Do Prices Determine Vertical Integration? Evidence from Trade Policy*

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Abstract

What is the relationship between product prices and vertical integration? While the literature has focused on how integration affects prices, this paper shows that prices can affect integration. Many theories in organizational economics and industrial organization posit that integration, while costly, increases productivity. If true, it follows from firms' maximizing behavior that higher prices cause firms to choose more integration. The reason is that at low prices, increases in revenue resulting from enhanced productivity are too small to justify the cost, whereas at higher prices, the revenue benefit exceeds the cost. Trade policy provides a source of exogenous price variation to assess the validity of this prediction: higher tariffs should lead to higher prices and therefore to more integration. We construct firm-level indices of vertical integration for a large set of countries and industries and exploit cross-section and time-series variation in import tariffs to examine their impact on firm boundaries. Our empirical results provide strong support for the view that output prices are a key determinant of vertical integration.

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1 Introduction

The relationship between vertical integration and product prices has generated much debate among economists and policy makers. Two strands of thought, broadly opposed, have emerged. The *foreclosure* view emphasizes the possibility of reduced competition, with accompanying increases in product prices.[1] The *efficiency* view, by contrast, maintains that integration increases productivity, thereby reducing prices.[2] Discussion usually revolves around which of these opposing effects is likely to dominate in a particular market or merger case. Either way, causality runs from vertical integration to prices.

Efficiency theories have another ramification, however, which can predict a *positive* association between prices and integration. This implication is easiest to see if one assumes perfect competition in the product market: supposing that integration increases productivity, a price-taking firm will integrate more when the price of its product is higher. At a low price, the increment in revenue resulting from integration is too small to justify any (fixed) cost integration may have; at a high price, the incremental revenue is large enough to make integration worthwhile. More generally, if integration affects efficiency, there will be a force running in the opposite direction, *from* prices *to* vertical integration.[3]

In this paper, we provide evidence that this mechanism is operative in a wide range of industries around the world. The main empirical challenge is to find sources of price variation that are exogenous to firms' vertical integration decisions. Our strategy is to exploit cross-section and time-series variation in Most-Favored-Nation (MFN) tariffs applied by GATT/WTO members. Since tariffs raise product prices in the domestic market, they should lead to more vertical integration among firms selling in that market.

MFN tariffs can be taken as exogenous to vertical integration for several reasons. First, they emerge from long rounds of multilateral trade negotiations. At the end of each round, GATT members commit not to exceed certain tariff rates (tariff bounds); if a country raises its tariffs above the bound level, other countries can take it to dispute settlement. Second, they

[1]Key theoretical contributions on market foreclosure include Salinger (1988), Ordover, Saloner, and Salop (1990), Hart and Tirole (1990) and Bolton and Whinston (1993). Market foreclosure concerns have been enshrined in anti-trust policies and have motivated policies such as "divorcement" legislation. See, for example, the guidelines on the assessment of non-horizontal mergers in the United States (1984 Merger Guidelines) and in the European Union (Council Regulation 2008/C 265/07)

[2]Numerous channels have been identified whereby integration enhances productivity. Technological synergies and efficiencies in asset use are frequently cited by policy makers and antitrust defendants. Organization economists have emphasized other benefits, and often associated costs: reductions in the costs of transactions, adaptation, or opportunism (Williamson, 1971, 1975; Klein, Crawford, and Alchian, 1978); better multitasking incentives (Holmström and Milgrom, 1991); alignment of control and incentives (Grossman and Hart, 1986; Hart and Moore, 1990); or improved coordination (Hart and Holmström, 2010). A complementary class of theories emphasize allocative, rather than productive, efficiency gains achieved by the elimination of double markups, though these shall not concern us. See Perry (1989) and Riordan (2008) for further discussion.

[3]Legros and Newman (2013) seems to be first to point out this relationship, in the context of a "property-rights" model of integration choices by competitive firms with or without entry. As discussed in Section 3, it can also be extended to imperfect competition.

must be applied in a non-discriminatory manner to imports from all countries, which severely limits negotiators' flexibility to respond to political pressure.[4] As a result, governments resort to administrative measures for the regulation of imports, such as anti-dumping and countervailing duties, to respond to short-term political pressure (e.g. Finger, Hall and Nelson, 1982). Third, they are persistent, significantly more so than integration choices. In our main analysis, we study vertical integration of firms in 2004. In that year, the prevailing tariffs resulted from the eight-year Uruguay Round of trade negotiation that was completed ten years earlier.[5] Finally, while firm size and industry concentration might lead to higher final good tariffs by alleviating free-riding problems in lobbying (Mitra, 1999; Bombardini, 2008), there is little reason to believe that vertical structure should have such an effect.[6]

The effect of product prices on integration that we propose should apply broadly, to many different markets. We therefore draw our evidence from the WorldBase dataset of Dun and Bradstreet (D&B), which contains information on firms in many different countries and industries. This approach allows us to exploit cross-country and cross-sector variation in MFN tariffs.[7] WorldBase contains listed and unlisted plant-level observations for a large set of countries and territories. For each plant, the dataset includes information about its production activities (at the 4-digit SIC level) and ownership (e.g. domestic or global parent). To measure vertical integration, we apply the approach of Fan and Lang (2000): combining information on firms' production activities with input-output tables, we construct firm-level vertical integration indices, which measure the fraction of inputs used in the production of a firm's final good that can be produced in house.

Our empirical results provide strong support for the view that output prices are a key determinant of vertical integration. We find that the higher is the MFN tariff applied by a country on the imports of a given product, the more vertically integrated are firms producing that product in that country. The effect is larger when we would expect organizational decisions to be more responsive to import tariffs (i.e. for firms that only serve the domestic market) and in sectors in which MFN tariffs have a larger impact on domestic prices.[8]

[4] The MFN treatment obligation stipulated in Article I of the General Agreement on Tariffs and Trade (GATT) forbids members to discriminate between trading partners. It requires that equal treatment be afforded to all imported goods, irrespective of their origin.

[5] By 2004, most GATT/WTO members had reduced their tariffs to meet the binding obligations agreed to in 1994, at the end of the Uruguay Round of trade negotiations (Bchir, Jean and Laborde, 2006).

[6] If anything, vertical integration will tend to make free-riding problems in lobbying for protection more severe: vertically integrated suppliers will have a diversity of interests that would weaken their lobbying incentives; moreover, coordination to lobby will be harder among suppliers that are in the same sector but belong to different firms than among independent suppliers. Our results are unaffected when controlling for firm size and industry concentration.

[7] The GATT non-discrimination principle implies that there is only one MFN tariff rate per industry in each country; the length of multilateral trade rounds — and the long gaps between them — imply that MFN tariffs vary little over time. Most of the variation is thus within countries across industries and within industries across countries (see Section 4.4).

[8] In our main empirical analysis, we focus on firms that have plants only in one country. There are three main reasons for this choice. First, these firms provide a cleaner analysis of the effects of product prices on

Our estimates imply that price changes can have large effects on firm boundaries. Depending on specification, we obtain estimates of the tariff elasticity of vertical integration in the range 0.02 up to 0.1. Though this may seem inconsequential at first blush, given that tariffs are expressed in ad-valorem terms rather than in units, and that the mean tariff is on the order of 5 percent, these translate into much larger price elasticities, in the range of 0.4 - 2.[9]

In our theory, in which firms are price takers, import tariffs affect firms' organization through their effect on domestic prices. However, tariffs can also have an impact on the degree of competition faced by domestic firms, which may also shape vertical integration decisions (Aghion, Griffith, and Howitt, 2006). To isolate the effect of product prices, we restrict our analysis to highly competitive sectors, in which tariffs will have little or no effect on the degree of competition, obtaining even stronger results.

Another possible explanation for the positive effect of tariffs on vertical integration is that, in the presence of credit constraints, protected firms may have more disposable cash to acquire their suppliers. This mechanism would be expected to be strongest where credit markets are least efficient, or in industries which are most financially dependent. We verify that the effect of tariffs on integration does not vary with either of these factors, as captured by standard measures of financial development and financial dependence.

To establish a causal link between tariffs and vertical integration, we also show that our results are not driven by omitted variables, which could be correlated with both vertical integration decisions and MFN tariffs on final products (e.g. the degree of industry concentration, input tariffs, and tariffs in export markets). Our results are unaffected when including these controls in our analysis. They are also robust to constructing vertical integration indices in different ways, using alternative econometric methodologies, and focusing on different samples of firms and countries.

An alternative strategy to verify the impact of product prices on firm boundaries is to exploit time variation in import tariffs, examining the effects of trade liberalization reforms — major unilateral or multilateral liberalization episodes, or the creation of regional trade agreements — on vertical integration decisions. The challenge with implementing this strategy is data availability, since we can only construct firm-level vertical integration measures for recent years, during which there have been few trade liberalization reforms.[10] The only major trade liberalization

firms' ownership structure; in the case of firms operating in many markets, it is harder to identify the relevant prices and tariffs. Second, focusing on national firms avoids issues having to do with the strategic behavior of multinationals across markets (e.g. transfer pricing, tariff jumping, export platforms). Finally, when integration occurs across international borders as opposed to within them, trade policy can alter bargaining power (surplus division) among suppliers as well as the value of what they jointly produce, further complicating the predicted effects (Ornelas and Turner, 2008; Antras and Staiger, 2012).

[9]Another way to get a sense of the effects of prices on organization would be to instrument prices with MFN tariffs. However, this would require comparable cross country data on domestic prices, which are very difficult to obtain (see Bradford, 2003). Moreover, even if these data were available, it would be hard to argue that the exclusion restriction is satisfied. The reduced-form approach followed in this paper avoids both problems.

[10]The first year for which we can use WorldBase to construct vertical integration indices is 1999. Important

episode that has occurred in recent years is arguably the entry of China into the WTO in 2001: to be accepted as a WTO member, China agreed to undertake substantial reductions in its import tariffs. We examine the organizational effects of these tariff changes, comparing the ownership structure of Chinese firms before and after WTO accession (in 1999 and 2007). Consistent with the predictions of our theoretical model, we find that firm-level vertical integration has fallen more in sectors that have experienced larger tariff cuts.

Finally, we also investigate the effect of trade policy on the degree of organizational convergence across countries. Our theory suggests that countries with similar domestic price levels should have firms with similar ownership structures. In line with this prediction, we show that differences in vertical integration across countries are significantly larger in sectors in which differences in MFN tariffs (and therefore differences in domestic prices) are larger. Moreover, we find that differences in vertical integration indices are smaller for country pairs engaged in regional trade agreements.[11] This effect is stronger for customs unions, which impose common external tariffs vis-à-vis non-members and should therefore achieve greater price convergence.

This paper focuses on vertical integration, which involves complementary goods linked in a buyer-supplier relationship. In principle, the theoretical mechanism we investigate may also apply to horizontal integration, which involves substitute goods, or lateral integration, involving goods sold in separate markets that are complementary either in production or consumption. To the extent that these forms of integration also are costly but enhance productive efficiency, we should expect firms to be more integrated in these other dimensions when tariffs — and thus product prices — are higher. Data limitations, as well as lack of an unconfounded measure of horizontal integration make it difficult to apply the methodology to these other cases at present, as discussed in Section 4.3. Thus we feel that vertical integration provides the cleanest test of the theory.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 presents a theoretical framework to guide our empirical analysis. Section 4 describes our data. Section 5 and 6 present our main results, exploiting cross-sectional and time series variation in tariffs. Section 7 analyzes the impact of trade policy on the degree of cross-country organizational convergence. The last section concludes.

