2 Individual Firms

Our model of the firm relies on two key features. First, managers enjoy monetary returns as well as private non-transferable benefits associated with their production perations. Because different managers view these operations differently, their private benefits come into conflict. For instance, a standardized production line could be convenient for the sectorally-mobile A suppliers, but may not fit the specific design needs of the B_i suppliers. Second, some operating decisions (e.g., choosing production techniques, deciding on marketing campaigns, etc.) cannot be agreed upon contractually; only the right to make them can be transferred through changes in ownership.

Once an enterprise composed of an A and a B_k has formed in the supplier market, a non-contractible decision about the way in which production is to be carried on must be made in each unit. Denote the A and B_k decisions respectively by $a \in [0, 1]$ and $b_k \in [0, 1]$. Successful firm production requires coordination between the two suppliers. More precisely, the enterprise will succeed with a probability $1 - (a - b_k)^2$, in which case it generates $R > 0$ units of output;

otherwise it fails, yielding 0. Output realizations are independent across enterprises (A-B_k pairs).

Managers are risk-neutral and bear a private cost of the decision made in their units. The A manager's utility is $y_A-(1-a)^2$, the B_k manager's is $y_k-b_k^2$, where $y_A, y_k \geq 0$ are their respective incomes and $(1-a)^2$ and b_k^2 are the respective costs. Observe that A's most preferred action is 1, while B_k's is 0, so managers disagree about the direction in which decisions should be made. Because managers' primary function is to implement decisions and convince their workforces to agree, they bear the cost of decisions even if they don't make them.

Assignment of decision rights via possible sale of assets is the organizational design problem in the model. Managers may remain *non-integrated* and retain control over their respective decisions. Or they can choose to *integrate* into a single firm by engaging a headquarters (HQ), transferring to it, in exchange for a fixed payment, a share of the realized revenue and the power to decide a and b_k. HQ is motivated only by monetary considerations, incurring no costs for a and b_k, and will want to maximize the integrated firm's income.

Before production, B_k managers match with A managers and sign contracts specifying an ownership structure and payment scheme. For simplicity, we take the payment scheme to be a fixed payment T from B_k to A.[10]

For each match (A,B_k), total revenue in event of success is given by R times the product market price, p_k, which is taken as given and correctly anticipated when managers and HQ's sign the contracts and make their decisions. Because A's are in excess supply, they must all receive α in equilibrium. Thus T will just cover A's anticipated private cost of production together with the opportunity cost α.

After contracts are signed, managers and HQ's make their production decisions, output is realized, product is sold, and revenue shares are distributed.

2.2.1 Integration

HQ's are elastically supplied at a cost normalized to zero. After paying its acquisition fee and receiving its compensating share of revenue, an HQ's continuation payoff is proportional to $(1-(a-b_k)^2)Rp_k$.[11] HQs decide both a and b_k, and since their incentive is to maximize he integrated firms' expected revenue, they choose $a=b_k$. Among the choices in which $a=b_k$, the Pareto-dominant one is that in which $a=b_k=1/2$ (which minimizes the total cost of the A and B_k managers). We assume HQs implement this choice. The private cost to each manager is then $\frac{1}{4}$, and the payoffs to the A and B_k managers are equal to α and $Rp_k-\alpha-\frac{1}{2}$, respectively (thus $T=\alpha+\frac{1}{4}$).

[10] In general, B_k may prefer to give A a positive contingent share of revenue. This complicates notation but does not change any qualitative conclusion regarding the dependence of integration on price (see Legros and Newman, 2009).

[11] The size of HQ's share is indeterminate and could be pinned down in many ways not modeled here; all that matters for our purposes is that it is positive.

2.2.2 Non-integration

Under non-integration, managers retain control of their respective activities. The decisions chosen are the (unique) Nash equilibrium of the game with payoffs $T-(1-a)^2$ for A, who chooses a, and $(1-(a-b_k)^2)\,Rp_k - b_k^2 - T$ for B_k, who chooses b_k. These are $a=1$ and $b_k = Rp_k/(1+Rp_k)$, with resulting expected output $1-\frac{1}{(1+Rp_k)^2}$. Notice that output increases with price: as p_k becomes larger, the revenue motive becomes more important for B_k managers, pushing them to better coordinate with their A partners. The equilibrium transfer under non-integration is $T=\alpha$; the payoffs are α for A's and $\frac{(Rp_k)^2}{1+Rp_k}-\alpha$ for B_k's.

2.2.3 Choice of Ownership Structure

To determine managers' choice of firm boundaries, we must compare their payoffs under integration and non-integration. A suppliers obtain α in both cases. B_k suppliers obtain a higher payoff under integration if and only if $Rp_k - \frac{1}{2} > \frac{(Rp_k)^2}{1+Rp_k}$, or $p_k > 1/R$.

Thus managers' organizational choices depend on product prices. At low prices, revenues are small enough that integration's better output performance is not valuable enough to the B_k to be worth the private cost he (and A, who would have to be compensated) would have to bear; thus, B_k opts for the "quiet life" of non-integration, wherein both profits and costs are low. At higher prices, the B_k manager's revenue motive now makes higher output and therefore coordination more valuable. Coordinating under non-integration would entail large and costly concessions from B_k to A, who chooses $a=1$ whatever the price; the compromise choice $a=b_k=\frac{1}{2}$, is now preferable, and B_k chooses to integrate.

2.3 Product Market Equilibrium and the OAS Curve

Equilibrium for the economy is a general equilibrium of the supplier and product markets. We have already characterized the supplier markets. Some A suppliers produce by themselves α units of the numeraire good; others are matched with B_k's for the production of goods $k=1,\ldots,K$ and receive α.

In product market k, the large number of enterprises implies that with probability one the supply is equal to the expected value of output given p_k; equilibrium requires that this price adjust so that demand equals supply.

To derive industry supply, suppose R is distributed in the population according to some continuous c.d.f. $G(R)$ with mean 1 and support $[\underline{R},\overline{R}]$. Since all enterprises in industry k with $R<1/p_k$ remain non-integrated, and the remaining ones integrate, total supply at price $p_k \in [1/\overline{R}, 1/\underline{R}]$ is (recall that n_k is the measure of B_k suppliers)

$$S(p_k) = n_k\left[\int_{\underline{R}}^{1/p_k} R(1-(\frac{1}{1+Rp_k})^2)dG(R) + \int_{1/p_k}^{\overline{R}} RdG(R)\right]. \tag{2}$$

(If $p_k < 1/\overline{R}$, supply is $n_k \int_{\underline{R}}^{\overline{R}} R(1 - (\frac{1}{1+Rp_k})^2)dG(R)$; if $p_k > 1/\underline{R}$, it is n_k.)

This Organizationally Augmented Supply (OAS) curve incorporates the ownership structure decisions of the industry's enterprises as well as the usual price-quantity relationship. When $p_k < 1/\overline{R}$, the industry is entirely non-integrated, but supply increases with price, since non-integration expected output increases. As price rises above $1/\overline{R}$, the most productive enterprises integrate, producing more than they would under non-integration; those that remain non-integrated also produce more, so that industry output rises further. Once p_k reaches $1/\underline{R}$, all firms are integrated and industry supply is fixed at n_k (the mean R being 1) for prices higher than that threshold. Observe that, for a given market price p_k, more productive enterprises (those with higher R) are more likely to be vertically integrated.

In the absence of trade, an equilibrium in the product market of good k is a price and a quantity that equate supply and demand: $D_k(p_k) = S(p_k)$. The degree of integration of the industry (i.e., the fraction $1 - G(1/p_k)$ of firms that integrate) is a nondecreasing function of the equilibrium price, strictly increasing on $[\underline{R}, \overline{R}]$.

2.4 Trade Policy and Firms' Organization

The world consists of C small countries, indexed by c, which have identical demands and technologies in the production of all goods. Trade is the result of endowment differences between countries. In particular, we assume that the countries can be divided into two homogeneous groups: a "Home" set H of countries relatively more endowed in the specific factors necessary to produce goods $k \in \{m+1, \ldots, K\}$; and a "Foreign" set F of countries (denoted with a "*") relatively more endowed in the specific factors necessary to produce goods $k \in \{1, \ldots, m\}$. We thus have $n_k < n_k^*$ for $k \in \{1, \ldots, m\}$ and $n_k > n_k^*$ for $k \in \{m+1, \ldots, K\}$. Good 0, the numeraire, is always traded freely across countries. We choose units so that the international market-clearing and the domestic price of good 0 in each country equal unity.

Each country c imposes an exogenously-given ad valorem tariff $t_k^c \geq 0$ on import-competing good k. In sectors $k \in \{1, \ldots, m\}$ domestic prices are thus equal to $p_k^c = (1 + t_k^c)P_k$ in Home countries and $p_k^{c*} = P_k$ in Foreign countries, where P_k denotes the international price. This is the solution to the following market-clearing condition:

$$\sum_c M_k^c\Big((1 + t_k^c)P_k\Big) = \sum_{c*} X_k^{c*}(P_k), \tag{3}$$

where $M_k^c = D\Big((1 + t_k^c)P_k\Big) - S\Big((1 + t_k^c)P_k\Big)$ denotes Home imports and $X_k^{c*} = S(P_k) - D(P_k)$ Foreign exports. For goods $k \in \{m+1, \ldots, K\}$ the market-clearing condition is

$$\sum_{c*} M_k^{c*}\Big((1 + t_k^{c*})P_k\Big) = \sum_c X_k^c(P_k). \tag{4}$$

From (3) and (4) we can derive an expression for international equilibrium prices as a function of the tariffs applied by all countries, that is, $P_k(\mathbf{t_k})$ for $k \in \{1, \ldots, m\}$, and $P_k(\mathbf{t_k^*})$ for $k \in \{m+1, \ldots, K\}$, where $\mathbf{t_k} = \{t_k^c\}_{c \in H}$ and $\mathbf{t_k} = \{t_k^{c^*}\}_{c^* \in F}$ (the separable form of demand ensures that the world product price in one sector depends only on tariffs imposed by importing countries in that sector).

