The Impact of Contract Enforcement Costs on Outsourcing and Aggregate Productivity

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Abstract

Legal institutions affect economic outcomes, but how much? This paper documents how costly supplier contract enforcement shapes firm boundaries, and quantifies the impact of this transaction cost on aggregate productivity and welfare. I embed a contracting game between a buyer and a supplier in a general-equilibrium macro-model. Contract enforcement costs lead suppliers to underproduce. Thus, firms will perform more of the production process in-house instead of outsourcing it. On a macroeconomic scale, in countries with slow and costly courts, firms should buy relatively less inputs from sectors whose products are more specific to the buyer-seller relationship. I first present reduced-form evidence for this hypothesis using cross-country regressions. I use microdata on case law from the United States to construct a new measure of relationship-specificity by sector-pairs. This allows me to control for productivity differences across countries and sectors and to identify the effect of contracting frictions on industry structure. I then proceed to structurally estimate the key parameters of my macro-model. Using a set of counterfactual experiments, I investigate the role of contracting frictions in shaping productivity and income per capita across countries. Setting enforcement costs to US levels (alternative: zero) would increase real income by an average of 3.6 percent (7 percent) across all countries, and by an average of 10 percent (13.3 percent) across low-income countries. Hence, transaction costs and firm boundaries are important on a macroeconomic scale.

JEL codes: D23; E02; F11; O43; L16; L22; K12

Keywords: Contract enforcement costs; Contracting frictions; Transaction costs; Outsourcing; Misallocation

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1 Introduction

A prominent and growing literature has established that legal institutions matter for economic development. Most of this literature has either studied these mechanisms at the microeconomic level, or documented their macroeconomic relevance via reduced-form regressions at the industry or country level.[1] Despite their contributions, this literature has not resolved a central question: just *how* important are legal institutions for aggregate outcomes?

In this paper, I am concerned with one particular dimension of legal institutions: the cost of enforcing a supplier contract in court. Countries differ vastly in the speed and cost of enforcement procedures: while Icelandic courts often resolve commercial disputes within a few months, cases in India that are decades old are commonplace.[2] This constitutes a transaction cost between firms (North, 1990). If enforcement of supplier contracts is costly, firms will perform a larger part of the production process within the firm, instead of outsourcing it, thereby avoiding having to contract with an external supplier. This increases the cost of production (Khanna and Palepu, 2000).[3,4] Higher production cost feeds into higher input prices in downstream sectors, thus amplifying the distortions on the macroeconomic scale.[5]

This paper exploits cross-country variation in enforcement costs and input expenditure shares to study the importance of enforcement costs for productivity and income per capita. I make three contributions to our understanding of the role of institutions for economic outcomes. First, building on the seminal work of Eaton and Kortum (2002) and Antràs (2003), I construct a tractable general-equilibrium model that reveals how contract enforcement costs, together with asset specificity, shape the firm's domestic outsourcing decision and the economy's industry structure. To describe contracting frictions, I extend the literature on hold-up in a bilateral buyer-seller relationship to a setting of enforceable contracts, where enforcement is subject to a cost and goods are relationship-specific. Contracts may alleviate hold-up problems only if enforcement costs are sufficiently low. Second, I find evidence for my model's qualitative predictions on external input use using cross-country reduced-form regressions. Using microdata on case law from the United States I construct a new measure of dependence on formal enforcement institutions, which arises in the model because of relationship-specific investment. By counting the number of court cases between two sectors, and normalizing it, I obtain the relative prevalence of litigation between these two sectors, which, for given enforcement costs, is informative about the extent to which firms rely on formal enforcement. The fact that this

[1] See, among others, Besley and Ghatak (2010) on the microeconomic level, and La Porta et al. (1997), Djankov et al. (2003), Acemoglu and Johnson (2005), and many papers that follow Rajan and Zingales (1998).

[2] Council of Europe (2005), Supreme Court of India (2009)

[3] In a case study on the TV broadcasting industry in India, Anand and Khanna (2003) give the example of the cable network firm Zee Telefilms Limited (ZTL), which was faced with a multitude of local cable operator firms that grossly understated the number of subscribers and underpaid fees. Litigation was slow and costly, thus ZTL was forced to expand into the cable operator's business. The resulting distribution subsidiary was not profitable for the first five years after its inception, a long time in an industry that consisted mostly of small young firms.

[4] See also the surveys by Bresnahan and Levin (2013), and Syverson (2011).

[5] This idea of a 'multiplier effect' goes back to Hirschman (1958). See also Ciccone (2002), Jones (2011a, 2011b), and Acemoglu et al. (2012).

is a bilateral measure means that I can control for cross-country heterogeneity in the upstream sectors, and causally identify the effect of costly enforcement on outsourcing. Third, I show that the presence of contracting frictions in vertical relationships has large consequences for aggregate productivity and welfare. I do this by structurally estimating my model and simulating the aggregate variables in the absence of enforcement costs. Hence, I conclude that the effects of contracting frictions on firm boundaries, such as those studies by Antràs (2003) and subsequent papers in the context of international trade, have large implications for aggregate productivity and welfare.

The analysis proceeds in several steps. I first propose a general-equilibrium model where firms face a binary decision between in-house production and domestic outsourcing for each task in the production process. Firms and suppliers draw independent productivity realizations for each task. In-house production uses labor, which is provided on a frictionless market. Outsourcing, however, is subject to contracting frictions that increase its effective cost. To understand what drives the magnitude of the distortion I explicitly model the interaction of the buyer and seller. The produced goods are relationship-specific, i.e. they are worth more within the buyer-seller relationship than to an outside party. Contracts specify a quantity to be delivered and a fee, and are enforceable at a cost which is proportional to the value of the claim.[6] Courts do not enforce penal clauses in the contract, and award damages only to *compensate* the innocent party. This places strong limitations on the ability to punish the underperforming party, and may give rise to the seller breaching the contract in equilibrium. When the buyer holds up the seller, the seller could recover his fee net of damages by going to court. In the presence of enforcement costs, the amount the seller could recover is lower, leading him to ex-ante produce less than the efficient quantity. On the other hand, if enforcement costs are high and the resulting inefficiency is large, it may be preferable to write an unenforceable (incomplete) contract, where the inefficiency depends on the degree of relationship-specificity (Klein, Crawford, and Alchian, 1979). This can be replicated through an enforceable contract where the specified quantity is zero.[7] Thus, the overall distortion when using an optimal contract is the minimum of the distortions implied by enforcement costs (in the case of a formal contract, and breach) and relationship-specificity (in the case of an informal contract). Hence, the possibility of formal enforcement will improve outcomes when enforcement costs are low compared to the distortions under an informal contract.

Next, I provide empirical evidence for my model's key qualitative prediction using cross-country reduced-form regressions. The model predicts that in countries where enforcement costs are high, firms spend less on inputs where (absent formal enforcement) distortions from hold-up problems would be very severe. I thus regress intermediate input expenditure shares by country and sector-pair on an interaction of country-wide enforcement costs and a sector-pair-level measure of dependence on formal enforcement institutions. I construct this measure of

[6] Enforcement costs include time costs, court fees, and fees for legal representation and expert witnesses.

[7] My model thus provides a new economic rationale for preferring informal contracts over formal ones, where the threat of litigation and its associated costs may lead the seller to ex-ante underinvest.

enforcement-intensity from data on case law from the United States for 1990-2012. Litigation can only be observed when firms write enforceable contracts to get around the hold-up problem, hence the prevalence of litigation is informative about the extent to which firms rely on formal enforcement institutions. My sector-pair-specific enforcement intensity index is therefore the number of court cases with a firm from the upstream sector, per firm in the downstream sector. On the sector-pair-country level this measure, interacted with enforcement costs in the country, is negatively correlated with the downstream sector's expenditure share on inputs from the upstream sector: in countries with high enforcement costs, intermediate input shares are lower for sector-pairs where litigation is common in the United States. Since this enforcement-intensity measure varies across sector-pairs, I can include country-upstream sector fixed effects and thus control for unobserved heterogeneity, such as differences in productivity and access to external financing, across sectors and countries. To the extent of my knowledge, my paper is the first to use this identification strategy in cross-country regressions. [8]

Finally, I quantify the impact of enforcement costs on aggregate variables by structurally estimating the key parameters of my model and performing a set of counterfactual exercises. This is possible because my model exploits the tractability of multi-country Ricardian trade models, most notably the one of Eaton and Kortum (2002), even though these papers study an entirely different question. I obtain a relatively simple expression for intermediate input use between sectors, where contracting frictions distort input prices and lower intermediate input expenditure shares in the same way iceberg trade costs lower trade shares in the Eaton-Kortum model. I structurally estimate the key elasticities, along with country-specific parameters such as sectoral productivity levels, from data on intermediate input shares and enforcement costs. This allows me to perform welfare counterfactuals, and highlight the macroeconomic significance of transaction costs: reducing enforcement costs to zero would increase real income per capita by an average of 7 percent across all countries (13.3 percent across low-income countries), and decrease consumer prices by an average of 8.5 percent. For many countries the welfare impact exceeds the gains from international trade that the literature has estimated. Since zero enforcement costs may be impossible to achieve in practice, I also calculate the counterfactual welfare gains when enforcement costs are set to US levels. The corresponding increase in real income would still be on average 3.6 percent across all countries, and on average 10 percent across low-income countries.

The paper contributes to the literature on legal institutions and their macroeconomic effects.[9] The challenges in this literature are twofold. First, it is hard to empirically identify

[8] My enforcement-intensity index is positively correlated with industry-level measures of relationship-specificity (Nunn 2007, Levchenko 2007, Bernard et al. 2010). These measures, however, are constructed using data on input-output relationships, which are endogenous in my analysis, and/or are only available for physical goods. Furthermore, they only vary across sectors, whereas my enforcement intensity variable is at the sector-pair level, allowing me to identify the institutional channel from cross-country heterogeneity in sectoral productivity.

[9] For example, theoretical work by Acemoglu, Antràs and Helpman (2007) studies the effects of contracting frictions on the incentives to invest in technology. The empirical literature often employs reduced-form cross-country regressions, see Rajan and Zingales (1998), La Porta et al. (1998), Acemoglu and Johnson (2005),

the effect of institutions on macro-outcomes due to the presence of many unobserved factors that correlate with institutions and development. The literature on cross-country regressions in macroeconomics typically deals with this by trying to proxy for these unobserved factors. This introduces measurement error and other problems. By exploiting variation across countries and sector-*pairs*, I can include country-upstream-sector fixed effects and thus control for unobserved heterogeneity in country-industry pairs in a much cleaner way. Second, the importance of enforcement institutions is hard to quantify. I therefore guide my empirical analysis using a micro-founded model. The empirical counterpart for the enforcement cost maps exactly into the theoretical concept.

The paper is also related to the literature on the role of intermediate inputs for aggregate outcomes.[10] These papers typically take the country's input-output structure as exogenous, or even take the US input-output table to describe the industry structure across countries. I show that input-output tables differ substantially and systematically across countries and exploit this variation in my empirical analysis. In the model I endogenize the sectoral composition of the firm's input baskets.

My paper also draws on the literature on contracting frictions, intermediate inputs, and productivity in international trade.[11] While my analysis is only concerned with domestic transactions, there are reasons to believe that this still captures most of the welfare effects. Contracting frictions are particularly important for service inputs, because these are naturally relationship-specific (i.e., once produced they cannot be 'sold' to an outside party). Services are typically performed within the boundaries of the economy. Furthermore, any distortion to international trade due to contracting frictions cannot cause a welfare loss greater than the overall gains from trade, thus I capture the bulk of the relevant distortions.[12]

Finally, viewed through the lens of industrial organization, my paper is related to the theoretical and empirical literature on transaction costs and vertical integration. In my theory, the firm's make-or-buy decision is influenced both by the presence of non-transferable firm-specific capabilities (Wernerfelt, 1984; Bloom and Van Reenen, 2007), and by its desire to overcome

and many others. Recent country studies include Laeven and Woodruff (2007) and Chemin (2010) on judicial efficiency in Mexico and, respectively, India; Ponticelli (2013) on bankruptcy reform in Brazil, and Cole, Greenwood, and Sanchez (2012) on courts and technology adoption in Mexico.

[10] Among others, Hirschman (1958), Romer (1980), and Jones (2011a, 2011b) for economic growth, Acemoglu et al. (2012) and Carvalho and Gabaix (2013) for fluctuations. Oberfield (2013) provides a firm-level theory for how input linkages shape aggregate productivity. Bartelme and Gorodnichenko (2014) document the cross-country dispersion in input shares, but do not study its determinants.

[11] Antràs (2003) pioneered the property rights approach in international trade. Khandelwal and Topalova (2011) show that increased access to intermediate inputs increases firm productivity. Nunn (2007) uses cross-country regressions to show that contracting institutions shape comparative advantage and explains this using a story similar to mine. Compared to his work, I show direct evidence on input use and study the quantitative effects of contracting institutions. To keep my model sufficiently tractable to allow estimation of the parameters, I draw from the literature on quantitative trade models, see Eaton and Kortum (2002), Chor (2010), Costinot, Donaldson, and Komunjer (2012), Caliendo and Parro (2012), and Arkolakis, Costinot, and Rodriguez-Clare (2012). More recently, Eaton, Kortum, and Kramarz (2015) provide a firm-level theory of international vertical linkages and the division of labor.

[12] Indeed, Irarrazabal et al. (2013) argue that exporting and multinational production are close substitutes. Garetto (2013) estimates that the gains from intra-firm international trade are roughly 0.23 percent of consumption per capita. For more complex sourcing strategies, see Ramondo and Rodriguez-Clare (2013).

transaction costs (Klein, Crawford and Alchian, 1979; Williamson, 1985). In modeling transaction costs and property rights, I deviate from the usual assumption of incomplete contracts and instead assume that contracts are enforceable at a cost, and that courts award expectation damages.[13] The residual rights of control are then endogenously assigned by an optimal contract, taking into account enforcement costs and relationship-specificity, to maximize the ex-ante investment. The strength of this approach is that it provides an intermediate case between the full enforcement case, where the outcome is efficient, and the no-enforcement case, where on the margin institutions do not play a role. How far away we are from each case is determined by the enforcement cost, a parameter for which there is a direct empirical counterpart. This allows me to quantify the transaction cost and study its importance in general equilibrium.[14] The paper also contributes to the empirical literature on the determinants of vertical integration.[15]

The paper proceeds as follows. Section 2 describes a macromodel of input choice, where contracting frictions distort the firm's make-or-buy decision. Section 3 qualitatively assesses the model's key prediction using cross-country reduced-form regressions. Section 4 structurally estimates the model of section 2, and evaluates the productivity and welfare implications of costly contract enforcement. Section 5 concludes.