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multilateral or regional trade liberalization episodes, such as the Uruguay Round Agreements, the NAFTA free trade area between the U.S., Canada and Mexico, or the MERCOSUR customs union between Argentina, Brazil, Paraguay and Uruguay, all occurred in the early or mid-nineties.

[11] Under Article I of the GATT, countries have to apply the same MFN tariff to all trading partners. Preferential treatment can only be granted to partners in regional trade agreements (under Article XXIV of the GATT) or developing countries (in the context of the Generalized System of Preferences, under the Enabling Clause).

2 Related literature

Understanding vertical integration decisions has been a fundamental concern of organization economics since Coase (1937)'s seminal paper. We have already mentioned (footnote 2) some of the seminal contributions, both formal and informal, that have shaped economists' understanding of how ownership structure affects productivity of individual firms. Recent theoretical work has embedded models of firms into market settings to study how firms' boundary choices are affected by market conditions. In particular, market thickness, demand elasticities, and terms of trade in supplier markets may have an impact on firms' vertical integration decisions (e.g. McLaren, 2000; Grossman and Helpman, 2002; Legros and Newman, 2008, 2013). So far, evidence on the implications of these models is sparse. This paper shows that market conditions — in particular, the level of product prices — do affect vertical integration decisions.

There is a very large empirical literature that examines the determinants of firms' vertical integration decisions (i.e. firm boundaries/ownership structure), usually with a view to assessing the importance of different tradeoffs that determine firm boundaries, or to examining effects of vertical integration on market outcomes (for an excellent survey, see Lafontaine and Slade, 2007). Most studies focus on single industries.[12] In this literature, Hortaçsu and Syverson (2007) concentrate on the U.S. cement industry and examine whether vertical integration leads to higher prices. In contrast with the predictions of market foreclosure theories, they find that more integration leads to lower prices; they do not address with the opposite direction of causality that is our concern.

A few studies examine a single country. For example, Acemoglu, Aghion, Griffith and Zilibotti (2010) use data on 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.

As for multi-country studies, one stream of the literature has analyzed other aspects of organization, such as management practices or the degree of delegation within firms. Bloom and Van Reenen (2007) study managerial practices in medium-sized manufacturing firms in the US and Europe (France, Germany and the UK), finding that best practices are strongly associated with superior firm performance. Bloom, Sadun and Van Reenen (2010), using survey data on manufacturing firms across a dozen countries, reveal that greater product market competition increases decentralization. Bloom, Sadun and Van Reenen (2012) using survey data they collected from several countries to show that firms headquartered in high trust regions are more likely to decentralize. Guadalupe and Wulf (2012) show that the 1989 Canada-United States

[12] These include the seminal papers by Stuckey (1983) on integration between aluminum refineries and bauxite mines and Joskow (1987) on ownership arrangements in electricity generating plants, as well as the more recent studies by Baker and Hubbard (2003, 2004) on the trucking industry, Woodruff (2002) on Mexican footwear; or Forbes and Lederman (2009, 2011) on airlines.

Free Trade Agreement (CUSFTA) led large U.S. firms to flatten their hierarchies. Other papers have studied how trade liberalization, by increasing the degree of competition, affects the number of horizontally differentiated product varieties a firm chooses to manufacture (Eckel and Neary, 2010; Bernard, Redding and Schott, 2011).

Various papers examine whether goods are sold within or across firm boundaries in the global economy (e.g. Antras, 2003; Nunn, 2007, Diez, 2010). This literature considers the organizational choices of multinational firms and highlights the role of contract enforcement and relationship-specific investments. By contrast, we focus on the organizational choices of firms that operate in a single country.

In terms of data and methodology, our analysis is closely related to the paper by Acemoglu, Johnson and Mitton (2009), who study the determinants of vertical integration using a cross-section of D&B data for 93 countries, emphasizing the role of financial development and contracting costs. Ours is the first paper to investigate the impact of product prices on vertical integration decisions.

3 Theoretical Framework

The fundamental logic of how the price level influences the degree of integration is most simply illustrated with a "reduced form" model in which vertical integration has three main features: (i) it enhances productivity; (ii) it does so at a cost; (iii) the cost is independent of product price. The first assumption is the defining attribute of efficiency theories of vertical integration. The second is necessary if there is anything to discuss: without it, given the first assumption, firms would always integrate to the maximal extent. The third is commonly made, either directly, or derived from more fundamental assumptions.

Consider a price-taking enterprise that requires $N \geq 2$ inputs to produce a final good priced at P. Before production, the enterprise chooses n, the number of inputs that will be produced inside a single firm.The effects of integration on productivity are modelled in the simplest possible way: the cost of producing Q units of output is $\psi(n)C(Q)$, where $\psi(\cdot)$ is decreasing and $C(Q)$ is increasing and convex. Thus, the more integrated the firm (higher is n), the lower the unit cost of producing Q.

Integration is costly (if not, we would always have $n = N$). Let $\Phi(n)$ be the cost of integrating n units into the firm $\Phi(\cdot)$ is increasing and $\Phi(0) = 0$. This function captures different types of costs (e.g. legal, bureaucratic, monitoring; or private costs of effort, subordination, or conformity). Note that here the integration cost is independent of P and Q. The enterprise's net profit is then

$$PQ - \psi(n)C(Q) - \Phi(n). \tag{1}$$

The enterprise chooses n and Q to maximize profit, taking P as given.

Since $\psi(\cdot)$ is decreasing and $C(\cdot)$ is increasing, the profit has (strictly) increasing differences (is strictly supermodular) in the choice variables n and Q. Basic principles of monotone comparative statics (e.g. Topkis, 1998; Vives, 2000) tell us that optimal choices of these variables will therefore co-vary. Since profit has (strictly) increasing differences in P and Q, the optimal quantity Q, and therefore the optimal degree of integration n, will increase with P. The intuition is that a given productivity increase via integration is more valuable when the price of output is higher, so higher prices increase integration incentives.[13]

In our empirical analysis, we will exploit variation in import tariffs to assess the validity of this prediction. We expect a positive relationship between tariffs and vertical integration: given a world price p, an ad-valorem tariff t raises the domestic price for a small country to $P = (1 + t)p$. Higher tariffs increase the gains from integration for firms located in the domestic market. Of course, in practice, firms will experience changes in other variables of the model, such as demand (which can affect P without affecting t), technology ($C(Q)$), or the integration cost $\Phi(n)$ at frequencies much higher than changes in MFN tariffs; indeed it is the relative infrequency with which MFN tariffs change that makes them a good proxy for the domestic price.

The basic prediction does not hinge on the assumption of perfect competition. The same logic applies if the domestic firm is a monopolist: as long as the the tariff-augmented price is below the monopoly price, an increase in the tariff will increase the monopolist's revenue, inducing more integration.[14]

Several corollaries and qualifications follow from this basic logic. First, the impact of import tariffs on integration choices should be stronger for firms that only serve the domestic market, since their profit depends only on the domestic price; the effect should be weaker for firms that also serve foreign markers (exporting firms and multinationals), since their profit and integration decisions depend partly on prices prevailing in other countries.

Second, the impact of trade policy on the degree of vertical integration should also depend on the extent to which import tariffs affect domestic prices. In particular, the higher is the share of imports that are subject to the tariff (i.e. the lower is the share of goods imported duty-free from regional trading partners), the larger should be the effect of tariffs on prices and organization.

[13]To be sure, in some models, particularly those in which incentives play a role, the extent of the efficiency gains may depend on other variables besides n, such as the price P or the distribution of the profits among the various production units (Legros and Newman, 2013). These more general specifications may also lead to nonlinearities and non-monotonicities in the predicted relationship between integration and price. However, these complications do not affect the basic contention that product prices influence integration decisions. We did not find systematic evidence of these more complex patterns in our data.

[14]In case of monopoly, the firm faces an inverse demand $P(Q)$ rather than a constant price P, but cannot charge more than the tariff-augmented world price $p(1 + t)$. It will charge less if the monopoly price $P(Q)$ is less than $p(1 + t)$. Thus its objective is to maximize $\min\,\{p(1 + t), P(Q)\}Q - \psi(n)C(Q) - \Phi(n)$, which has the same properties (nondecreasing differences in t and Q, supermodularity in n and Q) as the competitive firm's objective.

Finally, the law of one price implies a law of one organization: trade policy should affect the degree of organizational convergence across countries. In particular, vertical integration choices should be more alike among countries in sectors in which their import tariffs (and thus their domestic prices) are close. We also expect a tendency for convergence in prices and organizational choices among members of regional trade agreements; this result should be stronger for customs unions — in which members adopt common external tariffs – than in free trade areas — in which differences in external tariffs and rules of origins reduce the extent of price convergence.[15]

To summarize, for the purpose of our empirical analysis, the main predictions of our theoretical framework are:

1. Higher import tariffs on final goods should induce domestic firms producing these goods to be more vertically integrated.

2. The effect of tariffs on integration should be larger for firms serving only the domestic market.

3. The effect of tariffs on integration should be larger in sectors in which a smaller fraction of imports are exempt from the tariff.

4. Country pairs should have similar ownership structures in sectors where they face similar levels of protection; regional trade agreements, especially customs unions, should display similar ownership structures among members.

4 Dataset and variables

In Sections 5-7, we will provide evidence that product prices affect vertical integration decisions in a wide range of countries and industries, in line with the above predictions. Focusing on many countries and industries allows us to exploit MFN tariffs as a source of exogenous price variation.[16] In this section, we describe our dataset and the variables used in our empirical analysis.

4.1 The WorldBase database

Increasingly, researchers use multi-country firm-level data to study issues of organization economics (e.g. Bloom and Van Reenen, 2007; Bloom, Sadun and Van Reenen, 2012). However, cross-country empirical investigations at the firm level are notoriously challenging due to both

[15]See Cadot, de Melo, and Olarreaga (1999), for a comparison of different types of regional trade agreements and a discussion of rules of origin in free trade areas.

[16]As discussed in the introduction, MFN tariffs are very persistent, i.e. vary little in between rounds of multilateral trade negotiations. At a given point in time, given the GATT principle of non-discrimination (see footnote 4), MFN tariffs vary across countries (for a given industry) and across industries (for a given country).

the lack of data and the difficulty of comparing the few high quality time-series datasets that are available (mostly in rich countries). The reason for the data constraint is simple: economic censuses of firms are infrequently collected due to high costs and institutional restrictions, especially in poor countries. No institution has the capacity or resources to collect census data for a wide range of countries and periods. This is why researchers have to use other sources, such as business "compilations" (registries, tax sources) or surveys.

To measure vertical integration, we use data from Dun & Bradstreet's WorldBase, a database covering public and private companies in more than 200 countries and territories.[17] The unit of observation is the establishment/plant. With a full sample, plants belonging to the same firm can be linked via information on domestic and global parents using the DUNS numbers.[18]

The WorldBase dataset has been used extensively in the literature. Early examples include Caves' (1975) analysis of size and diversification patterns between Canadian and U.S. plants. More recent uses include Harrison, Love, and McMillian (2004), Black and Strahan (2002), Alfaro and Charlton (2009), and Acemoglu, Johnson and Mitton (2009). One of the advantages of WorldBase compared to other international datasets is that it is compiled from a large number of sources (e.g. partner firms, telephone directory records, websites, self-registration). Admittedly, sample coverage may vary across countries, but this problem can be mitigated by focusing on manufacturing firms above a size threshold of twenty employees (see discussion below).[19]

4.2 The sample

Our main sample is based on the 2004 WorldBase dataset (for the analysis of China's accession to the WTO, we use data from 1999 and 2007). As mentioned above, the unit of observation in WorldBase is the establishment/plant, a single physical location at which business is conducted or services or industrial operations are performed.

