Contracting Institutions and Firm Integration Around the World*

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Abstract

Firm integration is fundamentally shaped by contractual frictions. But do better contracting institutions, reducing these frictions, induce firms to be more or less deeply integrated? To address this question, this paper exploits unique micro data on ownership shares across half a million firm pairs worldwide, including domestic and cross-border ownership links. We uncover a new stylized fact: Firms choose higher ownership shares in subsidiaries located in countries with better contracting institutions. We develop a Property-Rights Theory of the multinational firm featuring partial ownership that rationalizes this pattern and guides our econometric analysis. The estimations demonstrate that better contracting institutions favor deeper integration, in particular in relationship-specific industries.

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1 Introduction

A key decision made by each and every firm around the world is its choice of ownership and control over the activities that are essential for its business – ranging from R&D to sales. Since the pioneering work of Coase (1937), a vast theoretical literature has evolved around this integration decision. The consensus view in this literature is that the single most important determinant of firm integration is contractual incompleteness, resulting from the fact that courts cannot fully verify and enforce complex contracts between business partners. More specifically, Gibbons (2005) distills from this literature four seminal theories of the firm, all of which attribute a fundamental role to contractual frictions in shaping firm integration.[1] In fact, according to these theories, the integration decision would become entirely obsolete if any contract, no matter how complex, could be perfectly enforced. Yet, despite the paramount importance of contractual frictions, it remains an open question whether a reduction in these frictions leads to more or less integration.

Empirically, firms face different degrees of contractual frictions, since the quality of contracting institutions varies substantially across countries. The World Bank estimates that a standardized lawsuit is completed within 164 days in Singapore, while a comparable lawsuit lasts 1,300 days (almost eight times as long) in Greece. These large international differences can be informative about how contractual frictions shape firm integration decisions. Indeed, we observe that firms choose different degrees of integration across countries, even within the same multinational group. Airbus SE, for instance, was the sole owner of the aircraft components producer Premium Aerotec GmbH in Germany, maintained a 79% share in EADS PZL Warszawa-Okęcie SA in Poland, and held a minority share of 34% in Sopeçaero Ltda in Brazil in 2014. To what extent do these patterns depend systematically on the contracting environment in the three countries? More generally, do better contracting institutions induce firms to be more or less deeply integrated?

This paper provides a first global investigation of how contracting institutions shape integration decisions across firm pairs. Clearly, the countries in the above-mentioned example differ along various dimensions, and therefore, it is an empirical challenge to distinguish the role of contracting institutions from these other country characteristics. To this end, we exploit detailed micro data on global ownership links from the Orbis database, which provides an unparalleled view on firms' integration decisions around the world. These data are unique in combining three key features: a high degree of granularity, precise measurement of ownership, and global coverage. First, information is available at the disaggregation level of the *firm pair*, at which the actual integration decision is made. Second, integration decisions are measured directly and precisely by *ownership shares*,

[1] These theories are the Transaction-Cost Theory, which goes back to Coase (1937) and was further developed by Williamson (1971, 1975, 1985), the Property-Rights Theory by Grossman and Hart (1986) and Hart and Moore (1990), the Incentive-System Theory (Holmstrom and Milgrom, 1991, 1994; Holmstrom, 1999), and the Adaptation Theory (Simon, 1951; Williamson, 1975).

which vary continuously and allow us to distinguish marginal differences in the forces shaping firm integration.[2] And third, the data have *vast international coverage*, including both domestic and international ownership linkages that involve more than half a million subsidiaries from 83 countries around the world. Notably, the data encompass multinational firms, which own subsidiaries in multiple countries, thereby providing particularly valuable variation for our analysis. This dataset allows us to exploit the large international differences in the quality of contracting institutions to understand how contracting frictions shape firms' integration decisions.

The paper makes three contributions. First, we establish a novel stylized fact in the global micro data: Firms integrate their subsidiaries more deeply (i.e., they choose higher ownership shares and are more likely to opt for full ownership) in countries with better contracting institutions. This positive correlation is evident in the raw data and it prevails after controlling for various observable factors and several dimensions of unobserved heterogeneity in our firm-pair data. Furthermore, contracting institutions turn out to be the most important predictor of firm integration among a large set of country-specific factors (such as the level of development, geography, and other institutional characteristics). This empirical regularity calls for a theoretical explanation.

Our second contribution is to develop a theoretical model, based on the seminal Property-Rights Theory (PRT) of the multinational firm by Antràs (2003), that rationalizes the stylized fact and guides our subsequent econometric analysis. Our model describes how a firm's headquarters (HQ) chooses the optimal ownership share in a production facility (producer). The producer needs to invest into partially contractible inputs, whereby the degree of input contractibility depends on the quality of contracting institutions in his country.[3] Furthermore, these inputs are partially relationship-specific, i.e., they can be sold on the outside market only at a discount. The degree of relationship-specificity varies across industries and determines the value of inputs on the outside market (henceforth, 'outside option'). This setup implies that the producer faces a hold-up problem and makes inefficiently low investments. The HQ's integration decision minimizes the inefficiency by solving the key trade-off in our model: A higher ownership share increases the HQ's *fraction* of the surplus at the expense of reducing the producer's investment incentives, which reduces the overall *size* of the surplus.

The model's first key prediction serves to explain the stylized fact described above: The HQ's optimal ownership share is increasing in the quality of contracting institutions in the producer's country. Intuitively, if courts can enforce contracts on a wider range of inputs, the HQ can contractually secure a greater surplus, hence the need for incentivizing the producer's investments decreases. Consequently, the HQ optimally chooses deeper integration in order to reap a larger

[2]While a large share of firm pairs in our data are fully integrated, partial integration is the most prevalent case (see Section 2.1 for details).

[3]For clarity, we refer to the HQ as 'she' and the producer as 'he' throughout the paper.

fraction of the surplus. In other words, good contracting institutions substitute for the need to incentivize the producer by leaving ownership rights to him, and hence they induce the HQ to choose a higher ownership share.

Our theoretical model further delivers a second key prediction: The positive effect of contracting institutions on the optimal ownership share is magnified by a higher relationship-specificity. The rationale for this positive interaction effect is as follows: In industries with a high degree of relationship-specificity, inputs have little value on the outside market. Therefore, the producer's potential outside option is relatively small and of little importance for his underinvestment. Consequently, any increase in the ownership share, reducing the producer's outside option, has only a weak negative effect on his investment incentives. It follows that an improvement in contracting institutions allows the HQ to disproportionately increase the optimal ownership share in highly relationship-specific industries. Intuitively, contracting institutions have more leverage if investments are highly relationship-specific.

Our third contribution is to conduct a novel empirical test of the impact of contracting frictions on firm integration. We exploit the model's second prediction and our detailed micro data to test how the interaction between contracting institutions and relationship-specificity affects the ownership shares. This approach allows us to control for any country-specific factors by fixed effects, thereby addressing first-order concerns related to omitted variables (such as cultural traits or informal institutions). Moreover, we can control for bilateral investment costs by country-pair fixed effects and identify the interaction effect across different subsidiaries owned by similar parent firms from the same country and industry. We find a positive interaction effect of country-level contracting institutions and industry-level relationship-specificity on the depth of integration, which is both statistically and economically significant. This finding supports the second key prediction of our model.

The positive interaction effect between contracting institutions and relationship-specificity is robust to addressing several challenges to identification. In an important set of robustness checks, we accommodate remaining concerns regarding omitted variables. To this end, we allow for the effects of economic development and other institutions on firm integration to differ arbitrarily across industries by including interaction terms of these country characteristics with subsidiary industry dummies (following Levchenko, 2007). Our rich data further allow us to demonstrate that our results are not confounded by firm heterogeneity among subsidiaries or headquarters. In a very ambitious within-firm specification, we even confirm the positive interaction effect across different subsidiaries owned by the same HQ. Next, we experiment with alternative measures and find very similar results for ownership dummies as dependent variables or when using various alternative proxies for contracting institutions and relationship-specificity. Our main finding is also upheld in different subsamples restricted to international firm links or focusing on subsidiaries in

OECD countries. To address the possibility that selection into different countries may be driven by factors correlated with the determinants of firm integration, we estimate a two-stage selection model à la Heckman (1979). Finally, we exploit the historic origins of countries' legal systems as an exogenous source of variation in contracting institutions using instrumental variables and propensity score matching techniques (similar to Nunn, 2007). The robustness of our main finding to all of these checks lends strong support to our model.

This paper contributes to the theoretical and empirical literature studying firm integration in an international context. Our theoretical framework builds on the PRT of the multinational firm by Antràs (2003) and extends the standard model in three key dimensions. First, we explicitly model partial ownership, allowing firms to choose continuous ownership shares, while the existing literature has treated the integration decision almost exclusively as a binary variable.[4] Second, we allow for partial contractibility, determined by the quality of contracting institutions as in Acemoglu et al. (2007) and Antràs and Helpman (2008). Third, we model partial relationship-specificity of the producer's inputs by introducing an outside market for these inputs. In so doing, we advance the recent approach by Antràs (2015) who considers a reduced-form modeling of relationship-specificity in a PRT setting with partially contractible inputs. Combining all three features in a unifying framework is new and essential for understanding the global ownership patterns in our data.

The empirical literature testing the PRT of the multinational firm has faced the major challenge that "data on the integration decisions of firms are not readily available" (Antràs, 2014, p. 5). In the absence of international micro data on integrated and non-integrated firm relationships, researchers have pursued two main approaches to studying the organization of multinational firms. The first is to exploit intra-firm trade data. Several papers have used industry- or product-level data on intra-firm import shares from the U.S.[5] The bulk of this literature has focused on technological determinants of intra-firm trade, such as input intensities, firm productivity, or the position of production stages in the value chain. To the best of our knowledge, only Antràs (2015) and Bernard et al. (2010) consider interaction terms between country-level contracting institutions and industry-level measures of specificity or contractibility, but their findings do not reveal a coherent pattern. More recently, researchers have exploited firm-level data on intra-firm trade from indi-

[4]Note that the original PRT by Grossman and Hart (1986) and Hart and Moore (1990) delivers the counterfactual prediction that shared ownership is never optimal (see, e.g., Holmstrom, 1999; Halonen, 2002). By allowing for partial relationship-specificity of the producer's inputs, we show that any ownership share between 0% and 100% can be an equilibrium outcome. Previous theoretical contributions have studied partially integrated production processes across *multiple* producers, either organized sequentially along the value chain (Antràs and Chor, 2013; Alfaro et al., 2019) or simultaneously contributing to a single production stage (Schwarz and Suedekum, 2014), but they do not consider partial integration of a *single* firm. Alternative approaches to modeling partial integration of a single firm in the PRT framework are discussed by Bircan (2013), Eppinger and Ma (2019), and Kukharskyy (2020).

[5]See, e.g., Antràs (2003, 2015), Antràs and Chor (2013), Bernard et al. (2010), Nunn and Trefler (2008, 2013), and Yeaple (2006).

vidual countries.[6] Among these studies, the contribution closest to our work is by Corcos et al. (2013), who also investigate the role of contracting institutions (among other factors) and find a positive relationship between contract enforcement in the foreign country and the share of French intra-firm imports, in line with the PRT.

The second prevalent approach to measuring firm integration combines information on multiple activities (primary and secondary industry codes) at the firm level with U.S. input-output tables at the industry level to calculate the propensity of firms to integrate certain activities. This 'vertical integration index' was introduced by Acemoglu et al. (2009) to study the relationship between contracting institutions and vertical integration in a large international cross-section of firms.[7] This relationship turns out to be insignificant, but the authors find more vertical integration in countries that have both higher contracting costs and greater financial development. In our main empirical analysis, we fully account for these country-level determinants of integration using fixed effects and focus on the interaction of contracting institutions with an industry's relationship-specificity.

We propose a third and complementary approach to measuring firm integration by using information on ownership shares across firm pairs. The key advantage of our approach is that the unit of observation in our analysis is the firm *pair* – the level at which the integration decision is made. Compared to studies of intra-firm imports, which exploit data from individual countries, our analysis encompasses subsidiaries and headquarters from many countries around the world. Compared to Acemoglu et al. (2009), we examine international ownership linkages and exploit the fact that parent and subsidiary firms located in different countries are governed by different contracting institutions.[8] The truly global nature of our analysis and its theory-driven focus on contracting institutions sets our paper apart from previous studies of ownership shares of U.S. multinationals, such as Asiedu and Esfahani (2001) and Desai et al. (2004).

As highlighted by Antràs (2015), the link between contracting institutions and integration not only provides an important angle for testing the PRT, but also allows to discriminate between this theory's predictions and the Transaction-Cost Theory (TCT) by Williamson (1985). Contrary to the PRT, the TCT suggests that integration becomes less desirable in countries with better contracting

[6] See Tomiura (2007) for Japan; Berlingieri et al. (2018), Carluccio and Bas (2015), Carluccio and Fally (2012), Corcos et al. (2013), and Defever and Toubal (2013) for France; Kohler and Smolka (2014, 2015) for Spain; and Bolatto et al. (2019) for Slovenia.

[7] Their approach has been adopted to study the impact of prices (Alfaro et al., 2016) and downstreamness (Alfaro et al., 2019) on vertical integration. Note that recent evidence on U.S. firms with multiple domestic plants (Atalay et al., 2014) or with multinational affiliates (Ramondo et al., 2016) suggests that integrated firm pairs do not necessarily engage in intra-firm trade even if they are vertically linked via I-O tables. In this paper, we do not rely on I-O tables to identify vertical links. Also, our theoretical explanation of the integration decision is not restricted to vertical links, nor does it presuppose any intra-firm trade, as producers in the model may sell their output to final consumers.

[8] This feature of the data is particularly important in view of the prediction derived by Antràs and Helpman (2008), who show that, in a PRT world, the quality of contracting institutions governing investments by the HQ has the opposite effect on firm integration compared to contracting institutions governing investments by the subsidiary.

institutions.[9] Our econometric analysis based on global micro data lends strong support to the PRT and thereby contributes to the literature seeking to contrast alternative theories of the firm (see Gibbons, 2005; Klein, 2005; Whinston, 2003).

We also relate to an empirical literature in international economics that studies the role of institutions as a source of comparative advantage. In their review of this literature, Nunn and Trefler (2014) conclude that the state-of-the-art approach to identifying the effect of a given institutional factor on trade is by interacting it with an industry-specific measure of sensitivity to this factor, while controlling for all other country and industry determinants via fixed effects (see also Chor, 2010). In particular, Berkowitz et al. (2006), Costinot (2009), Levchenko (2007), and Nunn (2007) explain bilateral trade flows by an interaction term of countries' contracting institutions and industry-specific measures of relationship-specificity or complexity. We take this approach to the micro level and show that contracting institutions shape not only international trade but also the ownership structures of multinational firms.[10]

The remainder of the paper is organized as follows. Section 2 describes the data and establishes the new stylized fact. Section 3 sets up our theoretical model and develops two key predictions for optimal ownership shares. Section 4 presents the main econometric analysis. Section 5 concludes.

2 Stylized Fact

2.1 Ownership Data

Our global micro data on ownership links are taken from the Orbis database provided by Bureau van Dijk (BvD). It includes firms' ownership shares (in %) in their subsidiaries in the cross-section of 2014. The three key advantages of the Orbis database for our purpose are the availability of firm-pair specific ownership information, its vast international coverage, and the fact that it includes both domestic and international ownership links. The database is unique in encompassing all three of these features.[11] We also observe the countries of residence, main activities (industry affiliations in the form of four-digit NAICS 2012 codes), and key balance sheet items for both HQ and subsidiaries.

We restrict the sample on the subsidiary side to countries hosting at least ten subsidiaries and exclude likely tax havens (mostly small island states, see Online Appendix A for details). On the

[9] We provide a detailed discussion of the intuition behind the TCT argument at the end of Section 3.3.