2 A Macroeconomic Model of Input Sourcing

This section presents a macroeconomic model where firms face the decision between producing in-house and outsourcing. The model economy is closed. Outsourcing is subject to frictions due to the presence of contract enforcement costs. These frictions distort the relative price of outsourcing, and thus lead to over-use of in-house production. I first discuss the firm's production functions, and then turn to the modes of sourcing. I pay particular attention to the contracting game that is played in the case of outsourcing, explaining how and when enforcement costs matter, and derive an expression for the magnitude of price distortions. Finally, I put the model into general equilibrium by adding households, and derive predictions for aggregate input use.

Methodologically, the model exploits the tractability of the Eaton and Kortum (2002) approach to modeling discrete sourcing decisions, albeit for a very different purpose. I model the firm's binary decision to outsource in the same way as Eaton and Kortum model the decision which country to buy from. The contracting frictions in my model, for which I provide a microfoundation, enter the expression for intermediate input shares in the same way that iceberg

[13] The literature in Law and Economics discusses the economics of enforcement costs and remedies for breach. See Hermalin et al. (2007) for a survey. Shavell (1980) and Edlin and Reichelstein (1996), among others, discuss the role of expectation damages for relationship-specific investment.

[14] Grossman and Helpman (2002) study the vertical integration decision in general equilibrium using incomplete contracts and search frictions as transaction costs. Their focus is entirely on qualitative predictions.

[15] See Lafontaine and Slade (2007) for a survey. Recent micro-level evidence comes from Alfaro et al. (2015a, 2015b).

trade costs enter the expression for trade shares in Eaton-Kortum. This allows me to model both frictions and input-output linkages between sectors in a tractable way, and it simplifies the structural estimation and evaluation of the welfare effects.

2.1 Technology

There are N sectors in the economy, each consisting of a mass of perfectly competitive and homogeneous firms. Sector n firms convert activities $\{(q_{ni}(j), j \in [0,1]\}_{i=1,\dots,N}$ into output y_n according to the production function[16]

$$y_n = \left(\sum_{i=1}^{N} \gamma_{ni}^{1/\rho} \left(\int_0^1 q_{ni}(j)^{(\sigma_n - 1)/\sigma_n} dj \right)^{\frac{\sigma_n}{\sigma_n - 1} \frac{\rho - 1}{\rho}} \right)^{\rho/(\rho-1)}, \quad n = 1, \dots, N. \tag{2.1}$$

The sets $\{(n, i, j), j \in [0,1]\}_{i=1,\dots,N}$ are the sets of inputs that sector n may source from a firm belonging to sector i, or, alternatively, produce itself using labor. The index j denotes the individual activities/varieties within each basket. As an example, consider a car manufacturing plant. Then, $n = car$ and $i \in \{$metal, electricity, R&D, $\dots\}$ are the different broad sets of activities, corresponding to the different upstream (roughly 2-digit) sectors, that need to be performed during the production process. The index j corresponds to the individual varieties of inputs (in the case of physical inputs) or tasks (in the case of intangible inputs). The firm faces the outsourcing decision for every j: a manufacturing plant may want to contract with an accounting firm to do the accounting for them, or decide to employ an accountant themselves, perhaps at a higher cost. In this case, the activity j would be 'accounting', and the upstream industry i would be the business services sector. The technological parameters γ_{ni} capture how much the broad set of inputs i are actually needed in the production process of sector n: the $\gamma_{cars,steel}$ will be high, whereas $\gamma_{cars,agriculture}$ will be low.

For each activity (n, i, j), the sector n firms have to decide whether to produce the activity themselves, or to outsource it. I model the boundaries of firms to be determined primarily by their capabilities.[17] Both the downstream firm and the potential suppliers draw an activity-specific productivity realization, which determine the cost of each option. The downstream firm decides on whether to outsource by comparing them. Outsourcing, however, is subject to contracting frictions, which increase its cost and thus lead to too much in-house production compared to a frictionless world. In order to keep the firm's decision problem tractable, I model outsourcing as buying activity (n, i, j) from a sector i firm via an intermediary. Once the decision has been taken, it is irreversible.[18] I discuss each of the two options in turn.

[16] This is a model where every sector buys from every other sector, but apart from parameters, they are all ex-ante identical. In a bilateral trade between two sectors, I always denote the downstream (buying) sector by n and the upstream (selling) sector by i.

[17] This can be motivated by managers having a limited span of control (Lucas, 1978), or that there are resources that cannot be transferred across firms (Wernerfelt, 1984).

[18] This eliminates competition between the potential employees and the suppliers. Bernard et al. (2003) relax this assumption to obtain variable markups.

2.1.1 In-house Production

The sector n firm can produce activity (n, i, j) itself by employing labor. One unit of labor generates $s_{ni}(j)$ units of activity (n, i, j), thus the production function is $q_{ni}(j) = s_{ni}(j)l(n, i, j)$, where $l(n, i, j)$ is labor used and $s_{ni}(j)$ is a stochastic productivity realization that follows a Fréchet distribution,

$$P(s_{ni}(j) < z) = e^{-S_n z^{-\theta}}.$$

I assume that the $s_{ni}(j)$ are i.i.d. across i, j, and n. The parameter S_n captures the overall productivity of sector n firms: higher S_n will, on average, lead to higher realizations of the productivity parameters $s_{ni}(j)$. The parameter θ is inversely related to the variance of the distribution. The labor market is perfectly competitive. Denote the wage by w, and the cost of one unit of activity (n, i, j) conditional on in-house production by $p^l_{ni}(j)$. Then,

$$p^l_{ni}(j) = \frac{w}{s_{ni}(j)}. \tag{2.2}$$

2.1.2 Arm's Length Transaction

In case of outsourcing, the sector n firms post their demand function to an intermediary. There is one intermediary per activity. In turn, the intermediary sources the goods from a sector i firm ('supplier'), who tailors the goods to the relationship. The intermediary then sells the goods on to the downstream sector firm, earning revenue $R(\cdot)$, as given by the downstream firm's demand function.

When dealing with the supplier, the intermediary chooses a contract that maximizes its profit subject to participation by a supplier firm. The supplier's outside option is zero. I will show that the chosen contract pushes the supplier down to its outside option, which means that this is also the contract that the social planner would choose if he wanted to maximize the overall surplus (conditional on the frictions). One supplier is chosen at random, and the intermediary and the supplier are locked into a bilateral relationship.

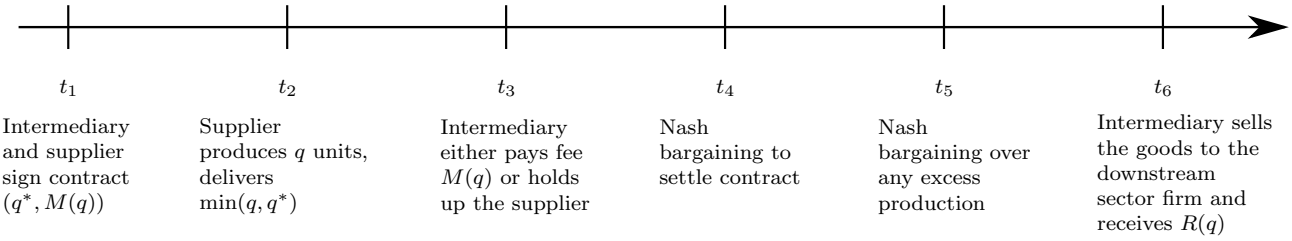
Suppliers can transform one unit of sector i output (produced using the production function (2.1)) into $z_{ni}(j)$ units of variety (n, i, j), thus the production function is $q_{ni}(j) = z_{ni}(j)y_i(n, i, j)$, with $y_i(n, i, j)$ being the amount of sector i goods used as inputs.[19] Again I assume that $z_{ni}(j)$ follows a Fréchet distribution,

$$P(z_{ni}(j) < z) = e^{-T_i z^{-\theta}}$$

and i.i.d. across i, j, and n. The average productivity realization is increasing in the parameter T_i, which captures the upstream sector's overall capabilities (productivity, endowments, etc.). The supplier's cost of producing one unit of variety (n, i, j) is then $c_{ni}(j) = p_i/z_{ni}(j)$, where p_i is the price index of sector i's output good, (2.1). The production of the variety is partially

[19] The assumption that variety (n, i, j) is produced using sector i goods in the case of outsourcing simply means that some of the supplier's production process may be outsourced as well. Ultimately, the whole production process is done using labor and a constant returns to scale production technology; the distinction between labor and intermediate inputs simply draws the firm boundaries and allows for better comparison with the data.

Figure 1: Timeline of the contracting game



reversible: by reverting, the supplier can get a fraction $\omega_{ni} \leq 1$ of its production cost back by selling it on the Walrasian market for the sector i good. This is meant to capture the degree of relationship-specificity of the variety: if $\omega_{ni} = 1$, the variety is not tailored to the relationship at all, whereas $\omega_{ni} = 0$ means that the good is worthless outside the relationship. All parameters, including the productivity realizations $z_{ni}(j)$, are common knowledge. I drop subscripts (n, i, j) for the remainder of the contracting game to simplify the notation.

The description of the contracting game proceeds as follows. I first describe the contracting space, and discuss the timing of events and the enforcement mechanism. I then solve the contracting game. Going back in time, I describe the problem of finding an optimal contract and characterize the equilibrium thereunder. I then return to the implications for input prices under arm's length transaction.

The contract The contract between intermediary and supplier is a pair $(q^*, M(\cdot))$, where $q^* \geq 0$ is the quantity of the good to be delivered[20], and $M : [0, q^*] \to R \backslash R^-$ is a nonnegative, increasing real-valued function that represents the stipulated payment to the supplier. $M(q^*)$ is the agreed fee. If $M(q) < M(q^*)$ for $q < q^*$, this represents damage payments that are agreed upon at the time of the formation of the contract, for enforcement in case of a breach of contract ("liquidated damages").[21] I will explain the exact enforcement procedure after stating the timing of events.

Timing of events

1. The intermediary and the supplier sign a contract $(M(q), q^*)$ which maximizes the intermediary's payoff, subject to the supplier's payoff being nonnegative. At this point the intermediary cannot perfectly commit to paying $M(q)$ once production has taken place, other than through the enforcement mechanism explained below.

[20] The supplier's chosen quantity q may likewise be interpreted as quality of the product, or effort. The legal literature calls this relationship-specific investment *reliance* (Hermalin et al., 2007).

[21] Most jurisdictions impose strong limits on punishment under these clauses. In English law, *in terrorem* clauses in contracts are not enforced (Treitel, 1987, Chapter 20). German and French courts, following the Roman tradition of literal enforcement of *stipulationes poenae*, generally recognize penal clauses in contracts, but will, upon application, reduce the penalty to a 'reasonable' amount (BGB § 343, resp. art. 1152 & 1231, code civil, and Zimmermann, 1996, Chapter 4). Given my assumptions on the courts awarding expectation damages (see below), any restrictions on M are not going to matter.

2. The supplier produces q units. He chooses q optimally to maximize his profits. I assume that if $q < q^*$, he delivers all the produced units; if $q \geq q^*$, he delivers q^* and retains control of the remaining units.[22] A unit that has been delivered is under the control of the intermediary.

3. The intermediary decides whether or not to hold up the supplier by refusing to pay $M(q)$.

4. If the contract has been breached (either because $q < q^*$ or because the intermediary did not pay the fee $M(q)$), either party could enforce the contract in a court. The outcome of enforcement is deterministic, and enforcement is costly. Hence, the two parties avoid this ex-post efficiency loss by settling out of court. They split the surplus using the symmetric Nash sharing rule, whereby each party receives the payoff under the outside option (i.e. the payoff under enforcement), plus half of what would have been lost to them in the case of enforcement (the enforcement costs). I explain the payoffs under enforcement below.

5. In case the supplier has retained control over some of the produced units, $q - q^*$, the two parties may bargain over them. Again I assume that they split the surplus according to the symmetric Nash sharing rule. Since there is no contract to govern the sale of these goods, the outside option is given by the supplier's option to revert the production process.

6. The intermediary sells the goods on to the downstream firm, receiving revenue $R(q)$.

Enforcement After the intermediary's decision whether or not to hold up the supplier, either party may feel that they have been harmed by the other party's actions: the supplier may have produced less than what was specified ($q < q^*$), and the intermediary may have withheld the fee $M(q)$. Either party may enforce the contract in the court. The court perfectly observes all actions by both parties, and awards *expectation damages* as a remedy. The basic principle to govern the measurement of these damages is that an injured party is entitled to be put "in as good a position as one would have been in had the contract been performed" (Farnsworth (2004), §12.8). The precise interpretation of this rule is as follows:

- If the supplier has breached the contract, $q < q^*$, he has to pay the intermediary the difference between the intermediary's payoff under fulfillment, $R(q^*) - M(q^*)$, and under breach, $R(q) - M(q)$. Hence, he has to pay

$$D(q, q^*) = R(q^*) - M(q^*) - (R(q) - M(q)).$$

- In addition, if the intermediary has not paid the fee $M(q)$, the court orders him to do so.

[22] Appendix B.1 considers an extension where the supplier decides about how much to deliver. The equilibrium production (and therefore inefficiency) under an optimal contract remains the same as in the model from the main text. See also Edlin and Reichelstein (1996).

It is important to stress that the resulting net transfer may go in either direction, depending on whether or not the parties are in breach, and on the relative magnitude of $M(q)$ and $D(q, q^*)$.