The trade balance condition for a Home country c requires

$$\sum_{k=1}^{m} P_k M_k^c\Big((1+t_k^c)P_k\Big) - \sum_{k=m+1}^{K} P_k X_k^c(P_k) + Z_0^c = 0, \tag{5}$$

where Z_0^c denotes the net transfer of the numeraire good to settle the trade balance. A similar condition must hold for a Foreign country.

Trade policies affect ownership structures through their impact on product prices. In particular, an increase in t_k^c leads to an increase in the domestic price of good k; an enterprise with productivity R will choose integration if that price exceeds $1/R$. Comparing two otherwise identical countries c and c', with $t_k^c > t_k^{c'}$, the domestic price and therefore degree of integration in industry k will be higher in c than in c'.

Figure 1: Tariffs and firm organization

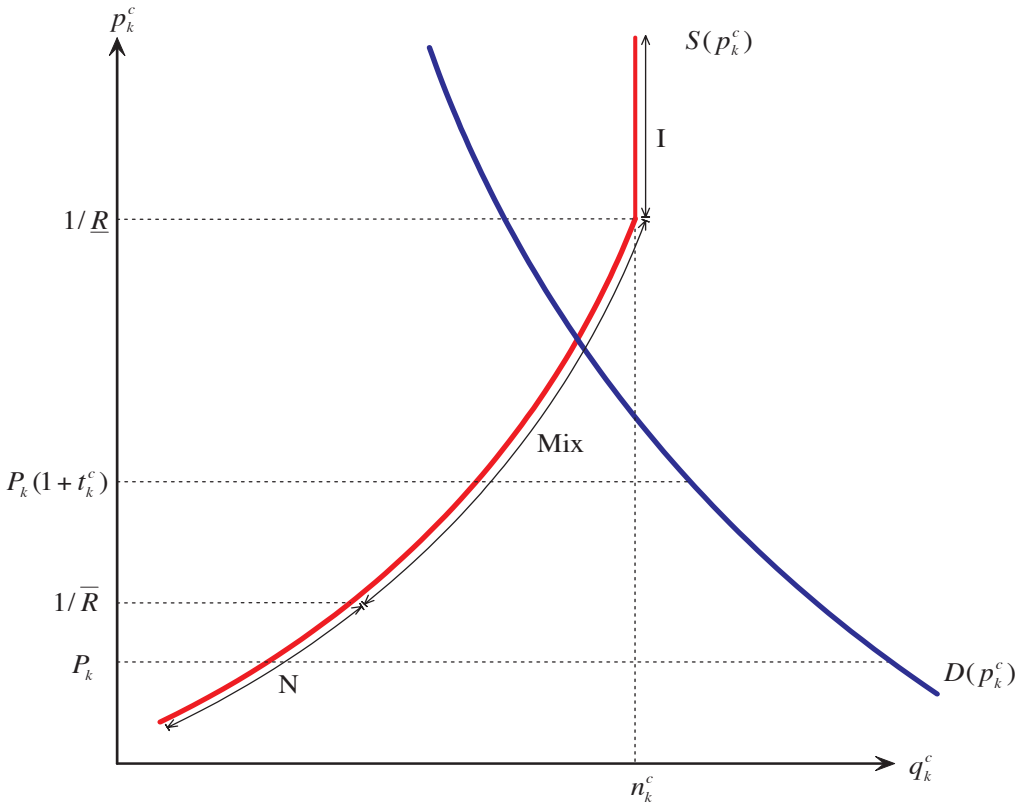

Figure 1 above depicts the organizationally augmented supply curve of industry k in country c. It also illustrates the price regions in which enterprises are all non-integrated (**N**), all integrated (**I**), and the middle range in which only some integrate (**Mix**). In this example, absent any tariff, the domestic price would be equal to the world price P_k, and all firms in the domestic industry would be non-integrated. Now consider a non-prohibitive tariff t_k^c that raises the domestic price to $p_k^c = P_k(1+t_k^c)$, which lies between $1/\overline{R}$ and $1/\underline{R}$. At this price, more productive enterprises (with $R > 1/p_k^c$) will integrate and less productive ones will remain non-integrated. Clearly, a lower tariff would lead to fewer integrated firms, a higher one to more. Integration thus increases with the tariff level.

Our theoretical framework can also be used to examine how trade policy affects the degree of organizational convergence across countries. In particular, for a given country pair cc', the difference in degree of integration within a sector k will depend on the differences in their applied tariffs: the more similar t_k^c and $t_k^{c'}$, the smaller the difference between p_k^c and $p_k^{c'}$ and the more similar firms' organizational choices within industry k.

Finally, consider a country pair cc' that has signed a regional trade agreement that eliminates all tariffs between them. This implies that prices should tend to convergence across member countries. Internal tariffs between member countries are usually reduced gradually. For example, in the case of the CUSFTA agreement, tariffs in most industries were reduced to zero linearly either over five years or ten years (see Trefler, 2004). We should thus expect more similar organizational structures between members of older trade agreements. We would also expect customs unions, in which member countries adopt common external tariffs, to be characterized by more similar ownership structures than free trade areas, in which differences in external tariffs and the existence of rules of origins should reduce the extent of price and organizational convergence.

For the purpose of our empirical analysis, we can reformulate the predictions of our theoretical model as follows.

1. Higher tariffs should lead to a higher degree of vertical integration within sectors.

2. Country pairs should have more similar ownership structures in sectors with closer levels of protection.

3. RTAs should lead to organizational convergence among member countries, which effect should be stronger for older trade agreements and for customs unions.

3 Data and Descriptive Statistics

3.1 The WorldBase Database

We use data for 2004 from Dun & Bradstreet's WorldBase, a database of public and private plant-level observations in more than 200 countries and territories.[12] The leading U.S. source of commercial credit and marketing information since approximately 1845, Dun & Bradstreet (D&B) presently operates in different countries and territories either directly or through affiliates, agents, and associated business partners.

WorldBase is the core database with which D&B populates its commercial data products including Who Owns Whom^{TM}, Risk Management Solutions^{TM}, Sales & Marketing Solutions^{TM}, and Supply Management Solutions^{TM}. These products provide information about the "activities, decision makers, finances, operations and markets" of the clients' potential customers, competitors and suppliers. D&B compiles their data from a wide range of sources, including partner firms in dozens of countries, telephone directory records, websites, and self-registration. All information is verified centrally via a variety of manual and automated checks.

Early uses of D&B data include Caves' (1975) analysis of size and diversification patterns between Canadian and U.S. plants. More recently, Harrison, Love, and McMillian (2004) used D&B's cross-country foreign ownership information. Other studies that have used D&B data include Black and Strahan's (2002) study of entrepreneurial activity in the United States, Acemoglu, Johnson, and Mitton's (2009) cross-country study of concentration and vertical integration, and Alfaro and Charlton's (2009) analysis of vertical and horizontal activity by multinationals.

WorldBase, albeit not without problems, is best suited to our analysis having four main advantages over most other sources. First, the data include both listed and non-listed plants, and information that supports aggregation at the firm level. Second, Amadeus and other data sources restricted to Europe are not useful for our purposes because they lack broad coverage of countries in particular developing countries, with different levels of trade barriers. WorldBase by contrast has data in more than 200 countries and territories. Third, D&B compiles data from a wide range of sources, whereas other databases collect data primarily from national firm registries. The wide variety of sources from which D&B collects data reduces the likelihood that the sample frame will be determined by national institutional characteristics. Finally, over its many years in business, D&B has devised many methods of checking its data and assuring the reliability of its dataset.[13]

[12]The dataset is not publicly available but was released to us by Dun and Bradstreet. For more information see: http://www.dnb.com/us/about/db_database/dnbinfoquality.html.

[13]See Alfaro and Charlton (2009) for a more detailed discussion of the WorldBase data and comparisons with other data sources.

3.2 The Sample

We use data from the 2004 WorldBase file, excluding records that lack primary industry and year started, for a total of more than 24 million observations. The unit of observation in WorldBase is the establishment (a single physical location at which business is conducted or services or industrial operations are performed) rather than the firm (one or more domestic establishments under common ownership or control). Establishments, which we also refer to as plants, have their own addresses, business names, and managers, but might be partly or wholly owned by other firms. Plants can be linked via information on domestic and global parents using the DUNS numbers. Our analysis is at the firm level, that is, we consider all plants connected by the same global or domestic parent to be one unit (see discussion below).

We use four categories of data recorded by WorldBase records for each establishment:

1. Industry information: the 4-digit SIC code of the primary industry in which each establishment operates, and for most countries, the SIC codes of as many as five secondary industries, listed in descending order of importance.[14]

2. Ownership information: information about the firms' family members (number of family members, its domestic parent and its global parent).[15]

3. Location information: country, state, city, and street address of each family member (used to link establishments within a family to the relevant tariff data).