For each establishment, we use different categories of data recorded in WorldBase:

[17]WorldBase is the core database with which D&B populates its commercial data products, including Who Owns Whom™, Risk Management Solutions™, Sales & Marketing Solutions™, and Supply Management Solutions™. These products provide information about the "activities, decision makers, finances, operations and markets" of the clients' potential customers, competitors and suppliers.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.

[18]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 DUNS 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.

[19]Other datasets use different methodologies in different countries. For example, the Amadeus dataset, provided like Orbis by Bureau Van Dijk, uses data from the national public body in charge of collecting the annual accounts in some countries (e.g. the UK) and collects it directly from firms in other countries (most of Eastern Europe). Because of different disclosure requirements, the amount and type of information also varies among countries. See Alfaro and Charlton (2009) for a more detailed discussion of the WorldBase data and comparisons with other data sources.

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.

2. Ownership information: information about the firms' family members (number of family members, domestic parent and global parent).[20]

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.

5. Information on the trade status (exporting/non-exporting).

We carry out the analysis at the firm level, using DUNS numbers to link plants that have the same ultimate owner. As discussed below, however, since the overwhelming majority of firms in our sample have only one establishment, the qualitative results of our analysis are unaffected if we measure vertical integration at the plant level or restrict the analysis to single-plant firms.

We exclude countries and territories with fewer than 80 observations. We further restrict the sample to Word Trade Organization (WTO) members for which we have data on tariffs/regional trading arrangements (see discussion below). Table A-1 in the Appendix lists the countries included in our main sample.[21] In robustness checks, we restrict the analysis to two subsamples of countries: members of the OECD, and countries for which we have information on at least 1000 plants.

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 and for which tariff data are widely available. We exclude firms that do not report their primary activity, 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).

We further exclude firms with less than 20 employees, as our theory is less apt to apply to self-employment or small firms with little prospect of vertical integration (see also Acemoglu, Aghion, Griffith and Zilibotti, 2010). Restricting the analysis to firms with more than 20 employees also enables us to correct for possible differences in the collection of data on small firms across countries (see Klapper, Laeven, and Rajan, 2006).

In our main sample, we focus on firms that are located only in one country. This provides a cleaner setting to verify the predictions of our theoretical model, since the degree of vertical

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

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

integration of these firms should depend primarily on the price at which they sell their product in their country. In the case of multinational corporations, 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). Multinational corporations are included in the robustness analysis (see Section 5.3). In order to link their organizational structure to domestic tariffs, we split them in separate entities — one for each country — and use the primary activity of the respective domestic ultimate to identify the relevant tariff.

We next describe the construction of the vertical integration indices and the other variables used in our empirical analysis. Appendix Table A-2 presents summary statistics for all variables.

4.3 Vertical integration indices

Constructing measures of vertical integration 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 countries.

To measure the extent of vertical integration for a given firm, we build on the methodology developed by Fan and Lang (2000). We combine information on plant activities and ownership structure from WorldBase 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.[22]

Given the difficulty of finding input-output matrices for all the countries in our dataset, we follow Acemoglu, Johnson and Mitton (2009) in using the U.S. input-output tables to provide a standardized measure of input requirements for each sector. 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.[23]

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 uses the SIC

[22] In Acemoglu, Johnson and Mitton (2009), the sample is restricted to a maximum of the 30,000 largest records per country in the 2002 WorldBase file (a limit imposed by cost constraints). For countries with more than 30,000 observations, they select the 30,000 largest, ranked by annual sales. Having information on the full sample of establishments in WorldBase, we are able to link establishments to firms (see discussion below).

[23] 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 by introducing measurement error in the dependent variable of our regressions. In addition, using the US input-output tables to construct vertical integration indices for other countries mitigates the possibility that the IO structure and control variables are endogenous. In robustness checks, we verify that our results are unaffected when restricting the analysis to OECD countries, which are closer to the U.S. in terms of technology (See Section 5.3).

industry classification. The BEA website provides a concordance guide, but it is not a one-to-one key.[24] 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 Acemoglu, Johnson and Mitton (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).[25] The IO_{ij}^f coefficients for this plant are:

		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.[26] 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

[24]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.

[25]There is no concern of right censoring in the number of reported activities: only 0.94 percent of establishments with primary activity in a manufacturing sector report the maximum number of five secondary activities.

[26]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.

that the degree of vertical integration for this plant is 0.123.

For firm f in primary sector k located in country c, we define the integration index in activity j as

$$V^j_{f,k,c} = \sum_i IO^{f,k}_{ij}, \tag{2}$$

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:

$$V_{f,k,c} = V^j_{f,k,c}, j = k. \tag{3}$$

In the case of multi-plant firms, we link the activities of all plants that report to the same headquarters and consider the main activity of the headquarters as the primary sector.

The approach we follow to identify vertical integration infers a firm's level of vertical integration from information about the goods it produces in each of its establishments and the aggregate input-output relationship among those goods. The advantage of this method is that one need not worry about the value of intra-firm activities being affected by transfer pricing. Another advantage is that using I-O tables avoids the arbitrariness of classification schemes that divide goods into "intermediate" and other categories (Hummels, Ishii, and Yi, 2001).

One might be concerned about measuring vertical integration at the firm level, in light of recent studies that find little evidence of trade between plants of the same firm.[27] However, this concern does not apply to our analysis. This is because 96% of the firms in our sample have only one plant and 87% of plants are not connected (see Table A-2). The qualitative results of our analysis are thus unaffected if we measure vertical integration at the plant-level or restrict the analysis to single-plant firms.

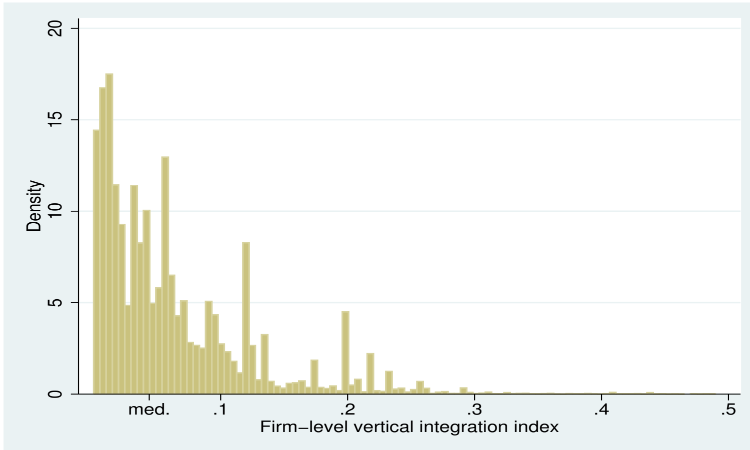
Summary statistics for firm-level vertical integration are presented in Appendix Table A-2, while Table A-3 reports average vertical integration indices by sector (at the 2-digit SIC level).[28] Our main sample consists of 196,586 domestic manufacturing firms with at least 20 employees located in 80 countries. The histogram in Figure 1 reports the distribution of vertical integration indices for all firms in our main sample. According to our measure, most firms produce relatively few inputs in house: the median vertical integration index is around 0.044 and the mean is 0.063.[29]

[27]Hortaçsu and Syverson (2009) find little evidence of commodity shipments across plants in US non-multinational firms. Similarly, Ramondo, Rappoport and Ruhl (2012) find the bulk of intra-firm trade between affiliate and the U.S. parent to be concentrated among a small number of large affiliates.

[28]The descriptive statics for our vertical integration measure are similar to Acemoglu, Johnson and Mitton (2009). They 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 (see Table A-2). The ordering of industries by degree of vertical integration in Table A-3 is also similar to that reported by Acemoglu, Johnson and Mitton (2009).

[29]It should be noted that this measure does not consider payments to capital and labor services and is thus

Figure 1: Firm-level vertical integration index



As mentioned in the introduction, the mechanisms outlined in our model could apply to other types of integration. In this paper, we focus on vertical integration, which we can measure using information available in our dataset on the primary and secondary activities of each firm and applying the methodology developed by Fan and Lang (2000). While it would be interesting to examine whether whether higher tariffs, by raising product prices, also lead firms to be more horizontally or laterally integrated, these cases present some difficulties. One virtue of the Fan-Lang index is that it depends only on firm characteristics and technology, and is in particular invariant to industry composition. Firm-level measures of horizontal integration (e.g. firm size to mean size ratio, measured variously) or industry-level measures (e.g. Herfindahl indices), which need not be good proxies for firm-level integration anyway, are not. This makes those measures vulnerable to selection effects: for instance, to the extent that firms are heterogeneous in productivity, a reduction in tariffs forces less productive firms to exit, shifting market share towards more productive firms (Melitz, 2003). This may result in a negative relationship between tariffs and industry concentration, which is not directly related to our mechanism. As for lateral integration, constructing a firm-specific measure would require sales of each plant by product line for narrowly defined industries, which we do not observe in our dataset.

4.4 Tariffs and other trade variables

Our main strategy to empirically assess the impact of market prices on ownership structure is to use data on most-favored-nation (MFN) tariffs applied by GATT/WTO members. As argued in the introduction, these tariffs offer a source of price variation that is exogenous to firm

always less than unity. Indeed, in the U.S. an industry pays on average around 56% of gross output to intermediates, the rest being value added. Thus, even a fully vertically integrated firm in a typical sector would have an index of only 0.56.

boundaries.

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, which are constrained under Article I of the GATT by the MFN principle of non-discrimination: each country c applies the tariff $\mathit{Tariff}_{k,c}$ to all imports of final good k that originate in other WTO member countries. Preferential treatment is only allowed for imports originating from RTA members or from developing countries (see discussion below).

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). In our main empirical analysis, we use applied MFN tariffs for 2004.[30] 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.

Applied MFN tariffs vary substantially both across sectors within countries and across countries for a given sector. For example, U.S. manufacturing tariffs in 2004 averaged 2.4 percent, with a minimum of zero and a maximum of 350 percent. As an example of cross-country variation, for a sector like SIC 3631 (Household Cooking Equipment), applied MFN tariffs varied between zero and 29 percent, with an average of 3.15 percent.

Our analysis focuses on tariffs on final goods in the domestic market. In some regressions, we also control for the tariffs applied to imported inputs, using the variable $\mathit{Input\ Tariff}_{k,c}$. This is a weighted average of 4-digit SIC applied MFN tariffs, using normalized IO-coefficients from the US input-output table as weights. To proxy for the level of protection faced by exporters in foreign markets, we use the variable $\mathit{Export\ Tariff}_{k,c}$. We construct this variable by weighting tariffs in destination markets with bilateral sectoral export shares using information from the UN Comtrade database.

The variable $\mathit{MFN\ share}_{k,c}$ measures the fraction of imports to which MFN tariffs apply, for each country and sector. This excludes imports from countries with which the importer has a preferential trade agreement, which do not face tariff restrictions. The higher is this share, the more sensitive its domestic prices should be to MFN tariffs. For example, the U.S. will have low MFN shares in sectors in which it imports a lot from its NAFTA trading partners (Canada and Mexico). In these sectors, the MFN tariff that the U.S. imposes on other WTO members will have little impact on domestic prices. In contrast, the effect may be substantial in sectors where most imports originate in countries with which the U.S. has no preferential trade agreement.

To distinguish between firms selling only in the domestic market and exporting firms, we

[30] If information on applied MFN tariffs is unavailable for that year, we use the closest available data point in a five year window around 2004 (2002-2006), with priority given to earlier years. For example, if data are available for 2003 and 2005, but not 2004, the 2003 data are chosen.

construct two measures. The dummy variable $Domestic_f$ is constructed from WorldBase and takes the value of 1 if firm f does not report to be an exporter. The variable $Import\text{-}competing_{k,c}$ is a country-sector specific measure of import-competition constructed using information from Comtrade. This is a dummy indicating whether a firm operates in one of the 25 percent most import-competing sectors, based on the ratio of a country's total imports/exports by sector.