[10] Recently, Boehm (2020) has demonstrated that the quality of contracting institutions is also a key determinant of domestic trade in intermediate inputs and that this matters for aggregate productivity.

[11] The Orbis ownership data have previously been used to study the international transmission of shocks through multinationals (Cravino and Levchenko, 2017), the hierarchical complexity of business groups (Altomonte and Rungi, 2013), as well as the role of downstreamness (Del Prete and Rungi, 2017), managerial culture (Kukharskyy, 2016; Gorodnichenko et al., 2017), and knowledge capital (Kukharskyy, 2020) for firm integration.

HQ side, we consider only industrial companies (i.e., we exclude banks, hedge funds, etc). We further restrict our sample for the main analysis to ownership shares of at least 10% – a conventional threshold for direct investment. These restrictions are implemented since we are interested in HQ that have a (potentially long-term) economic interest in the target firm – as described by our model – and do not merely invest due to (short-term) portfolio considerations. Online Appendix A provides further details on the Orbis data.

The resulting sample includes information on 790,844 firm pairs of 331,118 headquarters (from 106 countries) holding ownership shares in 627,672 subsidiaries (in 83 countries) in the cross-section of 2014. The availability of data on covariates reduces the sample used in the regression analysis below. The median HQ has only one subsidiary, which is typically located in the same country. One third of all HQ own shares in at least two subsidiaries, and 11% of them are multinational firms owning foreign subsidiaries (which make up around one fifth of all observations in our data). The fact that we observe multiple international ownership links for some firms proves to be particularly useful for our analysis.

Figure B.1 in Appendix B illustrates the distribution of ownership shares in the full sample. Full ownership is the most common organizational form observed in the data, chosen by 42% of all firm pairs. Yet, the majority of observations are characterized by shared ownership. Among these, ownership shares of around 50% to 51% are most frequently chosen (16% of all observations). Despite these two peaks in the distribution, there is considerable variation in the ownership shares. More than one quarter of all observations are minority shares and the remaining 15% encompass majority shares above 51% and below 100%. The mean ownership share is 67%, with a standard deviation of 36 percentage points.

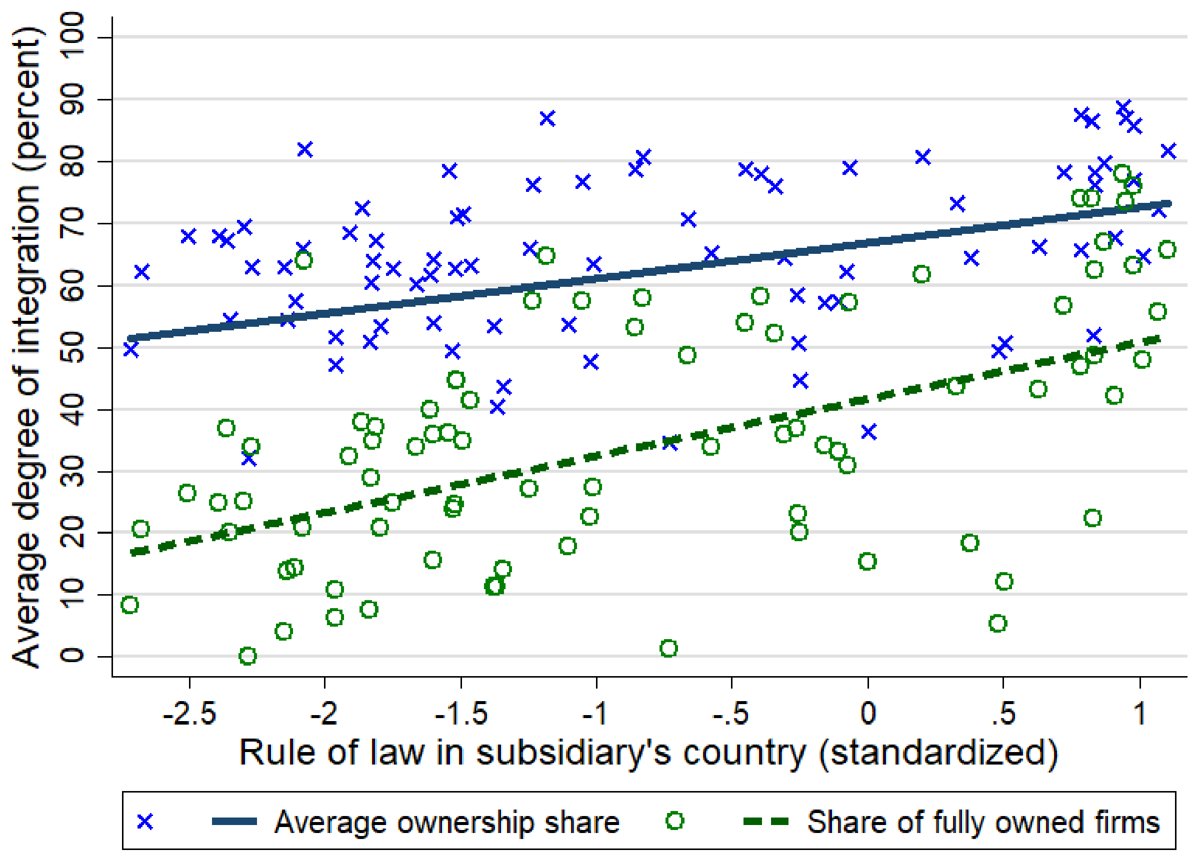
Based on these features of the data, we choose to follow a two-part empirical strategy in Section 2.3: First, we exploit all of the observed variation in ownership and consider the exact ownership share as a continuous outcome variable. Second, we focus on the salient point of the ownership distribution at 100% and consider an indicator variable for full ownership as our outcome variable to examine the choice between full and partial integration.

2.2 First pass at the data

Do firms choose higher or lower degrees of integration in countries with better contracting institutions? In this section, we take a first glance at the raw data to examine the correlation between ownership across firm pairs and contracting institutions in the subsidiary's country.

As our baseline measure of the quality of contracting institutions, we use the 'rule of law' index from the Worldwide Governance Indicators (Kaufmann et al., 2010). This measure is a weighted average of a number of variables that reflect experts' and practitioners' assessments of the effectiveness and predictability of judicial quality and the enforcement of contracts in a given country and year. We use this index as our main measure since it is available for a large number of countries and is well-established in the literature as a valid proxy for the quality of contracting institutions (see, e.g., Antràs, 2015; Nunn, 2007; Nunn and Trefler, 2014). However, we test the sensitivity of our main empirical results to using a wide range of alternative proxies. Online Appendix A provides a list of all subsidiary countries included in our dataset, ranked by the rule of law index. Contracting institutions are rated highest in Scandinavian countries; Ecuador and Nigeria are found at the bottom of the ranking.

Figure 1: Firm integration and contracting institutions



Note: The graph plots two measures of firm integration (average ownership shares and the share of fully owned firms) against the rule of law index in the subsidiary's country. The lines are obtained from univariate regressions of firm integration on the rule of law index in which each country-level observation is weighted by the underlying number of firm pairs. For the solid line, the dependent variable is the ownership share; the estimated slope parameter is 5.688 with a p-value of 0.019 (based on robust standard errors), and the R^2 is 0.024. For the dashed line, the dependent variable is a full ownership dummy, the estimated slope parameter is 9.181 with a p-value of 0.006 (based on robust standard errors), and the R^2 is 0.034. The sample is based on 790,844 firm pairs with subsidiaries located in 83 different countries.

Figure 1 illustrates the cross-country correlation between the depth of firm integration and the rule of law index in the subsidiary's country. It displays two alternative measures of firm integration: the average ownership share (crosses) and the share of fully owned firms (circles). As indicated by the univariate regression lines, both measures are positively correlated with the rule of law index, with p-values around 1-2%.

Clearly, the positive correlation between the depth of firm integration and the quality of contracting institutions illustrated in Figure 1 may be driven by a variety of forces. Does the correlation prevail after controlling for other factors influencing firms' integration decisions? And how important are contracting institutions compared to other country-level determinants, such as the level of economic and financial development or other types of institutions? We address these questions in multivariate regression analysis in the next subsection.

2.3 Regression Model

To explore the determinants of firm integration, we estimate the following econometric model:

$$S_{HM} = \varphi C_\ell + \boldsymbol{\chi}\mathbf{X}_{HM} + \alpha_i + \alpha_j + \alpha_k + \xi_{HM}, \tag{1}$$

where S_{HM} denotes a measure of ownership by headquarters H (active in industry i and country k) in subsidiary M (active in industry j and country ℓ). We consider two alternative measures of S_{HM}: the (continuous) ownership share and a (discrete) dummy variable indicating full ownership. The explanatory variable of primary interest is the quality of contracting institutions C_ℓ in the subsidiary's country ℓ, and φ is the key parameter to be estimated. The vector $\mathbf{X}_{HM}$ contains a set of other explanatory variables (with associated coefficient vector $\boldsymbol{\chi}$), and ξ_{HM} is an error term.

The high granularity of our data allows us to control for a host of unobservable factors by including full sets of fixed effects (FE) for the subsidiary's industry (α_j), the HQ's industry (α_i), and the HQ's country (α_k). The two sets of industry FE absorb various technological determinants of firm integration, most importantly the so-called 'headquarter intensity' of production, which plays a key role in the theoretical contributions by Antràs (2003) and Antràs and Helpman (2004). The empirical literature has typically approximated the headquarter intensity by industry-level capital intensity, skill intensity, or R&D intensity, and confirmed the relevance of this factor for intra-firm trade (see, e.g., Nunn and Trefler, 2008, 2013). The industry FE fully account for this effect as well as the positions of both firms in the value chain and the role of product differentiation and market power in their industries. Furthermore, one may argue that the level of development or the quality of contracting institutions in the HQ's country can also affect the integration decision. HQ country FE control for any such effects.

The vector $\mathbf{X}_{HM}$ includes various other observable factors that may affect the depth of firm integration: characteristics of the subsidiary's country, proxies for bilateral investment costs specific to the country pair, and characteristics of the two firms' ownership structures. For the subsidiary's country, we take the log of GDP as a measure of country size; the log of GDP per capita as a proxy for the income and wage level; the log of the endowment ratio (K_ℓ/L_ℓ), defined as the real capital stock divided by employment (average hours worked by employed persons), as a measure of relative factor abundance; and the average years of schooling as a proxy for the human capital stock (Barro and Lee, 1996). These variables are taken from the Penn World Tables (version 9.0; see Feenstra et al., 2015) for the year 2014. We further include an interaction term $\ln(K_j/L_j) \times \ln(K_\ell/L_\ell)$ – defined as the log of the capital-to-employment ratio (K_j/L_j) of the median firm by industry times the log of the relative capital endowment of subsidiary's country – to control for Heckscher-Ohlin-type confounding factors.

We further control for other characteristics of the institutional environment in the subsidiary's country using a set of proxies that have previously been used in the international economics literature (see, e.g., Nunn and Trefler, 2014; Javorcik, 2004): financial development, approximated by the sum of private credit and stock market capitalization divided by GDP from the World Bank's Global Financial Development Database (GFDD) in 2012; labor market flexibility, defined as one minus the rigidity of employment index from the World Bank's Doing Business Reports (based on Botero et al., 2004), averaged over the period 2004-2009 (the years when the index was reported); the index of intellectual property rights (IPR) protection developed by Park (2008) in 2010 (the last available year); and to these we add the risk of a contractual breach by the government as well as the expropriation risk score, both based on expert assessments by the information services company IHS Markit in the first quarter of 2014.[12]

We proxy for bilateral investment costs by including a dummy variable indicating domestic (as opposed to international) ownership links and a set of standard gravity control variables from the CEPII dataset (Head et al., 2010): the distance between the most populous cities in log kilometers, the time zone difference in hours, and indicator variables for countries sharing a common border, official language, or (current or past) colonial link. Finally, we control for two variables capturing the nature of the ownership structure: the number of subsidiaries of the HQ and the number of shareholders of the subsidiary.[13] These variables capture the complexity of the business group (cf. Altomonte and Rungi, 2013; Schwarz and Suedekum, 2014).

We estimate equation (1) for each of the dependent variables, the ownership share and the full ownership dummy, both by Ordinary Least Squares (OLS) and by (fractional) logit. For the sake of comparability, we standardize all explanatory variables to obtain mean values of zero and standard

[12] A key advantage of the country risk scores by IHS Markit is that they distinguish the risk of contractual breach and expropriation by the government from the risk that the judicial system may not enforce contracts between private parties, which we exploit as an alternative for the rule of law measure in a robustness check.

[13] We define the number of subsidiaries (shareholders) as the maximum value of the number of subsidiaries (shareholders) reported by BvD – which may include non-manufacturing firms, public entities, or private persons – and the number of subsidiaries (shareholders) actually observed in the database. The reason is that the reported numbers are missing for some firms in Orbis.

deviations of one in the estimation sample. The resulting standardized marginal effects then allow us to compare the relative importance of different explanatory variables for firm integration.

Inference is based on two-way cluster-robust standard errors following the procedure suggested by Cameron et al. (2011).[14] First, we cluster at the level of the subsidiary's country, at which the key explanatory variables are varying. Second, we cluster at the level of the HQ to account for interdependencies across a given HQ's ownership decisions.

2.4 Regression Results

Table 1 summarizes our estimation results for different specifications of equation (1). It substantiates the stylized fact illustrated in Figure 1: Subsidiaries are more deeply integrated by their owners in countries with better contracting institutions.

Whether we examine the continuous ownership share (columns 1 and 2) or a dummy indicating full ownership (columns 3 and 4), both the OLS and the logit estimates demonstrate that better contracting institutions are associated with deeper firm integration.[15] The estimates suggest that average ownership shares are ceteris paribus higher by 6.5-6.7 percentage points for subsidiaries in a country with a rule of law index that is higher by one standard deviation. Similarly, the probability of full ownership is around 11.3-17.7% higher if contracting institutions are better by one standard deviation.[16]

Not only are contracting institutions positively associated with firm integration after controlling for various other factors, but they turn out to be the single most important country-level determinant of ownership. Since the table reports standardized marginal effects, we can evaluate the relevance of contracting institutions to other factors by comparing the size of these estimates.[17] Focusing on the standardized coefficient estimates in column 1, the rule of law index plays a greater role than any other one of the potential determinants of firm integration at the level of the subsidiary country. It is even more important than the level of development, proxied by GDP per capita, which has a negative association (of a similar magnitude) with ownership shares. Among the other factors, the following are statistically significant: the capital-labor endowment ratio (which enters positively,

[14]Logit estimations are implemented by the Stata commands `cgmlogit` and `cgmflogit`. OLS estimations are implemented using the Stata routine `reghdfe` provided by Correia (2014), which efficiently absorbs our high-dimensional FE and allows for both multi-way clustering of standard errors as well as the use of instrumental variables.

[15]To enable fractional logit estimations and allow for comparability across estimation methods, we denoted ownership shares in Table 1 as shares ($S_{HM} \in (0, 1]$) rather than percentages ($S_{HM} \in (0, 100]$, as in the rest of the paper).

[16]To provide two illustrative examples: A one standard deviation improvement in the rule of law index is approximately equivalent to Isreal adopting Canadian standards in contract enforcement, or South Africa improving its contracting institutions to the level of South Korea.

[17]Note that we use the conventional terminology of "marginal effects" without intending any causal interpretation of these estimates. For OLS estimates, these are standardized coefficients and for logit regressions they are standardized marginal effects computed at the sample means of all variables.

in line with Antràs, 2003), years of schooling (negative), labor market flexibility (negative), and state contracting risk (positive). Columns 2-4 show a very similar pattern.