4. Basic operational information: sales and employment.

We exclude countries and territories with fewer than 80 observations and those for which the World Bank provides no data. We further restricted the sample to Word Trade Organization (WTO) members for which we have data on tariffs/regional trading arrangements (see the discussion below).

We focus on manufacturing firms (i.e., firms with a primary SIC code between 2000 and 3999), which best fit our theory of vertical integration. We exclude government/public sector firms, firms in the service sector (for which we have no tariff data) or agriculture (due to the existence of many non-tariff barriers), and firms producing primary commodities (i.e., mining and oil and gas extraction).

[14]D&B uses the United States Government Department of Commerce, Office of Management and Budget, Standard Industrial Classification Manual 1987 edition to classify business establishments. The Data Universal Numbering System — The D&B D-U-N-S Number — introduced in 1963, to identify businesses numerically for data-processing purposes, supports the linking of plants and firms across countries and tracking of plants histories including name changes.

[15]D&B also provides information about the firm's status (joint-venture, corporation, partnership) and its position in the hierarchy (branch, division, headquarters).

We exclude firms with fewer than 20 employees, as our theory does not apply to self-employment or small firms with little prospect of vertical integration (see also Acemoglu, Aghion, Griffith, and Zilibotti, 2009).[16]

We focus on firms that operate in only one country, since this provides a cleaner analysis of the effects of tariffs and RTAs on firms' ownership structure. This is because the degree of vertical integration of these firms depends only on the prices of the country in which they are located. In the case of multinational corporations (MNCs), on the other hand, it is harder to identify the relevant prices and tariffs. Moreover, focusing on national firms, avoids issues having to do with the strategic behavior of multinationals across markets (e.g., transfer pricing, tariff jumping).[17] Multinationals are included in the robustness analysis. There, we split MNCs into separate entities — one for each country — in order to link organizational structure to domestic tariffs.

Table A-2 in the Appendix lists the countries included in our final sample and the sample frame (the main sample is A.2).[18] As a robustness check, we also exclude countries for which we have fewer than 1,000 plants that are part of firms with at least 20 employees (see also Klapper, Laeven, and Rajan, 2006). The countries included in this restricted sample are listed in Table A.3.

3.3 Vertical Integration Indices

Constructing measures of vertical integration is difficult, as the exercise is highly demanding in terms of data, requiring firm-level information on sales and purchases of inputs by various subsidiaries of a firm. Such data are generally not directly available and, to the best of our knowledge, there is no source for such data for a wide sample of developed and developing countries.

To measure the extent of vertical integration for a given firm, we build on the methodology used by AJM (2009). We combine WorldBase information on plant activities and ownership structure with input-output data to determine related industries and construct the vertical integration coefficients $V_j^{f,k,c}$in activity j, where k is the primary sector in which firm f in country c is active. Note that the sample in AJM is restricted to a maximum of the 30,000 largest records per country in the 2002 WorldBase file (a limit imposed by cost constraints).[19]

[16]Restricting the analysis to firms with more than 20 employees enables us to correct for possible differences in the the collection of small firms data across countries.

[17]We describe an establishment as foreign-owned if it satisfies two criteria: (1) it reports to a global parent firm, and (2) the parent firm is located in a different country. Parents are defined in the data as entities that have legal and financial responsibility for another firm. For purposes of matching the tariff data, we use the SIC code of the domestic parent for multinationals.

[18]Further restrictions were imposed by data availability constraints related to the control variables as explained in the next subsections.

[19]For many countries, this restriction is not binding. For countries with more than 30,000 observations, AJM select the 30,000 largest, ranked by annual sales. They include all industries, except those operating only in

Having information for a broader sample of more than 24 million establishments in the 2004 WorldBase file, we are able, as discussed below, to link establishments to firms.

Given the difficulty of finding input-output matrices for all the countries in our dataset, we follow AJM (2009) in using the U.S. input-output tables to measure vertical linkages within firms. As the authors note, the U.S. input-output tables should be informative about input flows across industries to the extent that these are determined by technology.[20]

The input-output data are from the Bureau of Economic Analysis (BEA), Benchmark IO Tables, which include the make table, use table, and direct and total requirements coefficients tables. We use the Use of Commodities by Industries after Redefinitions 1992 (Producers' Prices) tables. While the BEA employs six-digit input-output industry codes, WorldBase the SIC industry classification. The BEA website provides a concordance guide, but it is not a one-to-one key.[21] For codes for which the match was not one-to-one, we randomized between possible matches in order not to overstate vertical linkages. The multiple matching problem, however, is not particularly relevant when looking at plants operating only in the manufacturing sector (for which the key is almost one-to-one).

For every pair of industries, i, j, the input-output accounts support calculation of the dollar value of i required to produce a dollar's worth of j. We construct the input-output coefficients for each firm f, IO_{ij}^f by combining the SIC information for each plant in each firm, the matching codes, and the U.S. input-output information. Here, $IO_{ij}^f \equiv IO_{ij} * I_{ij}^f$, where IO_{ij} is the input-output coefficient for the sector pair ij, stating the cents of output of sector i required to produce a dollar of j, and $I_{ij}^f \in \{0, 1\}$ is an indicator variable that equals one if and only if firm f owns plants in both sectors i and j. A firm that produces i as well as j will be assumed to supply itself with all the i it needs to produce j; thus, the higher IO_{ij} for an i-producing plant owned by the firm, the more integrated in the production of j the firm will be measured to be. Adding up the input-output coefficients IO_{ij}^f for all inputs i, gives the firm's degree of vertical integration in j.

To illustrate the procedure, consider the following example from AJM (2009) of a Japanese establishment with, according to WorldBase, one primary activity, automobiles (59.0301), and two secondary activities, automotive stampings (41.0201) and miscellaneous plastic products (32.0400). The IO_{ij} coefficients in the three activities for this plant are:

"wholesale trade" and "retail trade."

[20]Note that the assumption that the U.S. IO structure carries over to other countries can potentially bias our empirical analysis against finding a significant relationship between vertical integration and prices. On the other hand, it also mitigates the possibility that the IO structure and control variables are endogenous.

[21]This concordance is available upon request. The BEA matches its six-digit industry codes to 1987 U.S. SIC codes http://www.bea.gov/industry/exe/ndn0017.exe.

		Output (j)		
		Autos	Stampings	Plastics
	Autos	0.0043	0.0000	0.0000
Input (i)	Stampings	0.0780	0.0017	0.0000
	Plastics	0.0405	0.0024	0.0560
	SUM	0.1228	0.0041	0.0560

The table is a restriction of the economy-wide IO table to the set of industries in which this establishment is active (i.e., it contains all of the positive IO_{ij}^{f} values). For example, the IO_{ij} coefficient for stampings to autos is 0.078, indicating that 7.8 cents worth of automotive stampings are required to produce a dollar's worth of autos. Because this plant has the internal capability to produce stampings, we assume it produces itself all the stampings it needs.[22] The bottom row shows the sum of the IO_{ij}^{f} for each industry. For example, given that 12.3 cents worth of the inputs required to make autos can be produced within this plant, we would say that the degree of vertical integration for this plant is 0.123 in autos.

Our main unit of observation, however, is all plants that belong to the same *firm*, that is, all plants that report to the same headquarters. For example, if the plant in the example above is reported to be the headquarters of another Japanese plant (subsidiary), we consider the activities of both plants in constructing a measure of vertical integration for the firm. In the case of multi-plant firms, restricting analysis to the plant level may underestimate the number of activities carried out within the firm's boundaries.

We now describe the methodology used to construct the firm-level vertical integration indexes. For a given firm f in primary sector k located in country c, we define the integration index in activity j as

$$V_{j}^{f,k,c} = \sum_{i} IO_{ij}^{f,k}, \tag{6}$$

the sum of the IO coefficients for each industry in which the firm is active. Our measure of vertical integration is based on the firm's primary activity:

$$V^{f,k,c} = V_{j}^{f,k,c}, j = k. \tag{7}$$

In the case multi-plant firms (plants connected by the same global ultimate or headquarters), we consider the main activity of the headquarters or domestic parent.

Our approach to identifying vertical integration suffers from the data limitation that we do not observe intra-firm transactions. Instead, we infer it from information about the goods produced

[22]Many industries have positive IO_{ij} coefficients with themselves; for example, miscellaneous plastic products are required to produce miscellaneous plastic products. Any firm that produces such a product will therefore be measured as at least somewhat vertically integrated.

in each of the firm's establishments and the aggregate input-output relationship of those goods. The advantage of our method is that we have a large amount of data for many countries and industries and that we do not have to worry about the value of intra-firm activities being affected by transfer pricing. Another advantage, according to Hummels, Ishii, and Yi (2001), is that using I-O tables avoids the arbitrariness of classification schemes that divide goods into "intermediate" and other categories. Our index represents the opportunity for vertical integration which firms may exercise in different ways as they may still, for example, purchase inputs from or sell them to third parties.[23]

Table 1 presents summary statistics for the main vertical integration index. Appendix Table A-1 compares the index across the different samples. Our main sample consists of 196,586 domestic manufacturing firms with at least 20 employees located in 80 countries.[24]

3.4 Trade Policy

A further challenge in empirically assessing the impact of market prices on ownership structure is that both are determined simultaneously — prices should affect ownership structure but at the same time ownership structure also influences market prices. We use trade policy to deal with this endogeneity problem, arguing that most-favored-nation (MFN) tariffs and RTAs offer a plausibly exogenous source of price variation to the boundaries of the firm. Although one might still worry about the political economy determinants of these policies, as argued in the introduction, MFN tariffs, being negotiated at the multilateral level over long periods of time, are less "political" than unilateral forms of protection such as anti-dumping duties. Studies that have found that industry concentration and firm size may affect lobbying contributions and trade policy outcomes (e.g., Mitra, 1999; Bombardini, 2008) are based on U.S. non-tariff barriers in the manufacturing sector. Our empirical analysis controls for both firm size and industry concentration. We further argue that ownership structure is unlikely to have a systematic impact on the determination of trade policies in general, and on MFN tariffs in particular.[25] Regional trade agreements such as free trade areas and customs unions are also negotiated over long periods of time and regulated by GATT/WTO rules (Article XXIV and the Enabling Clause).