I assume furthermore that the plaintiff has to pay enforcement costs, which amount to a fraction δ of the value of the claim to him. The value of the claim is the net transfer to him that would arise under enforcement.[23] These costs include court fees, fees for legal representation and expert witnesses, and the time cost. The assumption that enforcement costs are increasing in the value of the claim is in line with empirical evidence (Lee and Willging, 2010), and also strengthens the link between the model and the empirical analysis in Section 3: my data for enforcement costs are given as a fraction of the value of the claim.[24] In line with the situation in the United States, I assume that enforcement costs cannot be recovered in court (Farnsworth, 2004, §12.8).[25]

Solving for the equilibrium of the contracting game I solve for a subgame-perfect Nash equilibrium, which, for a given contract, consists of the supplier's production choice q_s and the intermediary's holdup decision, as a function of q. The holdup decision function gives the intermediary's optimal response to a produced quantity q, and the optimal production choice q_s is then the supplier's optimal quantity q, taking the holdup decision function as given. The full solution of the game is in Appendix A. Here, I discuss the intuition for the optimal responses and the payoff functions.

Case 1: Seller breaches the contract. Consider first the case where the supplier decides to breach, $q < q^*$. The intermediary refuses to pay $M(q)$, in order to shift the burden of enforcement (and thus the enforcement costs) on the supplier. Hence, in the case of enforcement, the supplier would receive a net transfer of $M(q) - D(q, q^*)$. This transfer is positive: if it was negative, the supplier's overall payoff would be negative and he would not have accepted the contract in the first place. Thus, under enforcement, the supplier would be the plaintiff and would have to pay the enforcement costs. To avoid the efficiency loss, the two parties bargain over the surplus and settle outside of court. Under the symmetric Nash sharing rule each party receives its outside option (the payoff under enforcement) plus one half of the quasi-rents (the enforcement costs). Thus, the supplier's overall payoff under breach is

[23] If the net transfer is negative, he would not have chosen to enforce in the first place. However, the other party would then have had an incentive to enforce, and would have been the plaintiff. I show later that in equilibrium the plaintiff is always the supplier.

[24] Having the cost of enforcement in proportion to the value of the claim may also be seen as a desirable, to align the incentives of the plaintiff's attorney with those of the plaintiff. Following the report on civil litigation costs in England and Wales by Lord Justice Jackson (Jackson, 2009b), the UK government passed reforms to bring costs more in line with the value of the claims.

[25] Many countries have the enforcement costs paid by the losing party ('cost shifting'). See Jackson (2009a) for a comparative analysis. While cost shifting may mean that in some circumstances punishment would be possible and therefore higher quantities could be implemented, the resulting model does not allow for closed-form solutions.

$$\pi_s\left(q, M, q^*\right) = \underbrace{(1-\delta)\left(M(q) - D(q, q^*)\right)}_{\text{payoff under enforcement}} + \frac{1}{2}\underbrace{\delta\left(M(q) - D(q, q^*)\right)}_{\text{quasi-rents}} - \underbrace{qc_{ni}(j)}_{\text{production cost}} \tag{2.3}$$

if $q < q^*$. Since $D(q, q^*) = R(q^*) - M(q^*) - (R(q) - M(q))$, the above simplifies to

$$\pi_s\left(q, M, q^*\right) = \left(1 - \frac{1}{2}\delta\right)\left(R(q) - R(q^*) + M(q^*)\right) - qc_{ni}(j) \qquad \text{if } q < q^*. \tag{2.4}$$

Note that the intermediary's revenue function R appears in the supplier's payoff function. This is due to the courts awarding expectation damages: the fact that damage payments are assessed to compensate the intermediary for forgone revenue means that the supplier internalizes the payoff to the intermediary. The enforcement costs δ govern the supplier's outside option, and hence the settlement: higher enforcement costs means that the supplier can recover a smaller fraction of his fee net of damages; therefore, the terms of the settlement are worse for him. Note also that the contract (q^*, M) enters (2.4) only through q^* and $M(q^*)$, and only in an additive manner. This is because the court awards damages such that the *sum* of liquidated damages and expectation damages exactly compensates the intermediary.[26]

Case 2: Seller fulfills the contract. Consider next the case where the supplier fulfills his part of the contract, $q \geq q^*$. He delivers q^* units to the intermediary, and keeps the remaining units to himself. As in the case above, the intermediary refuses to pay the fee $M(q^*)$: subsequent enforcement of the contract would leave the seller with a payoff of only $(1-\delta)M(q^*)$; hence, under the settlement with the symmetric Nash solution, the intermediary only has to pay $(1 - \frac{1}{2}\delta)M(q^*)$. After the settlement of the contract, the two parties may bargain over the remaining $q - q^*$ units. The Nash sharing rule leaves the supplier with its outside option (what he would get by reversing the production process for the $q - q^*$ units) plus one half of the quasi-rents. Thus, the supplier's overall profits are

$$\pi_s\left(q, M, q^*\right) = \underbrace{\left(1 - \frac{1}{2}\delta\right) M(q^*)}_{\text{contract payoff}} + \underbrace{\omega_{ni}c_{ni}(j)\left(q - q^*\right)}_{\text{payoff under reverting}} + \frac{1}{2}\underbrace{\left(R(q) - R(q^*) - \omega_{ni}c_{ni}(j)\left(q - q^*\right)\right)}_{\text{quasi-rents}} - \underbrace{qc_{ni}(j)}_{\text{production cost}} \tag{2.5}$$

if $q \geq q^*$. Hence, even in the case where the supplier fulfills his part of the contract, the contract (q^*, M) only enters additively in the supplier's payoff function. The terms of the bargaining that governs the marginal return on production are now given by the degree of relationship-specificity. A higher degree of relationship-specificity, captured by a lower ω_{ni}, worsens the supplier's outside option and hence lowers his payoff under the settlement.

Going back in time, the supplier chooses q to maximize his profits, given piecewise by (2.4)

[26] This point was first made by Shavell (1980), who argued that when courts assign expectation damages, the parties may achieve first-best even if the contractually specified payoff is not state-contingent. Similarly, I argue here that under expectation damages the state-contingent payoffs do not matter, and later show that the presence of proportional enforcement costs then leads to efficiency loss.

and (2.5). The supplier's profit function is continuous at q^*, and the shape of the ex-ante specified payoff schedule M does not affect π_s. This means that the intermediary is unable to punish the supplier for producing less than the stipulated quantity, and $q < q^*$ may happen in equilibrium.

Optimal Contract We now turn to the intermediary's problem of finding an optimal contract. He chooses a contract (M, q^*) that maximizes his payoff π_b subject to participation by the supplier,

$$(M, q^*) = \arg\max_{(\hat{M}, \hat{q^*})} \pi_b \left(q_s(\hat{M}, \hat{q^*}), \hat{M}, \hat{q^*} \right) \tag{2.6}$$

$$\text{s.t.} \quad \pi_s \left(q_s(\hat{M}, \hat{q^*}), \hat{M}, \hat{q^*} \right) \geq 0 \tag{2.7}$$

where $q_s(\hat{M}, \hat{q^*})$ is the supplier's profit-maximizing quantity,

$$q_s(\hat{M}, \hat{q^*}) = \arg\max_{q \geq 0} \pi_s(q, \hat{M}, \hat{q^*}).$$

Since there is no ex-post efficiency loss, the intermediary's payoff π_b is the total surplus minus the supplier's payoff,

$$\pi_b \left(q, \hat{M}, \hat{q^*} \right) = R(q) - qc_{ni}(j) - \pi_s \left(q, \hat{M}, \hat{q^*} \right).$$

In the solution to the contracting game above, we have shown that a contract (M, q^*) enters the payoff functions in each case only in an additive manner. Therefore, by setting q^* and M, the intermediary can only influence the supplier's decision by shifting the threshold for breach q^*. In choosing an optimal contract, the intermediary thus decides whether he wants to implement the interior maximum in the case of breach by the seller (case 1), or the interior maximum in case of fulfillment by the supplier (case 2). He will choose the case that is associated with the smaller amount of distortions. The following proposition formalizes this intuition, and characterizes the equilibrium under an optimal contract. It describes (1) the produced quantity, (2) whether the equilibrium features a breach or a fulfillment by the seller, and (3) the distribution of the rents between the two parties. Appendix A contains the proof.

Proposition 1 (Equilibrium under an optimal contract) *An optimal contract (M, q^*) satisfies the following properties:*

1. *The quantity implemented, $q_s(M, q^*)$, satisfies*

$$\left. \frac{dR(q)}{dq} \right|_{q = q_s(M, q^*)} = \min \left(2 - \omega_{ni}, \frac{1}{1 - \frac{1}{2}\delta} \right) c \tag{2.8}$$

2. *$q_s(M, q^*) < q^*$ if and only if $(1 - \frac{1}{2}\delta)^{-1} < 2 - \omega_{ni}$.*

3. The whole surplus from the relationship goes to the intermediary:

$$\pi_s\left(q_s(M,q^*),M,q^*\right)=0$$

To interpret this result, it is helpful to compare the equilibrium quantity $q_s(M,q^*)$ to the first-best quantity $\tilde{q}$, which is defined as the quantity that maximizes the overall surplus from the relationship,

$$\tilde{q}\equiv\arg\max_{q\geq 0} R(q)-qc_{ni}(j).$$

The first statement of Proposition 1 says that the equilibrium quantity produced under an optimal contract, $q_s(M,q^*)$, is lower than the first-best quantity $\tilde{q}$ (recall that R is concave, and that $2-\omega_{ni}>1$). The intuition for the efficiency loss depends on whether the equilibrium features a breach or a fulfillment by the supplier. If the supplier breaches by producing $q<q^*$, the presence of proportional enforcement costs mean that the supplier could only recover a smaller fraction of his fee net of damages by going to court. Under the settlement he does not get the full return on his effort, which causes him to ex-ante produce less than the efficient quantity. Note that in the absence of enforcement costs ($\delta=0$), the supplier completely internalizes the intermediary's payoff through the expectation damages, and the resulting outcome would be first-best. Hence, the magnitude of the efficiency loss in this case depends solely on the magnitude of enforcement costs. In the case where the supplier fulfills his part of the contract, $q\geq q^*$, the degree of relationship-specificity governs the supplier's outside option in the bargaining, and thus the marginal return on production. A higher relationship-specificity (lower ω_{ni}) means that the supplier's outside option becomes worse, which results in a lower payoff under the settlement. The supplier anticipates the lower ex-post return on production, and produces less (Klein et al., 1979).

The second statement says that the optimal contract implements a breach by the seller if and only if the cost of enforcement is low compared to the degree of relationship-specificity. Given that it is impossible to implement the efficient quantity, the optimal contract implements the case with the lower associated distortions (hence also the minimum function in expression (2.8)). If the cost of enforcement is relatively low, the optimal contract implements a breach by setting a high q^*: after the hold-up, the control over the produced units is with the intermediary, and the supplier's only asset is the enforceable contract whose value depends on the (relatively low) enforcement costs. On the other hand, when the degree of relationship-specificity is low and enforcement costs are high, the optimal contract will pick a low q^* to allocate the residual rights of control over the excess production $q-q^*$ with the supplier. In that case, his ex-post return on production depends on his ability to reverse the production (i.e. the parameter ω_{ni}). Hence, the optimal contract maximizes the surplus by maximizing the producer's ex-post return on production.[27]

[27]This is similar to the optimal allocation of property rights (Grossman and Hart, 1986, Hart and Moore, 1990).

The third statement says that the above is implementable while still allocating the whole surplus from the relationship to the intermediary. This is not trivial, since the supplier's payoff schedule M is required to be nonnegative.

The reader may be concerned about the possibility of 'overproduction' ($q > q^*$) arising as an equilibrium outcome in the model despite there being little evidence on this actually happening in practice. The right way to interpret such an equilibrium is as an outcome to an informal contract, where the option to enforce the claim in a court is either non-existent or irrelevant. Indeed, a contract where $M = 0$ and $q^* = 0$ would be equivalent to the situation where enforceable contract are not available, as in the literature on incomplete contracts (Klein et al., 1979, and others). The only reason why the optimal contract in this case features a small but positive q^* is because this allows the intermediary to obtain the full surplus from the relationship. If I allowed for an ex-ante transfer from the supplier to the intermediary, setting q^* and M to zero would be an optimal contract in the case where the degree of relationship-specificity is relatively low compared to enforcement costs.[28]

To summarize, the main benefit of having enforceable contracts is that when the stipulated quantity q^* is sufficiently high, the degree of relationship-specificity does not matter for the resulting allocation and the ex-ante investment. The drawback is that the presence of enforcement costs distorts the supplier's decision. Hence, choosing a high q^* will only be optimal if the degree of relationship-specificity is sufficiently high, so that the efficiency loss associated with a breach is lower than the efficiency loss associated with an unenforceable contract.

The model also yields a qualitative prediction on the occurrence of breach, which I will use later to construct an empirical measure of relationship-specificity.

Corollary 2 (Relationship-specificity and breach) *Let $\delta < 1$ and the parties sign an optimal contract. Then, for sufficiently high degree of relationship-specificity (i.e. for a sufficiently low ω_{ni}) the seller breaches the contract in equilibrium.*

2.1.3 Returning to the Firm's Outsourcing Decision

How does the contracting game fit into the macromodel? The intermediary's profit-maximization problem is exactly the problem of finding an optimal contract, (2.6) – (2.7), where the revenue function $R(q)$ is the product of the quantity q and the downstream sector firm's inverse demand function for activity (n, i, j). The produced quantity under the optimal contract is then given by equation (2.8) in Proposition 1. The quantity distortion from the contracting frictions induces a move along the downstream sector firm's demand curve, and hence increases the price to the downstream sector firm. We obtain the price of activity (n, i, j) under arm's length

[28] The model thus makes a case for the possible desirability of informal contracts: if the degree of relationship-specificity is low and enforcement costs are high, it is preferable to choose an informal contract rather than specifying a high q^* and have the supplier underperform due to the presence of high enforcement costs.

transaction by inserting the produced quantity into the inverse demand function:

$$p^x_{ni}(j) = \frac{\mu_n p_i d_{ni}}{z_{ni}(j)}$$

where $\mu_n = \sigma_n / (\sigma_n - 1)$ is the markup due to monopolistic competition, and

$$d_{ni} = \min\left(2 - \omega_{ni}, \frac{1}{1 - \frac{1}{2}\delta}\right) \tag{2.9}$$

is the resulting price distortion due to contracting frictions. The functional form of d_{ni} in terms of the parameters ω_{ni} and δ is exactly the same as the distortion in equation (2.8).