We also collect information on all regional trade agreements in force in 2004 from the WTO Regional Trade Agreements Information System (RTA-IS).[31] We construct the dummy $RTA_{c,c'}$ that equals one when countries c and c' belong to a regional trade agreement formed under Article XXIV of the GATT.[32] To distinguish between different types of RTAs, we construct the dummy variables $Customs\ Union_{c,c'}$ and $Free\ Trade\ Area_{c,c'}$. We expect the former, which imply a common external tariff and no internal trade barriers, to have a stronger effect on organizational convergence than the latter, which permit member countries to maintain different external tariffs.

4.5 Other controls

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

In terms of country-specific variables, the empirical and theoretical literatures have studied the role of institutional characteristics and financial development.[33] We use the variable $Legal\ Quality_c$ to proxy for the quality of a country's institutions. This is the variable "rule of law" from Kaufmann, Kraay, and Mastruzzi (2003), which 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. The variable $Financial\ Development_c$ measures private credit by deposit money banks and other financial institutions as a fraction of GDP for 2004 and is taken from Beck, Demigurc-Kunt, and Levine (2006).

We also construct the variable $Capital\ Intensity_k$, using data from the NBER-CES manufacturing industry database (Bartelsmann and Gray, 2000) at the 4-digit-SIC level. 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.

To control for domestic industry concentration, we construct $Herfindahl_{k,c}$ indices using in-

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

[32] 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.

[33] Poor legal institutions may affect vertical integration decisions through their impact on the severity of hold-up problems. Financial development may affect integration positively if a sufficient level may be necessary for upstream and downstream firms to be able to integrate, or negatively insofar as integration facilitates borrowing and therefore substitutes for poor financial institutions. As Acemoglu, Johnson and Mitton (2009) note, the effect of each of these variables may be ambiguous when considered separately and there may be more robust predictions of their combined effect.

formation on sales of all plants in a given country and sector.[34]

To proxy for the degree of product differentiation, we use two dummy variables. The variable $Homogeneous1_k$ is equal to 1 when a sector is homogeneous according to the well-known classification by Rauch (1999).[35] The dummy variable $Homogeneous2_{k,c}$ is constructed using information on sector-country-specific import demand elasticities estimated by Broda, Greenfield and Weinstein (2006).[36] It takes value 1 whenever the elasticity is above the median for the country. Broda, Greenfield and Weinstein (2006) show that sectors with more homogeneous products are characterized by higher import demand elasticities.

In some specifications, we include the variable $Size_f$, using information on firm-level employment from WorldBase. Since firm size is clearly endogenous to vertical integration, we always use predicted size as an instrument, constructed by regressing firm size on sector-country dummies. Similarly, we construct labor productivity measured as firm sales divided by employment. Again, we instrument this variable using predicted (with sector-country dummies) labor productivity.

In the regressions on organizational convergence, 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 $Contiguity_{c,c'}$, for $Common\ Language_{c,c'}$ (official or primary), and $Colonial\ Relationship_{c,c'}$ (current or past). In some specifications, we also include the variable $Difference\ GDP_{c,c'}$ for the year 2004 constructed from the World Development indicators.

5 Tariffs and vertical integration

In this section, we assess the empirical validity of the main prediction of our theoretical model that higher prices for the final good lead to more vertical integration at the firm level. To examine the organizational effects of trade policy, we exploit variation in applied MFN output tariffs across countries and sectors (the following section exploits time-series variation in the degree of protection faced by firms). We estimate the following reduced form regression model:

$$V_{f,k,c} = \alpha + \beta_1 \text{ Tariff}_{k,c} + \beta_2 \mathbf{X}_{f,k,c} + \delta_k + \delta_c + \epsilon_{f,k,c}, \tag{4}$$

where $\mathbf{X}_{f,k,c}$ is the vector of explanatory variables, δ_k and δ_c are sector and country dummies and $\epsilon_{f,k,c}$ is an error term with $E(\epsilon_{f,k,c}|\mathbf{X}_{f,k,c}, \delta_k, \delta_c) = 0$. Thus, the effect of $Tariff_{k,c}$ on $V_{f,k,c}$ is causal conditional on covariates.

We study the determinants of $V_{f,k,c}$, the vertical integration index of firm f, with primary sector k, located in country c, as defined in (3). Since the distribution of vertical integration

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

[35]Rauch (1999) classifies products according to three different types: homogeneous goods, which are traded in organized exchanges; goods that are are not traded in organized exchanges, but for which a published reference price can be found; and differentiated goods, which fall under neither of the two previous categories.

[36]We thank David Weinstein for making these data available to us.

indices is rather skewed (see Figure 1), we use log of one plus $V_{f,k,c}$ as our dependent variable.[37]

Our main regressor of interest is the variable $Tariff_{k,c}$, which is the log of one plus the MFN tariff applied to output in sector k by country c.[38] Our model predicts that higher final good tariffs within an industry should lead firms in that industry to be more vertically integrated. We thus expect the coefficient β_1 to be positive.[39]

The vector $\mathbf{X}_{f,k,c}$ includes a series of firm- and sector-country-specific controls, that we will discuss below. 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. 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 1 reports the results of estimations in which we test the main predictions of our theoretical framework. Column (1) presents the results of the basic specification, which includes only the variable *Tariff* and country and sector fixed effects. The estimated coefficient for the tariff is 0.02 (implying a tariff elasticity of vertical integration of the same magnitude) and strongly significant. Consistent with the first prediction of our theoretical model, higher tariffs lead firms to be more vertically integrated. To the extent that domestic prices do not fully adjust to tariff changes, our estimates can be interpreted as a lower bound on the impact of prices on vertical integration. As discussed below, for competitive sectors, in which firms cannot strategically adjust their prices in response to tariff changes, our estimates imply a price elasticity of vertical integration of up to 2.1.

In columns (2) and (3) we verify whether the effect of domestic tariffs on organization is larger for firms that operate only in the domestic market (for which only this price should affect the degree of vertical integration). To do so, we interact the variable $Tariff_{k,c}$ with two dummy variables: $Domestic_f$, which is constructed using information on from WorldBase and takes the value of 1 if firm f does not report to be an exporter; and $Import\text{-}competing_{k,c}$, which is constructed using information from Comtrade and indicates whether a firm operates

[37]We have also used the log of the vertical integration index (removing zero observations), obtaining similar results. There are very few zeros in the dependent variable, so there is no need to perform a Tobit analysis. All results not shown due to space considerations are available upon request.

[38]Tariffs are expressed in ad-valorem terms. In the main specifications, we use log of (one plus the tariff) in order to be able to include zero tariffs. Although the distribution of tariffs is extremely skewed, the log of (one plus the tariff) is approximately normally distributed. In all regressions we scale vertical integration indices and tariffs so that adding unity to the variables is quantitatively irrelevant. This implies that the coefficients can still be interpreted as tariff elasticities of vertical integration. In alternative specifications, we used log vertical integration and log tariffs, obtaining very similar results.

[39]We have also performed a series of estimations including a quadratic term for $Tariff_{k,c}$, finding no evidence of a non-monotonic relationship between tariffs and vertical integration.

in one of the 25 percent most import-competing sectors, based on the ratio of a country's total imports/exports by sector. We expect the coefficients on the interaction terms to be positive.

In column (2) the coefficient for tariffs (which measures the impact of tariffs on vertical integration for exporters) is positive but insignificantly different from zero. On the other hand, the coefficient on the interaction term is positive, strongly significant and similar in magnitude to the baseline specification. Thus, import tariffs have a significant effect on vertical integration only for firms that sell exclusively in the domestic market. In column (3), we use the alternative measure to identify firms that do not export to foreign markets. Again, the coefficient on the interaction term is positive and significant at the five-percent level, indicating that import tariffs have a bigger impact on vertical integration decisions for firms that operate in import-competing sectors.

In column (4) we verify whether tariffs have a larger impact on vertical integration when the share of imports to which they apply is larger (implying a bigger effect on domestic prices). To do this, we include the variable $\textit{MFN share}_{k,c}$, capturing the fraction of imports to which MFN tariffs apply in a given country and sector, as well as the interaction between this variable and the tariff. The coefficient in the first row now measures the impact of MFN tariffs when no imports are subject to them (i.e. in a sector in which a country imports only from regional trading partners). Not surprisingly, this coefficient is not significant, since in this case MFN tariffs should have no impact on domestic prices. The interaction term is instead positive and significant at the one-percent level, indicating that the effect of MFN tariffs on vertical integration is positive and increasing in their importance for import volumes.

In columns (5)-(8) we repeat the same specifications, adding interaction terms that have been emphasized in previous studies on vertical integration. In particular, Acemoglu, Johnson and Mitton (2009) find evidence that contracting costs and financial development have a stronger impact on vertical integration in more capital-intensive sectors. We thus introduce two interaction terms: one between $\textit{Capital Intensity}_k$ and $\textit{Financial Development}_c$ and the other one between $\textit{Capital Intensity}_k$ and $\textit{Legal Quality}_c$. The coefficient on the first interaction term is positive and significant, indicating that more capital intensive sectors are more integrated in countries with more developed financial markets. The second interaction term has the expected negative sign but it is not significant. In all specifications, our results on the effect of tariffs on firm-level vertical integration are unaffected.

5.1 Alternative mechanisms

Our theoretical analysis focuses on a perfectly competitive setting, in which firms are price takers. According to our model, tariff changes should affect organizational choices through their impact on product prices: higher tariffs should raise prices and thus increase the incentives for vertical integration.

In reality, tariff changes may also affect vertical integration decisions through their impact on the degree of competition faced by firms. In particular, Aghion, Griffith and Howitt (2006) suggest a U-shaped relationship between competition and vertical integration: a small increase in competition reduces a producer's incentive to integrate by improving the outside options of non-integrated suppliers and hence raising their incentive to make relationship-specific investments; too much competition raises the producer's incentive to integrate, by allowing non-integrated suppliers to capture most of the surplus.

To isolate the organizational effects of product prices, in Table 2 we restrict our analysis to highly competitive sectors, in which tariffs changes should have little or no effect on the degree of competition. In all specifications, we impose two restrictions to define competitive industries: i) there are at least 20 domestic firms operating in that country and sector; ii) goods are homogeneous. Further restrictions are imposed in some specifications, as discussed below. To distinguish between differentiated and homogeneous sectors, we adopt two alternative methodologies: in Panel A, we use the dummy variable $Homogeneous1_k$, which identifies industries in which goods are traded in organized exchanges, classified as homogeneous according to Rauch (1999); in Panel B, we use instead the variable $Homogeneous2_{k,c}$, which identifies sectors with high import demand elasticities according to Broda, Greenfield and Weinstein (2006). Notice that the sample is much larger in the bottom panel, since the variable $Homogeneous2_{k,c}$ varies at the country-sector level.

In the baseline specifications of columns (1)-(2), competitive sectors are identified based only on the two criteria discussed above. Additional restrictions are imposed in the rest of the table. Columns (3)-(4) include only sectors with low levels of protection ($Tariff_{k,c} < 10\%$), in which domestic firms face a high level of foreign competition. In columns (5)-(6) the sample is restricted to sectors in which some foreign-owned firms have plants in the domestic market, further increasing the competitive pressure on domestic firms. In columns (7)-(8) we exclude concentrated sectors, i.e. industries for which the $Herfindahl_{k,c}$ index is above 0.1.