[23]Hortaçsu and Syverson (2009) combining U.S. Census data, the Commodity Flow Survey (a random sample of an establishment's shipments in each four weeks during the year, one in each quarter), and ZIP code information to measure intra-firm trade, find that shipments from upstream units to downstream units are surprisingly low. This result is at odds with international trade studies, which show that intra-firm trade accounts for roughly one-third of international shipments (e.g., Bernard, Jensen, Redding, and Schott, 2008). We obtain similar results using plant-level vertical integration measures, available upon request.

[24]Differences in methodology and samples restrict comparisons with AJM. However, the authors report a mean of 0.0487 and median of 0.0334 for their vertical integration index. For our main sample, the primary sector vertical integration index has a mean of 0.0627 and a median of 0.0437.

[25]No theory relates firm boundaries to incentives to form a lobbying group. Even if one allows that lobbying can play a role in determining MFN tariffs, it is not obvious how the direction of the political pressure (pro or anti trade) and its extent (e.g., size of campaign contributions) could be systematically related to firms' organizational decisions across a large set of countries and sectors.

3.4.1 Tariffs

We collect applied MFN tariffs at the 4-digit SIC level for all WTO members for which this information is available. We restrict the set of countries to WTO members, because they are constrained under Article I of the GATT by the MFN principle of non-discrimination: each country c must apply the same tariff t_k^c to all imports in sector k that originate in other WTO member countries; preferential treatment is allowed only for imports that originate in RTA members or in developing countries.

The source for MFN tariffs is the World Integrated Trade Solution (WITS) database, which combines information from the UNCTAD TRAINS database (default data source) with the WTO integrated database (alternative data source). Tariffs are for 2004 unless unavailable for that year in which case the closest available data point in a five year window around 2004 (2002-2006) is chosen with priority given to earlier years.[26] The original classification for tariff data is the harmonized system (HS) 6-digit classification. Tariffs are converted to the more aggregate SIC 4-digit level using internal conversion tables of WITS. Here, SIC 4-digit level MFN tariffs are computed as simple averages over the HS 6 digit tariffs.

We also construct for each 4-digit SIC sector and every country the fraction of imports to which MFN tariffs apply using information on RTAs (see below) and subtracting from total sectoral imports those that originate in countries with which the importer has a common RTA. Bilateral import data at the 4-digit SIC level for 2004 are from the COMTRADE database.

3.4.2 RTAs

We collect information on RTAs in force in 2004 from the WTO Regional Trade Agreements Information System (RTA-IS).[27] [,28] The legal basis for the creation of RTAs can be found in GATT/WTO Article XXIV (for agreements involving developed member countries) and the Enabling Clause (for agreements among only developing countries). Under Article XXIV, member countries can form free trade areas (FTAs) or customs unions (CUs) covering "substantially all trade " that require complete duty elimination and fixed timetables for implementation. The conditions contained in the Enabling Clause being much less stringent, RTAs between developing member countries may effectively involve less trade liberalization. Thus we construct a dummy *RTA* that equals one whenever two countries belong to a common RTA formed under Article XXIV. This variable does not include a number of preferential trade agreements under the Enabling Clause that do not imply the full elimination of trade barriers. Alternatively, we construct separate dummy variables for customs unions and free trade agreements. because we expect the former, which imply a common external tariff and no internal trade barriers, to have

[26] For example, if data are available for 2003 and 2005, but not 2004, the 2003 data are chosen.

[27] Available online (http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx).

[28] Note that the dataset does not include trade preferences under the Generalized System of Preferences (GSP), such as the U.S. African Opportunity Act program or the E.U. Everything but Arms program.

a stronger effect on organizational convergence than the latter, which permit member countries to maintain different external tariffs. We also construct the variable *Age* that equals the age of a regional trade agreement in years, since we expect older trade agreements to have a larger impact on firms' organizational structure.

3.5 Other Controls

We collect a number of country- and sector-specific variables to control for alternative factors that explain vertical integration emphasized by the literature.

In terms of country-specific variables, the empirical and theoretical literatures have studied the roles of institutional characteristics and financial development.[29] We use the variable "rule of law" from Kaufmann, Kraay, and Mastruzzi (2003) as a measure of the *Legal quality* of a country's institutions. This is a weighted average of a number of variables (perception of incidences of crime, effectiveness and predictability of the judiciary, and enforceability of contracts) between 1997 and 1998. The variable ranges from 0 to 1 and is increasing in the quality of institutions.

We also use private credit by deposit money banks and other financial institutions as a fraction of GDP in 2004 taken from Beck, Demigurc-Kunt, and Levine (2006) as a measure of a country's *Financial development*.

The literature stresses as well differential effects across industries. We combine these country-specific measures with sector-specific information from the United States, to proxy for exogenous variation in sector characteristics, such as hold-up problems.

First, we construct sectoral *Capital intensity* at the 4-digit-SIC level for the United States. Data comes from the NBER-CES manufacturing industry database (Bartelsmann and Gray, 2000). In line with the literature, capital intensity is defined as the log of total capital expenditure relative to value added averaged over the period 1993-1997.

Second, we use Nunn's (2007) measure of *Relationship dependence*, which proxies for the severity of hold-up problems. For each sector in the U.S., this variable measures the fraction of inputs not sold on an organized exchange or reference priced. We convert the data for 1997 from the BEA's input-output classification to 4-digit U.S.-SIC.[30]

Finally, we follow Rajan and Zingales (1998) in constructing the variable *External dependence*, which measures or the United States sectoral dependence on external credit f as the fraction of investment that cannot be financed with internal cash flows. The authors identify an industry's need for external finance (the difference between investment and cash generated from operations)

[29]Poor legal institutions should exacerbate hold-up problems and make integration more attractive than arms-length-relations. A sufficient level of financial development may be necessary for upstream and downstream firms to be able to integrate. As AJM note, the effect of each of these variables may be ambiguous when considered separately and there are more robust predictions of their combined effect.

[30]Nunn's dataset is available at http://www.economics.harvard.edu/faculty/nunn.

under two assumptions: (i) that U.S. capital markets, especially for the large, listed firms they analyze, are relatively frictionless enabling us to identify an industry's technological demand for external finance; (ii) that such technological demands carry over to other countries. Following their methodology, we construct similar data for the period 1999-2006.[31]

To control for domestic industry concentration we construct *Herfindahl* indices for each country-sector using sales of all plants in that sector.[32]

We also use a number of bilateral variables from CEPII: bilateral distance measured as the simple distance between the most populated cities (in km), dummies for contiguity, for common official or primary language, and common colonial relationship (current or past).

Finally, we use information on GDP and GNI per capita for the year 2004 obtained from the World Development indicators 2008.

Table 1 presents summary statistics for our control variables. Table A-4 in the Appendix is the correlation table.

4 Tariff and Vertical Integration

In this section, we assess the empirical validity of the first prediction of our theoretical model that higher tariffs lead to more vertical integration at the firm level. To do so, we estimate the following panel regression model:

$$V^{f,k,c} = \alpha + \beta_1 MFNt_{k,c} + \beta_2 Employment_f + \beta_3 \mathbf{X}_{k,c} + \delta_k + \delta_c + \epsilon_{f,c}. \tag{8}$$

The dependent variable is the vertical integration index of firm f with primary sector k located in country c, as defined in (7). We take logs of (one plus) the vertical integration index to mitigate problems with outliers.[33]

Our main regressor of interest is the log (one plus) MFN tariff (already expressed in ad-valorem terms) applied in sector k.by country c.[34]

[31] An industry's external financial dependence is obtained by calculating the industry median of external financing of U.S. companies using data from Compustat calculated as: (Capex-Cashflow)/Capex, where Capex is defined as capital expenditures and Cashflow as cash flow from operations. Industries with negative external finance measures have cash flows that are higher than their capital expenditures.

[32] These include sales by foreign-owned plants that operate in the given country-sector.

[33] Alternatively, we tried using as our dependent variable average vertical integration, $\overline{V}^{f,k,c} = \frac{1}{N_f} \sum_j V_j^{f,k,c}$, where N_f is the number of industries in which firm f is active. The results on tariffs are consistent, but somewhat less significant. This is not surprising, as our regressions consider the effects of MFN tariffs applied to a firms' primary activity not to all of its activities. We also used the log of the vertical integration index (removing zero observations) obtaining similar results. All results not shown due to space considerations are available upon request.