The Heckscher-Ohlin interaction term of the endowment ratio with capital intensity in the subsidiary's industry is negative and significant only for the ownership share. Domestic ownership links are characterized by lower shares than international links, presumably reflecting the idea that investing abroad is associated with additional fixed costs, which are only worth paying in case of a substantial stake in a foreign company. Most proxies for bilateral investment costs seem to have no significant association with ownership shares, but we find a stable negative correlation of ownership shares with the common language dummy. Finally, the characteristics of the ownership structure are strongly related to the depth of firm integration. Ownership naturally (and somewhat mechanically) decreases in the number of shareholders. Also, HQ hold higher shares and are more likely to be the sole owner if they also hold shares in other subsidiaries, or put differently, if they have a wider firm network.

We have explored the robustness of the stylized fact along various dimensions. First, we vary the set of control variables in OLS regressions, estimating both simpler specifications with fewer covariates or FE, and more ambitious specifications with additional sets of FE, including HQ firm FE. Second, we consider further institutional measures in the subsidiary's country, in particular the role of foreign equity restrictions, as measured by the OECD. Third, we instrument the rule of law index using legal origins (following Nunn, 2007), akin to the approach adopted in our main econometric analysis and described in Section 4.3.5. The estimation results from all of these robustness checks corroborate the empirical regularity (and are available upon request).

How can we rationalize the positive link between ownership and contracting institutions? Before we develop a theoretical explanation, it should be noted that this empirical regularity is hard to reconcile with a standard transaction cost view of the firm. The Transaction-Cost Theory (TCT) à la Williamson (1985) posits that, due to contractual frictions, relationships between non-integrated parties are plagued by hold-up problems. According to this theory of the firm, integration eliminates these hold-up problems at the expense of an exogenous governance cost. Since good contracting institutions constitute an alternative means to alleviate the hold-up problem, the TCT predicts less integration in countries with better contract enforcement.[18] This prediction clearly contradicts the stylized fact established in this section, which thus requires an alternative explanation. We provide this explanation in the next section by resorting to the seminal Property-Rights Theory along the lines of Grossman and Hart (1986) and Hart and Moore (1990).

[18]Chapter 6 in Antràs (2015) provides a formal treatment of this argument. See Section 3.3 for further discussion.

Table 1: Determinants of Ownership

	Ownership share		Full ownership dummy	
	OLS	Fractional Logit	OLS	Logit
	(1)	(2)	(3)	(4)
Subsidiary country characteristics				
Rule of law	0.0649***	0.0667**	0.113**	0.177***
	(0.004)	(0.010)	(0.012)	(0.006)
ln GDP	-0.00853	-0.00983	-0.00599	-0.00842
	(0.305)	(0.380)	(0.728)	(0.744)
ln GDP per capita	-0.0608**	-0.0676*	-0.0975*	-0.161*
	(0.031)	(0.076)	(0.067)	(0.062)
ln (K_ℓ/L_ℓ)	0.0535**	0.0557*	0.0735	0.132
	(0.031)	(0.082)	(0.135)	(0.102)
ln years of schooling	0.0458***	0.0526**	0.0999***	0.154***
	(0.008)	(0.020)	(0.004)	(0.004)
Financial development	0.00360	0.00886	0.0361*	0.0432
	(0.690)	(0.443)	(0.075)	(0.151)
Labor market flexibility	-0.0187**	-0.0218*	-0.0584**	-0.0805**
	(0.038)	(0.066)	(0.021)	(0.015)
IPR protection	-0.0225	-0.0207	-0.0359	-0.0574
	(0.208)	(0.329)	(0.297)	(0.278)
State contracting risk	0.0427***	0.0510***	0.0738**	0.114**
	(0.007)	(0.007)	(0.018)	(0.010)
Expropriation risk	0.0102	0.00981	0.0135	0.0231
	(0.392)	(0.513)	(0.592)	(0.526)
Subsidiary country-industry interaction				
ln $(K_j/L_j)\times$ln (K_ℓ/L_ℓ)	-0.00365***	-0.00362***	0.000139	-0.0000730
	(0.004)	(0.001)	(0.944)	(0.978)
Country-pair characteristics				
Domestic ownership link dummy	-0.0361***	-0.0449***	-0.0654***	-0.100***
	(0.000)	(0.000)	(0.000)	(0.000)
ln distance	-0.0117	-0.0148	-0.0276	-0.0387
	(0.260)	(0.259)	(0.151)	(0.176)
Time zone difference	0.00207	-0.00444	0.00763	0.00891
	(0.782)	(0.655)	(0.582)	(0.676)
Contiguity	-0.00219	-0.00401	-0.00607	-0.00988
	(0.394)	(0.289)	(0.232)	(0.186)
Common language	-0.00688**	-0.00872***	-0.00934	-0.0130
	(0.016)	(0.008)	(0.131)	(0.116)
Colonial link	-0.000640	-0.00104	-0.00315	-0.00486
	(0.809)	(0.729)	(0.440)	(0.395)
Ownership structure characteristics				
ln number of shareholders (subsidiary)	-0.136***	-0.128***	-0.204***	-0.359***
	(0.000)	(0.000)	(0.000)	(0.000)
ln number of subsidiaries (headquarter)	0.0234***	0.0211***	0.0356***	0.0626***
	(0.000)	(0.000)	(0.000)	(0.000)
(Pseudo) R^2	0.376	0.191	0.369	0.339

The table reports estimates of equation (1) with the ownership share as the dependent variable in columns 1 and 2, and with the full ownership dummy as the dependent variable in columns 3 and 4. Columns 1 and 3 report standardized coefficients from OLS regressions. Columns 2 and 4 report standardized marginal effects (evaluated at the sample means) from (fractional) logit regressions. All regressions control for fixed effects by HQ country, by HQ industry, and by subsidiary industry. The estimation sample includes 585,003 observations (firm pairs) with subsidiaries located in 47 different countries. The p-values reported in parentheses are based on two-way clustered standard errors by HQ and by subsidiary country. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

3 Theoretical Model

3.1 Set-up

The starting point of our analysis is the pioneering work by Antràs (2003), who introduced the PRT into the context of the multinational firm. We extend this model along multiple dimensions to account for the key features of our data and to guide our subsequent empirical analysis.

Consider a simple game between a firm's headquarters (H) and a (manufacturing) producer (M). Since the latter may eventually be owned to some degree by the former, we also refer to M as the subsidiary. The two parties can be located in the same or in different countries. Each firm is run by one owner-manager. The HQ possesses the idea (blueprint) for the production of a differentiated final good, and the producer has the capacity to implement this idea. Without loss of generality, we normalize both parties' ex-ante outside options to zero.[19] Assuming constant elasticity of substitution (CES) preferences over varieties of the final good implies the following iso-elastic demand for a single variety:

$$x = Dp^{-1/(1-\alpha)}, \quad 0 < \alpha < 1,$$

whereby x and p denote quantity and price, respectively, $D > 0$ is a demand shifter, and α is a parameter related to the elasticity of substitution between any two varieties, $\sigma = 1/(1-\alpha)$. This demand function yields the following revenue:

$$R = x^{\alpha} D^{1-\alpha}. \tag{2}$$

Final goods are produced by M using a continuum of (*m*anufacturing) inputs $m(i)$, indexed by points on the unit interval, $i \in [0, 1]$. One unit of $m(i)$ is produced from one unit of labor. Without loss of generality, we normalize the unit production costs of $m(i)$ to one. M combines these inputs into final goods according to the Cobb-Douglas production function:

$$x = \exp\left[\int_0^1 \ln m(i) \mathrm{d}i\right]. \tag{3}$$

We assume that the producer M is indispensable for the production of x, in the sense that H cannot manufacture final goods without M.[20] Note that the model is general enough to describe

[19] Throughout the paper, we use 'ex-ante' to describe the point in time before the relationship-specific investments are sunk and 'ex-post' to describe the period thereafter. As will become clear below, both parties may have non-zero outside options ex-post.

[20] This assumption can be rationalized by the fact that H lacks either the production capacity or the expertise required to assemble the final good (or both). This is the reason why the two parties need to form a relationship in the first place.

either a horizontal relationship, in which x is a final good, or a vertical relationship, in which x is reinterpreted as an intermediate input supplied by M to H (as in Antràs, 2003).

Firms operate in an environment of contractual incompleteness, i.e., courts cannot fully verify and enforce all of the subsidiary's investments into intermediate inputs. To formalize this idea, we adopt the notion of partial contractibility from Acemoglu et al. (2007) and Antràs and Helpman (2008). More specifically, we assume that investments into inputs in the range $[0, \mu]$, with $0 \leq \mu \leq 1$, can be stipulated in an enforceable ex-ante contract, while investments into the remaining inputs cannot be verified by the courts and are therefore non-contractible. Following these authors, we interpret μ as the quality of contracting institutions in M's country. The idea behind this notion of contracting institutions is that a more efficient judicial system can enforce contracts over a wider range of product characteristics (see Chapter 4 in Antràs, 2015, for a discussion). Clearly, there might also be technological factors that affect the degree of contractibility μ. Our modeling of μ as a country-specific variable reflects the notion that, for any given production technology, better contracting institutions are ceteris paribus more efficient at enforcing contracts. To consider an illustrative example, only well-functioning courts are able to verify whether high-tech inputs, such as computer chips, are produced according to the required standard. Hence, production of computer chips is contractible in countries with high judicial quality, but non-contractible in countries with poor contracting institutions.

Against the backdrop of contractual incompleteness, H chooses her ownership in M when the relationship is formed. We generalize the standard PRT approach, which typically considers the binary choice between integration and arm's-length contracting, by modeling the integration decision as a continuum. More specifically, H chooses the optimal ownership share $s \in [0, 1]$ in M, where $s = 1$ represents the case of full integration and $s = 0$ describes an arm's-length relationship between independent parties.

We assume that M's inputs must be customized to H's blueprint, and are therefore partially relationship-specific. More precisely, by selling an input on the outside market, one can recoup only a fraction $(1 - \rho)$ of the production costs, whereby $\rho \in [0, 1]$ measures the degree of relationship-specificity. For $\rho = 0$, M's inputs have the same value for an outside party as within the current relationship, whereas $\rho = 1$ represents the case of fully relationship-specific inputs.[21] In what follows, we treat ρ as an industry-specific variable, i.e., subsidiaries in industries with a high ρ produce highly relationship-specific inputs (see also Antràs, 2015).

Since some of M's inputs are non-contractible ex-ante, H and M bargain over the surplus from

[21] Our modeling of relationship-specificity presupposes the existence of a perfectly competitive outside market. The assumption that M's inputs have a lower value for a tertiary party (as compared to the current relationship) reflects the idea that an outside buyer would have to incur additional costs to customize these inputs to her production process. This reduced-form approach can be rationalized by a richer model of the outside market along the lines of Grossman and Helpman (2001, 2002).

the relationship ex-post, i.e., after M's investments are sunk. Following the PRT approach, we assume that these negotiations take place irrespective of the ownership structure (i.e., even under full integration) and they take the form of generalized Nash bargaining. More precisely, each party obtains his or her outside option (i.e., the payoff in case of a breakdown of the relationship) plus a fraction of the ex-post surplus from the relationship (the so-called quasi-rent), defined as revenue minus both parties' outside options. Let $\beta \in (0,1)$ denote the share of the quasi-rent accruing to H (henceforth, H's bargaining power), while the remaining share $(1-\beta)$ goes to M.

If H and M fail to agree in bargaining, the relationship breaks down and the intermediate inputs can be sold on the outside market. Each party's outside option depends on the fraction of inputs he or she possesses. The HQ has enforceable ownership rights over contractible inputs $m(i)$, $i \in [0,\mu]$. The extent to which each party has residual control rights over non-contractible inputs depends on H's ownership share $s \in [0,1]$ in M. More specifically, H controls the fraction s of non-contractible inputs, while M controls the remaining share $(1-s)$ of $m(i)$, $i \in [\mu, 1]$. Therefore, a change in the ownership share effectively shifts residual control rights between the two parties: A higher s increases H's outside option but reduces the outside option of M.

Our modeling of outside options allows us to rationalize the continuous ownership shares observed in the data. Furthermore, this modeling approach is appealing for two reasons. First, our 'zero-sum' notion of outside options reflects the original idea of residual control rights by Grossman and Hart (1986), who argue that, "if one party gets rights of control, then this diminishes the rights of the other party to have control" (p. 693).[22] Second, the idea that H and M receive outside options proportional to their ownership shares constitutes a reasonable approximation to reality. To see this, note that the hypothetical 'relationship breakdown' in our model is best illustrated in practice by a voluntary liquidation process, which can be invoked by shareholders to end the operation of a (solvent) company. As a general rule, once the company's assets are sold and its outstanding debt is paid off, the remaining surplus from such a voluntary liquidation is distributed between the shareholders in proportion to their shares of stock.[23]

The timing of events is as follows. In t_1, H chooses the ownership share s in M.[24] In t_2, H

[22]The reader familiar with Antràs and Helpman (2004, 2008) will notice two differences in our modeling of outside options compared to their approach. First, while M's outside option in Antràs and Helpman (2004, 2008) is set to zero regardless of the ownership structure, it is equal to zero in our framework only under full integration (i.e., $s = 1$). Second, if the bargaining breaks down, in the current framework H cannot produce final goods on her own (see also footnote 20).

[23]See, e.g., https://www.law.cornell.edu/cfr/text/26/1.331-1 and https://www.law.cornell.edu/uscode/text/26/332 for the case of the U.S. Similar regulations apply to 'members' voluntary liquidation' (MVL) in the EU, see https://www.lexisnexis.com/uk/lexispsl/restructuringandinsolvency/document/393781/55KG-P041-F18C-C30S-00000-00/Members__voluntary_liquidation__MVL__overview# (all links accessed on May 26, 2019).

[24]Following Grossman and Hart (1986) and Hart and Moore (1990), we do *not* assume a direct cost of acquisition of (a larger share of) M. Our results remain qualitatively unchanged if we introduce a fixed cost of integration into the model.

stipulates the amount of contractible inputs to be produced by M and commits to compensating him for the associated production costs. In t_3, M invests into non-contractible inputs and provides the amount of contractible inputs stipulated in the ex-ante contract. In t_4, the parties bargain over the surplus from the relationship. In t_5, final goods are produced and sold, and the revenue is distributed among the parties according to the agreements reached in t_2 and t_4. In the following section, we solve this game by backward induction.

3.2 Equilibrium

Before characterizing the subgame perfect equilibrium of the game described above, it is instructive to consider first the *hypothetical* case of complete contracts (i.e., $\mu = 1$). If courts could perfectly verify and enforce investments into all intermediate inputs, the parties would agree on the amount of $m(i), i \in [0, 1]$, which maximizes the joint surplus:

$$\max_{\{m(i)\}_{i=0}^{1}} \pi = R - \int_0^1 m(i)\mathrm{d}i.$$

Solving this maximization problem using equations (2) and (3) yields the first-best (FB) amount of inputs:

$$m(i) = \alpha R \equiv m^{FB} \quad \forall i \in [0, 1], \tag{4}$$

whereby $R = D\alpha^{\frac{\alpha}{1-\alpha}}$ is obtained from plugging equations (3) and (4) into equation (2) and solving the resulting expression for R. Note that, in this case of complete contracts, the optimal ownership share is indeterminate and the integration decision becomes obsolete, reflecting the essential role of contractual frictions in understanding firm integration, which we have stressed in the introduction.

Consider now the relevant case of contractual incompleteness, introduced in Section 3.1. In t_4, each party obtains his or her outside option plus a fraction of the quasi-rent (Q), defined as follows:

$$Q = R - (1-\rho)(1-s)\int_\mu^1 m(i)\mathrm{d}i - \left[(1-\rho)s\int_\mu^1 m(i)\mathrm{d}i + (1-\rho)\int_0^\mu m(i)\mathrm{d}i\right], \tag{5}$$

whereby R is given by equation (2). The second term on the right-hand side represents M's outside option, which is equal to the outside value $(1-\rho)$ of the fraction $(1-s)$ of non-contractible inputs $m(i), i \in [\mu, 1]$. The term in the square brackets denotes H's outside option and consists of the outside value of the fraction s of non-contractible inputs, as well as the outside value of contractible inputs $m(i), i \in [0, \mu]$.