In all specifications, the coefficient for $Tariff_{k,c}$ is positive and significant at least at the five-percent level. The results of Table 2 allow us to identify the price-level effects of tariff changes on firm boundaries, abstracting from possible competition effects. In line with our theoretical model, these results suggest that higher import tariffs lead domestic firms to be more vertically integrated, by increasing the price at which they sell their final products.

Table 2 shows that, in competitive sectors, the tariff elasticity of vertical integration ranges between 0.025 and 0.1.[40] Given that tariffs are expressed in ad-valorem terms rather than in units, at the average tariff rate of around 5 percent, these estimates imply that the *price* elasticity of vertical integration is much greater: the estimates of the upper panel of Table 2 imply that

[40]In terms of standard deviations, a one standard deviation increase in tariffs implies an up to 0.12 standard deviation increase in vertical integration.

the price elasticity of vertical integration ranges between 0.61 (column 1) and 2.1 (column 8).[41] Price changes can thus have significant effects on firm boundaries.

The fact that tariffs continue to positively affect vertical integration when restricting the analysis to homogeneous and highly competitive sectors is consistent with the predictions of our theoretical model. By contrast, it is difficult to reconcile this result with models in which tariffs affect firm boundaries through their impact on the degree of competition.

Another possible explanation for our results could be that protected firms have more disposable cash to acquire their suppliers. Notice that this explanation relies on the fact that firms are credit constrained, so that the amount of cash available matters for takeovers decisions. If this is the reason behind the positive impact of tariffs on vertical integration, we would expect the effect to be stronger in sectors and countries in which credit constraints are more severe. To verify this, we have interacted the tariff variable with the inverse of our measure *Financial Development*$_c$ and with a standard measure of financial dependence, which capture the extent of financial market imperfections in different countries and sectors.[42] We have tried different specifications (e.g. including the interaction terms separately or together, including a triple interaction between tariffs, financial dependence and the inverse of financial development). In all cases, the interaction terms were insignificant and the sign and significance of the tariff coefficient was unaffected, suggesting that cash availability is not the reason behind the positive effect of tariffs on vertical integration.[43]

5.2 Omitted variables

Our analysis shows that firms are more vertically integrated when import tariffs on their final product are higher. In this section, we deal with endogeneity concerns, to establish a causal relationship between tariffs and organization decisions. As argued above, reverse causality is unlikely to be a problem in our analysis, since there is no reason to believe that firms' ownership structures affect applied MFN tariff rates. However, MFN tariffs on final products could be correlated with omitted variables that may also affect vertical integration decisions.

In what follows, we show that our results are robust to controlling for two sets of potential

[41] To see this, denote the domestic price of good k in country c as $p_{k,c} = (1+t_{k,c})P_k$, where P_k is the world price of good k and $t_{k,c}$ is the tariff. Then the tariff elasticity of domestic prices is given by $\frac{\partial p_{k,c}}{\partial t_{k,c}} \frac{t_{k,c}}{p_{k,c}} = \frac{t_{k,c}}{1+t_{k,c}} + \frac{\partial P_k}{\partial t_{k,c}} \frac{t_{k,c}}{P_k}$, 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). Define $\frac{\partial V_{k,c}}{\partial t_{k,c}} \frac{t_{k,c}}{V_{k,c}} \equiv \beta$. The price elasticity of vertical integration can then be written as $\frac{\partial V_{f,k,c}}{\partial p_{k,c}} \frac{p_{k,c}}{V_{k,c}} = \beta \left[\frac{t_{k,c}}{1+t_{k,c}} + \frac{\partial P_k}{\partial t_{k,c}} \frac{t_{k,c}}{P_k} \right]^{-1}$. Abstracting from terms of trade effects, and substituting the average tariff of 5 percent, we obtain $\frac{\partial V_{f,k,c}}{\partial p_{k,c}} \frac{p_{k,c}}{V_{k,c}} = \beta * 21$.

[42] Following Rajan and Zingales (1998), we define a firm's external dependence on finance as capital expenditures minus cash flow from operations divided by capital expenditures. Our sectoral measure of external dependence on finance is the median firm's external dependance on finance in a given sector in the U.S in the period 1999-2006, constructed from Compustat.

[43] The results of these regressions are omitted due to space considerations, but are available upon request.

omitted variables. First, we include measures of input tariffs and export tariffs, which are correlated with output tariffs and may also affect vertical integration decisions.[44] Second, we control for firm size, labor productivity and industry concentration, which can affect the degree of protection through their impact on lobbying pressure (e.g. Mitra, 1999; Bombardini, 2008) and may also be correlated with firms' ownership structures.

The results of these regressions are presented in Table 3. For comparison, in the first two columns, we report the results of the baseline specifications. In column (3)-(8), we add additional controls, first one by one and then simultaneously: $\textit{Input Tariff}_{k,c}$, $\textit{Export Tariff}_{k,c}$, $\textit{Herfindahl}_{k,c}$, $\textit{Size}_f$ (instrumented with predicted size) and $\textit{Labor Productivity}_f$ (instrumented with predicted labor productivity). Notice that, in all specifications, the coefficient on *Tariff* is positive, highly significant, and very stable. These results indicate that omitted variables are not a concern and that higher output tariffs lead to more vertical integration.

Of the additional controls, firm size and labor productivity have a positive and significant effect on organization, a result that continues to hold in all additional robustness checks. The fact that more productive firms are more likely to be integrated can be explained by the theoretical model, in which firms with higher levels of exogenous productivity have more incentives to vertically integrate at any given price.[45]

The estimated coefficient on input tariffs in Table 3 is positive and significant, though this result disappears in some of the robustness checks (e.g. Table A-4). It should be stressed that our theory generates no clearcut predictions concerning the effects of input tariffs on boundary choices: whether higher input prices strengthen or weaken the incentives for integration depends on whether inputs sales are part of the revenue of the enterprise (in which case higher input tariffs will lead to higher integration) or part of its (contractible) costs. For example, if an automobile manufacturer produces more stampings than it needs and sells the remainder on the market, then the sale of stampings will enter its revenue; in this case, the higher the price of stampings, the higher the incentives to integrate. On the other hand, if stampings are purchased on the open market, an increase in their price will diminish revenue and reduce the incentives to integrate.

Finally, notice that the coefficient on $\textit{Export Tariff}_{k,c}$ is insignificant in all specifications and in the additional robustness checks (see Table A-4). This finding can easily be explained by our model: if countries are small, tariffs in foreign markets should have no impact on domestic prices and thus on vertical integration decisions by domestic firms.[46]

[44] The simple correlation of output tariffs with input tariffs is 0.78 and the one with export tariffs is 0.31.

[45] While we cannot formally test whether the instruments (average firm size and labor productivity in a given country-sector pair) are valid, because the model is exactly identified, we are confident that including predicted firm size or productivity as controls does not introduce any endogeneity bias, since the coefficient of the variable *Tariff* is unaffected when including these controls.

[46] By contrast, this result is hard to reconcile with models of vertical integration choices by multinationals, in which tariffs affect location decisions, and these are inextricably intertwined with boundary decisions. For example, in the model by Diez (2010) tariffs in one country (North or South) should always decrease vertical

5.3 Additional robustness checks

In line with the predictions of our theoretical model, our empirical analysis shows that higher output tariffs lead domestic firms to be more vertically integrated. This effect is stronger for firms serving only the domestic market — for which organizational choices should depend solely on domestic prices — and operating in sectors in which a smaller share of imports originate from regional trading partners — for which MFN tariffs should have a larger impact on domestic prices.

The results presented in Tables 1-3 already show that the organizational effects of tariffs are robust to the inclusion of many different controls that account for alternative drivers of vertical integration decisions. In a series of additional robustness checks, we have verified that higher tariff on final goods continue to have a positive and significant effect on firm-level vertical integration when using different econometric methodologies or focusing on alternative samples.

In Table A-4 in the Appendix, we have reproduced all the specifications of Table 3, using a Poisson quasi-maximum likelihood (PQML) estimator to assess the effect of tariffs on vertical integration. The rationale for this exercise is that Santos Silva and Tenreyro (2006) have shown that for log-linear models the OLS estimator gives biased estimates in the presence of heteroscedasticity and have suggested the PQML estimator as an alternative with good statistical properties. Vertical integration is now estimated in levels, which allows to include observations for which the dependent variable is zero, while the explanatory variables are in logs and can thus be interpreted as elasticities. Standard errors are again clustered at the sector-country level. Our main result on the impact of output tariffs is unaffected: in all specifications, the coefficient for the output tariff is always positive and significant. Input and export tariffs have instead no significant effect on firm-level vertical integration.

The organizational effects of output tariffs were also unaffected in a series of additional estimations discussed below. The results of these specifications are omitted from the paper due to space considerations, but are available upon request.

We have restricted the sample to OECD countries. Our methodology for constructing vertical integration indices better applies to these countries: since they are more similar to the United States in terms of technology, it is less problematic to use U.S. input-output matrix to measure technological linkages between sectors.[47]

We have used an alternative measure of vertical integration, constructed based on all the firm's activities rather than its primary activity: $\overline{V}_{f,k,c} = \frac{1}{N_f} \sum^{j} V^{j}_{f,k,c}$, where N_f is the number of industries in which firm f is active. The coefficients for MFN tariffs remained strongly significant but, not surprisingly, they dropped slightly in magnitude.

integration in the other country, so tariffs faced by exporters should have a negative effect on vertical integration.

[47]Moreover, most MFN tariffs applied by OECD countries in 2004 coincide with the bindings set in the Uruguay Round of multilateral trade negotiations (1986-1994), particularly in non-agricultural sectors (Bchir, Jean and Laborde, 2006). Governments have thus no room to adjust them under the pressure of import-competing firms.

In our analysis, we cluster standard errors at the sector-country level. Alternatively, we have tried clustering at the sector level, at the country level and two-way clustering at the sector and country level. In all cases, the coefficient for $Tariff_{k,c}$ remained strongly statistically significant.

We have also carried out the analysis on two additional samples of firms. First, we have restricted the sample to countries for which we observe at least 1000 plants of sufficient size in order to eliminate any bias that may arise from differences in sampling across countries. Second, we have included multinational firms to the main sample. As noted above, since multinationals have plants in different countries, it is hard to identify with precision the tariffs that affect their organization decisions; we have thus split them into separate firms by country and used the primary activity of the respective domestic ultimate to identify the relevant tariff. For each of these samples, we have reproduced all the specifications of Table 3, adding a dummy variable for multinational status for the sample including multinationals. As expected, the coefficient for $Tariff_{k,c}$ remained always positive and strongly significant.

6 Time-series evidence: China's accession to the WTO

As noted in the introduction, China's accession to the WTO in 2001 is arguably the only major trade liberalization episode that has occurred in the last decade, for which we can use D&B data to construct vertical integration measures. To be accepted as a member of the WTO, China agreed to undertake a series of important commitments to better integrate in the world economy and offer a more predictable environment for trade and foreign investment in accordance with WTO rules.[48] In particular, China had to substantially expand market access to goods from foreign countries, reducing its import tariffs from an average of 13.3 percent in 2001 to 6.8 percent by the end of the implementation period.[49]

Our identification strategy is based on the comparison of two periods, a pre-accession one and a post-accession one, to verify whether firm-level vertical integration was reduced by more in those sectors that experienced larger tariff cuts. We thus construct vertical integration measures for all Chinese manufacturing firms that are in the WorldBase dataset for the years 1999 (pre accession) and 2007 (post accession), following the same procedure described in Section 4.3. We use 2007 instead of 2004 as the post-accession period because we expect firms' ownership structure to react slowly to price changes induced by tariff reductions.