[34] In the main specifications, we use log (one plus MFN tariff) in order to be able to include zero tariffs. Although the distribution of tariffs is extremely skewed, log tariffs are approximately normally distributed. Using, in alternative specifications, the log of the tariff variable yields similar results.

The set of explanatory variables includes number of employees, $Employment_f$, which allows us to control for the relation between firm size and ownership structure.[35] Recall that our model predicts that more productive firms, as proxied by firm size (see, for example, Bernard, Jensen, Eaton, and Kortum (2003) for the close relation between firm size and productivity), are more likely to be integrated for a given market price p_k^c. We thus expect β_2 to be positive. The vector $\mathbf{X}_{k,c}$ consists of different interactions between sector and country characteristics, previously suggested by papers on the determinants of vertical integration (e.g., interaction between a sector's capital intensity and a country's level of financial development). All variables are expressed in logs. We also include sector fixed effects at the 4-digit SIC level (δ_k), which allows us to capture cross-industry differences in technological or other determinants of vertical integration (e.g., a sector's capital intensity). Finally, we add country fixed effects (δ_c), which capture cross-country differences in institutional determinants of vertical integration (e.g., a country's level of financial development and the quality of its contracting institutions) and also control for country-specific differences in the way firms are sampled.[36] Given that tariffs vary only at the sector-country level, while the dependent variable varies at the firm level, we cluster standard errors at the sector-country level.

Table 2 reports the main results. Column (1) presents the results of the basic specification, which includes the MFN tariff, firm size, and country and sector fixed effects. Consistent with our theoretical model's predictions, tariffs have a positive and significant effect on firm-level vertical integration. The estimate for β_1 implies that a 100 percent tariff increase leads to a 2.15 percent increase in the vertical integration index. In terms of economic magnitudes, this implies that an increase in manufacturing tariffs from 1 percent to their mean level of 4.85 percent (a 385 percent increase) increases vertical integration by 0.0215*385=8.28 percent, a sizable effect.

Note that tariffs act as a proxy variable for domestic prices. Thus, the estimate for β_1 can be interpreted as the impact of prices on vertical integration if and only if prices and tariffs vary one to one. This would be true for a small open economy that faces a horizontal export supply curve and imposes a specific tariff. In the case of a small country using ad-valorem tariffs, this relation would be weaker. More important, if a country faces a downward-sloping export supply curve, imposing a tariff will have an impact on its terms of trade. Therefore, the elasticity of domestic prices with respect to tariffs is strictly smaller than one.[37] Notice also that, to the

[35]Our dataset contains different numbers of firms from different countries. This variation in the selection of samples of firms could be a source of variation in vertical integration. The main source of the problem would be potential correlation between vertical integration and firm size (combined with differential selection on firm size across countries). Controlling for firm size alleviates this problem.

[36]D&B samples establishments in the formal sector (and there are, of course, differences in the size of the formal sector across rich and poor countries). In the robustness checks, we try an alternative way to control for this by restricting the sample to countries for which we have at least 1,000 plants that are part of firms with at least 20 employees.

[37]Let $p_k^c = (1 + t_k^c)P_k$. Then $\frac{\partial p_k^c}{\partial t_k^c}\frac{t_k^c}{p_k^c} = \frac{\partial P_k}{\partial t_k^c}\frac{t_k^c}{P_k} + \frac{t_k^c}{1+t_k^c}$, where the first part on the right is the direct impact of an ad-valorem tariff on domestic prices (< 1) and the second term is the terms of trade effect (< 0).

extent that countries are able to manipulate tariffs to improve their terms of trade, high tariffs are likely to be observed precisely in sectors in which they increase domestic prices only by a small amount.[38] These arguments imply that the estimate for β_1 should be interpreted as a lower bound on the impact of prices on vertical integration. The true impact is likely to be several orders of magnitude larger.

Turning to the effect of firm size on vertical integration, we find that, holding constant the domestic price level, larger firms are more vertically integrated. A 100 percent increase in employment leads to a 6 percent increase in the firm's level of vertical integration.

In column (2), we add as controls MFN share (which corresponds to the the fraction of imports to which MFN tariffs apply) and MFN share times the log (of one) plus the MFN tariff. The coefficient of tariffs (first row) now measures the impact of tariffs when the MFN share is zero. This coefficient is non-significant. But when the MFN share rises, the impact of tariffs becomes positive and significant at the one-percent level (as measured by the interaction term, which is positive and significant).[39]

In columns (3) and (4) we add different sets of controls to account for other determinants of vertical integration, as suggested by the literature. In column (3), we include two interaction terms, one between *Capital intensity* and *Financial development* and one between *Capital intensity* and *Legal quality*. Note that the tariff coefficient remains relatively unchanged and remains significant at the one-percent level. The estimate for the interaction term between *Capital intensity* and *Financial development* is also highly significant, indicating that more capital intensive sectors are more integrated in countries with more developed financial markets. The interaction term between *Capital intensity* and *Legal quality* has the expected negative sign but it is not significant. In column (4), we include two alternative interaction terms, one between *Relationship specificity* and *Legal quality* and one between *External dependence* and *Financial development*. Again, tariffs are positive and highly significant and the interaction terms insignificant.[40]

As mentioned above, the determination of MFN tariffs is arguably "less political" than other forms of protection (e.g., anti-dumping duties). Although there is no theory that relates firm boundaries to incentives to form a lobbying group, one might still worry, for example, that larger firms, which are more likely to vertically integrate, may be more effective at lobbying for protection (leading to higher MFN tariffs). That is to say MFN tariffs may be correlated with other (omitted) firm characteristics associated with both the potential to lobby and the incentive to vertically integrate. Our regression analysis controls for firm size (proxied by employment) as well as controlling for industry and country effects and a number of industry-country variables

[38]Broda, Limao and Weinstein (2008) provide evidence that non-WTO countries exploit their market power in trade by setting higher tariffs on goods that are supplied inelastically. Ludema and Mayda (2010) provide similar evidence for WTO countries.

[39]A Wald test of whether both coefficients are zero is rejected at the one-percent level.

[40]These results are broadly consistent with the theoretical framework described by AJM. Their empirical analysis finds a significant negative effect of the interaction between *Capital intensity* and *Legal Quality*, but does not find a significant effect for the interaction between *Capital intensity* and *Financial development*.

stressed in the literature.

As an additional test, columns (4)-(8) in Table 2 include Herfindahl indices to control for the possibility of high concentration leading to both high tariffs and vertical integration. As seen in the table, point estimates for the tariff coefficient remain similar in terms of both magnitude and significance. The Herfindahl indices, however, are not significant.[41]

5 Trade Policy and Organization Convergence

The theoretical framework discussed in Section 2 suggests that trade policy should, through its effect on prices, affect the degree of organizational convergence across countries. The focus of this section is on cross-country differences in ownership structure at the sectoral level. For each country, we construct an industry measure of vertical integration by estimating the following regression model:

$$V^{f,k,c} = \beta Employment_f + V_{kc} + \epsilon_{f,c}. \tag{9}$$

The estimate for the sector-country dummy V_{kc} gives us a measure of the average level of vertical integration of industry k in country c, controlling for the effect of firm size (employment) on the average level of vertical integration in that industry-country pair. All variables are expressed in logs.

5.1 Tariff Differences

We first examine whether cross-country differences in sectoral organizational structure are affected by differences in tariffs. Our model predicts that, for a given country-pair cc', organizational differences should be smaller for sectors characterized by similar levels of protection. To verify this, we estimate the following model:

$$|\hat{V}_{k,c} - \hat{V}_{k,c'}| = \alpha + \beta_1 |MFNt_{k,c} - MFNt_{k,c'}| + \beta_2 |\mathbf{X}_{k,c} - \mathbf{X}_{k,c'}| + \delta_k + \delta_{cc'} + \epsilon_{k,c,c'}. \tag{10}$$

The dependent variable is the absolute difference between countries c and c' in the estimated vertical integration indexes for sector k (from equation (9) above). All differences are expressed in logs. The main regressor of interest is the (log of the) absolute difference between these countries' MFN tariffs in sector k. The term $|\mathbf{X}_{k,c} - \mathbf{X}_{k,c'}|$ captures differences in other sector-country characteristics that may affect the degree of organizational convergence. Note that, because we are including dyad fixed effects ($\delta_{cc'}$), β_1 is identified by the cross-sectoral variation in the tariff difference for a given country pair.

[41] We obtain similar results when we use the log of the vertical integration index.

In the first column of Table 3, the only explanatory variable is the log-difference in MFN tariffs. In line with our predictions, we find that, for a given country-pair differences in sectoral vertical integration indexes are significantly (at the 1 percent level) larger in sectors in which differences in MFN tariffs are larger. A 100 percent increase in the difference in MFN tariffs leads to a roughly 0.9 percent increase in the difference in vertical integration indexes.

The second column adds interactions between capital intensity and differences in financial development and legal quality. The coefficient on the difference in MFN tariffs remains relatively unchanged in magnitude and is significant at the 5 percent level. The interaction term of capital intensity with legal quality is positive and strongly significant while the interaction term of capital intensity with the difference in financial development is positive but not significant. The last column includes, as alternative control variables, the difference in financial development interacted with external dependence, and the difference in legal quality interacted with relationship-dependence. Whereas the coefficient on the difference in MFN tariffs is relatively higher and significant at the 5 percent level, both interaction terms are negative with the relation between legal quality and relationship-dependence variables being significant.