Going back in time, the downstream sector firms decide on whether to produce in-house or to outsource by comparing the price of the good under the two regimes, $p^l_{ni}(j)$ and $p^x_{ni}(j)$. Given the perfect substitutability between the two options, the realized price of activity (n, i, j) is

$$p_{ni}(j) = \min\left(p^l_{ni}(j), p^x_{ni}(j)\right) \tag{2.10}$$

2.2 Households' Preferences and Endowments

There is a representative household with Cobb-Douglas preferences over the consumption of goods from each sector,

$$U = \prod_{i=1}^{N} c_i^{\eta_i}, \tag{2.11}$$

with $\sum_{i=1}^{N} \eta_i = 1$. Households have a fixed labor endowment L and receive labor income wL and the profits of the intermediaries Π. Their budget constraint is $\sum_{i=1}^{N} p_i c_i \leq wL + \Pi$, and thus $p_i c_i = \eta_i (wL + \Pi)$.

2.3 Equilibrium Prices and Allocations

I first describe prices and input use under cost minimization, and then define an equilibrium of the macromodel and give sufficient conditions for existence and uniqueness. All proofs are in Appendix A.

To describe sectoral price levels and expenditure shares, some definitions are helpful. Let $X_{ni} \equiv \int_0^1 p_{ni}(j) q_{ni}(j) \mathbf{1}_{\{j: p^x_{ni}(j) < p^l_{ni}(j)\}} dj$ be the expenditure of sector n firms on activities that are sourced from sector i, and $X_n = \int_0^1 p_{ni}(j) q_{ni}(j) dj$ the total expenditure (and gross output) of sector n. We then have

Proposition 3 (Sectoral price levels and expenditure shares) *Under cost minimization by the downstream sector firms, the following statements hold:*

1. *The cost of producing one unit of raw output y_n in sector n is*

$$p_n \equiv \left(\sum_{i=1}^{N} \gamma_{ni} \left(\alpha_n \left(S_n w^{-\theta} + T_i \left(p_i \mu_n d_{ni} \right)^{-\theta} \right)^{-\frac{1}{\theta}} \right)^{1-\rho} \right)^{1/(1-\rho)} \tag{2.12}$$

where w is the wage, and $\alpha_n \equiv \left(\Gamma \left(\frac{1-\sigma_n}{\theta} + 1 \right) \right)^{\frac{1}{1-\sigma_n}}$, with $\Gamma(\cdot)$ being the gamma function.

2. *The input expenditure shares X_{ni}/X_n satisfy*

$$\frac{X_{ni}}{X_n} = \gamma_{ni} \alpha_n^{1-\rho} p_n^{\rho-1} \frac{T_i \left(\mu_n p_i d_{ni} \right)^{-\theta}}{\left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni} \right)^{-\theta} \right)^{1+(1-\rho)/\theta}}. \tag{2.13}$$

Furthermore, X_{ni}/X_n is decreasing in d_{ni}.

Proposition 3 gives expressions for the sectoral price levels and intermediate input expenditure shares. The sectoral price levels solve the system of equations (2.12), and depend on the cost of production under outsourcing and in-house production, and therefore on the productivity parameters T_i and S_n, as well as contracting frictions d_{ni}. The fact that suppliers may themselves outsource part of their production process gives rise to input-output linkages between sectors; the sectoral price levels are thus a weighted harmonic mean of the price levels of the other sectors. This amplifies the price distortions: an increase in the price of coal increases the prices of steel and machines, which in turn increases the cost of producing steel due to the steel industry's reliance on heavy machinery.

The expenditure shares on intermediate inputs, equation (2.13), are then determined by the relative effective cost of outsourcing versus in-house production. Higher effective cost of outsourcing will lead downstream firms to produce more activities in-house instead of outsourcing them. Thus, the expenditure share of sector n on inputs from sector i is increasing in sector i's productivity, T_i, and the importance of sector i products for sector n, γ_{ni}, and decreasing in sector i's input cost p_i and contracting frictions d_{ni}.

Proposition 3 yields the key qualitative prediction of the model, namely that contracting frictions, captured by $d_{ni} > 1$, negatively affect the downstream sector's fraction of expenditure on intermediate inputs from the upstream sector i. The elasticity θ determines the magnitude of this effect. The downstream firm may substitute away from input bundles that have become more costly due to the contracting frictions, as governed by the elasticity of substitution between input baskets ρ.

On an algebraic level, equation (2.13) closely resembles a structural gravity equation in international trade, with intermediate input expenditure shares replacing trade shares, and contracting frictions d_{ni} replacing trade barriers. This is the result of modeling the outsourcing decision in a similar way to Eaton and Kortum's way of modeling the international sourcing decision, and simplifies the quantitative evaluation of the model. In section 4 I use equation (2.13) to estimate the key parameters, including θ and ρ, and use these estimates to study the

importance of costly contract enforcement for aggregate productivity and welfare.

I now proceed to closing the model. Intermediaries make profits due to monopolistic competition

$$\Pi = \sum_n \sum_i \Pi_{ni} = \sum_n \sum_i \left(1 - \frac{\sigma_n - 1}{\sigma_n} \frac{1}{d_{ni}}\right) X_{ni} \tag{2.14}$$

and the markets for sectoral output clear

$$p_i c_i + \sum_n (X_{ni} - \Pi_{ni}) = X_i, \qquad i = 1, \ldots, N \tag{2.15}$$

An equilibrium is then a vector of sectoral price functions $(p_n(w))_{n=1,\ldots,N}$ that satisfies (2.12). Given the sectoral prices, all other prices and quantities can be directly calculated: input shares $(X_{ni}/X_n)_{n,i}$ from (2.13), and profits Π and gross output levels $(X_n)_{n=1,\ldots,N}$ from the linear system (2.14) and (2.15), where consumption levels are $c_i = \eta_i (wL + \Pi)/p_i$. The following proposition gives a set of sufficient conditions for existence and uniqueness of an equilibrium:

Proposition 4 (Sufficient conditions for equilibrium existence and uniqueness) *Let Ξ be the matrix with elements $\Xi_{ni} = (\alpha_n \mu_n)^{-\theta} \gamma_{ni}^{\theta/(\rho-1)} T_i$ for all $n, i = 1, \ldots, N$. Assume that*

1. *the spectral radius of Ξ is strictly less than one, and*
2. *$0 < \theta/(\rho - 1) < 1$.*

Then, for all $(d_{ni})_{n,i}$ with $d_{ni} \geq 1$ for all n, i, an equilibrium price vector $(p_n(w))_{n=1,\ldots,N}$ exists and is unique. Furthermore, $p_n(w)$ is homogenous of degree one in w.

The condition that the spectral radius of Ξ is less than one rules out 'infinite loops' in the production process, i.e. that one basket of sectoral output goods can be used as inputs to produce more than one basket of the same goods.

3 Reduced-form Empirical Evidence

In this section I present qualitative evidence that is consistent with my model's predictions. To do that, I exploit cross-country variation in intermediate input expenditure shares, enforcement costs, and variation across sector-pairs in the degree to which they rely on formal enforcement. The statements I make here are entirely of a qualitative nature. Later, I will turn to the quantitative importance of contracting frictions for outsourcing and welfare by structurally estimating the model from Section 2.

To empirically operationalize the model, I here state a corollary to Proposition 3.

Corollary 5 *For sufficiently high relationship-specificity $1 - \omega_{ni}$, sector n's expenditure share on intermediary inputs from sector i is strictly decreasing in the enforcement costs δ.*

The corollary directly follows from the fact that the expenditure share X_{ni}/X_n is strictly decreasing in d_{ni} (Proposition 3), and that d_{ni} is strictly increasing in δ for sufficiently low ω_{ni} (equation (2.9)). As explained in Section 2, when there is high relationship-specificity, the supplier and intermediary write contracts such that the suppliers outside option in ex-post bargaining is based on a threat to go to court, rather than a threat to revert production and sell it elsewhere. In these cases, the better the courts work the smaller the inefficiency and the larger the quantity supplied. This results in firms being more willing to outsource their production, and hence a higher intermediate input expenditure share.

In this section I bring Corollary 5 to the data by estimating the following reduced-form regression:

$$\frac{X_{ni}^c}{X_n^c} = \alpha_{ni} + \alpha_i^c + \alpha_n^c + \beta\delta^c(1-\omega_{ni}) + \varepsilon_{ni}^c \tag{3.1}$$

where X_{ni}^c is the total expenditure of sector n in country c on intermediate inputs from sector i, both domestically and internationally sourced; X_n^c is the gross output of industry n in country c; δ^c is a country-level measure of enforcement cost; $1-\omega_{ni}$ is relationship-specificity; α_{ni} are sector-pair fixed effects; α_i^c are upstream sector times country fixed effects, and α_n^c are downstream sector times country fixed effects. In this equation, the expenditure share on intermediate inputs is a function of an interaction of a sector-pair characteristic (relationship-specificity) with a country characteristic (enforcement costs), as well as characteristics of the upstream and downstream sectors in the country, and sector-pair characteristics that are invariant across countries. A negative value for β implies that a worsening of formal contract enforcement has particularly adverse effects on outsourcing in sector pairs characterized by high relationship-specificity, as predicted by Corollary 5. Equation (3.1) exploits variation in bilateral expenditure shares across countries, controlling for factors that affect the expenditure shares on the upstream side (such as sectoral productivity levels, skill and capital endowments, land and natural resources, but also institutional and policy factors such as subsidies, access to external financing, and import tariffs) and downstream side (firm scale, taxes).

Equation (3.1) is similar to the functional form used by Rajan and Zingales (1998) and subsequent papers, who explain country-sector-level variables using an interaction of a country-specific variable with a sector-specific variable. This literature typically goes to great lengths to try to control for the plethora of confounding factors that co-vary with the interaction term. Still, some of these factors may be left unaccounted, or badly proxied, for. My specification improves on this by exploiting variation across countries and bilateral sector *pairs*. This allows me to include upstream sector-country level fixed effects, thereby controlling for unobserved heterogeneity in the upstream sectors.

3.1 Data

Input expenditure shares I use cross-country data on input expenditure from the Global Trade Analysis Project (GTAP) database, version 8 (Narayanan et al., 2012).[29] It contains input-output tables on 109 countries, from varying years ranging from the beginning of the 1990's to mid-2000 and typically originating from national statistical sources. See **??** in Appendix D for detailed information on data availability and the primary source of each country's input-output table. A notable quality of this dataset is that it includes many developing countries, for which industry-level data is typically scarce. The tables cover domestic and import expenditure for 56 sectors, which I aggregate up to 35 sectors that roughly correspond to two-digit sectors in ISIC Revision 3. To have a more direct link to my model's predictions, I use input expenditure shares rather than expenditure levels.[30] Table 1 contains summary statistics on expenditure shares at the country level.

Table 1: Summary statistics for country-wide input shares

Variable	Mean	Std. Dev.	Min	Max	N
Intermediate Input Share	0.53	0.08	0.25	0.69	109
Domestic Intermediate Input Share	0.37	0.08	0.12	0.58	109

Note: 'Intermediate input share' refers to the sum of all intermediate inputs (materials) in gross output. The domestic intermediate input share is defined analogously, but only includes domestically sourced intermediate inputs.

Enforcement cost The World Bank Doing Business project provides country-level information on the monetary cost and time necessary to enforce a fictional supplier contract in a local civil court. The contract is assumed to govern the sale of goods between a buyer and a seller in the country's largest business city. The value of the sale is 200% of the country's income per capita. The monetary cost is the total cost that the plaintiff (who is assumed to be the seller) must advance to enforce the contract in a court, and is measured as a fraction of the value of the claim. It includes court fees, fees for expert witnesses, attorney fees, and any costs that the seller must advance to enforce the judgment though a sale of the buyer's assets. The time until enforcement is measured from the point where the seller decides to initiate litigation, to the point where the judgment is enforced, i.e. the payments are received. I construct a total cost measure – again, as a fraction of the value of the claim – by adding the interest foregone

[29] Recent papers outside the literature on CGE models that have used the GTAP input-output tables are Johnson and Noguera (2011) and Shapiro (2013).

[30] There is a large related literature in industrial organization that measures the degree of vertical integration as the fraction of value added in gross output (see Adleman, 1955, Levy, 1985, Holmes, 1999, and also Macchiavello, 2009). My measure is similar, but distinguishes between intermediate inputs from different sectors. Furthermore, my data for intermediate input shares directly map into the theoretical counterpart in the model. I discuss concerns regarding the observability of firm boundaries in section 3.3.

during the proceedings, assuming a three percent interest rate:[31]

$$\delta^c = (\text{monetary cost, in pct})_c + 0.03\,(\text{time until enforcement, years})_c\,.$$

I use the cost measures for the year 2005, or, depending on availability, the closest available year to 2005.

Dependence on Enforcement Recall that in the model, the more relationship-specific is the good exchanged between the sectors, the more the parties rely on formal contract enforcement to minimize distortions. In reality, relationship-specific investment may not be the only reason for having to rely on court enforcement: the presence of repeated interaction and relational contracts may allow trading partners to overcome hold-up problems without the involvement of courts. Hence, if enforcement costs are the same across sectors, the prevalence of litigation should be informative about the buyer and seller's dependence on enforcement instutions: high rates of litigation imply that the scope for hold-up is large (be it though high relationship-specificity or the absence of relational contracts), and these are exactly the situations where enforcement costs – and the quality of legal instutions in general – matter.[32]

I therefore construct a measure of "enforcement-intensity," i.e. the frequency with which firms from a particular sector-pair resolve conflicts in court, for one particular country where enforcement costs are low, so that enforcement costs themselves are not censoring the prevalence of litigation in an asymmetric way across industries.[33] In particular, using data for the United States, for each pair of sectors I observe the number of court cases over a fixed period of time.