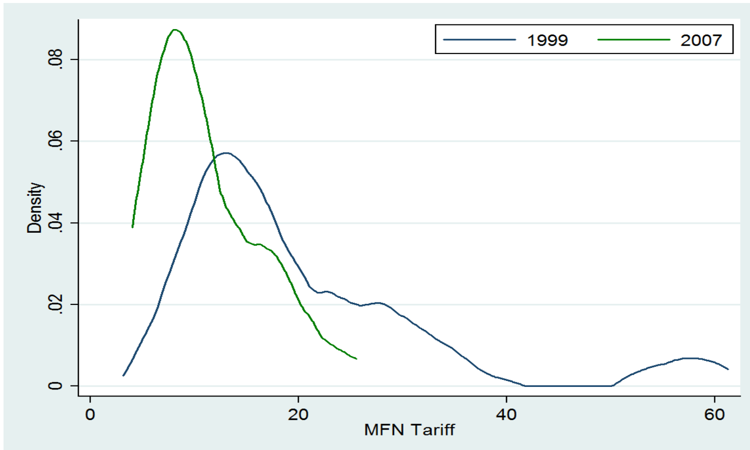
Figure 2 provides the histograms of the MFN tariffs applied by China in 1999 and 2007. The sample is based on those manufacturing sectors for which we observe firms (with at least 20 employees, excluding multinationals) in both years, consisting of almost 29,000 firms that we observe in at least one year. For the sectors in this sample, applied tariffs fell from an average 20

[48] A detailed list of China's commitments can be found in its Protocol of Accession. China's accession implied few trade policy changes for other WTO members, since most of them had already been granting it MFN status.

[49] The implementation period lasted until 2010, though most tariff reductions had to be completed by 2005.

to an average of 9.9 percent between 1999 and 2007, with a lot variation across sectors.[50] At the same time, the average level of vertical integration for the sample of firms declined from 0.111 to 0.084.[51] Figure 3 visualizes the leftward shift in the distribution of VI indices between 1999 and 2007.

Figure 2: Chinese import tariffs, 1999 and 2007



In what follows, we examine whether Chinese firms have adjusted their vertical integration structure following WTO accession in response to the tariff reductions. To this purpose, we run two sets of regressions. First, we use a very similar specification as in our main test (4), using only those sectors for which we observe some firms in both 1999 and in 2007:

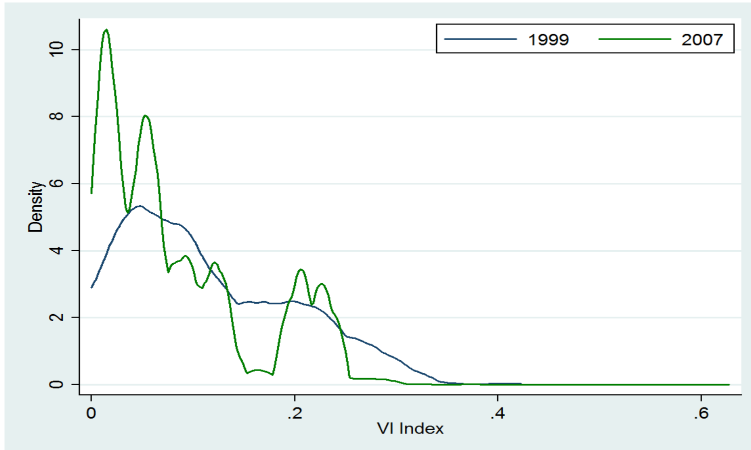
$$V_{f,k,t} = \alpha + \beta_1 \text{ Tariff}_{k,t} + \beta_2 \mathbf{X}_{f,k,t} + \delta_k + \delta_t + \epsilon_{f,k,t}. \tag{5}$$

Here, $\mathbf{X}_{f,k,t}$ is again a vector of controls, which includes $Public_{f,t}$, a dummy for public ownership from Worldbase, and $Herfindahl_{k,t}$. We control for $Public_{f,t}$ since public ownership is very common in China and may be correlated with vertical integration. Again, we expect the coefficient of $Tariff_{k,t}$ to be positive. Notice that, by controlling for sector fixed effects, we exploit the time variation of tariffs within sectors. Specifically, the tariff coefficient is identified by the deviation of firm-level vertical integration from its sector mean that is due to the time variation in tariffs

[50] The maximum reduction in tariffs was 415 percent (SIC 3578, Calculating and Accounting Machines), the median reduction was 51 percent. Only in a few sectors, tariffs did not change or actually increased (e.g. SIC 2084 Wines, Brandy and Brandy Spirits).

[51] One may be concerned that tariff levels and reductions may be endogenous to industry characteristics, for example because industries with larger firms, more concentrated industries, or industries with more prevalence of public ownership would lobby for higher initial tariff levels and smaller subsequent tariff reductions. If on the other hand, these sectors are systematically different in terms of vertical integration, one may spuriously obtain negative correlations between vertical integration and tariffs. In our sample, however, this is not the case: the level of tariffs in 1999 is neither significantly correlated with sector-level average firm size, nor with industry concentration or public ownership in the same year. Moreover, changes in tariffs between 1999 and 2007 are also not significantly correlated with the level of the previous variables in 1999.

Figure 3: Chinese vertical integration indices, 1999 and 2007



relative to their sector mean. Given that we only consider sectors for which we can observe firms in both periods, sector averages of vertical integration and tariffs are well identified. General trends in vertical integration, which may be due to other reforms that occurred in China over the sample period, are picked up by time dummies.[52]

In a second set of regressions, we focus on within-firm variation in VI indices. Unfortunately, the overlap between the firms sampled in 1999 and 2007 is small. Once we exclude multinationals and plants with less than 20 employees, as we have done in our earlier analysis, there are 145 firms that we can observe in both years. For this set of firms, we take time differences of equation (5) and estimate

$$\Delta V_{f,k} = \alpha + \beta_1 \Delta \text{ Tariff}_k + \beta_2 \Delta \mathbf{X}_{f,k} + \Delta \epsilon_{f,k}. \tag{6}$$

Again, we expect the coefficient of $\Delta\, Tariff_k$ to be positive. In these regressions, we control not only for changes in firm size, industry concentration and public ownership status, but alternatively also for changes in the degree of state ownership by sector, by including the variable *Privatization*. This measures the fraction of government-owned firms that were privatized in a given sector (at the 2-digit industry level) between 1999 and 2004 and is taken from Bai, Lu and Tao (2009).

Table 4 presents the results for both sets of regressions. Columns (1)-(4) reports the results for the regressions with sector dummies. In all specifications, we find a positive and significant (at the one percent level) coefficient on the tariff variable, implying larger reductions in vertical integration in sectors that have experienced larger tariff reductions. The coefficient magnitude is around 0.03, which is slightly larger than our cross-section estimates. The coefficient of the public-ownership dummy is positive and highly significant, indicating that publicly owned firms

[52] In these regressions, unobserved firm-specific effects are assumed to be common for all firms in a given sector.

are more vertically integrated. Finally, the level of industry concentration has no significant effect on vertical integration.

Turning to the specification in differences, in columns (5)-(10) we obtain similar results. The coefficient of tariff changes is always positive, significant and similar in magnitude to the specification with sector dummies. In column (6) we add changes in industry concentration as control, which leaves the tariff coefficient unaffected. Column (7) adds change in public ownership status as control, which is insignificant and does not change the tariff coefficient. In column (8) we alternatively use *Privatization* as a control, which is again insignificant and also leaves the coefficient of tariffs unchanged. Finally, in columns (9) and (10), we simultaneously control for changes in public ownership structure and changes in industry concentration by adding the Herfindahl index. While changes in tariffs remain positive and significant, changes in industry concentration and changes in public ownership have no significant effects.

7 Trade policy and organizational convergence

The purpose of this section is to assess the validity of the predictions of our model on how trade policy affects organizational convergence between countries, through its impact on price convergence.

To measure organizational convergence, we construct sector-country-specific measures of vertical integration by regressing firm-level vertical integration on industry-sector dummies and firm size. The estimate for the sector-country dummy gives us a measure of the average level of vertical integration of industry k in country c, denoted by $\hat{V}_{k,c}$.

We first examine whether cross-country differences in sectoral organizational structure are affected by differences in tariffs. For a given country-pair c, c', we expect organizational differences to be smaller in sectors characterized by similar levels of protection.

To verify this, we estimate the following model:

$$|\hat{V}_{k,c} - \hat{V}_{k,c'}| = \alpha + \beta_1 |\text{ Tariff}_{k,c} - \text{ Tariff}_{k,c'}| + \beta_2 |\mathbf{X}_{k,c} - \mathbf{X}_{k,c'}| + \delta_k + \delta_{c,c'} + \epsilon_{k,c,c'}. \tag{7}$$

The dependent variable is the absolute difference between countries c and c' in the estimated vertical integration indices for sector k. 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 ($\delta_{c,c'}$), β_1 is identified by the cross-sectoral variation in the tariff difference for a given country pair. To allow for correlation of the errors between sectors for a given country pair, we cluster standard errors by dyad.

The results of these regressions are reported in Panel A of Table 5. In column (1), 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 indices are significantly (at the one 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 indices. 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.

We next examine the relation between the degree of sectoral organizational convergence and common membership in a regional trade agreement. In contrast to the regressions on tariff differences, a causal interpretation of these regression results is more difficult, since it is possible that countries that are generally more similar are more likely to form RTAs.

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

$$|\hat{V}_{k,c} - \hat{V}_{k,c'}| = \alpha + \beta_1 RTA_{c,c'} + \beta_2 \mathbf{X}_{c,c'} + \delta_k + \delta_c + \delta_{c'} + \epsilon_{k,c,c'}. \tag{8}$$

The dependent variable is as in model (7), expressed as before in logs. The main regressor of interest is now $RTA_{c,c'}$, a dummy that equals one if countries c and c' are members of the same RTA. The vector $\mathbf{X}_{c,c'}$ 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 GDP (differences expressed in logs of absolute values). Finally, we include sector fixed effects (δ_k) and country fixed effects (δ_c and $\delta_{c'}$). Standard errors are clustered by country-pair.

The results of these regressions are reported in Panel B of Table 5. In column (1), in which we include only a dummy for regional trade agreements, the coefficient of RTA is negative and significant at the one-percent level. 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. The results for an alternative specification, which separates customs unions (CUs) from free trade areas (FTAs), are presented in column (2). 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 membership to FTAs has no significant impact on differences in organizational structure. In column (3), 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 10 percent level. Contiguity and common language have a significant negative effect on the difference in vertical integration indices, while differences in GDP have a significant positive effect. Colonial relationship and distance do not affect the degree of organizational convergence.

As done for the results presented in Section 5, we have verified that our findings on trade policy and organizational convergence are robust to using different samples of firms (e.g. restricting the sample of countries included in the analysis, including multinationals). In all specifications, are results continue to hold: tariff differences have a significant positive effect on differences in vertical integration; and membership in RTAs, and CUs in particular, continues to reduce differences in vertical integration among member countries.

8 Conclusions

Recent work in organization economics suggests that product prices can have a key impact on integration decisions. This mechanism arises in a setting in which vertical integration increases productive efficiency, but does so at a cost. At low prices, the productivity gains from integration have little value, so non-integration is preferred; at higher prices, integration becomes worthwhile. We assess the empirical validity of this mechanism by studying the organizational effects of trade policy, which provides a source of price variation that is exogenous to firms' ownership decisions. We have constructed firm-level vertical integration indices for a large set of countries and industries and exploited cross-country and cross-sectoral differences in applied MFN tariffs, as well as time variation in tariffs resulting from China's accession to the WTO, to study the impact of prices on firm boundaries. In line with our model's predictions, we find that higher tariffs on final goods lead firms to be more vertically integrated; this effect is stronger for non-exporting firms, which are more sensitive to domestic prices, and for sectors in which domestic prices are more sensitive to import tariffs.