5.2 Regional Trade Agreements

In the remainder of this section, we examine the relation between the degree of sectoral organizational convergence and common membership in a regional trade agreement. In contrast to the previous regressions, however, a causal interpretation of these regression results is more difficult because it is possible that countries that are generally more similar are more likely to form RTAs.

To assess the validity of our third empirical prediction, we explore how RTAs affect the extent to which two countries have similar vertical integration structures at the industry level.

$$|\hat{V}_{k,c} - \hat{V}_{k,c'}| = \alpha + \beta_1 RTA_{cc'} + \beta_2 AgeRTA_{cc'} + \beta_3 \mathbf{X}_{cc'} + \delta_k + \delta_c + \delta_{c'} + \epsilon_{k,c,c'}. \tag{11}$$

The dependent variable is as in model (10), expressed as before in logs. The main regressor of interest is now $RTA_{cc'}$, a dummy that equals one if countries c and c' are members of the same RTA. We include the age of the trade agreement to capture the effect that older RTAs are likely to have greater impact on differences in organizational structure. The vector $\mathbf{X}_{cc'}$ captures a series of bilateral controls, such as dummies for contiguity, common language, and colonial relationship, as well as variables that capture the distance between countries, and differences in legal quality, financial development, GDP and in GNI per capita (differences expressed in logs of absolute values). Finally, we include sector fixed effects (δ_k) and country fixed effects (δ_c and $\delta_{c'}$).

Table 3 presents the results for this regression. In the first column of the left panel, in which we include only a dummy for regional trade agreements, the coefficient of RTA is negative and

significant at the one-percent level.[42] This implies that the difference in vertical integration indices for a country pair in an RTA is about 9.2 percent smaller than for a country pair without an RTA. In the second column the age of the RTA is added as an additional control variable. Coefficients for RTA and for age are both negative and significant at the 1 percent level. Thus, as expected, country pairs with older RTAs have more similar organizational structures than countries with young RTAs. The coefficients imply that country pairs that have an RTA with an average age (8.52 years) have a roughly 10 percent smaller difference in vertical integration indices than country pairs without an RTA ($-0.059 - 0.004 * 8.52 \approx -0.095$).

The results for an alternative specification, that separates free trade agreements and custom unions are presented in column three. Again, results remain robust and significant at the 1-percent level. As expected, the quantitative impact on organizational convergence is greater for CUs than for FTAs. Country pairs that belong to the same CU have a approximately 18.5% smaller difference in organizational structure than country pairs without a RTA, while country pairs that belong to the same FTA have only a 4% smaller difference in organizational structure. The fourth column adds the age of these trade agreements. Notice that the coefficient for customs unions remains highly significant, while FTAs are only significant if they are sufficiently old.

In the last column, we keep the coefficients for CUs and FTAs separate and add a series of bilateral control variables that may have an impact on similarity of organizational structure. The coefficient for CUs is reduced somewhat in size, but remains significant at the 5 percent level. Contiguity and common language have a significant negative effect on the difference in vertical integration indices, as does distance. The dummy for common colony is insignificant. Differences in legal quality, GDP and GNI per capita have a significant positive effect on the difference in vertical integration. Differences in financial development are not significant.

6 Robustness Checks

We perform several additional robustness checks. We first repeat our analysis for the sample of countries for which we observe at least 1,000 plants that are part of firms with at least 20 employees. Results for specification (8), presented in Table 5, are almost unchanged. Point estimates for the tariff coefficient remain similar in magnitude, and the significance of the estimates is not affected by restricting the sample of countries.[43]

In a second set of regressions we add multinational firms to the main sample. As noted in the text, because multinational firms have plants in different countries, the relevant product price and what tariffs might be distorting it are unclear. We use the primary activity of the respective

[42]Standard errors are clustered by sector. Clustering at the country-pair level, which would be appropriate here, is not possible because the panel is strongly unbalanced across sectors rendering the clustered variance-covariance-matrix numerically singular.

[43]We also used the average integration index (not shown), in which case the coefficients for tariffs dropped slightly in magnitude, but remained strongly significant .

domestic ultimate to which a plant belonging to a multinational reports.[44] Table 6 reports the results. We find that the coefficient for MFN tariffs remains significant in all specifications.

With respect to the results on organizational convergence when the sample size is restricted, tariff differences continue to have a significant positive effect on differences in vertical integration in all specifications using the primary vertical integration index, as can be seen in Table 7, columns (1)-(3). Adding multinationals to the analysis we find in columns (4)-(6), that the impact of tariff differences on differences in vertical integration remains highly significant in all specifications.

Finally, results for regional trade agreements are also robust to restricting sample size, as can be seen in Table 8, columns (1)-(3). In the reduced sample, having an RTA reduces differences in vertical integration by roughly 5 percent when controlling for sector and country effects. The estimates of the coefficients for RTAs and CUs are robust across specifications and mostly significant at the one-percent level. When considering multinationals, having an RTA continues to reduce differences in vertical integration as can be seen in Table 8, columns (4)-(6). The significant impact of RTA remains robust and significant at the 1 percent level across specifications.

7 Conclusions

This paper describes a simple model in which firm boundaries depend on the prices of the products they sell: the higher the prices, the more integrated firms will be. More generally, when equilibrium prices converge across economies, so do ownership structures. The reason behind these predictions is that integration, although more productive than non-integration because of its comparative advantage in the coordination of firms' operating decisions, also imposes higher private costs on enterprise managers. At low prices, the productivity gains from integrating have little value, and managers choose non-integration. As prices rise, the relative value of coordination increases, favoring integration.

To examine the validity of these predictions empirically, we use a new dataset from Dun and Bradstreet (D&B) that contains both listed and unlisted plant-level observations in more than 200 countries. This dataset enables us to construct firm-level vertical integration indexes with which to study the link between product prices and firms' ownership structure. In particular, we exploit the cross-country and cross-sectoral variation in MFN tariffs and existence of regional trade agreements, which provide a source of price variation that is plausibly exogenous to firms' ownership decisions. Consistent with the model's predictions, we find that higher prices, as proxied by higher MFN tariffs, lead to more vertical integration at the firm level. Note that our estimates should be interpreted as a lower bound of the impact of prices on vertical integration.

[44]Note also that because multinationals are usually active in many sectors and the primary SIC code of their global ultimate is not necessarily a good measure of their primary activity.

This is due to different reasons: first, ad-valorem tariffs do not have one-to-one effects on domestic prices; second, if a country faces a downward-sloping export supply curve, increasing its level of protection will depress the world price, weakening the effect on domestic prices; and finally, to the extent that countries can manipulate their terms of trade, high tariffs are likely to be observed precisely in those sectors in which their effect on domestic prices is smaller (see Broda, Limao and Weinstein, 2008).

Our results lend empirical support to a simple model of the determination of firm boundaries in a global economy. As such they have implications beyond the positive theory of the firm. Enterprises' integration choices affect not only their productivity, but also aggregate economic performance and consumer welfare. In our model, integration enhances consumer welfare, but the unregulated market may provide too little of it (see Legros and Newman, 2009), because managers may overvalue their private costs. Thus, to the usual welfare costs of tariffs, which we have shown increase integration, there are additional organizational design effects to consider.

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Table 1: Summary Statistics

	Median	Mean	Std. Dev.	N
Vertical integration index	0.044	0.063	0.063	196,586
MFN tariffs	2.480	4.849	7.253	196,586
Employment	38.000	98.936	472.395	196,586
Herfindahl	0.053	0.132	0.188	196,586
Capital intensity	-2.857	-2.902	0.458	387
Relationship specificity	-0.456	-0.526	0.356	387
Financial dependence	-0.756	-0.524	3.058	387
Financial dependence	0.332	0.554	0.479	80
Legal quality	0.545	0.583	0.209	80
Financial development	-0.234	-0.478	1.141	80
GDP	8295	13126	12434	80
GNI per capita	9.486	9.811	0.927	80
Difference Ver. int. index	-1.593	-1.707	1.614	299,649
Difference Legal quality	-1.198	-1.475	1.134	299,649
Difference Financial development	-0.234	-0.478	1.141	299,649
Difference GDP	0.450	0.201	1.812	299,649
Difference GNI per capita	-0.132	-0.467	1.230	299,649
Distance	9.017	8.629	0.965	299,649
Regional Trade Agreement (RTA)	0.000	0.263	0.440	299,649
RTA Age	0.000	2.045	6.333	299,649
Free Trade Agreement (FTA)	0.000	0.148	0.355	299,649
FTA Age	0.000	0.892	3.790	299,649
Customs Union (CU)	0.000	0.115	0.319	299,649
CU Age	0.000	1.153	5.273	299,649
Contiguity	0.000	0.041	0.139	299,649
Colonial relationship	0.000	0.020	0.178	299,649
Common language	0.000	0.122	0.328	299,649

Notes: Vertical integration indices constructed using plant level data from 2004 WorldBase, Dun & Bradstreet. Tariff data from TRAINS/WTO. Info on regional trade agreements (RTAs) from WTO. Financial development from Beck, Demigurc-Kunt and Levine (2006). Legal quality from Kaufmann, Kraay, and Mastruzzi (2004). GDP and GNI per capita from World Bank. Capital Intensity from NBER-CES manufacturing industry database. Relationship specificity from Nunn (2007). Financial dependence from Compustat following Rajan and Zingales (1998). All variables are in logs except for RTA, FTA, CU, RTA Age, FTA Age, CU Age, contiguity, colonial relationship, and common language, which are dummy variables.