My data come from the LexisLibrary database provided by LexisNexis. It contains cases from US federal and state courts. I take all cases between January 1990 and December 2012

[31]The expression is the proportional cost associated with a linear approximation of $v(1-\text{monetary cost, pct})/(1+\text{discount rate})^{(\text{time, yrs})}$, where v is a future payment. I obtain very similar results when using an eight percent interest rate instead of three percent.

[32]Note that in my model the two parties do not actually go to court, but settle in order to avoid the enforcement costs. This is a result of my contracting game being entirely deterministic: if the outcome of the enforcement is known in advance, there is no point in actually going to court. It would be straightforward to extend the game to a setting where, in some cases, the parties do actually end up in court; however, the resulting friction would then be stochastic and it would be impossible to integrate the contracting into the general-equilibrium macromodel. One simple way to get the prediction of more litigation for higher degree of relationship-specificity would be to change the model by assuming that (1) parties cannot settle outside of court with an exogenous probability, and (2) the possibility of an ex-ante transfer from the supplier to the intermediary, so that an informal contract ($q^* = 0$ and $M = 0$) is optimal in the case when relationship-specificity is low. Then, the threat of litigation only occurs in the case of seller breach, and higher relationship-specificity is associated with a higher prevalence of litigation.

[33]It may seem at first glance that the prevalence of litigation across sectors *in each country* would be more suitable to measure the dependence on legal institutions. The model (and plenty of anecdotal evidence), however, suggest that the decision to litigate depends on enforcement costs; hence, country-specific litigiosity ratios would generally understate the true dependence on legal institutions (and in an asymmetric way across sectors) and would lead to biased coefficient estimates. Of course, by constructing enforcement-intensity indices for one country only, I assume that all non-institutional factors that affect the dependence on court enforcement are constant across countries – an assumption that is implicitly made in Rajan and Zingales (2007), Nunn (2008), and the vast majority of existing work on the topic. I will argue below that even though this assumption may be violated, it is unlikely to drive the regression results.

that are related to contract law, ignoring appeal and higher courts, and match the plaintiff and defendant's names to the Orbis database of firms, provided by Bureau Van Dijk.[34] Orbis contains the 4-digit SIC industry classification of firms; I thus know in which sectors the plaintiffs and defendants are active in. The Bureau of Justice Statistics (1996) documents that in cases related to the sale of goods or provision of services between two businesses, the seller is more than seven times more likely to be the plaintiff. I thus assign the plaintiff to the upstream industry. To obtain the likelihood of litigation between the two sectors, I divide the observed number of cases by a proxy for the number of buyer-seller relationships. If each downstream sector firm has exactly one supplier in each upstream sector, the correct way to normalize is to use the number of firms in the downstream sector. This yields a measure $z_{ni}^{(1)}$. Since the presence of more firms in the upstream sector may mean that there are more buyer-seller relationships, I construct an alternative measure where I divide the number of cases by the geometric mean of the number of firms active in the upstream and downstream industries, yielding a measure $z_{ni}^{(2)}$.[35,36] I interpret these two measures as related to the likelihood of litigation, and hence enforcement-intensity, for each pair of sectors. Table 2 shows summary statistics for $z_{ni}^{(1)}$ and $z_{ni}^{(2)}$.

$$z_{ni}^{(1)} = \frac{(\#\text{ cases between sectors } i \text{ and } n)}{(\#\text{ firms in sector } n)}, \qquad z_{ni}^{(2)} = \frac{(\#\text{ cases between sectors } i \text{ and } n)}{\sqrt{(\#\text{ firms in sector } i)\,(\#\text{ firms in sector } n)}} \tag{3.2}$$

My measure is conceptually different from existing measures of relationship-specificity/contract-intensity along three key dimensions.[37] First, the existing measures are only available for physical goods, whereas my measures cover services sectors as well. Second, the existing measures depend on input share data or assume that input shares are constant across countries. In section 3.2 I document that input shares vary sharply across countries, which renders the existing measures inapplicable to the study of cross-country input use patterns. Third, and most relevant to my identification strategy, my measure varies across bilateral sector-pairs, instead of being associated with the upstream sector. Given that the sectors in my dataset are fairly broad, it is likely that the products being sold to one sector are quite different to the ones sold to other sectors. The fact that my measure is sector-pair-specific is key to my identification strategy, as it allows me to include upstream sector-country fixed effects to control for unobserved sector characteristics like productivity.

[34] See Appendix D for details on the construction of matches and matching statistics.

[35] I use the number of firms in Orbis. The results are extremely similar when using the number of firms from the Census Bureau's Statistics on U.S. Businesses instead.

[36] Results are robust to dividing the cases by the number of upstream sector firms as well.

[37] There are three existing measures of contract-intensity (sometimes directly interpreted as relationship-specificity). Nunn (2007) uses the fraction of a sector's inputs that are traded on an organized exchange, Levchenko (2007) uses the Herfindahl index of input shares, and Bernard et al. (2010) measure contractability as the weighted share of wholesalers in overall importers.

Table 2: Summary statistics for enforcement-intensity measures

Variable	Mean	Std. Dev	Min	Max	N	Correlation with X_{ni}/X_n
$z_{ni}^{(1)}$	$5.34 \cdot 10^{-5}$	$1.778 \cdot 10^{-4}$	0	.00303	1225	0.17
$z_{ni}^{(2)}$	$2.22 \cdot 10^{-5}$	$0.586 \cdot 10^{-4}$	0	.00122	1225	0.29

Note: The table shows summary statistics for the relationship-specificity measures $z_{ni}^{(1)}$ and $z_{ni}^{(2)}$, as defined by equation (3.2). The correlation between the two variables is 0.48.

Table 3: Average enforcement-intensity of upstream sectors, $z_{ni}^{(2)}$ measure

Upstream sector	$\overline{z_{ni}^{(2)}} * 10^4$	Upstream sector	$\overline{z_{ni}^{(2)}} * 10^4$
Insurance	1.099	Transport nec	0.163
Business services nec	0.785	Gas manufacture, distribution	0.118
Financial services nec	0.548	Transport equipment nec	0.116
Electricity	0.443	Food products and beverages	0.114
Trade	0.388	Recreation and other services	0.112
Chemical,rubber,plastic prods	0.357	Mineral products nec	0.109
Paper products, publishing	0.354	Electronic equipment	0.108
PubAdmin/Defence/Health/Educat	0.351	Oil and Gas	0.104
Agriculture, Forestry, Fishing	0.286	Wearing apparel	0.072
Metal products	0.233	Motor vehicles and parts	0.069
Communication	0.221	Water	0.044
Ferrous metals	0.22	Minerals nec	0.040
Metals nec	0.211	Petroleum, coal products	0.036
Machinery and equipment nec	0.199	Coal	0.035
Construction	0.198	Textiles	0.032
Air transport	0.194	Wood products	0.028
Manufactures nec	0.194	Leather products	0.019
Sea transport	0.176		

Note: The table shows the enforcement-intensity $z_{ni}^{(2)}$ of an upstream sector i, averaged across downstream sectors. $z_{ni}^{(2)}$ is defined as the number of court cases where a sector i firm sues a sector n firm, divided by the geometric mean of the number of firms in sectors n and i.

Table 3 shows the ranking of upstream sectors by the average degree of enforcement-intensity, as measured by $z_{ni}^{(2)}$ (the ranking for $z_{ni}^{(1)}$ is very similar). Services sectors are on average more enforcement-intensive than manufacturing sectors, which are in turn more enforcement-intensive than raw materials-producing sectors. This is broadly in line with the interpretation of enforcement-intensity as the degree of relationship-specificity (Monteverde and Teece, 1982, Masten 1984, Nunn, 2007). Once a service has been performed, it cannot be sold to a third party, thus the scope for hold-up should be high. On the other end of the spectrum, raw materials have low depreciability and may be readily obtained through organized markets, thus there is relatively little scope for hold-up.

3.2 Cross-country Dispersion in Input-Output Tables

Table 4: Cross-country dispersion in two-digit intermediate input shares

I. Average standard deviations of intermediate input expenditure shares

	$\overline{\sigma}$
All sector pairs	.023
Goods-producing upstream sectors only	.020
Services-producing upstream sectors only	.028

II. Frequency distribution of standard deviations of input expenditure shares, σ_{ni}

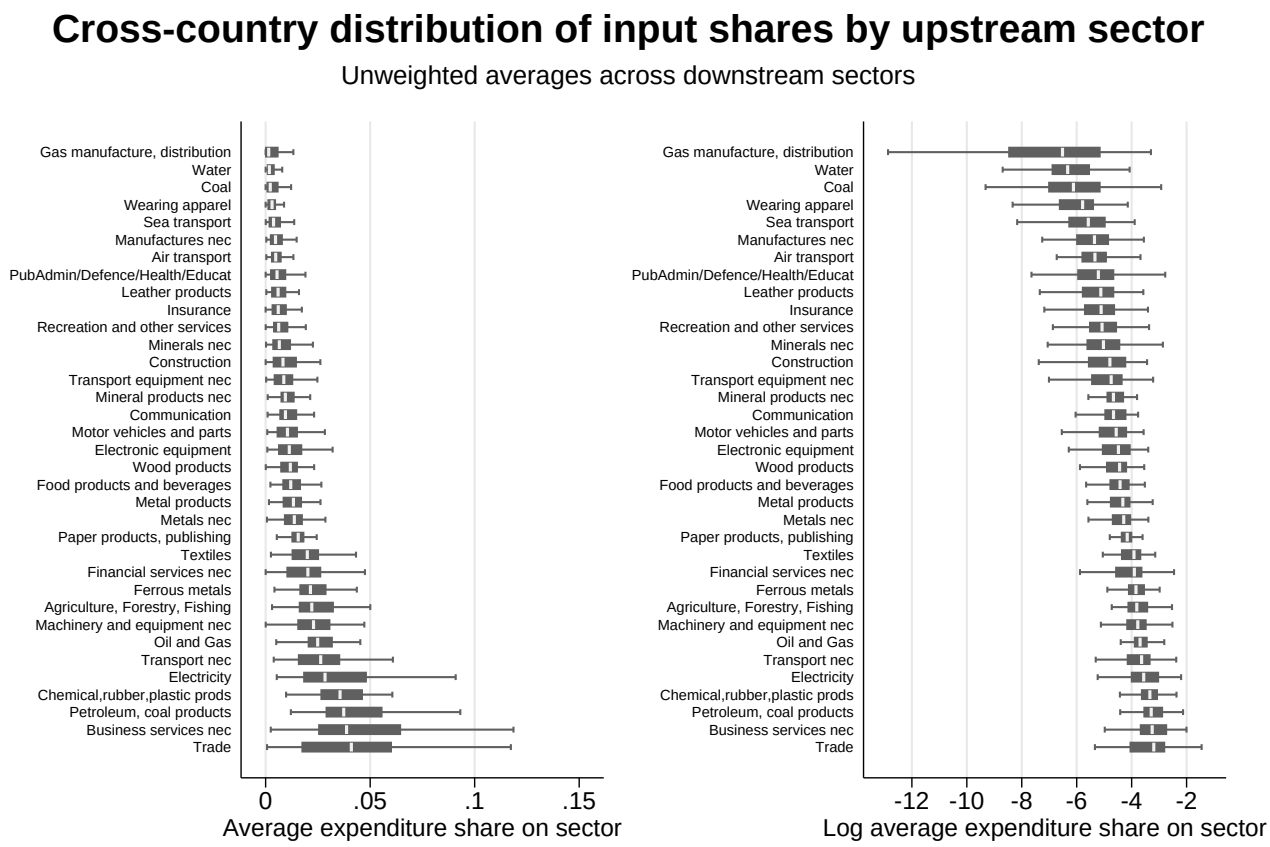
Category	# sector pairs	% of total
All	1225	100
$\sigma_{ni} < .02$	838	68.4
$.02 < \sigma_{ni} < .04$	194	15.8
$.04 < \sigma_{ni} < .06$	68	5.6
$.06 < \sigma_{ni} < .08$	46	3.8
$.08 < \sigma_{ni} < .1$	18	1.5
$.1 < \sigma_{ni} < .15$	34	2.8
$\sigma_{ni} > .15$	27	2.2

Note: The table presents statistics regarding the cross-country dispersion of intermediate input expenditure shares, at the two-digit sector-pair level. Part I shows means of the standard deviations, Part II shows the frequency distribution of standard deviations. All intermediate input shares cover both domestically and internationally sourced inputs.

Table 4 shows the dispersion of intermediate input shares at the two-digit level from their respective means.[38] To obtain the numbers in the first part of the table, I first calculated the standard deviation of the intermediate input shares for each sector-pair, and then took averages of these standard deviations. The average dispersion of expenditure shares across all sector-pairs is 2.3 percentage points. For services-producing upstream sectors, the dispersion is significantly higher (at the 1% level) than for sectors that produce physical goods. Most striking, however, is the fact that here is a sizeable number of sector-pairs for which the cross-country dispersion in input expenditure shares is high. The second part of Table 4 shows that

[38] See Jones (2011b) for a comparison of input-output tables among OECD economies.

Figure 2: Cross-country distribution of input shares by upstream sector



Source: Author's calculations from GTAP 8 data. Excludes outliers.

for roughly 5 percent of sector pairs, the standard deviation is greater than 10 percentage points.

For which inputs is the cross-country dispersion in expenditure shares particularly large? Figure 2 shows for every upstream sector the expenditure share on this sector, averaged across downstream sectors. I use unweighted averages, to make sure the cross-country variation in the resulting input shares is not due to a different sectoral composition. The left panel shows that the dispersion is higher for inputs with higher average expenditure shares. Still, even in log-deviations there is considerable heterogeneity across inputs. Among the inputs with high average expenditure shares, the (wholesale and retail) trade, business services, electricity, transport, and financial services sectors show particularly high dispersion across countries. Note that these sectors are also particularly contract-intensive, as shown by Table 3, whereas the percentage-wise cross-country dispersion in input shares on the (not very contract-intensive) oil and gas and petroleum and coal products sectors is relatively low. This suggests that contracting frictions may play a role for external input use. In the following regressions I will try to rule out (or at least control for) alternative explanations.