Positive correlations between prices and vertical integration have been observed in many industries. For example, a 1989 report on the beer industry by the British Monopolies and Mergers Commission found that retail prices were higher in integrated than non-integrated pubs. Similarly, Hastings (2004) noted that increases in gasoline prices in California in the 1990's were associated with increases in the number of vertically integrated gasoline stations. Policymakers have often drawn a causal inference from this correlation: vertical integration causes higher prices, though industrial economists have been rather more reticent to draw such a conclusion.[53] Though it is still certainly possible that vertical integration may raise prices in some industries in the manner suggested by the foreclosure theories, our analysis suggests that a positive correlation between vertical integration and prices may also reflect causality working in the opposite way: higher prices may induce more vertical integration.

[53] Recent empirical studies have questioned this inference in the context of specific industries, either by providing alternative explanations for a positive correlation between prices and integration (Hastings, 2004) or by showing that the correlation is actually negative (Hortaçsu and Syverson, 2007).

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Table 1: Tariffs and vertical integration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff$_{k,c}$	0.0203***	0.0034	0.0160**	0.0042	0.0202***	0.0035	0.1600***	0.005
	(0.0061)	(0.0088)	(0.0063)	(0.0080)	(0.0600)	(0.0086)	(0.0061)	(0.0081)
Domestic$_f$		-0.0926***				-0.0923***		
		(0.0108)				(0.0109)		
Tariff$_{k,c}$		0.0214***				0.0212***		
x Domestic$_f$		(0.0054)				(0.0054)		
Import-competing$_{k,c}$			-0.0362***				-0.0351***	
			(0.0135)				(0.0134)	
Tariff$_{k,c}$			0.0155**				0.0148**	
x Import-competing$_{k,c}$			(0.0070)				(0.0070)	
MFN share$_{k,c}$				-0.0237				-0.0215
				(0.0190)				(0.0190)
Tariff$_{k,c}$				0.0245***				0.0230***
x MFN share$_{k,c}$				(0.0074)				(0.0075)
Capital Intensity$_k$					0.0322**	0.0321**	0.0297**	0.0293**
x Financial Development$_c$					(0.0142)	(0.0144)	(0.0148)	(0.0145)
Capital Intensity$_k$					-0.0833	-0.0823	-0.0774	-0.0735
x Legal Quality$_c$					(0.0564)	(0.0573)	(0.0589)	(0.0572)
# Observations	196,586	196,586	196,586	196,586	196,586	196,586	196,586	196,586
# Sectors	386	386	386	386	386	386	386	386
R^2	0.117	0.119	0.117	0.117	0.117	0.119	0.117	0.117
Sector and Country Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the sector-country level in parentheses denoting *** 1%, **5%, and *10% significance. The sample includes firms $\geq$ 20 employees in the manufacturing sector, excluding multinationals. Dependent variable: log of one plus $V_{f,k,c}$, the vertical integration index of firm f, with primary sector k, located in country c. Explanatory variables are in logs, except MFN tariffs, where we use log of one plus the tariff. The variable *Tariff*$_{k,c}$ is the MFN tariff imposed by country c in sector k. The dummy variables *Domestic*$_f$ and *Import-competing*$_{k,c}$ are alternative ways to capture firms that only sell in the domestic market. *Domestic*$_f$ identifies firms that do not export. *Import-competing*$_{k,c}$ identifies the top 25 percent most import-competing sectors, as measured by a country's total imports/exports. *MFN share*$_{k,c}$ measures the fraction of imports of good k by country c that are subject to the MFN tariff, i.e. do not originate from countries with which country c has a regional trade agreement. *Capital Intensity*$_k$ is the total capital expenditures divided by value added. *Financial Development*$_c$ measures private credit by deposit money banks and other financial institutions as a fraction of GDP. The variable *Legal Quality*$_c$ proxies for the quality of a country's institutions

Table 2: Tariffs and vertical integration, competitive industries

	Panel A: Homogeneous sectors based on Rauch (1999)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Homogeneous sectors, many firms		Homogeneous sectors, many firms, low tariffs		Homogeneous sectors, many firms, foreign presence		Homogeneous sectors, many firms, low concentration	
$\text{Tariff}_{k,c}$	0.0290**	0.0292**	0.0380**	0.0381**	0.0316**	0.0315**	0.0747***	0.0982***
	(0.0117)	(0.0117)	(0.0149)	(0.0154)	(0.0145)	(0.0144)	(0.0228)	(0.0216)
$\text{Capital Intensity}_k$		0.0063		0.0203		- 0.0035		0.68
x $\text{Financial Development}_c$		(0.0524)		(0.0436)		(0.4420)		(0.1610)
$\text{Capital Intensity}_k$		-0.0615		-0.2330		0.0499		1.027
x Legal Quality_c		(0.1950)		(0.1440)		(0.1870)		(0.7290)
Observations	13,095	13,095	11,279	11,279	10,918	10,918	8,539	8,539
# Sectors	56	56	54	54	53	53	37	37
R^2	0.073	0.073	0.052	0.052	0.068	0.068	0.047	0.047
Sector and Country Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
	Panel B: Homogeneous sectors based on Broda, Greenfield and Weinstein (2006)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Homogeneous sectors, many firms		Homogeneous sectors, many firms, low tariffs		Homogeneous sectors, many firms, foreign presence		Homogeneous sectors, many firms, low concentration	
$\text{Tariff}_{k,c}$	0.0257***	0.0248***	0.0345***	0.0341***	0.0363***	0.0363***	0.0648***	0.0639***
	(0.0083)	(0.0084)	(0.0085)	(0.0084)	(0.0101)	(0.0102)	(0.0112)	(0.0116)
$\text{Capital Intensity}_k$		0.0216		0.0041		0.0560		-0.0267
x $\text{Financial Development}_c$		(0.0248)		(0.0245)		(0.0367)		(0.0299)
$\text{Capital Intensity}_k$		-0.1240		-0.0952		- 0.3018**		-0.0840
x Legal Quality_c		(0.0875)		(0.1170)		(0.1306)		(0.1400)
Observations	78,437	78,437	69,823	69,823	69,980	69,980	50,315	50,315
# Sectors	337	337	328	328	309	309	234	234
R^2	0.106	0.107	0.099	0.099	0.111	0.111	0.087	0.087
Sector and Country Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the sector-country level are in parentheses; denoting *** 1%, **5%, and *10% significance. The sample includes firms $\geq$ 20 employment in the manufacturing sector, excluding multinationals. In all columns, the sample is restricted to industries in which at least 20 domestic firms operate in a given country, and in which products are homogeneous. In Panel A, homogeneous sectors are defined using the variable $\textit{Homogeneous1}_k$ based on Rauch (1999); in Panel B, we use instead the variable $\textit{Homogeneous2}_{k,c}$ based on Broda, Greenfield and Weinstein (2006). In columns (3)-(8), we impose further restrictions: columns (3)-(4) include only sectors in which $\textit{Tariff}_{k,c} < 10\%$; columns (5)-(6) include only sectors in which some foreign firms operate in the domestic market; in columns (7)-(8), the sample is restricted to sectors in which $\textit{Herfindahl}_{k,c} \leq 0.1$. Dependent variable: log of one plus $V_{f,k,c}$, the vertical integration index of firm f, with primary sector k, located in country c. Explanatory variables are in logs, with the exception of MFN tariffs, where we use log of one plus the tariff. $\textit{Tariff}_{k,c}$ is the MFN tariff imposed by country c in sector k. $\textit{Capital Intensity}_k$ is the total capital expenditures divided by value added. $\textit{Financial Development}_c$ measures private credit by deposit money banks and other financial institutions as a fraction of GDP. The variable $\textit{Legal Quality}_c$ proxies for the quality of a country's institutions.

Table 3: Tariffs and vertical integration, controlling for possible omitted variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tariff$_{k,c}$	0.0203***	0.0202***	0.0203***	0.0190***	0.0214***	0.0210***	0.0212***	0.0198***	0.0183***
	(0.0061)	(0.0060)	(0.0074)	(0.0058)	(0.0065)	(0.0059)	(0.0059)	(0.0057)	(0.0061)
Capital Intensity$_k$		0.0322**	0.0333**	0.0387**	0.0425**	0.0401**	0.0319**	0.0390**	0.0507**
x Financial Development$_c$		(0.0142)	(0.0161)	(0.0154)	(0.0176)	(0.0187)	(0.0146)	(0.0189)	(0.0234)
Capital Intensity$_k$		-0.0833	-0.0785	-0.100*	-0.106	-0.103	-0.0836	-0.0944	-0.127
x Legal Quality$_c$		(0.0564)	(0.0617)	(0.0604)	(0.0682)	(0.0711)	(0.0577)	(0.0705)	(0.0885)
Input Tariff$_{k,c}$			0.0391***		0.0330**				0.0464***
			(0.0142)		(0.0141)				(0.0170)
Export Tariff$_{k,c}$				0.00252	-0.0038				-0.0049
				(0.0052)	(0.0060)				(0.0063)
Herfindahl$_{k,c}$						0.0128			0.0141
						(0.0228)			(0.0316)
Size$_f$							0.0352***		0.0440***
							(0.0075)		(0.0111)
Labor Productivity$_f$								0.0267***	0.0287***
								(0.0054)	(0.0069)
# Observations	196,586	196,586	154,915	185,630	146,228	178,199	196,586	178,448	133,545
# Sectors	386	386	311	386	311	386	386	386	311
R^2	0.117	0.117	0.119	0.123	0.125	0.117	0.122	0.125	0.132
Sector and Country Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the sector-country level are in parentheses denoting *** 1%, **5%, and *10% significance. The sample includes firms $\geq$ 20 employment in the manufacturing sector, excluding multinationals. Dependent variable: log of one plus $V_{f,k,c}$, the vertical integration index of firm f, with primary sector k, located in country c. Explanatory variables are in logs, with the exception of output tariffs, input tariff and export tariff, where we use log of one plus the tariff. *Tariff*$_{k,c}$ is the MFN tariff imposed by country c in sector k. *Capital Intensity*$_k$ is the total capital expenditures divided by value added. *Financial Development*$_c$ measures private credit by deposit money banks and other financial institutions as a fraction of GDP. The variable *Legal Quality*$_c$ proxies for the quality of a country's institutions. *Import Tariff*$_{k,c}$ is the tariff imposed by country c on inputs of good k. *Export Tariff*$_{k,c}$ is the tariff faced by firms exporting good k from country c. *Herfindahl*$_{k,c}$ is the Herfindahl index of sector k in country c. In columns (7)-(9) we report 2SLS estimates. *Size*$_f$ measures firm size (instrumented with employment predicted with sector-country dummies). *Labor productivity*$_f$ is measured as sales per worker (instrumented with sales per worker predicted with sector-country dummies).