Table 2: Tariffs and Vertical Integration, Firm Level Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MFN Tariff	0.0215***	0.0050	0.0214***	0.0212***	0.0225***	0.0225***	0.0052	0.0223***
	(0.0061)	(0.0079)	(0.0059)	(0.0060)	(0.0060)	(0.0060)	(0.0077)	(0.0058)
Employment	0.0425***	0.0426***	0.0425***	0.0425***	0.0442***	0.0442***	0.0443***	0.0442***
	(0.0045)	(0.0045)	(0.0045)	(0.0045)	(0.0048)	(0.0048)	(0.0049)	(0.0048)
MFN share		-0.0170					-0.0241	
		(0.0198)					(0.0245)	
MFN share x MFN tariff		0.0248***					0.0260***	
		(0.0073)					(0.0078)	
Capital int. x Financial dev.			0.0319**					0.0396**
			(0.0147)					(0.0193)
Capital int. x Legal quality			-0.0837					-0.1030
			(0.0580)					(0.0731)
Relation spec. x Legal quality				-0.0349				
				(0.0296)				
External dep. x Financial dev.				0.0000				
				(0.0013)				
Herfindahl					0.0110	0.0110	0.0107	0.0113
					(0.0231)	(0.0231)	(0.0231)	(0.0229)
# Observations	196,586	196,586	196,586	196,586	178,199	178,199	178,199	178,199
R^2	0.122	0.122	0.122	0.122	0.123	0.123	0.123	0.123
Number of Sectors	386	386	386	386	386	386	386	386
Sector Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector

Notes: Robust standard errors in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log of one plus the vertical integration index of firm f in primary sector k located in country c. Sample includes firms $\geq$ 20 employees in the manufacturing sector, excluding MNCs. All control variables are in logs except for MFN tariff which, corresponds to log one plus MFN tariff.

Table 3: Tariffs and Organizational Convergence

	(1)	(2)	(3)
Difference MFN tariffs	0.0089***	0.0086**	0.0095**
	(0.0034)	(0.0037)	(0.0037)
Capital intensity x difference Financial dev.		0.0020	
		(0.0066)	
Capital intensity x difference Legal quality		0.0419***	
		(0.0062)	
External dep. x difference Financial dev.			-0.0057
			(0.0009)
Relation spec. x difference Legal quality			-0.0553***
			(0.0061)
# Observations	212,770	171,908	171,908
R^2	0.164	0.164	0.165
# Country pairs	4392	3444	3444
Sector Fixed Effect	YES	YES	YES
Diadic Fixed Effect	YES	YES	YES
Cluster	Country-pair	Country-pair	Country-pair

Notes: Robust standard errors in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log of the absolute difference between countries c and c' in the estimated vertical integration index in the primary sector k. All variables are in logs. Sample includes firms ≥ 20 employees in the manufacturing sector, excluding MNCs.

Table 4: Regional Trade Agreements and Organizational Convergence

	(1)	(2)	(3)	(4)	(5)
RTA	-0.0921***	-0.0593***			
	(0.0095)	(0.0108)			
RTA x Age		-0.00412***			
		(0.0006)			
Customs union			-0.185***	-0.1770***	-0.0359**
			(0.0150)	(0.0178)	(0.0172)
Free trade area			-0.0404***	0.0039	0.0157
			(0.0099)	(0.0120)	(0.0128)
Customs union x Age				-0.0005	
				(0.0007)	
Free trade area x Age				-0.0073***	
				(0.0009)	
Contiguity					-0.204***
					(0.0159)
Colonial relationship					0.0322
					(0.0236)
Common language					-0.0911***
					(0.0107)
Distance					0.0136*
					(0.0070)
Difference Legal quality					0.0300***
					(0.0033)
Difference Financial dev.					-0.0030
					(0.0031)
Difference GDP					0.0285***
					(0.0032)
Difference GNI p.c.					0.0480***
					(0.0044)
# Observations	299,649	299,649	299,649	299,649	240,385
R^2	0.109	0.109	0.109	0.109	0.122
# Country pairs	101	101	101	101	101
Sector Fixed Effect	YES	YES	YES	YES	YES
Country Fixed Effect	YES	YES	YES	YES	YES
Cluster	Sector	Sector	Sector	Sector	Sector

Notes: Robust standard errors in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log of (one plus) the absolute difference between countries c and c' in the estimated vertical integration index in the primary sector k. Differences and distance are in logs. Sample includes firms $\geq$ 20 employees in the manufacturing sector, excluding MNCs.

Table 5: Robustness–Tariffs and Vertical Integration, Countries ≥ 1,000 plants

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MFN tariff	0.0214***	0.0048	0.0212***	0.0213***	0.0228***	0.0052	0.0225***	0.0227***
	(0.0059)	(0.0078)	(0.0057)	(0.0060)	(0.0061)	(0.0078)	(0.0058)	(0.0062)
Employment	0.0439***	0.0440***	0.0439***	0.0439***	0.0449***	0.0450***	0.0449***	0.0449***
	(0.0046)	(0.0046)	(0.0046)	(0.0046)	(0.0048)	(0.0048)	(0.0048)	(0.0048)
MFN share		-0.0208				-0.0229		
		(0.0216)				(0.0259)		
MFN share x MFN tariff		0.0247***				0.0261***		
		(0.0076)				(0.0082)		
Capital int. x Financial dev.			0.0368**				0.0418**	
			(0.0174)				(0.0213)	
Capital int. x Legal quality			-0.0998				-0.111	
			(0.0742)				(0.0875)	
Relation spec. x Legal quality				-0.0210				-0.0232
				(0.0379)				(0.0441)
External dep. x Financial dev.				0.0011				0.0005
				(0.0016)				(0.0019)
Herfindahl					0.0089	0.0086	0.0089	0.0087
					(0.0252)	(0.0253)	(0.0250)	(0.0251)
# Observations	189,324	189,324	189,324	189,324	174,479	174,479	174,479	174,479
R^2	0.124	0.124	0.124	0.124	0.123	0.123	0.123	0.123
Number of Sectors	386	386	386	386	386	386	386	386
Sector Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector

Notes: Robust standard errors are in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log of one plus the vertical integration index of firm f in primary sector k located in country c. All variables are in logs except for MFN tariff which corresponds to log one plus MFN tariff. Sample includes firms ≥ 20 employment in the manufacturing sector located in countries with at least 1,000 plants, excluding MNCs.

Table 6: Robustness–Tariffs and Vertical Integration, Multinationals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MFN tariff	0.0182***	-0.0012	0.0179***	0.0179***	0.0193***	-0.0008	0.0190***	0.0189***
	(0.0061)	(0.0084)	(0.0061)	(0.0061)	(0.0061)	(0.0082)	(0.0060)	(0.0061)
Employment	0.0610***	0.0611***	0.0610***	0.0610***	0.0644***	0.0645***	0.0644***	0.0644***
	(0.0062)	(0.0062)	(0.0062)	(0.0062)	(0.0061)	(0.0061)	(0.0060)	(0.0061)
MFN share		-0.0256				-0.0310		
		(0.0201)				(0.0248)		
MFN share x MFN tariff		0.0297***				0.0306***		
		(0.0076)				(0.0081)		
Multinational	-0.0238***	-0.0240***	-0.0237***	-0.0239***	-0.0199**	-0.0201**	-0.0198**	-0.0200**
	(0.0082)	(0.0082)	(0.0082)	(0.0082)	(0.0089)	(0.0089)	(0.0089)	(0.0089)
Capital int. x Financial dev.			0.0291*				0.0364*	
			(0.0149)				(0.0193)	
Capital int. x Legal quality			-0.0977*				-0.1180*	
			(0.0571)				(0.0706)	
Relation spec. x Legal quality				-0.0224				-0.0303
				(0.0253)				(0.0308)
External dep. x Financial dev.				-0.0006				-0.0006
				(0.0011)				(0.0015)
Herfindahl					0.0163	0.016	0.0169	0.0160
					(0.0227)	(0.0227)	(0.0224)	(0.0226)
# Observations	215,286	215,286	215,286	215,286	193,938	193,938	193,938	193,938
R^2	0.117	0.118	0.118	0.117	0.119	0.119	0.119	0.119
Number of Sectors	386	386	386	386	386	386	386	386
Sector Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector	Country-sector

Notes: Robust standard errors are in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log one plus the vertical integration index of firm f in primary sector k located in country c. All variables are in logs except for MFN tariff, which corresponds to log one plus MFN tariff. Sample includes firms $\geq$ 20 employment in the manufacturing sector, including MNCs.