In t_3, M anticipates the outcome of Nash bargaining from period t_4 and chooses the amount of non-contractible inputs that maximizes her payoff from the ex-post negotiations net of production costs of these inputs:[25]

$$\max_{\{m(i)\}_{i=\mu}^{1}} \pi_M = (1-\rho)(1-s)\int_{\mu}^{1} m(i)\mathrm{d}i + (1-\beta)Q - \int_{\mu}^{1} m(i)\mathrm{d}i. \tag{6}$$

Using equations (2), (3), and (5), the solution to this maximization problem yields the optimal amount of non-contractible (n) inputs:

$$m(i) = \delta\alpha R \equiv m_n \qquad \forall i \in [\mu, 1], \tag{7}$$

as a function of revenue, obtained from plugging equations (3) and (7) into equation (2) and solving the resulting expression for R:

$$R = \left(\left[\exp \int_0^{\mu} \ln m(i)\mathrm{d}i\right]^{\alpha} (\delta\alpha)^{\alpha(1-\mu)} D^{1-\alpha}\right)^{\frac{1}{1-\alpha(1-\mu)}}, \tag{8}$$

whereby

$$\delta \equiv \frac{1-\beta}{1-\beta+s(1-\rho)+\rho\beta}. \tag{9}$$

Since $0 < \delta \leq 1$ for all $\beta \in (0,1)$ and $\rho, s \in [0,1]$, it can be seen immediately from the comparison of equations (4) and (7) that $m_n \leq m^{FB}$ for any given level of R. Intuitively, M anticipates ex-post hold-up with respect to non-contractible inputs and underinvests into these inputs compared to the first-best level.

The magnitude of M's underinvestments into non-contractible inputs (the size of m_n) depends crucially on the ownership share and the degree of relationship-specificity. Since these dependencies are key to understanding the main predictions derived in the next section, we formulate:

Lemma 1. *For any given level of revenue, the subsidiary's investments into non-contractible inputs (i) decrease in the ownership share, and (ii) this negative effect is mitigated by a higher relationship-specificity.*

Proof. For part *(i)*, note that $\frac{\partial m_n}{\partial s}\big|_R < 0$ is implied by $\frac{\partial \delta}{\partial s} < 0$ from equation (9). For part *(ii)*, the cross partial-derivative of m_n with respect to s and ρ is $\frac{\partial^2 m_n}{\partial s \partial \rho}\big|_R = \frac{1-(1-\rho)(s-\beta)}{[1+(1-\rho)(s-\beta)]^3}\alpha(1-\beta)R$. Since $(s-\beta) \in (-1,1)$ for all $s \in [0,1]$ and $\beta \in (0,1)$, we immediately have $\frac{\partial^2 m_n}{\partial s \partial \rho}\big|_R > 0$ for all $\alpha \in (0,1)$, $\rho \in [0,1]$, and $R > 0$.

The intuition behind the first part of Lemma 1 derives from the fact that an increase in s ceteris paribus decreases M's outside option, and thereby worsens his ex-post bargaining position. If M expects to receive a smaller payoff ex-post, his ex-ante incentives to invest into m_n decrease. To understand the second part of Lemma 1, consider two different industries, one with a very high

[25] Note that contractible inputs do not enter M's maximization problem, since they are chosen by H in t_2, and M is fully compensated for the associated production costs.

relationship-specificity (ρ approaching one) and one with a low relationship-specificity (ρ close to zero). In the highly relationship-specific industry, M's investments have only a small value on the outside market. Hence, a marginal change in the ownership share s has little effect on M's outside option and on his payoff (see equation (6)). In other words, if the relationship-specificity is high, H can increase the ownership share without reducing M's investment incentives too much at the margin. By contrast, in an industry with a low degree of relationship-specificity, there is potentially much to gain for M on the outside market. Thus, any change in the ownership share affecting this relatively large outside option has a substantial impact on M's payoff. As a result, an increase in the ownership share strongly aggravates the underinvestment problem if the relationship-specificity is low. Generalizing this argument for all values of ρ, we conclude that a higher relationship-specificity mitigates the negative effect of an increased ownership share on the subsidiary's investment incentives.

Consider now H's optimization problem. In t_2, the HQ stipulates the amount of contractible inputs that maximizes her payoff from Nash bargaining net of the compensation for these inputs:

$$\max_{\{m(i)\}_{i=0}^{\mu}} \pi_H = (1-\rho)s(1-\mu)m_n + (1-\rho)\int_0^{\mu} m(i)\mathrm{d}i + \beta Q - \int_0^{\mu} m(i)\mathrm{d}i, \tag{10}$$

subject to M's participation constraint (PC), obtained from plugging equation (7) into equation (6):

$$\pi_M = (1-\beta)Q - (1-\mu)\left[1-(1-\rho)(1-s)\right]m_n \geq 0, \tag{11}$$

whereby Q and m_n are given by equations (5) and (7), respectively.[26] In our baseline analysis, we assume that M's PC is fulfilled and non-binding (i.e., $\pi_M > 0$), and solve the unconstrained maximization problem from equation (10). There are two reasons for this approach. First, it allows us to illustrate the HQ's key trade-off in the simplest possible manner. Second, we show in Appendix A.1 that M's PC is slack for the vast majority of relevant parameter values. Intuitively, the need to incentivize M typically implies a more stringent upper bound on the optimal ownership share than the PC would. Nevertheless, we verify in Section 3.4.1 that our key predictions are qualitatively unchanged if the PC is binding and H solves the optimization problem from equation (10) with equation (11) as an equality constraint.

After plugging equations (5), (7), (8), and (9) into equation (10), and solving H's maximization problem for the optimal number of contractible (c) inputs, we obtain:

$$m(i) = \omega\alpha R \equiv m_c \qquad \forall i \in [0,\mu], \tag{12}$$

[26] The HQ also accounts for M's incentive compatibility constraint (ICC), which ensures that M utilizes non-contractible inputs $(1-s)(1-\mu)m_n$ within the current relationship rather than selling them on the outside market. Formally, the ICC is fulfilled whenever M's payoff from Nash bargaining is not smaller than his ex-post outside option, i.e., $(1-\rho)(1-s)(1-\mu)m_n + (1-\beta)Q \geq (1-\rho)(1-s)(1-\mu)m_n$. Notice that $Q \geq 0$ is a sufficient condition for M's ICC to hold. Since this condition is implied by M's PC from equation (11), the ICC may be ignored whenever the PC is fulfilled.

as a function of revenue, obtained from inserting equation (12) into equation (8):

$$R = \delta^{\frac{\alpha(1-\mu)}{1-\alpha}} \omega^{\frac{\alpha\mu}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} D, \tag{13}$$

whereby

$$\omega \equiv \frac{s\alpha(1-\rho)(1-\mu) - \beta^2(1-\rho)\left[1-\alpha(1-\mu)\right] + \beta\left[1+s(1-\rho)-\alpha(1+s)(1-\mu)(1-\rho)\right]}{\left[1-\alpha(1-\mu)\right]\left[\rho+\beta(1-\rho)\right]\left[1-\beta+s(1-\rho)+\rho\beta\right]}. \tag{14}$$

In t_1, H chooses the optimal ownership share by solving the following maximization problem:

$$\max_s \pi_H = (1-\rho)s(1-\mu)\delta\alpha R - \rho\mu\omega\alpha R + \beta[R-(1-\rho)(1-\mu)\delta\alpha R-(1-\rho)\mu\omega\alpha R], \tag{15}$$

keeping in mind M's PC from equation (11). Plugging equations (9), (13), and (14) into equation (15), we obtain from the first-order condition the optimal ownership share:

$$s^*(\mu,\rho) = \frac{1+\beta^2(1-\rho)-2\beta-\alpha(1-\beta)(1-\mu)[1-\beta(1-\rho)]}{(1-\rho)[\beta+\alpha(1-\beta)(1-\mu)]}. \tag{16}$$

Plugging this ownership share as well as equations (9), (13), and (14) into equation (15), it can be shown that H's maximum profits from the relationship are positive for all admissible parameter values.

3.3 Comparative Statics and Key Predictions

In this section, we use comparative statics analysis to derive two key predictions regarding the effect of contracting institutions on the optimal ownership share. The relationship between s^* and μ is summarized in

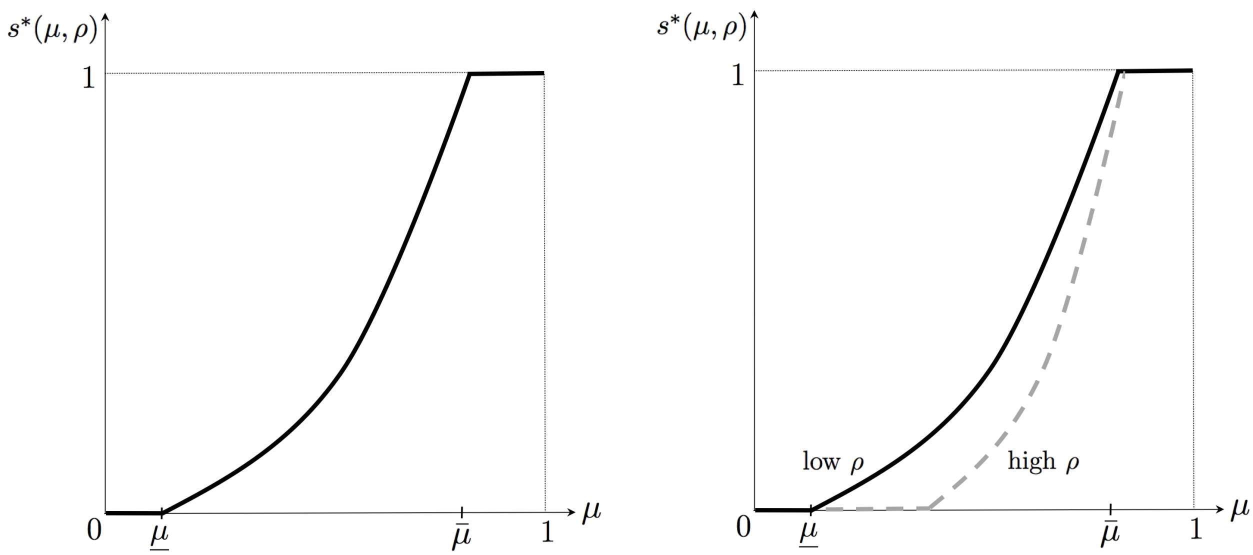
Proposition 1. *The optimal ownership share increases in the quality of contracting institutions.*
Proof. $\frac{\partial s^*}{\partial \mu} = \frac{\alpha(1-\beta)^2}{(1-\rho)[\beta+\alpha(1-\beta)(1-\mu)]^2} > 0 \ \forall\ \alpha,\beta \in (0,1), \mu \in [0,1], \rho \in [0,1)$.

To understand the intuition behind this result, consider the trade-off faced by H when choosing s^*. On the one hand, a higher ownership share increases H's outside option, and thereby raises her profits specified in equation (10). On the other hand, a higher s^* reduces M's payoff (see equation (6)) and aggravates the ex-post hold-up from the viewpoint of M. This worsens M's ex-ante underinvestment in non-contractible inputs (see the first part of Lemma 1), and reduces the total revenue from equation (8). Simply put, by choosing a higher ownership share in the subsidiary, the HQ trades off a larger *fraction* of the surplus against a larger surplus *size*. When contracting institutions improve, the range of non-contractible inputs shrinks. This reduces the need for incentivizing M by giving him residual control rights. As a result, H optimally retains a larger fraction of the surplus for herself by choosing a higher ownership share s^*. Hence, Proposition 1 rationalizes the stylized fact described in Section 2.

Figure 2(a) illustrates the positive relationship between s^* and μ established in Proposition 1.[27] In an environment of poor contracting institutions, where μ is below the threshold $\underline{\mu}$, the HQ optimally chooses an ownership share of zero in order to provide maximal incentives for M. For $\mu \in (\underline{\mu}, \overline{\mu})$, the optimal ownership share increases monotonically in μ, reflecting the fact that better contracting institutions can enforce contracts on a wider range of inputs, and thereby substitute for the need to incentivize M's investment. For very high institutional quality, above the threshold $\overline{\mu}$, the HQ maximizes her fraction of the surplus by choosing full ownership. It should be noted that, for some parameter combinations, $\underline{\mu}$ may lie below zero and $\overline{\mu}$ may exceed one, but also in these cases, the optimal ownership share s^* lies within the unit interval and it is strictly increasing in the quality of contracting institutions for all values of μ.

Figure 2: Optimal ownership share s^*

(a) Direct effect of μ (b) Interaction between μ and ρ



Before we proceed, it is worth pausing to discuss how Proposition 1 relates to the theoretical results in Antràs and Helpman (2008). Based on a PRT of the firm featuring partial contractibility, the authors show that H's optimal *revenue share* is increasing in the quality of contracting institutions in M's country. While this result is conceptually in line with our Proposition 1, it is important to note that the optimal revenue share in their model is a hypothetical construct, which cannot be enforced by the courts. By contrast, the optimal ownership share s^* in our model constitutes a tangible claim to inputs and can be directly mapped to equity shares observable in the data (see Section 3.1 for a discussion).

[27] As depicted in the figure, the second-order derivative of s^* with respect to μ is positive: $\frac{\partial^2 s^*}{\partial \mu^2} = \frac{2\alpha^2(1-\beta)^3}{(1-\rho)[\beta+\alpha(1-\beta)(1-\mu)]^3} > 0$. The threshold values $\underline{\mu} = \frac{\beta[2-\alpha(2-\rho)]-\beta^2(1-\alpha)(1-\rho)+\alpha-1}{\alpha(1-\beta)[1-\beta(1-\rho)]}$ and $\overline{\mu} = \frac{\beta[3(1-\alpha)-\rho(1-2\alpha)]-\beta^2(1-\alpha)(1-\rho)+\alpha(2-\rho)-1}{\alpha(1-\beta)[2-\rho-\beta(1-\rho)]}$ can easily be derived from $s^*(\underline{\mu}) = 0$ and $s^*(\overline{\mu}) = 1$, respectively.

Consider next the interaction effect between μ and ρ in their impact on s^*, summarized in

Proposition 2. *The positive effect of contracting institutions on the optimal ownership share is stronger in industries with a higher degree of relationship-specificity.*

Proof. $\frac{\partial^2 s^*}{\partial\mu\partial\rho} = \frac{\alpha(1-\beta)^2}{(1-\rho)^2[\beta+\alpha(1-\beta)(1-\mu)]^2} > 0 \; \forall \; \alpha, \beta \in (0,1), \mu \in [0,1], \rho \in [0,1)$.

The intuition behind this key result builds on the insights from Proposition 1 and Lemma 1: According to Proposition 1, the optimal ownership share is monotonically increasing in the quality of contracting institutions. Also, Lemma 1 shows that the negative effect of a higher ownership share on M's investments into non-contractible inputs is mitigated if these inputs are highly relationship-specific. Hence, if contracting institutions improve, H increases the optimal ownership share more strongly in industries with a higher degree of relationship-specificity, where the adverse effect of a higher s^* on M's investments is less severe. In other words, contracting institutions have more leverage in relationship-specific industries.

Figure 2(b) illustrates the interaction effect between contracting institutions μ and relationship-specificity ρ. It plots the optimal ownership share s^* as a function of μ for a low value of ρ (solid line) and for a high value of ρ (dashed line). Reflecting Proposition 2, the line is steeper for the highly relationship-specific industry. The more specific M's investments, the less does an increase in the optimal ownership share disincentivize these investments. Hence, H can better exploit an improvement in institutional quality by increasing her ownership share more strongly in the highly relationship-specific industry.