Table 4: Tariffs and vertical integration, China's accession to the WTO

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\text{Tariff}_{k,t}$	0.0313***	0.0356**	0.0313***	0.0357**						
	(0.0096)	(0.0160)	(0.0096)	(0.0160)						
$\text{Herfindahl}_{k,t}$		-0.0040		-0.0040						
		(0.0113)		(0.0113)						
$\text{Public}_{f,t}$			0.0055***	0.0059***						
			(0.0010)	(0.0015)						
Change Tariff_k					0.0364*	0.0459*	0.0364*	0.0364*	0.0456*	0.0451*
					(0.0202)	(0.0234)	(0.0203)	(0.0205)	(0.0234)	(0.0230)
Change Herfindahl_k						-0.0371			-0.0307	-0.0406
						(0.0292)			(0.0297)	(0.0301)
Change Public_f							0.0007		-0.0351	
							(0.0135)		(0.0320)	
Privatization_k								-0.0351		0.0574
								(0.0798)		(0.1180)
# Observations	28,928	13,682	28,928	13,682	145	75	145	145	75	75
# Sectors	88	88	88	88	88	75	88	88	75	75
R^2	0.921	0.902	0.921	0.902	0.042	0.087	0.042	0.042	0.104	0.089
Sector Fixed Effects	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO
Time Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the sector level in parentheses denoting *** 1%, **5%, and *10% significance. In columns (1)- (4), the dependent variable is the log of one plus $V_{f,k}$, the vertical integration index of firm f, with primary sector k; in columns (5)-(10), it is the change in the log of one plus the vertical integration index between 1999 (pre accession) and 2007 (post accession). The sample includes Chinese firms observed in 1999 and/or 2007 with $\geq$ 20 employees in the manufacturing sector, excluding multinationals. $\textit{Tariff}_k$ is the log of (one plus) MFN tariff applied by China in sector k. $\textit{Public}_f$ is a firm-level dummy for public ownership, $\textit{Privatization}_k$ is a sector-level measure of privatization and $\textit{Herfindahl}_k$ is the Herfindahl index for sector k.

Table 5: Trade policy and organizational convergence

Panel A: Tariff differences		
	(1)	(2)
Difference Tariffs$_{k,c,c'}$	0.0089***	0.0086**
	(0.0034)	(0.0037)
Capital Intensity$_k$		0.0020
x Difference Financial Development$_{c,c'}$		(0.0066)
Capital Intensity$_k$		0.0419***
x Difference Legal Quality$_{k,c,c'}$		(0.0062)
# Observations	212,770	171,908
# Country pairs	80	80
R^2	0.164	0.164
Sector and Country-pair Fixed Effects	YES	YES

Panel B: Regional Trade Agreements			
	(1)	(2)	(3)
RTA$_{c,c'}$	-0.0921***		
	(0.0235)		
Customs Union$_{c,c'}$		-0.185***	-0.0760*
		(0.0376)	(0.046)
Free Trade Area$_{c,c'}$		-0.0404	0.0203
		(0.0266)	(0.0264)
Distance$_{c,c'}$			0.0188
			(0.0146)
Contiguity$_{c,c'}$			-0.196***
			(0.0754)
Common Language$_{c,c'}$			-0.119***
			(0.0313)
Colonial Relationship$_{c,c'}$			0.0663
			(0.0421)
Difference GDP$_{c,c'}$			0.0389***
			(0.0087)
# Observations	299,649	299,649	299,649
# Country pairs	101	101	101
R^2	0.109	0.109	0.111
Sector and Country Fixed Effects	YES	YES	YES

Notes: Robust standard errors clustered at the country-pair level 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 of firms with primary sector k. The variable *Difference Tariffs*$_{k,c,c'}$ is the difference between the MFN tariff imposed by country c and c' in sector k. *Capital Intensity*$_k$ is the total capital expenditures divided by value added. *Difference Financial Development*$_{cc'}$ measures differences in private credit by deposit money banks and other financial institutions as a fraction of GDP. The variable *Difference in Legal Quality*$_c$ proxies differences in the quality of institutions across between two countries. The variables *Contiguity*$_{c,c'}$, *Colonial Relationship*$_{c,c'}$, *Common Language*$_{c,c'}$ and *Difference GDP*$_{c,c'}$ capture bilateral geographical, cultural and economic linkages.

Appendix

Table A-1: Main sample

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: The sample includes all firms in the 2004 WorldBase dataset by Dun & Bradstreet, which are located in WTO member countries and have primary activities in manufacturing sectors. It excludes firms with less than 20 employees and multinationals.

Table A-2: Summary statistics

Sample				N
Plants				225,212
Connected plants				29,214
Multi-plant firms				6,830
Single-plant firms				189,756
Firms				196,586
Country variables	**Median**	**Mean**	**Std. Dev.**	**N**
Vertical Integration Index$_f$	0.044	0.063	0.063	196,586
Size$_f$	38.000	98.936	472.395	196,586
Labor productivity$_f$	11.506	11.446	1.082	178,448
Domestic$_f$	0	0.233	0.423	196,586
Import-competing$_{k,c}$	0.702	0.705	0.571	196,586
Tariff$_{k,c}$	2.480	4.849	7.253	196,586
Input Tariff$_{k,c}$	2.546	3.994	4.954	154,915
Export Tariff$_{k,c}$	5.654	6.611	5.039	185,630
MFN Share$_{k,c}$	0.564	0.545	0.351	196,586
Herfindahl$_{k,c}$	0.053	0.132	0.188	178,199
Homogeneous1$_k$	0	0.081	0.273	196,586
Homogeneous2$_{k,c}$	0	0.491	0.499	173,587
Capital Intensity$_k$	-2.857	-2.902	0.458	387
Financial Development$_c$	0.332	0.554	0.479	80
Legal Quality$_c$	0.545	0.583	0.209	80
Country-pair variables	**Median**	**Mean**	**Std. Dev.**	**N**
Difference Ver. Int. Index$_{k,c,c'}$	-1.593	-1.707	1.614	299,649
Regional Trade Agreement$_{c,c'}$	0.000	0.263	0.440	299,649
Free Trade Agreement$_{c,c'}$	0.000	0.148	0.355	299,649
Customs Union$_{c,c'}$	0.000	0.115	0.319	299,649
Distance$_{c,c'}$	9.017	8.629	0.965	299,649
Contiguity$_{c,c'}$	0.000	0.041	0.139	299,649
Colonial Relationship$_{c,c'}$	0.000	0.020	0.178	299,649
Common Language$_{c,c'}$	0.000	0.122	0.328	299,649
Difference GDP$_{c,c'}$	0.450	0.201	1.812	299,649

Sources: Vertical Integration Index$_f$, Size$_f$, Labor Productivity$_f$, Domestic$_f$ and *Herfindahl$_{k,c}$* constructed using plant-level data from 2004 WorldBase, Dun & Bradstreet. Sample includes manufacturing firms with at least 20 employees and excludes multinationals. *Tariff$_{k,c}$* from the World Integrated Trade Solution (WITS); *Input Tariff$_{k,c}$*, *Export Tariff$_{k,c}$*, and *MFN Share$_{k,c}$* constructed using data from WITS and the UN Comtrade database. *Import-Competing$_{k,c}$* constructed using data from Comtrade. Information on regional trade agreements from the WTO. *Homogeneous1$_k$* from Rauch (1999), *Homogeneous2$_{k,c}$* constructed using data from Broda, Greenfield and Weinstein (2006). *Capital Intensity$_k$* from NBER-CES manufacturing industry database. *Financial Development$_c$* from Beck, Demigurc-Kunt and Levine (2006). *Legal Quality$_c$* from Kaufmann, Kraay, and Mastruzzi (2004). *GDP$_c$* from the World Bank. *Contiguity$_{c,c'}$*, *Colonial Relationship$_{c,c'}$*, and *Common Language$_{c,c'}$* from CEPII. *Vertical Integration Index$_f$*, *Tariff$_{k,c}$*, *Input Tariff$_{k,c}$*, *Export Tariff$_{k,c}$*, *Size$_f$*, *Herfindahl$_{k,c}$*, and *MFN Share$_{k,c}$* are in levels; all other variables (with the exception of indicator variables) are in logs.

Table A-3: Vertical integration by 2-digit SIC industry

Industry	SIC	VI index
TEXTILES	22	0.115
APPAREL	23	0.111
CHEMICALS	28	0.098
PRIMARY METAL PRODUCTS	33	0.091
ELECTRICAL MACHINERY	36	0.089
TRANSPORTATION EQUIPMENT	37	0.067
PETROLEUM REFINING	29	0.062
LEATHER	31	0.062
RUBBER AND PLASTICS	30	0.060
MACHINERY, EXCEPT ELECTRICAL	35	0.060
MANUFACTURING NEC	39	0.059
LUMBER AND WOOD PRODUCTS	24	0.059
FOOD AND KINDRED PRODUCTS	20	0.056
TOBACCO MANUFACTURES	21	0.053
STONE, CLAY, GLASS, & CONCRETE	32	0.049
FABRICATED METAL PRODUCTS	34	0.039
PRINTING AND PUBLISHING	27	0.039
SCIENTIFIC INSTRUMENTS	38	0.036
PAPER AND ALLIED PRODUCTS	26	0.034
FURNITURE AND FIXTURES	25	0.022

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

Table A-4: Tariffs and vertical integration, Poisson quasi-maximum likelihood estimator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\text{Tariff}_{k,c}$	0.0126**	0.0121**	0.0281***	0.0114*	0.0258***	0.0117*	0.0126**	0.0108*	0.0191*
	(0.0058)	(0.0058)	(0.0086)	(0.0061)	(0.0092)	(0.0064)	(0.0058)	(0.0064)	(0.0105)
Capital Intensity_k		0.0385**	0.0545**	0.0443**	0.0651**	0.0484**	0.0399**	0.0469**	0.0822**
x Financial Development_c		(0.0165)	(0.0267)	(0.0178)	(0.0293)	(0.0208)	(0.0165)	(0.0205)	(0.0361)
Capital Intensity_k		-0.153**	-0.232**	-0.164**	-0.265**	-0.189**	-0.163***	-0.176***	-0.337**
x Legal Quality_c		(0.0629)	(0.1030)	(0.0679)	(0.1140)	(0.0744)	(0.0629)	(0.0738)	(0.1370)
Input $\text{Tariff}_{k,c}$			-0.0122		-0.0042				0.0210
			(0.0201)		(0.0208)				(0.0210)
Export $\text{Tariff}_{k,c}$				0.0043	0.0002				-0.0011
				(0.0050)	(0.0070)				(0.0072)
$\text{Herfindahl}_{k,c}$						0.0027			0.0284
						(0.0290)			(0.0520)
Size_f							0.0438***		0.0565***
							(0.0079)		(0.0142)
Labor Productivity_f								0.0322***	0.0365***
								(0.0079)	(0.0105)
# Observations	149,992	149,992	116,086	142,364	110,448	133,413	149,992	133,607	99,017
# Sectors	386	386	311	386	311	386	386	386	311
Sector and Country Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors clustered at the country-sector level are in parentheses denoting *** 1%, **5%, and *10% significance. The sample includes firms ≥ 20 employment in manufacturing sectors, excluding multinationals. Dependent variable: $V_{f,k,c}$, the vertical integration index of firm f, with primary sector k, located in country c. Explanatory variables are in logs and can be interpreted as elasticities. $\textit{Tariff}_{k,c}$ is the log of the MFN tariff imposed by country c in sector k. $\textit{Capital Intensity}_k$ is the total capital expenditures divided by value added. $\textit{Financial Development}_c$ measures private credit by deposit money banks and other financial institutions as a fraction of GDP. The variable $\textit{Legal Quality}_c$ proxies for the quality of a country's institutions. $\textit{Import Tariff}_{k,c}$ is the tariff imposed by country c on inputs of good k. $\textit{Export Tariff}_{k,c}$ is the tariff faced by firms exporting good k from country c. $\textit{Herfindahl}_{k,c}$ is the Herfindahl index of sector k in country c. $\textit{Size}_f$ is predicted (with sector-country dummies) firm size, $\textit{Labor Productivity}_f$ is predicted (with sector-country dummies) sales per worker.