Table 7: Robustness–Tariff Differences and Organizational Convergence

	(1)	(2)	(3)	(4)	(5)	(6)
	Countries ⩾ 1,000 plants			Including Multinationals		
Difference MFN tariffs	0.0091**	0.0070*	0.0087**	0.0199***	0.0208***	0.0217***
	(0.0040)	(0.0043)	(0.0043)	(0.0030)	(0.0034)	(0.0034)
Capital int. x difference Financial dev.		-0.0118			0.0029	
		(0.0075)			(0.0066)	
Capital int. x difference Legal quality		0.0568***			0.0477***	
		(0.0074)			(0.0063)	
External dep. x difference Financial dev.			-0.00582***			-0.00673***
			(0.0010)			(0.0008)
Relation specificity x difference Legal quality			-0.0650***			-0.0519***
			(0.0075)			(0.0061)
# Observations	142,573	121,709	121,709	233,105	187,182	187,182
R^2	0.171	0.172	0.172	0.146	0.147	0.148
# country pairs	1004	853	853	4566	3585	3585
Sector Fixed Effect	YES	YES	YES	YES	YES	YES
Diadic Fixed Effect	YES	YES	YES	YES	YES	YES
Cluster	Country-pair	Country-pair	Country-pair	Country-pair	Country-pair	Country-pair

Notes: Robust standard errors in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log of one plus the vertical integration index of firm f located in country c in primary sector k. All variables are in logs. In columns (1)-(3), the sample includes firms $\geq$ 20 employment in the manufacturing sector located in countries with at least 1,000 plants, excluding MNCs; in columns (4)-(6), the sample includes MNCs.

Table 8: Robustness–Organizational Convergence and RTAs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Countries ⩾ 1,000 plants				Including Multinationals			
RTA	-0.0474***	-0.0239**			-0.0819***	-0.0476***		
	(0.0091)	(0.0103)			(0.0089)	(0.0091)		
RTA x Age		-0.00281***				-0.00435***		
		(0.0006)				(0.0005)		
Customs union			-0.127***	-0.132***			-0.166***	-0.154***
			(0.0145)	(0.0170)			(0.0143)	(0.0154)
Free trade area			0.0094	0.0299**			-0.0339***	0.0142
			(0.0100)	(0.0122)			(0.0093)	(0.0109)
Customs union x Age				0.0007				(0.0009)
				(0.0007)				(0.0006)
Free trade area x Age				-0.00586***				-0.00788***
				(0.0008)				(0.0008)
# Observations	210,475	210,475	210,475	210,475	328,756	328,756	328,756	328,756
R^2	0.118	0.118	0.119	0.119	0.057	0.058	0.058	0.058
Number of Sectors	456	456	456	456	15686	15686	15686	15686
Sector Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Country Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Sector	Sector	Sector	Sector	Sector	Sector	Sector	Sector

Notes: Robust standard errors in parentheses denoting *** 1%, **5%, and *10% significance. Dependent variable: log of (one plus) the vertical integration index of firm f in primary sector k located in country c. In columns (1)-(4), the sample includes firms $\geq$ 20 employment in the manufacturing sector located in countries with at least 1,000 plants, excluding MNCs; in columns (5)-(8), the sample includes MNCs.

Table A-1: Sample Comparisons: Vertical Integration Indices

	firms $\geq$ 20 empl. no MNCs	firms $\geq$ 20 empl. count with $\geq$ 1,000 obs., no MNCs	firms $\geq$ 20 empl. MNCs
# of plants	225,212	217,723	279,869
# of connected plants	29,214	29,008	64,789
# of connected firms	6,830	6,768	10,224
# of firms	196,586	189,324	215,286
# of MNCs	0	0	18700
Mean, Vertical integration index	0.0627	0.0640	0.0640
Median, Vertical integration index	0.0437	0.0439	0.0439
Min, Vertical integration index	0.0000	0.0000	0.0000
Max, Vertical integration index	0.0629	0.8333	0.8333
St. dev., Vertical integration index	0.0633	0.0623	0.0645

Notes: Plant- and firm-level data from 2004 WorldBase data, Dun & Bradstreet. Sample includes firms $\geq$ 20 employees in the manufacturing sector. Column (1) is the main sample; columns (2) and (3) are samples used in robustness checks.

Table A-2: Sample Frame

WB code	Freq.	Percent	Cum.	WB code	Freq.	Percent	Cum.
ALB	4	0.00	0.00	MAR	603	0.31	61.52
ARG	998	0.51	0.51	MDG	18	0.01	61.53
AUS	5,079	2.58	3.09	MEX	2,641	1.34	62.87
AUT	1,464	0.74	3.84	MLI	13	0.01	62.88
BEL	928	0.47	4.31	MOZ	16	0.01	62.89
BEN	4	0.00	4.31	MUS	46	0.02	62.91
BFA	8	0.00	4.32	MWI	2	0.00	62.91
BGD	6	0.00	4.32	MYS	3,101	1.58	64.49
BGR	360	0.18	4.50	NER	1	0.00	64.49
BOL	55	0.03	4.53	NIC	21	0.01	64.50
BRA	5,594	2.85	7.38	NLD	676	0.34	64.84
CAN	7,469	3.80	11.18	NOR	847	0.43	65.27
CHE	1,150	0.58	11.76	NZL	959	0.49	65.76
CHL	454	0.23	11.99	OMN	67	0.03	65.80
COL	550	0.28	12.27	PAK	4	0.00	65.80
CRI	176	0.09	12.36	PER	888	0.45	66.25
CZE	1,736	0.88	13.24	PHL	351	0.18	66.43
DEU	19,302	9.82	23.06	PNG	4	0.00	66.43
DNK	425	0.22	23.28	POL	446	0.23	66.66
ECU	183	0.09	23.37	PRT	5,433	2.76	69.42
ESP	2,322	1.18	24.55	PRY	50	0.03	69.45
FIN	448	0.23	24.78	ROM	614	0.31	69.76
FRA	8,965	4.56	29.34	RWA	2	0.00	69.76
GAB	3	0.00	29.34	SAU	314	0.16	69.92
GBR	6,622	3.37	32.71	SEN	47	0.02	69.94
GHA	81	0.04	32.75	SGP	790	0.40	70.35
GRC	2,231	1.13	33.89	SLV	129	0.07	70.41
GTM	93	0.05	33.93	SWE	689	0.35	70.76
HND	77	0.04	33.97	TGO	4	0.00	70.76
HUN	2,346	1.19	35.17	THA	507	0.26	71.02
IDN	233	0.12	35.29	TTO	79	0.04	71.06
IND	2,592	1.32	36.60	TUN	991	0.50	71.57
IRL	587	0.30	36.90	TUR	2,557	1.30	72.87
ISR	1,538	0.78	37.68	TZA	24	0.01	72.88
ITA	8,426	4.29	41.97	UGA	37	0.02	72.90
JAM	43	0.02	41.99	URY	114	0.06	72.96
JOR	148	0.08	42.07	USA	52,917	26.92	99.87
JPN	34,441	17.52	59.59	VEN	231	0.12	99.99
KEN	134	0.07	59.66	ZAF	1	0.00	99.99
KOR	3,060	1.56	61.21	ZMB	17	0.01	100.00
				Total	196,586	100.00	

Notes: Data from 2004 WorldBase data, Dun & Bradstreet. Sample includes firms $\geq$ 20 employees in the manufacturing sector, excluding MNCs.

Table A-3: Sample Frame: Restricted Sample

WB code	Freq.	Percent	Cum.
ARG	998	0.53	0.53
AUS	5,079	2.68	3.21
AUT	1,464	0.77	3.98
BEL	928	0.49	4.47
BRA	5,594	2.95	7.43
CAN	7,469	3.95	11.37
CHE	1,150	0.61	11.98
CZE	1,736	0.92	12.9
DEU	19,302	10.2	23.09
DNK	425	0.22	23.32
ESP	2,322	1.23	24.54
FIN	448	0.24	24.78
FRA	8,965	4.74	29.52
GBR	6,622	3.5	33.01
GRC	2,231	1.18	34.19
HUN	2,346	1.24	35.43
IND	2,592	1.37	36.8
IRL	587	0.31	37.11
ISR	1,538	0.81	37.92
ITA	8,426	4.45	42.37
JPN	34,441	18.19	60.56
KOR	3,060	1.62	62.18
MEX	2,641	1.39	63.58
MYS	3,101	1.64	65.21
NLD	676	0.36	65.57
NOR	847	0.45	66.02
NZL	959	0.51	66.52
PRT	5,433	2.87	69.39
SGP	790	0.42	69.81
SWE	689	0.36	70.18
TUN	991	0.52	70.7
TUR	2,557	1.35	72.05
USA	52,917	27.95	100
Total	189,324	100	

Notes: Data from 2004 WorldBase data, Dun & Bradstreet. Sample includes firms $\geq$ 20 employment in the manufacturing sector located in countries with at least 1000 plants, excluding MNCs.

Table A-4: Correlation Table

	Vertical int. index	MFN Tariff	Employment	Herfindahl	Cap. Int. x Fin. dev.	Cap. Int. x Leg. qual.	Ext. dep. x Fin. dep.	Rel. spec. x Fin. dev.
Vertical integration index	1.0000							
MFN Tariff	0.0689	1.0000						
Employment	0.0675	0.1351	1.0000					
Herfindahl	0.0056	0.1571	0.1492	1.0000				
Capital int. x Financial dev.	0.0231	0.3724	0.1823	0.2334	1.0000			
Capital int. x Legal quality	-0.0414	0.4730	0.2080	0.2797	0.7786	1.0000		
External dep. x Financial dev.	-0.0043	0.0540	0.0332	0.0880	0.2091	0.1672	1.0000	
Relation spec. x Financial dev.	0.0341	0.4549	0.1969	0.2433	0.5640	0.6248	0.1013	1.0000

Notes: Plant- and firm-level data from 2004 WorldBase data, Dun & Bradstreet. All variables are in logs except the Herfindahl index.