Note that, while the effect of ρ on the *slope* of $s^*(\mu)$ is clear-cut, its effect on the *level* of s^* is a priori ambiguous. In the case depicted in Figure 2(b), the dashed line lies strictly below the continuous line. However, for alternative parameter combinations, it may lie strictly above this line or intersect it once in the unit interval.[28] This ambiguity is explained by the interplay of two opposing effects: On the one hand, an increase in relationship-specificity ρ decreases M's outside option and reduces his investments. On the other hand, an increase in ρ enlarges the surplus that M can obtain within the relationship (the quasi-rent from equation (5)), which improves his investment incentives.[29] Importantly, the positive interaction effect of μ and ρ on s^* summarized in Proposition 2 holds regardless of the direct effect of relationship-specificity on the ownership share.

To sum up, our model based on the PRT provides a theoretical rationale for the stylized fact that firms are more integrated in countries with better contracting institutions (Proposition 1), and

[28]Evaluating $\frac{\partial s^*}{\partial\rho}$ at the lower ($\underline{\mu}$) and upper ($\overline{\mu}$) threshold values of μ reported in footnote 27 yields $\frac{\partial s^*}{\partial\rho}|_{\mu=\underline{\mu}} = -\frac{\beta}{1-\rho} < 0$ and $\frac{\partial s^*}{\partial\rho}|_{\mu=\overline{\mu}} = \frac{1-\beta}{1-\rho} > 0$. Bearing in mind Proposition 1, there is a unique threshold $\hat{\mu}$ such that the dashed line is underneath the solid line for $\mu < \hat{\mu}$, and it lies above the solid line for $\mu \geq \hat{\mu}$. Solving $\frac{\partial s^*}{\partial\rho} = 0$ for μ yields the cutoff $\hat{\mu} = \frac{\alpha(1-\beta)+2\beta-1}{\alpha(1-\beta)}$. Since $\hat{\mu}$ is not restricted to the unit interval, the dashed line may cross the solid line at $\mu < 0$, $\mu > 1$, or $\mu \in [0,1]$.

[29]The relative magnitude of these opposing effects depends on M's bargaining power $(1-\beta)$. Formally, m_n from equation (7) increases in ρ if and only if $\beta < s$, and it decreases in ρ if this inequality is reversed.

it further delivers the testable prediction that relationship-specificity magnifies the positive effect of contracting institutions on firm integration (Proposition 2).

At this point, it is instructive to revisit our discussion of the role of contracting institutions under the alternative assumptions of the TCT. In particular, how do contracting institutions and relationship-specificity interact in their impact on firm integration under the TCT? Since a formal treatment of this question lies beyond the scope of this paper, we provide a brief review of the theoretical results in Antràs (2015). To fix ideas, consider a binary choice between integration and arm's-length contracting. According to the TCT, contracting institutions and relationship-specificity play no role under *integration* because the HQ can enforce the integrated producer's ex-ante investments by fiat (at the expense of exogenous governance costs). Yet, under *arm's-length contracting*, an improvement of contracting institutions increases the HQ's profits, in particular in industries with higher degrees of relationship-specificity. Intuitively, a higher quality of contracting institutions mitigates the ex-post hold-up that plagues commercial transactions between independent parties and alleviates the ex-ante underinvestment into relationship-specific inputs. This effect is more pronounced in industries with higher degrees of relationship-specificity since the hold-up problem in those industries is relatively more severe. As a result, the relative attractiveness of integration vs. arm's-length contracting under the TCT *decreases* in the quality of contracting institutions, and it decreases *more strongly* in highly relationship-specific industries (see equation (8.8) in Antràs, 2015). Notice that the TCT-based prediction on the interaction between contracting institutions and relationship-specificity points in the opposite direction compared to our Proposition 2. Since the TCT delivers the alternative hypothesis to the null hypothesis from the PRT, testing our Proposition 2 provides a vantage point for empirical discrimination between these two alternative theories of the firm.

3.4 Extensions

Before turning to an empirical test of Proposition 2, we discuss the generality of our theoretical results. In Section 3.4.1, we show that our main predictions continue to hold if M's participation constraint is binding, whereas considering ex-ante transfers would yield trivial and uninteresting results. In Section 3.4.2, we provide a generalization of the benchmark model that incorporates joint production. This extension allows us to verify within our framework the positive link between headquarter intensity and firm integration, which is at the core of Antràs (2003) and Antràs and Helpman (2004), and it confirms our main predictions.

3.4.1 Participation Constraint and Ex-ante Transfers

Recall that our predictions in Section 3.3 were derived under the assumption that M's PC from equation (11) is not binding for any optimal ownership share given by equation (16). In Appendix A.1, we provide a sufficient condition for M's PC to be non-binding and show that it is fulfilled for the vast majority of relevant parameter values. Nevertheless, we verify that our main theoretical results continue to hold also in those cases for which M's PC is binding. A tedious but straightforward analysis of H's maximization problems from equations (10) and (15), subject to M's PC from equation (11), yields the optimal ownership share:

$$s^*_{\text{PC}} = \frac{1-\beta-\alpha(1-\mu)[1-\beta(1-\rho)]}{\alpha(1-\rho)(1-\mu)}.$$

It can be verified that both the first-order derivative of this share with respect to μ as well as the cross-partial derivative with respect to μ and ρ are positive for all $\alpha, \beta \in (0,1), \mu, \rho \in [0,1)$:

$$\frac{\partial s^*_{\text{PC}}}{\partial \mu} = \frac{1-\beta}{\alpha(1-\rho)(1-\mu)^2} > 0, \quad \frac{\partial^2 s^*_{\text{PC}}}{\partial \mu \partial \rho} = \frac{1-\beta}{\alpha(1-\rho)^2(1-\mu)^2} > 0.$$

Hence, Propositions 1 and 2 continue to hold in case of a binding PC.

Notice that our benchmark model does not include ex-ante lump sum transfers (side payments), which are frequently assumed in the literature to ensure that the entire surplus from the relationship accrues to one party (the HQ). As shown in Appendix A.2, allowing for these transfers in the present context would result in an uninteresting case of zero optimal ownership shares, regardless of the quality of contracting institutions. To understand the intuition behind this result, recall the key trade-off faced by H in our model: By choosing a higher ownership share, H weighs a higher fraction of the surplus against a larger surplus size. If she can extract the entire surplus from M via ex-ante transfers, this trade-off vanishes and maximizing the surplus becomes H's only objective. Since both M's investments in non-contractible inputs and the overall revenue decrease in s (see equations (7) and (8)), H's optimal ownership share in the presence of ex-ante transfers is always equal to zero. To generate a non-trivial trade-off from the viewpoint of the HQ, the baseline model does not include ex-ante transfers.

3.4.2 Headquarter Intensity

So far, we have assumed that all investments required for production are borne solely by M. One might wonder whether our predictions extend to the case in which both parties invest into relationship-specific and non-contractible inputs, resulting in a two-sided hold-up problem. To tackle this question, we introduce an element of joint production by replacing equation (3) with the Cobb-Douglas production technology from Antràs and Helpman (2004):

$$x = \left(\frac{h}{\eta}\right)^{\eta}\left(\frac{m}{1-\eta}\right)^{(1-\eta)}, \tag{17}$$

whereby h represents headquarter services provided by H, and $\eta \in (0,1)$ captures the relative importance of headquarter services in the production process (henceforth, headquarter intensity or HI). Each unit of h is produced from one unit of labor. Without loss of generality, we normalize H's unit production costs to one. As in the benchmark model, we assume that M produces a continuum of manufacturing inputs $m = \exp\left[\int_0^1 \ln m(i)\mathrm{d}i\right]$, whereby only the fraction $\mu \in [0,1]$ of the inputs $m(i)$ is contractible, while the remaining fraction $(1-\mu)$ cannot be verified and enforced by the courts. As before, we also assume that the parties can recoup a fraction $(1-\rho)$ of the production costs of manufacturing inputs on the outside market, whereby $\rho \in [0,1]$ captures the degree of relationship-specificity. To keep our model simple, we assume that headquarter services h are fully non-contractible and entirely relationship-specific.

The timing of the game is identical to the one described in Section 3.1, apart from the period t_3, in which H now provides headquarter services, while M simultaneously and non-cooperatively invests into non-contractible manufacturing inputs and provides the amount of contractible manufacturing inputs stipulated in period t_2. This set-up implies a two-sided hold-up problem and ex-ante underinvestment by both parties.

As shown in Appendix A.3, solving the model yields the following optimal ownership share:

$$s^*_{\text{HI}} = \frac{1+\beta^2(1-\rho)\big[1-\alpha[1-\mu(1-\eta)]\big]-2\beta-\alpha\big[1-\mu(1-\eta)-\beta[2-\rho(1-\eta)-\mu(2-\rho)(1-\eta)]\big]}{(1-\rho)\Big[\beta-\alpha\left[\beta\big(1-\mu(1-\eta)\big)-(1-\eta)(1-\mu)\right]\Big]}. \tag{18}$$

Before discussing the effect of contracting institutions on the optimal ownership share, two remarks are in order. First, since s^*_{HI} from equation (18) reduces to s^* from equation (16) for $\eta = 0$, the equilibrium presented in this section generalizes the results of the one-sided hold-up game analyzed in Section 3.2. Second, the optimal ownership share increases in the headquarter intensity η for all permissible values of $\alpha, \beta, \eta \in (0,1)$, $\mu \in [0,1]$, and $\rho \in [0,1)$:

$$\frac{\partial s^*_{\text{HI}}}{\partial \eta} = \frac{\alpha(1-\alpha)(1-\mu)(1-\beta)^2}{(1-\rho)\Big[\beta-\alpha\left[\beta\big(1-\mu(1-\eta)\big)-(1-\eta)(1-\mu)\right]\Big]^2} > 0.$$

This result squares well with the findings by Antràs and Helpman (2004) and the general logic of the PRT: As the headquarter intensity increases (i.e., manufacturing inputs become relatively less important in the production process), the need for incentivizing M decreases and the relative attractiveness of integration increases. In our framework, this results in a marginal increase in the continuous ownership share.

Consider now the effect of contracting institutions on the optimal ownership share. Both the first-order derivative of s^*_{HI} with respect to μ, as well as the cross-partial derivative of s^*_{HI} with respect to μ and ρ are positive for all permissible parameter values:

$$\frac{\partial s^*_{\mathrm{HI}}}{\partial \mu} = \frac{\alpha(1-\alpha\eta)(1-\eta)(1-\beta)^2}{(1-\rho)\Big[\beta - \alpha\left[\beta\big(1-\mu(1-\eta)\big) - (1-\eta)(1-\mu)\right]\Big]^2} > 0, \quad \frac{\partial^2 s^*_{\mathrm{HI}}}{\partial \mu \partial \rho} = \frac{1}{(1-\rho)}\frac{\partial s^*_{\mathrm{HI}}}{\partial \mu} > 0.$$

Hence, Propositions 1 and 2 continue to hold in the extended model in which both parties invest into relationship-specific and non-contractible inputs.

4 Econometric Analysis

4.1 Econometric Specification

Our theoretical model provides us with a new angle for identifying the effect of contracting institutions on firm integration, beyond the positive correlation established in Section 2. It suggests that the positive effect of contracting institutions on ownership shares should be more pronounced in industries characterized by a high relationship-specificity (see Proposition 2). To test this interaction effect, we set up the following econometric model:

$$S_{HM} = \gamma(C_\ell \times R_j) + \boldsymbol{\psi}\mathbf{Y}_{HM} + \delta_j + \delta_{ik} + \delta_{k\ell} + \varepsilon_{HM}, \tag{19}$$

where S_{HM} represents the ownership share (in percent) of headquarters H in subsidiary M, and $C_\ell \times R_j$ is the key interaction term of contracting institutions C_ℓ in the subsidiary's country ℓ and relationship-specificity R_j of the subsidiary's industry j, with coefficient γ. We include control variables $\mathbf{Y}_{HM}$ (with coefficient vector $\boldsymbol{\psi}$) and a large number of fixed effects by the subsidiary's industry j (denoted by δ_j), by the HQ's industry i and country k (δ_{ik}), and by country pair ($\delta_{k\ell}$), all of which are discussed below. ε_{HM} denotes the error term.

Proposition 2 predicts a positive interaction effect, i.e., $\gamma > 0$. Intuitively, a higher relationship-specificity mitigates the negative effect of the ownership share on the subsidiary's investments, and therefore allows the HQ to increase her ownership share more strongly in response to better contracting institutions. Thus, cross-country differences in institutional quality should have a stronger positive effect on the ownership share in subsidiary industries with a high relationship-specificity.

Importantly, since the main explanatory variable in equation (19) varies by country and industry of the subsidiary, we can control for unobserved heterogeneity across subsidiary countries by FE. In our preferred specification, displayed in equation (19), these country-specific effects are nested within the country-pair FE $\delta_{k\ell}$, which additionally control for heterogeneity across HQ countries as well as any (observable or unobservable) country pair-specific factors (such as bilateral investment costs). The industry FE δ_j account for important industry-specific factors, including headquarter intensity and relationship-specificity itself. Note that by including the FE δ_{ik}, we identify the interaction effect across different subsidiaries owned by very similar firms – HQ from the same country and industry. The vector of control variables $\mathbf{Y}_{HM}$ (with associated coefficient vector $\boldsymbol{\psi}$) includes all of the elements of $\mathbf{X}_{HM}$ from equation (1) that are not absorbed by the FE, in particular the ownership structure characteristics.

By exploiting the interaction between country-level institutions and industry-level technological characteristics, equation (19) resembles a difference-in-differences model, where we control for the respective first differences with FE. It is reminiscent of the econometric models traditionally used to assess the effect of institutions on international trade patterns, as discussed by Nunn and Trefler (2014).[30] However, there are two crucial differences between our model and this approach. First, by looking at ownership shares, we examine the intensity of investment links instead of trade flows. Second, our micro data analysis exploits variation across different subsidiary countries and industries within a given HQ country-industry cell, in contrast to the analysis of comparative advantage, which is typically conducted at the aggregate level of industries and countries.[31]

We estimate equation (19) by OLS due to computational limitations implied by the large number of fixed effects, and due to the well-known complications that arise in non-linear models when interpreting interaction terms (see Ai and Norton, 2003), as in the case of our main explanatory variable. To directly map our theoretical prediction to the data, and to exploit all observable variation in firm integration, we focus on the continuous ownership share as our preferred dependent variable in this section. However, in robustness checks, we also consider dummy variables for full ownership or majority ownership as dependent variables. Standard errors are two-way clustered (following Cameron et al., 2011) – first at the level of the key explanatory variable, i.e., the subsidiary's country-industry, and second at the level of the HQ.

We measure the quality of a country's contracting institutions C_ℓ by the rule of law index, as in Section 2. Note that by mapping the contractibility μ of the subsidiary's investments to the quality of contracting institutions in the subsidiary's country, we have implicitly assumed that it is *this* country's courts that are responsible for enforcing the subsidiary's investment decisions.

[30] Acemoglu et al. (2007), Berkowitz et al. (2006), Costinot (2009), Levchenko (2007), and Nunn (2007) show that contracting institutions can constitute a source of comparative advantage in international trade.

[31] Ma et al. (2010) and Wang et al. (2014) are recent exceptions analyzing the role of institutions for firm-level exports.

This assumption indeed seems to reflect the prevailing legal practice in many countries.[32] It seems possible, however, that μ may also be affected by the quality of contracting institutions in the HQ's country – either directly, if courts in the HQ's country rule over contracts between the two firms, or indirectly, if multinationals transfer their institutional practices to their subsidiaries (see Chari et al., 2010). A virtue of our data is that it includes international ownership links, which allows us to control for the potentially confounding role of contracting institutions in the HQ's country via FE.