Table 5: The Determinants of Expenditure Shares on Intermediates: Benchmark Results

Dependent variable: Expenditure share of sector n on intermediate inputs from sector i, X^c_{ni}/X^c_n	(1)	(2)	(3)	(4)	(5)	(6)
Contract enforcement interaction : $\delta^c(\#\text{Cases}_{ni}/\sqrt{\#\text{Firms}_n\#\text{Firms}_i})$	-71.78***		-101.0***		-120.3***	
	(15.39)		(24.07)		(28.53)	
Contract enforcement interaction : $\delta^c(\#\text{Cases}_{ni}/\#\text{Firms}_n)$		-9.246		-14.42***		-15.35***
		(4.829)		(3.987)		(4.176)
Upstream × Downstream fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Upstream × Country fixed effects			Yes	Yes	Yes	Yes
Downstream × Country fixed effects					Yes	Yes
N	133525	133525	133525	133525	133525	133525
R^2	0.447	0.447	0.531	0.531	0.537	0.537

Standard errors in parentheses, clustered at the country level

Note: Dependent variable is the expenditure of sector n in country c on domestically and internationally sourced intermediate inputs from sector i, divided by the total gross output of sector n in country c.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.3 Results

Table 5 presents the results of estimating equation (3.1) using ordinary least squares (standard errors clustered at the country level in parentheses). The first two columns include only sector-pair fixed effects, and do not correct for sectoral productivity differences across countries. Nevertheless, the estimates of the interaction term's coefficient, β, are negative. Columns (3) and (4) correct for the presence of unobserved heterogeneity in the upstream sectors by including fixed effect for each upstream sector-country pair. The estimates of the coefficient increase in magnitude, suggesting that the specifications that exclude upstream sector-level characteristics suffer from omitted variable bias. Both estimates are now significant at the .1% level. In columns (5) and (6) I also include downstream sector-country fixed effects to control for differences in the size of the downstream sectors across countries. The interaction coefficients increase slightly as a result, and remain statistically significant. I interpret the results from Table 5 as supporting my model's prediction that in countries with high enforcement costs, sectors are using less inputs that rely heavily on contract enforcement. The estimates in columns (5) and (6), my preferred specifications, imply that a one-standard deviation change in each of the interacted variables decreases the input share by .13 and .05 percentage points, respectively. I will discuss the quantitative effects of enforcement costs in more detail in section 4, using my structural estimates.

One potential concern is that my dependent variable, the expenditure share on intermediate inputs, does not correctly measure outsourcing. Indeed, the unit of observation that underlies the construction of an input-output table is the plant, meaning that intra-firm transactions between plants belonging to different sectors also show up in the expenditure on intermediate inputs.[39] In order to resolve this concern, I repeat the above regressions using only sector-pairs where the upstream sector is a services sector. Since services that are performed within the firm boundaries are typically not priced and are thus not included in the firm-level questionnaires that underlie the construction of input-output tables, the likelihood of the observed transactions being within the firm boundaries is much lower. The first two columns in Table 6 show that the resulting point estimates are smaller in magnitude, but still statistically significant at the 5 percent level.

There is an extensive and growing literature that documents that social capital, particularly trust, may help in overcoming frictions.[40] Bloom et al. (2012) document that interpersonal trust affects the internal organization of firms through decentralization. Thus, there is the possibility that trust also affects the make-or-buy decision, which could mean that enforcement costs do not accurately capture the magnitude of frictions between firms and potentially lead to biased estimates. To address this concern, I include an interaction of a country-level trust measure

[39] That said, Atalay et al. (2003) document that shipments of physical goods between vertically integrated plants in the U.S. are surprisingly low – less than .1 percent of overall value for the median plant. Ramondo, Rappoport, and Ruhl (2015) show that similar facts hold for international shipments between vertically integrated plants

[40] See Algan and Cahuc (2013) for a survey of the relationship between trust and growth.

Table 6: The Determinants of Expenditure Shares on Intermediates: Robustness

Dependent variable: Expenditure share of sector n on intermediate inputs from sector i, X^c_{ni}/X^c_n	(1)	(2)	(3)	(4)	(5)	(6)
Contract enforcement interaction : $\delta^c(\#\text{Cases}_{ni}/\sqrt{\#\text{Firms}_n\#\text{Firms}_i})$	-90.24***		-72.24**		-123.6***	
	(25.01)		(23.29)		(30.24)	
Contract enforcement interaction : $\delta^c(\#\text{Cases}_{ni}/\#\text{Firms}_n)$		-7.871*		-12.65**		-15.71***
		(3.796)		(3.191)		(4.635)
Trust interaction : $\text{trust}^c(\#\text{Cases}_{ni}/\sqrt{\#\text{Firms}_n\#\text{Firms}_i})$			29.99		4.808	
			(43.62)		(54.78)	
Trust interaction : $\text{trust}^c(\#\text{Cases}_{ni}/\#\text{Firms}_n)$				0.692		-7.113
				(5.996)		(8.099)
High US expenditure share × enforcement cost: $I^{US}_{ni}\delta^c$					-0.0082	-0.011*
					(0.004)	(0.0048)
High US expenditure share × trust: $I^{US}_{ni}\text{trust}^c$					-0.0007	-0.0006
					(0.005)	(0.005)
Upstream × Downstream fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Upstream × Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Downstream × Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Up services	Up services	Full	Full	Full	Full
N	53410	53410	106575	106575	106575	106575
R^2	0.459	0.459	0.482	0.481	0.566	0.566

Standard errors in parentheses, clustered at the country level

Note: Dependent variable is the fraction of expenditure of sector n on intermediate inputs from sector i in country c in total gross output of sector n in country c. Specifications (1) and (2) uses the subsample where the upstream sector is a services sector (defined as anything except agriculture, mining, and manufacturing). Specifications (3) to (6) use the subsample of countries where the trust measure is available (i.e. all countries except Bahrain, Bolivia, Cambodia, Cameroon, Sri Lanka, Costa Rica, Ecuador, Honduras, Cote d'Ivoire, Kazakhstan, Kuwait, Laos, Mauritius, Mongolia, Oman, Nepal, Nicaragua, Panama, Paraguay, Tunisia, Qatar, and the UAE).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

with enforcement-intensity. I follow the consensus in the literature by measuring trust as the fraction of people that respond to the question "Generally speaking, would you say that most people can be trusted, or that you can't be too careful when dealing with others?" with "Most people can be trusted" as opposed to "Need to be very careful". I use the numbers reported by Algan and Cahuc (2013) in their Figure 1, which in turn are based on data from the World Values Survey, European Values Survey, and Afrobarometer.

The estimates of the trust interaction's coefficient come out as insignificant at the 5-percent level, as reported in specifications (3) and (4) of Table 6. The coefficient on the enforcement cost interaction remains negative and statistically significant. This suggests that while trust may be a way to alleviate frictions in informal interpersonal relationships, they may not be a substitute for enforcement of formal contracts between businesses in a court.

There is a concern that my measure of enforcement-intensity is capturing to some extent the magnitude of intersectoral expenditure flows in the United States, perhaps because of the lack of data for the number of buyer-seller relationships to normalize the number of court cases (and the possibility that the proxies in (3.2) are unsatisfactory). I construct a dummy I_{ni}^{US} that takes the value 1 if the intermediate input expenditure share in the US is above the median US expenditure share, and 0 otherwise. In specifications (5) and (6) of Table 6, I include an interaction of I_{ni} with enforcement costs, and with trust. The key explanatory variable, the interaction of enforcement cost with enforcement-intensity, remains statistically significant.[41]

Given that my dependent variable in the above regressions is the expenditure share on both imported and domestically sourced intermediate inputs, it is natural to ask whether the lack of distinction between the two modes of sourcing matters. Table 7 shows the results from estimating equation 3.1 with the expenditure share of domestically sourced inputs in gross output as the dependent variable. The point estimates of the interaction term's coefficient are slightly smaller than before. One is led to speculate that in domestic transactions, alternative ways to resolve hold-ups may be more relevant than in international transactions.

4 Structural Estimation, and Quantitative Results

In this section I return to my model from Section 2 and structurally estimate the key parameters using the dataset from the previous section. I then perform a set of counterfactuals to evaluate the importance of enforcement costs for aggregate welfare.

4.1 Identifiability and Estimation Strategy

To guide the estimation strategy, it is helpful to first establish which parameters we need to identify. I am ultimately interested in aggregate welfare, which I measure as real income per

[41] Results are very similar when including the US input-output expenditure shares interacted with enforcement costs, instead of $I_{ni}\delta^c$.

Table 7: The Determinants of Expenditure Shares on Intermediates: Domestic Inputs Only

Dependent variable: Expenditure share of sector n on domestic intermediate inputs from sector i, $X^c_{ni,\text{dom}}/X^c_n$	(1)	(2)	(3)	(4)	(5)	(6)
Contract enforcement interaction : $\delta^c(\#\text{Cases}_{ni}/\sqrt{\#\text{Firms}_n\#\text{Firms}_i})$	-45.14**		-63.46***		-72.11***	
	(13.37)		(17.58)		(21.68)	
Contract enforcement interaction : $\delta^c(\#\text{Cases}_{ni}/\#\text{Firms}_n)$		-7.713		-10.75***		-10.80***
		(4.531)		(2.882)		(2.971)
Upstream × Downstream fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Upstream × Country fixed effects			Yes	Yes	Yes	Yes
Downstream × Country fixed effects					Yes	Yes
N	133525	133525	133525	133525	133525	133525
R^2	0.315	0.315	0.453	0.453	0.465	0.464

Standard errors in parentheses, clustered at the country level

Note: Dependent variable is the fraction of expenditure of sector n on domestic inputs from sector i in country c in total gross output of sector n in country c. The results are robust towards inclusion of trust and I_n^{US} interactions as used in Table 6.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

capita. Since the wage is the numeraire, we have that

$$\frac{Y^c}{P^c L^c} = \frac{1 + \Pi^c / L^c}{P^c}$$

where P is the consumer's price index in country c. Thus, changes in income per capita come about from changes in the consumer's price level and changes in profits per capita. The consumer price index is $P^c = \prod_i p_i^{\eta_i}$. Profits can be calculated from intermediate input expenditure levels $X_{ni}^c = (X_{ni}^c / X_n^c)\, X_n^c$, which in turn can be calculated from the market clearing conditions

$$\eta_i \left(L^c + \Pi^c\right) + \sum_n \left(X_{ni}^c - \Pi_{ni}^c\right) = X_i^c$$

for every $i = 1, \ldots, N$. Thus, aggregate welfare can be calculated by knowing only the parameters vectors $\eta = (\eta_i)_{i=1,\ldots,N}$ and $\sigma = (\sigma_n)_{n=1,\ldots,N}$ in addition to the equilibrium sectoral price levels p_i and the input-output expenditure shares X_{ni}^c / X_n^c. These are given by the equations (2.12) and (2.13), which are equivalent to

$$p_n^{1-\rho} = \sum_{i=1}^{N} \left(\left[\gamma_{ni}^{\theta/(\rho-1)} \alpha_n^{-\theta} S_n \right] + \left[\gamma_{ni}^{\theta/(\rho-1)} \alpha_n^{-\theta} T_i \mu_n^{-\theta} \right] (p_i d_{ni})^{-\theta} \right)^{(\rho-1)/\theta} \tag{4.1}$$

$$\frac{X_{ni}}{X_n} = p_n^{\rho-1} \frac{\left[\gamma_{ni}^{\frac{\theta}{\rho-1}} \alpha_n^{-\theta} T_i \mu_n^{-\theta} \right] (p_i d_{ni})^{-\theta}}{\left(\left[\gamma_{ni}^{\frac{\theta}{\rho-1}} \alpha_n^{-\theta} S_n \right] + \left[\gamma_{ni}^{\frac{\theta}{\rho-1}} \alpha_n^{-\theta} T_i \mu_n^{-\theta} \right] (p_i d_{ni})^{-\theta} \right)^{1+(1-\rho)/\theta}} \tag{4.2}$$

Thus, it is possible to calculate the equilibrium prices and quantities by knowing only the elasticities ρ and θ, the frictions d_{ni}^c, and the technology/productivity terms that are captured by the square brackets. In other words, it is not necessary to identify the country-specific productivity levels in order to perform the welfare counterfactuals. This attractive feature of the model vastly simplifies the welfare analysis. I thus proceed in two steps:

1. Estimate the elasticities ρ and θ and the technology/productivity terms from data on input shares X_{ni}^c / X_n^c and contracting frictions d_{ni}^c, using equations (4.1) and (4.2). I construct the contracting frictions d_{ni}^c from enforcement costs δ^c and a structural measure of relationship-specificity ω_{ni}, using the expression from my model, $d_{ni}^c = \min\left(1/(1 - \frac{1}{2}\delta^c), 2 - \omega_{ni}\right)$. I assume that relationship-specificity ω_{ni} is given by

   $$\omega_{ni}^{(i)} = 1 - m \cdot z_{ni}^{(i)}.$$

   Thus, the relative degrees of relationship-specificity are given by the measure of enforcement-intensity coming from the court data, $z_{ni}^{(i)}$. The parameter m, which I jointly estimate with the other parameters, governs the magnitude of relationship-specificity and therefore the importance of enforcement costs in shaping contracting frictions d_{ni}.

2. I set the consumer's Cobb-Douglas utility function parameters η_i to equal the corresponding (country-specific) household expenditure shares in the GTAP dataset. The last remaining parameters to determine are the σ_n, which are not identifiable through equation (4.2), and enter the welfare calculations through the profit share. I set them equal to the values reported by Broda and Weinstein (2006); for services sectors I use the average of Broda and Weinstein's values, which is 3.94. Since these elasticities are fairly low and will imply higher profit shares than what we observe in the data, I also pursue an alternative strategy where I set the profit shares directly to the value observed in the United States. More on this in Section 4.3 below.