Our industry-level measure of relationship-specificity R_j is taken from Antràs and Chor (2013), who compute it from the Rauch (1999) classification of products by their degree of horizontal differentiation.[33] This classification distinguishes three categories of goods: (i) homogenous (traded on an organized exchange), (ii) reference-priced (not sold on an organized exchange, but reference prices are quoted in trade publications), and (iii) differentiated (all residual goods). For each industry, our baseline measure of R_j is calculated as the share of product codes in the industry that are classified as differentiated or reference-priced.[34] The idea underlying this approach is that, unlike homogenous goods, differentiated goods are customized to the specific needs of a buyer-seller relationship. The more differentiated goods there are within a given industry, the thinner is the outside market for the typical goods produced in this industry, and hence, the higher is the relationship-specificity. The size of the sample for our main regression analysis is reduced, compared to Section 2, by the fact that the relationship-specificity measure is only available for subsidiaries in goods-producing industries, but not in the services sector.

4.2 Main Estimation Results

In Table 2, we provide empirical evidence supporting the idea that better contracting institutions have a stronger positive effect on ownership shares for subsidiaries producing highly relationship-

[32]For instance, the European Council Regulation (EC) No 44/2001 (see http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:012:0001:0023:en:PDF) cites the default legal principle that "jurisdiction is generally based on the defendant's domicile" (in our context, the subsidiary's country). This principle typically applies to contracts between firm pairs within the EU (and potentially also to cases in which one of the two firms is an EU resident), unless specified otherwise by the contracting parties. Also, the Chinese Law on Sino-Foreign Equity Joint Ventures explicitly stipulates that "All activities of an equity joint venture shall be governed by the laws and regulations of the People's Republic of China" (see http://english.mofcom.gov.cn/article/lawsdata/chineselaw/200301/20030100062855.shtml, both accessed on May 10, 2017).

[33]These data are available on the authors' websites at the six-digit 2002 U.S Input-Output industry classification level. We map them to the four-digit NAICS 2012 level using official correspondence tables provided by the Bureau of Economic Analysis: http://www.bea.gov/industry/xls/2002DetailedItemOutput.xls and by the U.S. Census Bureau: http://www.census.gov/eos/www/naics/concordances/concordances.html (both accessed on April 4, 2016).

[34]Due to ambiguities for some goods, there are two versions of the Rauch (1999) classification, a 'conservative' and a 'liberal' one, whereby the former maximizes and the latter minimizes the number of goods that are classified as differentiated. Following Alfaro et al. (2019) and Antràs and Chor (2013), we use the liberal classification in our baseline analysis and the conservative version in a robustness check. Also, reference-priced goods may be understood as either differentiated or homogenous. We treat reference-priced goods as differentiated in our baseline analysis and classify them as non-differentiated in a robustness check.

specific inputs, as predicted by Proposition 2. The table develops our preferred specification of equation (19) step by step.

In column 1, we examine the correlation without any control variables, which reveals a positive estimate of the interaction effect γ. It suggests that the positive correlation between the rule of law index and ownership shares is concentrated in industries with high relationship-specificity. Figure B.2 in Appendix B provides a graphical illustration of this interaction effect in the raw data. In column 2, we add all control variables from Table 1, namely all observables as well as subsidiary industry FE (which absorb the direct effect of relationship-specificity), HQ country FE, and HQ industry FE.[35] The point estimate of γ becomes smaller but continues to be highly significant.

Table 2: Ownership shares, contracting institutions, and relationship-specificity

Dep. var.: Ownership share	(1)	(2)	(3)	(4)	(5)
Rule of law × relationship-specificity	5.138***	2.358***	2.720***	2.576***	2.374***
	(1.396)	(0.597)	(0.508)	(0.528)	(0.499)
Rule of law	-1.174	3.509***			
	(1.294)	(0.868)			
Relationship-specificity	4.255*				
	(2.265)				
Control variables from Table 1	no	yes	yes	yes	yes
Subsidiary industry fixed effects	no	yes	yes	yes	yes
HQ country and industry fixed effects	no	yes	yes	nested	nested
Subsidiary country fixed effects	no	no	yes	yes	nested
HQ country-industry fixed effects	no	no	no	yes	yes
Country-pair fixed effects	no	no	no	no	yes
Observations	269,544	227,001	267,205	265,408	266,849
R^2	0.019	0.347	0.369	0.409	0.416

The table reports OLS estimates of (variations of) equation (19). Standard errors two-way clustered by subsidiary country-industry and by HQ are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

As an important step towards identification, we add in column 3 subsidiary country FE (which absorb the direct effect of rule of law). Note that this specification constitutes a substantial improvement over simple cross-country regressions, as it identifies the effect of country-level institutions across industries with varying degrees of relationship-specificity after controlling for any (observable or unobservable) country characteristics. The positive interaction effect is confirmed.

In column 4, we add HQ country-industry FE to control for potential confounding factors such as international differences in financing conditions of a given industry. Finally, to arrive at our preferred specification in column 5, we further add country-pair FE to account for unobserved bilateral factors, such as cultural differences or ethnic ties. In all of these regressions, we estimate a significantly positive interaction effect.

The estimated size of the effect is quite stable across all specifications in columns 2 through 5.

[35]The coefficient estimates for the control variables are not reported to save space.

A quantitative interpretation of the preferred estimate in column 5 suggests that an improvement in contracting institutions by one standard deviation would increase the ownership share by 2.4 percentage points *more* for a subsidiary in a highly relationship-specific industry (composed of differentiated goods only) compared to a subsidiary in a non-specific (homogenous) industry.

Our estimation results provide strong support for Proposition 2, and hence for the PRT. In line with this theoretical prediction, we find that firms choose ceteris paribus deeper integration of subsidiaries in countries with better contracting institutions, and this effect increases in the relationship-specificity of the subsidiary's industry. Intuitively, the HQ's optimal ownership share is higher if contracting institutions are better because there is less need to incentivize the subsidiary's investments via ownership rights. This mechanism is more pronounced in highly relationship-specific industries, where any increase in ownership has a smaller adverse effect on the investment incentives of the subsidiary. Therefore, the quality of contracting institutions has a disproportionately positive effect on the depth of firm integration in relationship-specific industries.

4.3 Robustness Analysis

In this section, we thoroughly explore the robustness of our main empirical finding. We address potential concerns related to omitted variables bias (Section 4.3.1), measurement of variables (Section 4.3.2), sample definition (Section 4.3.3), and selection bias (Section 4.3.4). Sections 4.3.5 and 4.3.6 make two further steps towards identification by addressing the possibility of reverse causality via instrumental variables (IV) and propensity score matching (PSM) techniques, respectively. We find strong empirical support for Proposition 2 in all robustness checks.

4.3.1 Controlling for confounding factors

Arguably, the main threat to identification of the interaction effect γ in equation (19) lies in confounding factors that are correlated with either contracting institutions or relationship-specificity and are not yet fully controlled for. To address this issue, we include additional covariates and FE in our preferred specification (from column 5 of Table 2). We begin by controlling in a very general way for differential effects of subsidiary country characteristics across industries, then we explicitly account for observable firm characteristics of both the HQ and the subsidiary, and finally we address potentially remaining unobservable factors via additional FE (including HQ firm FE).[36]

We first consider the possibility that country-specific variables may have differential effects across industries. Even after controlling for subsidiary country characteristics via FE, the interaction effect might be confounded by country-specific factors, such as economic development or

[36]We abstain from including these additional covariates and FE in the main specification because we are either left with a substantially reduced sample (in the case of firm characteristics or within-HQ estimates) or we risk overfitting the econometric model (e.g., for the large sets of additional FE).

other institutions, which are correlated with the quality of contracting institutions. If these country characteristics affect the firms' integration decisions and if they have a different effect in more specific industries, this may bias our estimates. Moreover, subsidiary country characteristics may affect the ownership decisions through channels other than relationship-specificity.

To account for all of these channels, we adopt a very general approach that controls for *arbitrary* effects of country-specific factors across industries. The results are displayed in Table 3. We begin by controlling for the differential effects of economic size and economic development by adding two full sets of interaction terms of subsidiary industry dummies with GDP and GDP per capita in the subsidiary's country to our main specification of equation (19).[37] Column 1 of Table 3 shows that our interaction effect is fully robust to this important robustness check.

We proceed analogously by controlling for interaction terms of subsidiary industry dummies with proxies for endowments (capital-labor ratio and human capital, in column 2) and of all the other types of institutions in the subsidiary's country that we have considered in Section 2 (financial development, labor market flexibility, IPR protection, state contracting risk, and expropriation risk, in column 3). We find that these stringent tests do not alter our previous conclusions, as the estimated interaction effect is even larger than in the baseline regression and remains highly significant.

Table 3: Controlling for differential effects of subsidiary country and industry characteristics

Dep. var.: ownership share	(1)	(2)	(3)	(4)	(5)
	GDP	Endowments	Institutions	Industry K/L	All
Rule of law × specificity	2.822***	3.459***	4.246***	2.374***	4.936***
	(0.722)	(0.630)	(1.429)	(0.489)	(1.746)
Observations	266,849	266,329	225,790	266,854	225,790
R^2	0.418	0.418	0.414	0.416	0.417

The table reports estimates of equation (19). All regressions include the control variables and fixed effects from column 5 of Table 2. In addition, we control for interactions of a full set of subsidiary industry dummies with the following characteristics of the subsidiary country: GDP and GDP per capita in column 1, endowments (capital-labor ratio and human capital) in column 2, and other institutions (financial development, labor market flexibility, IPR protection, state contracting risk, and expropriation risk) in column 3. Column 4 includes interactions of a full set of subsidiary country dummies with the subsidiary industry's capital intensity. In column 5, we simultaneously include all interactions from columns 1 through 4. Standard errors two-way clustered by subsidiary country-industry and by HQ are reported in parentheses. Asterisks indicate significance levels: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

It is also conceivable that technological features of the subsidiary's industry have varying effects on ownership shares across country characteristics other than the ones considered in columns 1 through 3. Since Antràs (2003), the literature has discussed the headquarter intensity – typically

[37] This approach was first developed by Levchenko (2007) for studying exports and adopted by Antràs (2015) in a context similar to our paper.

proxied by an industry's capital intensity – as an important technological determinant of firm integration. While the direct effect of headquarter intensity is absorbed by industry FE, this variable may also have a differential effect across countries. As can be seen from column 4 of Table 3, our main finding is robust to adding a full set of interaction terms of the capital intensity of the subsidiary's industry with subsidiary country dummies.

Finally, in column 5, we conduct the most stringent test by combining all of the aforementioned sets of interaction terms in a single regression. We continue to find a significantly positive interaction effect between contracting institutions and relationship-specificity in this highly demanding robustness check. This allows us to conclude that differential effects of other relevant country and industry characteristics cannot explain our main findings.

Next, we address potential concerns about omitted variables related to the characteristics of the individual firms. While we have abstracted from firm heterogeneity in our theoretical model, differences across firms – both headquarters and subsidiaries – may play a role for ownership decisions. For instance, one might suspect that particularly large and productive subsidiary firms are more lucrative investment targets, therefore attracting higher ownership shares; alternatively, one might argue that large and productive firms are more likely to be listed on the stock exchange and thus characterized by widespread shareholdings. In either case, if firms producing relationship-specific goods can grow larger on average (e.g., due to market power), and if these firms tend to locate in countries with better contracting institutions (e.g., due to better infrastructure), then neglecting firm heterogeneity might bias the estimate of our main interaction effect. One could construct similar narratives for other dimensions of firm heterogeneity.

For this reason, in Table 4, we control for various observable characteristics of the subsidiary firm, which may be relevant for ownership shares. We successively add these variables in two steps: First, we include two variables on which we have data for many firms: the firm's age and a shareholder dummy, indicating whether the subsidiary itself holds any shares in other firms. Second, we include other variables available for only a subset of firms: firm size (measured by $\ln employment$), labor productivity (defined as $\ln(value\ added/employment)$), and capital intensity (defined as $\ln(capital/employment)$). These variables are lagged by one year (based on unconsolidated financial accounts in Orbis in 2013), which ameliorates potential concerns regarding reverse causality. As can be seen from columns 1 and 2 of Table 4, the interaction effect of rule of law and relationship-specificity continues to be positive and significant after controlling for observable subsidiary firm characteristics. Furthermore, the estimates reveal that ownership shares are higher for older subsidiaries that are larger, more productive, and more capital intensive, while the evidence on the shareholder dummy is mixed.

In the next step, we control for firm heterogeneity among HQ. We include the same lagged firm characteristics as in the case of subsidiaries, except for the shareholder dummy, which is replaced

Table 4: Firm heterogeneity

Dep. var.: ownership share	(1)	(2)	(3)	(4)	(5)	(6)
	Subsidiary firm controls		HQ firm controls		Both firm controls	
Rule of law × specificity	1.203**	3.306***	2.049***	3.059**	1.650***	3.232**
	(0.578)	(1.256)	(0.531)	(1.188)	(0.614)	(1.598)
Subsidiary firm characteristics						
Age	1.040***	0.640***			1.379***	1.189***
	(0.0950)	(0.117)			(0.118)	(0.233)
Shareholder dummy	0.219**	-0.695***			-0.138	-1.015***
	(0.0919)	(0.110)			(0.123)	(0.192)
Employment		4.164***				2.421***
		(0.168)				(0.317)
Labor productivity		1.062***				0.00848
		(0.170)				(0.343)
Capital intensity		0.434***				-0.249
		(0.166)				(0.323)
HQ firm characteristics						
Age			-0.0336***	-0.0509***	-0.0425***	-0.0402**
			(0.00968)	(0.0160)	(0.00791)	(0.0204)
Subsidiary dummy			2.031***	0.846***	1.919***	0.753***
			(0.125)	(0.220)	(0.135)	(0.288)
Employment				4.048***		3.175***
				(0.404)		(0.412)
Labor productivity				2.063***		1.825***
				(0.328)		(0.359)
Capital intensity				2.052***		2.070***
				(0.285)		(0.366)
Observations	163,787	63,351	108,996	39,178	86,703	20,022
R^2	0.484	0.492	0.459	0.479	0.510	0.536

The table reports estimates of equation (19). All regressions include the control variables and fixed effects from column 5 of Table 2. In addition, we control for one-year lags of the listed firm-level control variables for the subsidiary firm (columns 1-2), for the HQ (columns 3-4), and for both firms (columns 5-6). Standard errors two-way clustered by subsidiary country-industry and by HQ are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

by a subsidiary dummy, indicating whether the HQ itself is owned (to some degree) by other entities in our data. Columns 3 and 4 of Table 4 confirm the positive and significant estimates for the interaction effect of rule of law and relationship-specificity. Younger, larger, more productive, and more capital intensive HQ, as well as those HQ that are subsidiaries themselves, tend to hold higher ownership shares. After including control variables for *both* firms – HQ and subsidiaries – in the last two columns of Table 4, these patterns are confirmed and we continue to find a positive and significant interaction effect.

Table 5 controls for remaining sources of unobserved heterogeneity in the data using additional fixed effects. While we have already addressed primary concerns regarding omitted variables above, one may still envision more intricate narratives of potentially confounding factors. For instance, we have so far controlled for the (technological) fundamentals of both parties' industries via HQ and subsidiary FE. However, it is conceivable that industry-*pair* specific factors may also affect ownership shares. As shown by Antràs and Chor (2013), the integration decision is affected by the interaction of 'downstreamness' of the subsidiary's industry with the demand elasticity for final goods, which constitutes an industry characteristic of the HQ in case of vertically integrated subsidiaries. To control for these and other (including unobservable) factors, column 1 of Table 5 adds industry-pair FE to our main specification. The estimate of the interaction effect is of similar magnitude as our main estimate and continues to be highly significant.

In our main analysis, we have controlled for arbitrary effects of HQ country characteristics across different industries using HQ country-industry FE. Yet, it seems possible that the differential effect of HQ country characteristics on ownership shares varies also across *subsidiary* industries. For instance, institutions in the HQ country may have a differential effect on ownership shares across industries, depending on the characteristics of the goods produced by the subsidiary. To eliminate this and other similar concerns, we add HQ country-subsidiary industry FE in column 2. The size and significance of the estimate remain unchanged.

Table 5: Additional fixed effects and within-HQ firm estimates

Dep. var.: ownership share	(1)	(2)	(3)
Rule of law × specificity	1.955***	1.956**	1.842*
	(0.563)	(0.760)	(0.994)
Industry-pair FE	yes	yes	yes
HQ country-subsidiary industry FE	no	yes	yes
HQ firm FE	no	no	yes
Observations	261,448	260,228	165,226
R^2	0.444	0.462	0.689

The table reports estimates of equation (19). All regressions include the control variables and fixed effects from column 5 of Table 2. Added fixed effects included in columns 1-3 are indicated in the table footer. Standard errors two-way clustered by subsidiary country-industry and by HQ are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

A significant advantage of our data over those used in previous studies is that we can identify both firms that form an ownership link – the HQ and the subsidiary. To fully exploit this advantage, we proceed by identifying the effect of contracting institutions from variation across different subsidiary countries and industries *within* the same HQ. For this purpose, we add HQ firm FE to the previous specification. This approach implicitly restricts the sample to HQ that hold ownership shares in at least two subsidiaries in different countries or industries. Column 3 of Table 5 shows that, within a given firm, the HQ chooses higher ownership shares in those subsidiaries that are located in countries with better contracting institutions and this effect is magnified in relationship-specific industries.[38] The interaction effect of rule of law and relationship-specificity estimated

[38]As mentioned in Section 2.4, the positive correlation between ownership shares and contracting institutions is confirmed within HQ.

within HQ firms has a similar magnitude as before, though it is estimated with less precision as the p-value increases to 6%. Overall, the evidence from these demanding tests corroborates our main finding.

4.3.2 Measurement

Our main empirical results are insensitive to the measurement of our dependent variable and the key explanatory variables. We demonstrate this by conducting a large set of robustness checks that use alternative measures of firm integration, contracting institutions, and relationship-specificity. To economize on space, we briefly summarize our estimation results in this section and relegate the details to Online Appendix B.1.

As a first step, we examine two binary measures of firm integration in place of the continuous ownership share S_{HM} in equation (19). First, we reconsider the indicator variable for full ownership ($S_{HM} = 100\%$), as in Section 2. Second, we further consider an indicator variable for majority ownership ($S_{HM} \geq 50\%$). Note that these regressions are estimated by OLS since the large number of FE renders probit or logit regressions infeasible. In these estimations, we find a significant positive interaction effect of contracting institutions and relationship-specificity on the probability of (full or majority) firm integration.

While the literature has largely focused on the rule of law index as a preferred measure of the quality of contracting institutions C_ℓ, there exists a wide range of other proxies from different sources. To make sure that our main findings do not hinge on the choice of one particular measure, we explore six alternative proxies, including for instance, (i) the index of contract enforcement between private parties by IHS Markit, (ii) the law and order component of the International Country Risk Guide by Political Risk Services, and (iii) the inverse of the time it takes to enforce a contract from the World Bank's Doing Business database (see Online Appendix B.1 for definitions). For all six alternative measures, the interaction effect with relationship-specificity is estimated to be positive and highly statistically significant.

We also consider two alternative measures of relationship-specificity R_j. In the first case, we use the conservative (rather than liberal) variant of the Rauch (1999) classification. In the second case, we reclassify reference-priced goods as non-differentiated (instead of differentiated), but adhere to the liberal classification. For both measures, our estimate of γ is positive and significant at the 1% level.

4.3.3 Subsamples

We have explored different subsamples in a set of robustness checks, the results of which are shown in Online Appendix B.2. The quality of contracting institutions varies mainly between developed and developing countries, but less among OECD countries, which make up the bulk of observations in the Orbis database. To ensure that our main findings are not driven purely by developing countries with poor institutions, we examine two separate subsamples restricted to subsidiaries located in either OECD or non-OECD countries, respectively. The positive and significant interaction effect is confirmed within each subsample, though the point estimate is indeed greater for non-OECD countries.

As noted in the introduction, a substantial share of the literature studying the role of contracting institutions for firm integration has thus far focused on international investments and on vertical buyer-seller relationships (for an overview, see Antràs and Chor, 2013; Antràs, 2015). While our theory and empirical analysis are more general, we show that our results are relevant to this literature, as they continue to hold even if we (i) focus on foreign direct investments (FDI) and exclude all domestic ownership links, or (ii) restrict the sample to subsidiaries active in a different four-digit NAICS industry from their owner, which may be considered 'vertical' relationships.[39]

Throughout the paper, we have restricted ownership shares to a minimum of 10% to exclude small investments, which may be driven by portfolio considerations rather than lasting business interests. When increasing this threshold to 25%, excluding even more of the relatively small investments, we continue to find the positive interaction effect. We also experiment with the set of excluded potential tax havens and find that our results are insensitive to the definition of a tax haven.

4.3.4 Selection

In our main analysis, we have taken the location of the subsidiary as given and focused on how contracting institutions in the subsidiary's country shape the HQ's integration choice. However, the HQ's choice of production location, i.e., the selection of the country in which its subsidiary operates, is also likely to be driven by contracting institutions and other country characteristics. Under certain conditions, this location choice can affect our analysis of the intensive margin of integration. In particular, one may envision that the HQ solves a two-stage decision problem: First, she chooses whether or not to produce in a given country, and then she decides on the degree of integration of the producer (the optimal ownership share). Depending on the determinants of the location choice, such a decision structure might introduce selection bias to our estimates. Note that the direction of this bias is a priori unclear, as it depends on how the variables that drive selection in the first stage are correlated with both firm integration and our key explanatory variables.

[39]This definition reflects the notion that subsidiaries active in a different industry from their parent are less likely to replicate the activity of the HQ, but instead the two firms find themselves at different (vertical) positions along the value chain. The same definition has been used for instance by Alfaro and Charlton (2009) and Fajgelbaum et al. (2015). As noted in footnote 7, our theoretical argument does not presuppose the existence of supply-use relationships between the two firms.

To address this issue, we estimate a two-stage model that applies the selection correction proposed by Heckman (1979) and uses a measure of 'religious distance' between countries as an excluded variable in the selection equation (following the trade literature; see Helpman et al., 2008). Online Appendix B.3 describes this procedure and the estimation results in detail. The estimates indicate that selection is a statistically relevant issue, as the coefficient of the inverse Mills ratio turns out to be significant in the second-stage regression. However, the economic magnitude of this bias is small. Most importantly, the estimated interaction effect of rule of law and relationship-specificity remains positive and highly significant after the selection correction. The point estimate of 3.425 (with a standard error of 0.815) is slightly greater than in our main analysis. This strengthens our main finding.

4.3.5 Instrumental Variables

Since we regress micro-level ownership shares on aggregate variables, measured at the levels of industries and countries, reverse causality does not appear to be a relevant issue when estimating equation (19). We might, however, imagine that the government of a country that has attracted many large foreign investments (in relationship-specific industries) would have particularly strong incentives to improve the quality of domestic contracting institutions. While a large bulk of foreign investment need not be reflected in high average ownership shares at the firm level, we nevertheless address the possibility of reverse causality by using instrumental variables (IV).

We adopt the IV approach developed by Nunn (2007), using the historic origin of a country's legal system as an IV for the rule of law index. For this purpose, we rely on the classification of legal systems into British common law or civil law of French, German, or Scandinavian origin, which was developed by La Porta et al. (1998) and revised by La Porta et al. (2008).[40] We choose British common law as the base category and use three indicator variables for the other categories. Since legal origins are pre-determined, they are exogenous to ownership structures and can therefore resolve a possible reverse causality issue. In addition, the IV approach also tackles other potential biases due to omitted variables, discussed in Section 4.3.1, or due to measurement error in our proxy for contracting institutions.

Table 6 reports the results of two-stages least squares (2SLS) estimation of our preferred specification of equation (19). Column 1 reports the first-stage estimation results of regressing the interaction term between the rule of law index and relationship-specificity on a set of interaction terms between legal origin dummies and relationship-specificity. It shows that these interaction terms are both individually and jointly significant, with a high partial R^2 of 0.274 and a Kleibergen-Paap

[40] The original classification includes the Socialist tradition as a fifth category. La Porta et al. (2008) reclassify the Socialist countries by French or German civil law, from which their legal systems originated and to which many of them reverted after the break-up of the Soviet Union. We follow this revised approach.

Table 6: Instrumental variables

Dep. var.: ownership share	(1)	(2)
	First stage	Second stage
Rule of law × specificity		3.733***
		(0.983)
French legal origin × specificity	-1.104***	
	(0.153)	
German legal origin × specificity	-0.319*	
	(0.170)	
Scandinavian legal origin × specificity	0.618***	
	(0.141)	
Observations		266,849
Partial R^2 (excluded IV)		0.274
F-statistic (excluded IV, Kleibergen-Paap)		92.82
p-value of F-test		0.000

The table reports estimation results of a 2SLS regression. Column 1 reports the first-stage estimates and column 2 reports the second-stage estimates of equation (19), in which we instrument the interaction of rule of law × specificity by interactions of legal origin dummies with specificity, including all the control variables and FE from column 5 of Table 2. Standard errors clustered by subsidiary country-industry and by HQ are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

F-statistic of 92.82, which exceeds the Stock and Yogo (2002) critical values by far and points to a strong IV. The second-stage regression shown in column 2 yields a positive and significant estimate of our main interaction effect, supporting Proposition 2.[41]

4.3.6 Propensity Score Matching

The critical assumption for the validity of the IV approach to estimating equation (19) is that the historical origins of countries' legal systems have no *differential* effect (by relationship-specificity) on firm integration in 2014 other than through contracting institutions, conditional on all control variables. This exclusion restriction may be violated if legal origins are correlated with other cultural or institutional characteristics that also shape firm integration differentially across industries. To address such a potential violation of the exclusion restriction, we continue to follow Nunn (2007) and implement Propensity Score Matching (PSM). The idea of PSM, which goes back to Rosenbaum and Rubin (1983, 1984), is to select observations from treatment and control groups that are similar based on observable characteristics, assuming that they are also similar in terms of unobservables.

[41] In unreported robustness checks, we have also used legal origin as an IV for contracting institutions in estimating their direct effect on firm integration in equation (1). In line with Proposition 1 and the evidence presented in Table 1, we find a positive and significant effect of the rule of law index on ownership shares.

In our application, we seek to compare similar firm pairs involving subsidiaries in countries with favorable and unfavorable contracting institutions. Therefore, we select all observations of subsidiaries located in countries whose legal system is of British origin ($L_{HM} = 1$), which has been shown to be most favorable for investors, and match them to the most comparable observation of a subsidiary located in a country with French legal origin ($L_{HM} = 0$) *in the same industry*. Comparability is determined by the propensity score, i.e., the predicted value of the indicator P_{HM}, as explained by the following probit regression:

$$P_{HM} = \Pr(L_{HM} = 1 | \mathbf{W}_{HM}) = \Phi(\boldsymbol{\upsilon} \cdot \mathbf{W}_{HM} + \omega_{HM}), \tag{20}$$

where we match observations on the variables summarized in the vector $\mathbf{W}_{HM}$ (with associated coefficients $\boldsymbol{\upsilon}$), and ω_{HM} is an error term. In the baseline PSM approach, $\mathbf{W}_{HM}$ includes the following variables: log number of subsidiaries of the HQ and log number of shareholders of the subsidiary, capital intensity of the HQ's industry, dummy variables indicating domestic ownership and common language, and log of GDP per capita in the subsidiary's country. Capital intensity is defined as the logarithm of total capital over total employment, measured in the HQ's industry in 2013. It serves as a proxy for the relative importance of the HQ's inputs in the production process, which is an important determinant of the severity of hold-up problems identified in the incomplete-contracts literature (see Antràs, 2015, and our model extension in Section 3.4.2). To better control for country-level confounding factors, we then vary the set of matching variables $\mathbf{W}_{HM}$ by adding alternatively the following characteristics of the subsidiary's country: the capital-to-labor endowment ratio, average years of schooling, labor market flexibility, and state contract alteration risk. These variables are chosen because they have been revealed to significantly predict ownership in Table 1.

Based on the predicted propensity score $\widehat{P}_{HM}$ from equation (20), we match observations within a given subsidiary industry with their so-called 'nearest neighbor' (with replacement), i.e., the single observation with the most similar propensity score, while restricting observations to the common support.[42]

For the matched observations, we construct the ratio of ownership shares for the subsidiary in the British legal origin country (B) over the one located in the French legal origin country (F). The logarithm of this ratio is then regressed on our preferred measure of relationship-specificity:

$$\ln\left(S_{HMB}/S_{HMF}\right) = \kappa_1 + \kappa_2 \cdot R_j + \zeta_{HMBF}, \tag{21}$$

[42] Formally, we choose for each observation involving a subsidiary with British legal origin the observation involving a subsidiary with French legal origin in the same industry j for which the absolute difference in propensity scores is smallest. This procedure is implemented by the Stata module `psmatch2` provided by Leuven and Sianesi (2015). A similar approach has been adopted by Ma et al. (2010) using firm-level data.

with coefficients κ_1 and κ_2, and an error term ζ_{HMBF}. Standard errors are clustered at the level of the industry j in which subsidiary M is active. Since the contracting institutions in British legal origin countries are more favorable for investors, Proposition 2 would predict higher ownership shares for subsidiaries in these countries producing more relationship-specific goods, which translates into an estimate $\widehat{\kappa}_2 > 0$.

Table 7 reports our results from estimating equation (21). We start in column 1 by combining all possible observations in the same industry involving subsidiaries from a British and a French legal origin country, which results in more than 138 million pairs of matched observations. The regression reveals a positive estimate for the coefficient of relationship-specificity, confirming our model prediction based on the PRT. However, ownership shares may differ between these pairs for a variety of reasons other than legal origins. Therefore, we restrict the analysis to matched firm-pair observations that are similar in terms of the variables contained in $\mathbf{W}_{HM}$. For all variants of $\mathbf{W}_{HM}$, we find estimates $\widehat{\kappa}_2$ that are positive and significant, as reported in columns 2-6. These estimates, which lie in the range of 0.63-1.06, are smaller than in the unmatched sample. This finding is in line with the expected direction of a bias that would arise from reverse causality or from omitted variables positively correlated with contracting institutions and ownership. Overall, the PSM results lend further support to our hypothesis that better contracting institutions increase the depth of integration between firms more strongly in relationship-specific industries.

Table 7: Propensity score matching

Dep. var.: $\ln(S_{HMB}/S_{HMF})$	(1)	(2)	(3)	(4)	(5)	(6)
	Unmatched	Baseline PSM	K/L	Schooling	Labor flex.	State contr.
Specificity	1.156***	0.839***	0.882***	0.889***	1.060***	0.631***
	(0.360)	(0.237)	(0.237)	(0.208)	(0.347)	(0.176)
Observations	138,603,804	59,365	58,610	58,651	30,661	58,460
R^2	0.002	0.006	0.005	0.005	0.008	0.003

The table reports estimates of equation (21). The dependent variable is the log ratio of ownership shares across two subsidiaries. Column 1 considers the unmatched sample of all possible combinations of observations involving one subsidiary in a British and one in a French legal origin country. Columns 2-5 are restricted to the sample of (nearest neighbor) pairs matched based on the propensity score predicted by variants of equation (20). In column 2, observations are matched via the following variables: log number of subsidiaries of the HQ and log number of shareholders of the subsidiary, capital intensity of the HQ's industry, dummy variables indicating domestic ownership and common language, and log of GDP per capita in the subsidiary's country. Columns 3 to 6 one by one add four alternative subsidiary country characteristics to the set of covariates in the matching model, as indicated in the header and described in the text. Standard errors clustered by subsidiary industry are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

5 Concluding Remarks

The fundamental role of contractual frictions in shaping firm integration is widely accepted in the economics discipline. However, there is no consensus on whether reducing these frictions eventually leads to more or less integrated firms. We contribute to this debate in three ways. First, we establish in a global cross-section of firm pairs that suppliers in countries with better contracting institutions are more deeply integrated by their headquarters. Second, we develop a generalized Property-Rights Theory of the firm that explains how better contracting institutions increase the willingness of headquarters to obtain a larger ownership share in their subsidiaries, and demonstrates that this effect is particularly pronounced in industries with a high degree of relationship-specificity. Third, we test the model using our unique micro data on global ownership links and find strong empirical support for the positive interaction effect of contracting institutions and relationship-specificity on firm integration.