   I then calculate the changes in real income per capita when the enforcement costs are set to US levels, using the estimated elasticities ρ and θ, the magnitude parameter m, the calibrated η_i and σ_n, and holding the estimated technology/productivity terms constant.[42]

4.2 Estimation

I use the same dataset as in the reduced-form regressions of Section 3. My estimating equations are the model's expressions for sectoral price levels, equation (4.1), and intermediate input expenditure shares, equation (4.2). Given the high dimsionality of the estimand (T_i^c and S_n^c are each 3815 parameters, γ_{ni} are an additional 1225), I use a simple nonlinear least squares criterion:

$$\left(\hat{m}, \hat{\theta}, \hat{\rho}, \hat{\boldsymbol{\sigma}}, \hat{\boldsymbol{\gamma}}, \hat{\mathbf{T}}, \hat{\mathbf{S}}\right) = \arg \min_{m,\theta,\rho,\boldsymbol{\sigma},\boldsymbol{\gamma},\mathbf{T},\mathbf{S}} \left\| \frac{X_{ni}^c}{X_n^c} - g\left(m, \theta, \rho, \boldsymbol{\sigma}, \boldsymbol{\gamma}, \mathbf{T}, \mathbf{S}\right) \right\|^2 \tag{4.3}$$

where

$$g\left(m, \theta, \rho, \boldsymbol{\sigma}, \boldsymbol{\gamma}, \mathbf{T}, \mathbf{S}\right) = \gamma_{ni} \alpha_n^{1-\rho} \left(p_n^c\right)^{\rho-1} \frac{T_i^c \left(\mu_n p_i^c d_{ni}^c\right)^{-\theta}}{\left(S_n^c + T_i^c \left(\mu_n p_i^c d_{ni}^c\right)^{-\theta}\right)^{1+(1-\rho)/\theta}} \tag{4.4}$$

and the sectoral price levels are given by (4.1). I also impose the conditions for existence and uniqueness of an equilibrium, Proposition 4. For every set of parameters I solve for the model's equilibrium price vector p and calculate the expenditure shares. For searching over the parameter space I use a stochastic Simulated Annealing algorithm, which is designed to find global minima. Simulated Annealing is not particularly good for pinning down the exact minimum in a trough, thus I occasionally perform a Newton-type search to get to the bottom of a valley. Even though it is impossible to write g as a function of the parameters directly, the gradient admits a closed-form expression, which makes this procedure computationally feasible.

Table 8 shows the estimation results, once using the preferred $d_{ni}^{(1)}$ measure of contracting frictions, and once with the alternative measure $d_{ni}^{(2)}$. The structural estimates of the elasticity

[42] A series of recent papers, starting with Arkolakis et al. (2012), use a sufficient statistic approach to study the welfare impact of trade barriers. Even though my setup is structurally very similar to theirs, I cannot follow a sufficient statistic approach because I would need to have data on each country's input-output structure under the counterfactual, i.e. under the enforcement costs of the US.

Table 8: NLS estimates of θ and ρ

	$d_{ni}^{(1)}$	$d_{ni}^{(2)}$
θ	1.76	1.652
	(0.757)	(0.505)
$\log \rho$	1.305	1.130
	(0.267)	(0.297)
N	133525	133525
Pseudo-R^2	0.706	0.709

Note: The table shows partial results from the NLS regression (4.3) and (4.4), using $z_{ni}^{(1)}$ and $z_{ni}^{(2)}$, respectively, to construct $\omega_{ni}^{(1)}$ and $\omega_{ni}^{(2)}$. Robust standard errors are in parentheses. The Pseudo-R^2 is defined as $1 - RSS/TSS$.

of the input share, θ, are 1.76 and 1.65, respectively, which is well below the trade elasticities typically estimated using structural gravity equations (Head and Mayer, 2013). The point estimates for the elasticity of substitution between broad input baskets ρ are 3.7 and 3.1. Lower values for ρ would mean that the impact of contracting frictions on prices would be larger, since firms are less able to substitute other input baskets when frictions are large. I will regard the first specification, which uses $d_{ni}^{(1)}$, as the benchmark, and will limit my discussion mostly to the the results coming from these estimates. The other specification generally yields larger welfare implications.

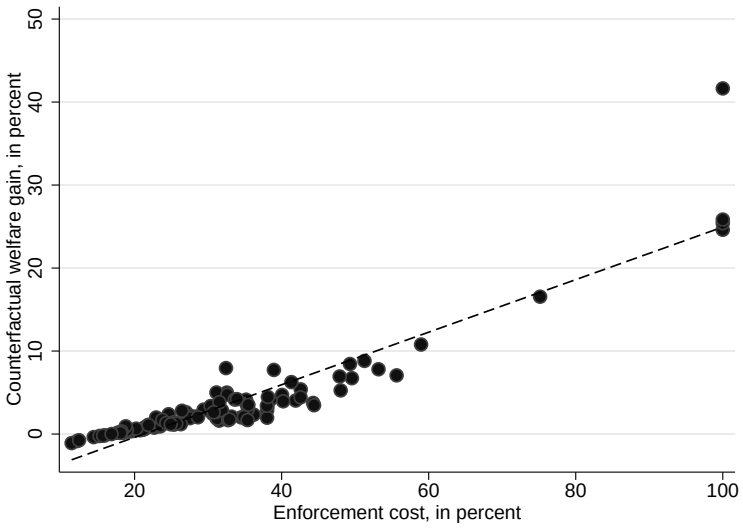
4.3 Welfare Analysis

Table 9 shows the increase in real income and decrease in the consumer's price index that would arise if each country's enforcement costs were set to US levels (17%). The first column lists the level of enforcement costs before the change. The second and third column show the percentage change in real output per capita y and the consumer price level P^c as the enforcement costs are reduced. The magnitudes are sizable, ranging up to a 41.6% increase in real income (23.5% drop in consumer prices) for the case of Indonesia. The mean changes are a 3.6% increase in real income, and a 4.1% drop in consumer prices. In Table 10, I show the average welfare changes for different groups of countries. Enforcement costs are particularly damaging in Africa and South-Eastern Asia. Figure 3 visualizes the welfare gains. A reduction in enforcement costs by one percentage point leads roughly to a 0.32% increase in real income.

According to equation (4.1), the change in real income can be decomposed into two factors: (i) a drop in the consumer's price index P^c due to the decrease in the firm's cost of intermediate inputs, (ii) a change in profits. The latter may be either positive or negative: on the one hand, a decrease in the d_{ni}^c increases outsourcing, which increases the amount of profits made; on the other hand, the profit share decreases as the amount of underproduction declines. Table 9 shows that the latter effect dominates for most countries.

How important are frictions in sourcing services inputs relative to physical inputs? Column 4 of Table 9 shows the fraction of the welfare gain that is explained by a reduction in fric-

Figure 3: Welfare gains from setting enforcement costs to US levels



Note: Welfare gains are calculated using the benchmark specification, column (1) in Table 8.

tions associated with physical inputs (agriculture, mining, manufacturing), assuming that the sourcing of services inputs is not subject to frictions. By considering contracting frictions for physical inputs only, one would miss roughly half of the welfare loss. In developing countries, the frictions on physical inputs are more important, mainly because physical goods are a larger part of the household's consumption basket. In OECD economies, they account for less than 38 percent of the welfare gains (see Table 10).

Since the Broda-Weinstein elasticities imply very high profit shares (around 20-30%), I also show the welfare results when the profit shares Π_{ni}/X_{ni} are set to 5%, which roughly corresponds to the fraction of pre-tax corporate profits in US gross output.[43] Columns four and five of Table 9 show the results. The welfare gains from a reduction in enforcement costs are higher than before, since holding the profit shares constant eliminates the profits-reducing effect from a reduction in enforcement costs. Profits now unambiguously increase as firms outsource more.

The last two columns of Table 9 show the counterfactual welfare gains using the estimates resulting from my alternative measure of relationship-specificity, $\omega_{ni}^{(2)}$. The estimated elasticity of substitution between input baskets, ρ, is lower, thus firms are less able to substitute away when contracting frictions are large for one particular input. The resulting counterfactual welfare gains are therefore larger than in the baseline estimates.

To understand how much inter-firm transaction costs in the form of contracting frictions matter for the aggregate economy, I perform a second counterfactual, where I set the enforcement costs to zero and thereby eliminate contracting frictions altogether. The results are in

[43]Data from the NIPA, Bureau of Economic Analysis, for the years 1998 to 2009. Note that this is not a direct calibration of the infrasectoral elasticities of substitution σ_n, but rather a calibration of Π_{ni}/X_{ni} which, according to the model, depends on the σ_n. This is also why the consumer price level changes in Table 9 are the same in the variable and fixed profit share columns: the σ_n enter the price level calculation only through the terms in the square brackets in equation (4.1), which are directly estimated from the data.

Table 11. The average increase in real income is around 7 percent across all countries and 13.3 percent across low-income countries. Hence, the aggregate effects of distortions to the firm boundaries that originate from transaction costs are sizable, confirming North's (1990) hypothesis.

5 Conclusion

This paper has studied the importance of contracting frictions for the firm's outsourcing decision, and estimated the associated loss in aggregate productivity. The existing literature typically models contracting frictions through incomplete contracts. However, there is little evidence that judicial systems across countries differ in the degree of contractual incompleteness. In this paper I have thus considered a dimension along which we *know* that countries differ – the cost of contract enforcement. I have developed a rich yet tractable model to explain how costly contract enforcement increases the effective cost of intermediate inputs, and how this leads to too much in-house production. Using a novel measure of relationship-specificity constructed from microdata on US case law, I have shown that in countries where enforcement costs are high, firms tend to produce inputs that are very relationship-specific within the firm boundaries. I have then estimated my model parameters and quantified the welfare loss from costly enforcement.

What have we learned? First, contracting frictions distort the prices of externally sourced inputs, particularly those that are relationship-specific, leading to a reduction in the amount of outsourcing. The welfare effects are large. Thus, I have shown that transaction costs and the boundaries of the firm matter on a macroeconomic scale. The welfare effects exceed the gains from trade for many countries. While the literature on contracting frictions in international trade has shed much light on the role of contracting frictions in shaping input use, it is bound to miss the bulk of the distortions for two reasons. First, any barriers to international trade (such as contracting frictions) can only have welfare effects up to the gains of moving from autarky to free trade. Therefore, the welfare effects of international contracting frictions must be second-order. Second, contracting frictions are particularly important for relationship-specific goods, in particular services. These are mostly traded within the economy boundaries.

A second lesson is that economists should take care when interpreting input-output tables. Rather than being merely matrices of 'technological coefficients', they contain information on the firm's sourcing decisions and thus reflect the country's institutions and endowments. My paper also shows the shortcoming of using the United States' input-output table as a proxy for sectoral linkages in other countries, since input-output tables vary significantly and systematically across countries.

The third lesson is one for policy. My paper highlights the importance of judicial reform: the welfare costs from costly contract enforcement are substantial, and must not be ignored. A good rule of thumb to assess the magnitude of the welfare loss due to costly contract enforcement is that every percentage point in the cost of enforcement decreases welfare by 0.32 percent.

Judicial reforms must weigh the benefits against the costs. They may be targeted to reduce the costs of legal representation, such as in the case of the United Kingdom (Jackson, 2009b), or attempt to clear the backlog of cases and speed up the litigation and enforcement process.

Table 9: Welfare gains from setting supplier contracting frictions to US levels

		Using relationship-specificity $\omega_{ni}^{(1)}$					Using $\omega_{ni}^{(2)}$	
		Variable Profit Shares			Fixed Profit Shares		Variable Profit Shares	
	δ	Δy, in %	ΔP, in %	% due to phys. inputs†	Δy, in %	ΔP, in %	Δy, in %	ΔP, in %
Albania	0.42	4.04	-8.79	43.6	9.87	-8.79	5.17	-9.74
Argentina	0.21	0.74	-0.95	37.6	1.03	-0.95	0.99	-1.22
Armenia	0.21	0.83	-1.18	67.9	1.27	-1.18	1.22	-1.56
Australia	0.24	1.46	-1.98	32.4	2.15	-1.98	2.02	-2.53
Austria	0.16	-0.15	0.22	29.6	-0.23	0.22	-0.26	0.30
Azerbaijan	0.21	0.47	-0.58	66.6	0.63	-0.58	0.62	-0.77
Bahrain	0.20	0.38	-0.34	35.2	0.38	-0.34	0.63	-0.53
Bangladesh	0.75	16.55	-18.14	82.7	23.10	-18.14	15.49	-16.96
Belarus	0.19	0.32	-0.46	84.2	0.49	-0.46	0.43	-0.57
Belgium	0.22	1.10	-1.60	35.5	1.73	-1.60	1.81	-2.09
Bolivia	0.38	3.28	-5.55	55.5	6.10	-5.55	4.08	-6.59
Botswana	0.36	2.34	-3.64	44.7	3.94	-3.64	3.01	-4.34
Brasil	0.23	0.77	-1.07	45.6	1.14	-1.07	1.03	-1.40
Bulgaria	0.28	2.11	-2.92	46.4	3.18	-2.92	2.96	-3.70
Cambodia	1.00	24.61	-20.94	76.6	28.11	-20.94	70.22	-35.84
Cameroon	0.53	7.81	-13.03	60.5	15.47	-13.03	11.37	-15.77
Canada	0.27	2.64	-3.30	33.8	3.66	-3.30	3.83	-4.32
Chile	0.33	5.00	-5.45	24.7	6.31	-5.45	10.87	-8.25
China PR	0.14	-0.37	0.53	72.1	-0.56	0.53	-0.52	0.67
Colombia	0.59	10.79	-11.75	40.3	14.14	-11.75	13.36	-14.03
Costa Rica	0.32	1.62	-2.37	57.0	2.54	-2.37	2.02	-2.79
Cote dIvoire	0.48	5.26	-9.19	88.4	10.35	-9.19	6.15	-10.11
Croatia	0.18	0.34	-0.38	62.9	0.42	-0.38	0.48	-0.52
Cyprus	0.22	0.89	-1.12	48.6	1.21	-1.12	1.12	-1.32
Czech Republic	0.39	7.73	-7.81	53.6	9.22	-7.81	13.90	-11.21
Denmark	0.28	2.16	-3.17	34.0	3.45	-3.17	3.18	-3.93
Ecuador	0.32	2.45	-3.17	62.8	3.46	-3.17	3.24	-4.03
Egypt	0.35	2.01	-2.53	75.3	2.75	-2.53	2.55	-3.28
El Salvador	0.26	1.27	-1.83	66.9	1.96	-1.83	1.57	-2.19
Estonia	0.18	0.28	-0.45	45.9	0.47	-0.45	0.44	-0.57
Ethiopia	0.21	0.48	-1.08	87.7	1.12	-1.08	0.61	-1.27
Finland	0.15	-0.23	0.46	44.1	-0.47	0.46	-0.33	0.55
France	0.20	0.55	-0.87	35.1	0.93	-0.87	0.84	-1.10
Georgia	0.44	3.75	-7.38	74.3	8.12	-7.38	4.15	-7.82
Germany	0.18	0.15	-0.24	32.6	0.25	-0.24	0.22	-0.30
Ghana	0.28	1.92	-3.54	68.1	3.81	-3.54	2.61	-3.89
Greece	0.21	0.52	-0.67	44.8	0.72	-0.67	0.69	-0.87
Guatemala	0.38	4.14	-6.36	62.5	7.08	-6.36	5.46	-7.67
Honduras	0.43	5.38	-6.13	54.2	6.98	-6.13	7.11	-7.33
Hong Kong	0.23	2.00	-2.87	48.5	3.13	-2.87	3.78	-3.92
Hungary	0.18	0.16	-0.22	47.3	0.23	-0.22	0.24	-0.28
India	0.51	8.82	-11.14	62.2	13.11	-11.14	11.12	-12.49
Indonesia	1.00	41.64	-23.51	58.5	34.21	-23.51	76.09	-34.74
Iran	0.21	0.61	-0.85	56.5	0.91	-0.85	0.76	-1.04
Ireland	0.31	5.01	-5.74	36.8	6.60	-5.74	8.13	-7.40
Israel	0.33	4.74	-3.57	39.5	4.24	-3.57	10.86	-6.54
Italy	0.41	6.26	-7.23	39.0	8.33	-7.23	9.62	-9.40
Japan	0.35	4.14	-4.87	39.5	5.48	-4.87	5.66	-6.29
Kazakhstan	0.25	1.14	-1.09	63.9	1.21	-1.09	1.95	-1.64
Kenya	0.38	2.86	-2.48	83.6	2.80	-2.48	3.73	-3.74
Kuwait	0.23	0.92	-0.98	27.9	1.07	-0.98	1.44	-1.41
Kyrgyzstan	0.31	1.92	-3.66	60.9	3.90	-3.66	2.48	-4.16
Laos	0.35	1.76	-3.91	83.6	4.12	-3.91	2.00	-4.14
Latvia	0.19	0.32	-0.41	61.1	0.44	-0.41	0.48	-0.55
Lithuania	0.25	1.42	-2.11	41.9	2.28	-2.11	1.90	-2.64
Luxembourg	0.11	-1.09	1.71	27.3	-1.78	1.71	-1.68	2.26
mean	0.33	3.58	-4.12	53.2	4.92	-4.12	5.44	-5.18