What are the policy implications of our findings? Policymakers in developing countries may hope to attract foreign direct investment (FDI) by improving the quality of domestic contracting institutions. Perhaps surprisingly, a standard transaction-cost view of the firm would suggest that such improvements discourage (rather than encourage) foreign ownership, since they facilitate market-based transactions and thus undermine the incentive for FDI. This paper has demonstrated that the Property-Rights Theory confirms the policymakers' intuition: Better contracting institutions should induce investors to choose higher degrees of integration. This intuition is strongly supported by our extensive empirical analysis of global firm pairs. Furthermore, we show that the quality of contracting institutions has a particularly strong effect on the integration intensity in industries with a high degree of relationship-specificity. Since relationship-specific industries are typically also characterized by high technology and information content, improving judicial quality may entail further favorable outcomes through spillovers from FDI.

A Mathematical Appendix

A.1 Participation constraint

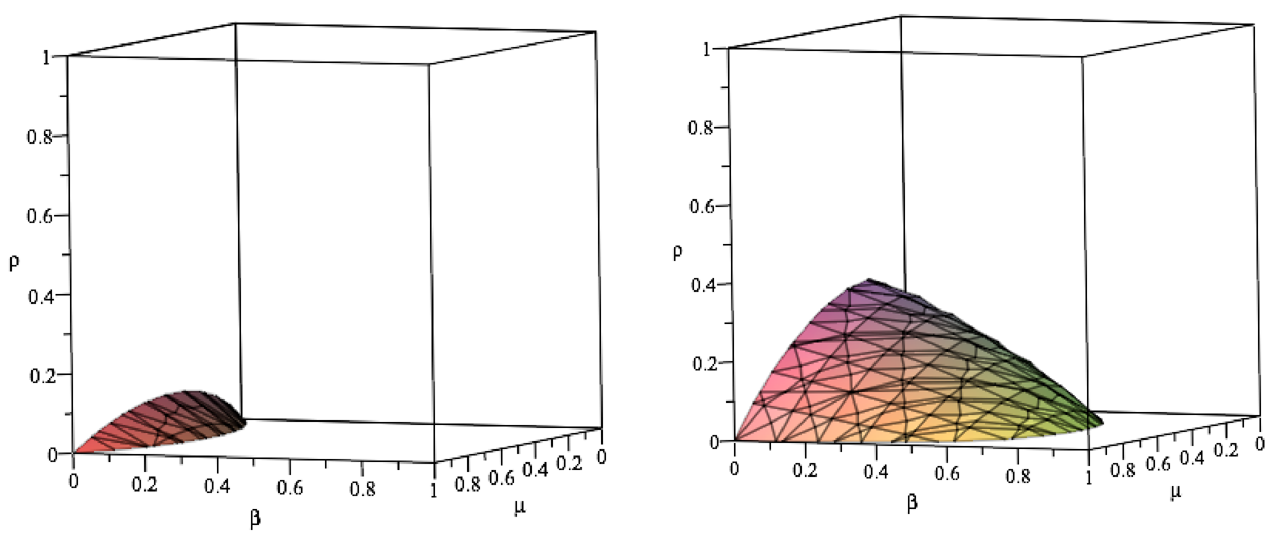
To obtain a sufficient condition for which the optimal ownership share s^* from the viewpoint of H does *not* violate M's PC, we use equations (5), (7), (9), (12), (13), (14), and (16), as well as the definition of $\alpha = \frac{\sigma-1}{\sigma}$ in equation (11). The resulting condition reads:

$$\sigma[\rho+\beta(1-\rho)]+\mu^2(\sigma-1)^2(1-\beta)(1-\rho)-\mu(\sigma-1)\Big[\sigma\left[1-2\rho-\beta(1-\rho)\right]-(1-\beta)(1-\rho)\Big]\geq 0.$$

A tedious but straightforward analysis shows that this inequality is more likely to hold the higher ρ and β, less likely to hold the higher σ, and is ambiguously affected by a change in μ.

Figure A.1: Combinations of β, μ, and ρ which satisfy M's PC with equality

(a) $\sigma = 2.25$ (b) $\sigma = 13$



To assess the overall likelihood of this inequality to hold for various *combinations* of parameter values, we fix the value of σ and depict all possible combinations of $\beta \in (0,1)$ and $\mu, \rho \in [0,1]$ which fulfill the above-mentioned condition with equality. The value of $\sigma = 2.25$ assumed in Figure A.1(a) is the mean value in Crozet and Koenig (2010), obtained from estimating a structural model of international trade using French firm-level data. The plane depicted in this figure illustrates the parameter combinations for which M's PC is fulfilled with equality, while it is slack (i.e., $\pi_M > 0$) for any combination of β, μ, and ρ above this plane, and it would be violated (i.e., $\pi_M < 0$) below this plane. As can be seen from Figure A.1(a), M's PC is slack (and can hence be ignored) for the vast majority of parameter values. In Figure A.1(b), we choose an alternative value of $\sigma = 13$, reflecting the mean value estimated by Broda and Weinstein (2006) for five-digit industries, which may be considered a rather high value for the average elasticity of substitution. Compared to Figure A.1(a), M's PC is binding for a larger subset of the parameter space. Nevertheless, it is still non-binding for the vast majority of permissible parameter values.

A.2 Ex-ante transfers

Assume that, after the optimal ownership share is chosen (i.e., in period t_1), H charges from M a transfer (participation fee) T. This transfer can be positive or negative, and it ensures that M is just indifferent between participating in the current relationship and obtaining his ex-ante outside option (normalized to zero). This assumption can be justified by assuming an infinitely elastic supply of M agents competing for a given relationship. Formally, the equilibrium transfer satisfies the following condition:

$$\pi_M - T = 0 \tag{A.1}$$

whereby π_M is given by equation (6). Since the transfer is conducted in t_1, it does not affect M's maximization problem in period t_3. Hence, the optimal amount of non-contractible inputs m_n is the same as in equation (7).

Under consideration of the ex-ante transfer, H's pure profit reads $\pi_{HT} = \pi_H + T$, whereby π_H is given by equation (10) and T is determined by equation (A.1). H's objective function in period t_2 reads:

$$\max_{\{m(i)\}_{i=0}^{\mu}} \pi_{HT} = R - (1-\mu)m_n - \int_0^{\mu} m(i)\mathrm{d}i, \tag{A.2}$$

whereby m_n is given by equation (7). Notice that, in the presence of ex-ante transfers, H reaps the entire surplus from the relationship. Using equations (7), (8), and (9), the maximization problem from equation (A.2) yields the optimal amount of contractible inputs:

$$m(i) = \theta\alpha R \equiv m_c \qquad \forall i \in [0, \mu], \tag{A.3}$$

as a function of equilibrium revenue (obtained from plugging equation (A.3) into equation (8)):

$$R = \delta^{\frac{\alpha(1-\mu)}{1-\alpha}} \theta^{\frac{\alpha\mu}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} D, \tag{A.4}$$

whereby

$$\theta \equiv \frac{1 + s(1-\rho) - \beta(1-\rho) - \alpha(1-\beta)(1-\mu)}{[1-\alpha(1-\mu)]\,[1 + s(1-\rho) - \beta(1-\rho)]}. \tag{A.5}$$

In period t_1, H maximizes $\pi_{HT} = R - (1-\mu)\delta\alpha R - \mu\theta\alpha R$ via the choice of s, whereby δ, R, and θ are given by equations (9), (A.4), and (A.5), respectively. The first-order condition of this maximization problem yields the following optimal ownership share:

$$s^* = -\frac{\rho\beta}{1-\rho},$$

which is negative. To understand the intuition behind this result, notice from equation (9) that $s^* = -\frac{\rho\beta}{1-\rho}$ would fully eliminate M's underinvestment (since $\delta|_{s=s^*} = 1$). With ex-ante transfers, H obtains the entire surplus from the relationship and maximizes the overall surplus by choosing the lowest possible ownership share, which is equal to zero regardless of contracting institutions.

A.3 Headquarter intensity

M's maximization problem in period t_3 continues to be given by equation (6). Using the joint production technology from equation (17), this maximization problem delivers M's reaction function:

$$m(i) = (1-\eta)\delta\alpha R \equiv m_n^* \qquad \forall i \in [\mu, 1], \tag{A.6}$$

whereby δ is given by equation (9). In t_3, H chooses the amount of h which maximizes her share of the quasi-rent from equation (5) minus production costs of headquarter services: $\max \pi_H = \beta Q - h$.[43] This maximization problem yields the optimal amount of non-contractible headquarter services:

$$h_n = \eta\beta\alpha R, \tag{A.7}$$

as a function of revenue (obtained from plugging equations (17), (A.6), and (A.7) into equation (2)):

$$R = \left(\left[\exp\int_0^{\mu} \ln m(i)\mathrm{d}i\right]^{\alpha(1-\eta)} \beta^{\alpha\eta}\,\delta^{\alpha(1-\eta)(1-\mu)}\,\alpha^{\alpha[1-\mu(1-\eta)]}(1-\eta)^{-\alpha\mu(1-\eta)}D^{1-\alpha}\right)^{\frac{1}{1-\alpha[1-\mu(1-\eta)]}}. \tag{A.8}$$

[43] Recall that h is assumed to be fully relationship-specific, and hence, it does not affect H's outside option.

In t_2, H chooses the amount of contractible inputs that maximizes her profit:

$$\max_{\{m(i)\}_{i=0}^{\mu}} \pi_H = (1-\rho)s(1-\mu)m_n + (1-\rho)\int_0^{\mu} m(i)\mathrm{d}i + \beta Q - \int_0^{\mu} m(i)\mathrm{d}i - h_n, \tag{A.9}$$

subject to M's participation constraint ($\pi_M \geq 0$), whereby m_n^*, h_n, and R are given by equations (A.6), (A.7), and (A.8), respectively. To keep the exposition as simple as possible, we assume in what follows that M's PC is fulfilled and non-binding. It should be noted, however, that our results continue to hold in case of a binding PC. Utilizing equations (5), (A.6), (A.7), and (A.8) in equation (A.9), and solving H's maximization problem yields the optimal amount of contractible manufacturing inputs and the associated revenue:

$$m(i) = (1-\eta)\kappa\alpha R \equiv m_c^* \qquad \forall i \in [0,\mu], \qquad R = \delta^{\frac{\alpha(1-\mu)}{1-\alpha}}\kappa^{\frac{\alpha\mu}{1-\alpha}}\alpha^{\frac{\alpha}{1-\alpha}}D, \tag{A.10}$$

whereby

$$\kappa \equiv \frac{\beta - \alpha[\beta\eta - \delta(1-\rho)(1-\mu)(s-\beta)]}{[(1-\rho)\beta+\rho]\Big[1-\alpha\left[1-\mu(1-\eta)\right]\Big]}, \tag{A.11}$$

and δ is given by equation (9).

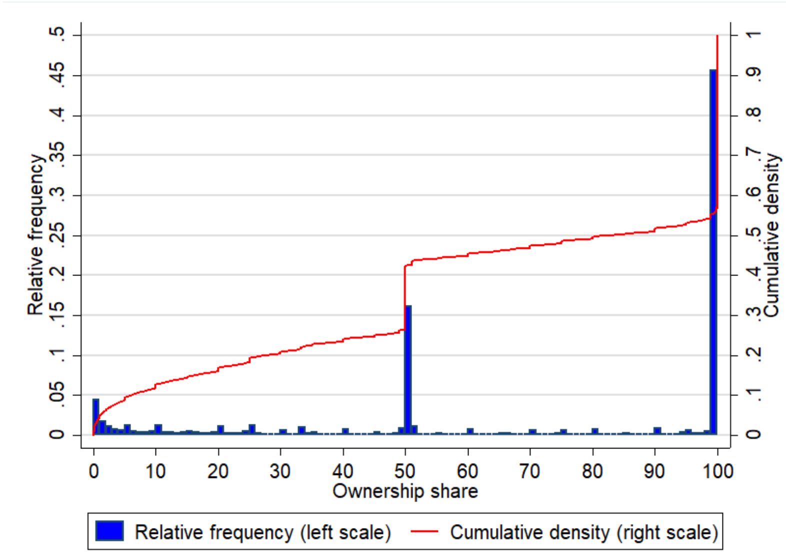
In t_1, H chooses the optimal ownership share by solving the following maximization problem:

$$\max_{s} \pi_H = (1-\rho)s(1-\mu)\delta\alpha R - \rho\mu\kappa\alpha R + \beta[R - (1-\rho)(1-\mu)\delta\alpha R - (1-\rho)\mu\kappa\alpha R] - \eta\beta\alpha R.$$

Utilizing equations (9), (A.10), and (A.11), we obtain from the first-order condition of this problem the optimal ownership share presented in equation (18).

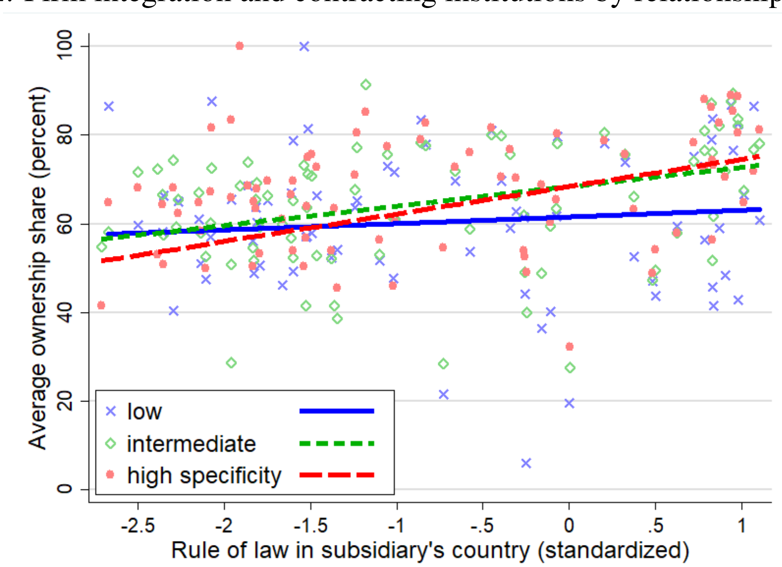
B Data Appendix

Figure B.1: Distribution of ownership shares



Note: The graph shows the relative frequency (left scale) and cumulative density (right scale) of ownership shares across 790,844 firm pairs.

Figure B.2: Firm integration and contracting institutions by relationship-specificity



Note: The ownership shares depicted on the vertical axis are arithmetic means by the subsidiary's country and the relationship-specificity category of the subsidiary's industry, whereby 'low' relationship-specificity means that the industry contains zero differentiated or reference-priced products according to the liberal Rauch (1999) classification, for 'intermediate' specificity the share of these products lies between zero and one, and 'high' reflects a share equal to one. The lines are obtained from univariate regressions of the mean ownership shares on the rule of law index, whereby each observation is weighted by the underlying number of firm pairs. For low relationship-specificity the slope is 1.519 (p=0.485, R^2=0.019, N=34,959), for intermediate specificity it is 4.385 (p=0.033, R^2=0.131, N=135,114), and for high specificity it is 6.191 (p=0.009, R^2=0.219, N=133,261).

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