Continued on the next page

Table 9: Welfare gains from setting supplier contracting frictions to US levels *(ctd.)*

		Using relationship-specificity $\omega_{ni}^{(1)}$					Using $\omega_{ni}^{(2)}$	
		Variable Profit Shares			Fixed Profit Shares		Variable Profit Shares	
	δ	Δy, in %	ΔP, in %	% due to phys. inputs†	Δy, in %	ΔP, in %	Δy, in %	ΔP, in %
Madagascar	0.50	6.73	-7.27	93.4	8.28	-7.27	6.63	-7.53
Malawi	1.00	25.84	-24.54	66.3	34.05	-24.54	30.36	-26.68
Malaysia	0.32	7.95	-6.66	41.5	8.07	-6.66	20.17	-12.01
Malta	0.40	4.71	-4.72	66.4	5.37	-4.72	6.42	-5.86
Mauritius	0.24	1.01	-1.32	55.9	1.42	-1.32	1.29	-1.55
Mexico	0.35	3.02	-5.71	37.8	6.26	-5.71	4.53	-7.30
Mongolia	0.33	2.10	-3.00	30.5	3.24	-3.00	3.00	-3.74
Morocco	0.29	2.94	-3.68	58.0	4.08	-3.68	4.10	-4.65
Mozambique	1.00	25.41	-28.67	54.0	41.47	-28.67	27.88	-29.96
Namibia	0.38	1.97	-2.49	56.2	2.70	-2.49	2.92	-3.37
Nepal	0.35	3.62	-3.88	77.9	4.31	-3.88	4.68	-6.46
Netherlands	0.29	2.03	-3.06	28.2	3.33	-3.06	2.93	-3.79
New Zealand	0.24	1.70	-2.19	35.0	2.40	-2.19	2.69	-3.00
Nicaragua	0.31	1.87	-3.46	58.0	3.70	-3.46	2.23	-4.04
Nigeria	0.38	3.41	-5.98	73.9	6.53	-5.98	3.37	-6.30
Norway	0.12	-0.74	1.60	36.2	-1.63	1.60	-1.08	1.89
Oman	0.18	0.15	-0.15	43.9	0.17	-0.15	0.24	-0.24
Pakistan	0.31	2.66	-4.15	70.7	4.50	-4.15	3.33	-4.79
Panama	0.56	7.07	-8.79	39.2	10.14	-8.79	9.00	-10.56
Paraguay	0.35	2.07	-3.61	79.7	3.86	-3.61	2.56	-4.45
Peru	0.40	3.95	-4.07	69.1	4.55	-4.07	5.20	-5.31
Philippines	0.32	2.88	-3.89	68.2	4.27	-3.89	4.23	-4.96
Poland	0.20	0.65	-0.98	46.2	1.05	-0.98	0.93	-1.23
Portugal	0.19	0.46	-0.54	49.5	0.59	-0.54	0.79	-0.77
Qatar	0.26	1.19	-1.09	39.0	1.22	-1.09	1.97	-1.73
Romania	0.24	1.33	-2.60	67.8	2.76	-2.60	1.77	-3.05
Russia	0.16	-0.20	0.28	48.7	-0.30	0.28	-0.25	0.35
Saudi Arabia	0.33	1.67	-1.55	36.9	1.74	-1.55	2.55	-2.30
Senegal	0.33	1.76	-3.11	61.0	3.30	-3.11	2.11	-3.53
Singapore	0.19	0.93	-0.89	45.3	1.00	-0.89	2.06	-1.54
Slovakia	0.30	3.37	-4.04	48.9	4.52	-4.04	5.53	-5.48
Slovenia	0.32	3.84	-5.97	42.4	6.68	-5.97	5.77	-7.27
South Africa	0.38	4.47	-5.49	38.1	6.18	-5.49	6.79	-7.24
South Korea	0.12	-0.84	0.94	44.7	-1.02	0.94	-1.31	1.35
Spain	0.21	0.65	-0.90	36.6	0.97	-0.90	0.94	-1.15
Sri Lanka	0.34	4.15	-4.01	60.9	4.54	-4.01	5.04	-5.00
Sweden	0.35	3.52	-5.59	43.6	6.17	-5.59	5.01	-6.68
Switzerland	0.25	2.39	-2.27	25.2	2.58	-2.27	4.08	-3.43
Taiwan	0.22	1.08	-1.28	49.2	1.40	-1.28	1.66	-1.76
Tanzania	0.18	0.13	-0.33	70.8	0.34	-0.33	0.18	-0.39
Thailand	0.18	0.31	-0.46	65.7	0.48	-0.46	0.47	-0.58
Tunisia	0.26	2.80	-3.42	72.2	3.76	-3.42	4.49	-4.51
Turkey	0.31	2.62	-2.90	53.4	3.21	-2.90	3.33	-3.72
Uganda	0.49	8.44	-8.76	61.0	10.30	-8.76	12.63	-11.74
Ukraine	0.44	3.48	-3.47	45.9	3.86	-3.47	5.01	-4.83
United Arab Emirates	0.31	2.45	-2.02	42.5	2.31	-2.02	4.16	-3.20
United Kingdom	0.25	1.25	-1.73	28.1	1.87	-1.73	1.86	-2.22
United States	0.17	0.00	0.00	–	0.00	0.00	0.00	0.00
Uruguay	0.25	1.18	-1.90	33.4	2.03	-1.90	1.76	-2.38
Venezuela	0.48	6.94	-8.15	52.8	9.42	-8.15	10.01	-10.83
Vietnam	0.34	4.21	-5.53	76.7	6.18	-5.53	6.20	-7.05
Zambia	0.43	4.42	-7.66	64.0	8.54	-7.66	5.80	-8.63
Zimbabwe	0.35	1.69	-2.36	61.1	2.52	-2.36	2.16	-2.88
mean	0.33	3.58	-4.12	53.2	4.92	-4.12	5.44	-5.18

†'Percentage due to physical inputs' is the fraction of the change in real income (column 2) that is explained through frictions associated with physical inputs, i.e. agricultural, mining, and manufacturing products.

Table 10: Welfare gains from setting contracting frictions to US levels: Averages

		Using relationship-specificity $\omega_{ni}^{(1)}$					Using $\omega_{ni}^{(2)}$	
		Variable Profit Shares			Fixed Profit Shares		Variable Profit Shares	
	δ	Δy, in %	ΔP, in %	% due to phys. inputs†	Δy, in %	ΔP, in %	Δy, in %	ΔP, in %
High income: OECD	0.24	1.95	-2.31	37.7	2.62	-2.31	3.26	-3.12
High income: non-OECD	0.24	1.21	-1.34	45.7	1.49	-1.34	1.90	-1.85
Upper middle income	0.31	2.72	-3.44	54.5	3.89	-3.44	4.05	-4.42
Lower middle income	0.39	4.95	-5.87	65.0	6.88	-5.87	7.30	-7.18
Low income	0.54	9.86	-10.18	73.0	13.36	-10.18	14.75	-12.30
Africa	0.42	5.41	-6.69	66.4	8.27	-6.69	6.70	-7.68
Northern Africa	0.30	2.58	-3.21	68.5	3.53	-3.21	3.71	-4.15
Eastern Africa	0.48	7.70	-8.45	69.8	11.08	-8.45	9.13	-9.44
Middle Africa	0.53	7.81	-13.03	60.5	15.47	-13.03	11.37	-15.77
Western Africa	0.37	3.09	-5.46	72.8	6.00	-5.46	3.56	-5.96
Southern Africa	0.37	2.92	-3.87	46.3	4.28	-3.87	4.24	-4.98
Americas	0.35	3.38	-4.40	50.6	4.97	-4.40	4.68	-5.51
Northern America	0.22	1.32	-1.65	33.8	1.83	-1.65	1.92	-2.16
Central America	0.37	3.48	-4.95	53.7	5.52	-4.95	4.56	-5.98
South America	0.35	3.72	-4.57	50.1	5.21	-4.57	5.31	-5.85
Asia	0.33	4.47	-4.30	56.2	5.27	-4.30	7.97	-5.83
Western Asia	0.27	1.67	-1.90	48.0	2.13	-1.90	2.69	-2.60
Central Asia	0.28	1.53	-2.37	62.4	2.55	-2.37	2.21	-2.90
Eastern Asia	0.23	1.35	-1.76	47.4	1.94	-1.76	2.05	-2.28
South-Eastern Asia	0.46	10.54	-8.22	64.5	10.81	-8.22	22.68	-12.61
Southern Asia	0.41	6.07	-7.03	68.5	8.41	-7.03	6.74	-7.79
Europe	0.25	1.75	-2.26	44.2	2.54	-2.26	2.66	-2.89
Northern Europe	0.23	1.44	-1.91	41.3	2.13	-1.91	2.18	-2.40
Western Europe	0.20	0.71	-0.87	30.5	0.97	-0.87	1.13	-1.16
Eastern Europe	0.27	2.11	-2.47	54.3	2.78	-2.47	3.39	-3.33
Southern Europe	0.29	2.60	-3.65	48.1	4.12	-3.65	3.73	-4.45
Oceania	0.24	1.58	-2.08	33.7	2.27	-2.08	2.35	-2.76

Note: Table shows the average counterfactual welfare changes when enforcement costs are set to US levels (17%). Income groups are from the July 2013 World Bank income classifications; Regions are defined according to the UN geographical classification.

Table 11: Welfare gains from eliminating supplier contracting frictions: Averages

		Using relationship-specificity $\omega_{ni}^{(1)}$					Using $\omega_{ni}^{(2)}$	
		Variable Profit Shares			Fixed Profit Shares		Variable Profit Shares	
	δ	Δy, in %	ΔP, in %	% due to phys. inputs†	Δy, in %	ΔP, in %	Δy, in %	ΔP, in %
All Countries	0.33	7.03	-8.51	53.14	10.46	-8.51	11.35	-10.77
High income: OECD	0.24	5.86	-7.26	38.0	8.60	-7.26	10.07	-9.64
High income: non-OECD	0.24	4.60	-5.20	46.0	6.07	-5.20	7.78	-7.18
Upper middle income	0.31	5.89	-7.56	55.0	8.96	-7.56	9.45	-9.66
Lower middle income	0.39	8.15	-10.28	64.5	12.62	-10.28	12.23	-12.36
Low income	0.54	13.37	-14.41	72.6	19.73	-14.41	21.58	-17.47
Africa	0.42	8.34	-10.90	66.1	13.90	-10.90	10.72	-12.61
Northern Africa	0.30	6.31	-7.79	68.5	9.10	-7.79	9.37	-9.93
Eastern Africa	0.48	10.79	-12.56	69.4	17.01	-12.56	13.18	-14.16
Middle Africa	0.53	11.06	-18.63	58.8	23.75	-18.63	16.68	-22.53
Western Africa	0.37	5.33	-9.95	72.0	11.50	-9.95	6.31	-10.89
Southern Africa	0.37	5.29	-7.15	46.9	8.26	-7.15	7.75	-9.09
Americas	0.35	6.38	-8.59	50.0	10.16	-8.59	9.27	-10.72
Northern America	0.22	5.07	-6.58	36.6	7.65	-6.58	7.57	-8.53
Central America	0.37	6.08	-8.99	53.1	10.52	-8.99	8.08	-10.79
South America	0.35	6.86	-8.72	50.5	10.42	-8.72	10.45	-11.12
Asia	0.33	8.49	-8.57	56.2	10.87	-8.57	16.30	-11.64
Western Asia	0.27	4.42	-4.99	48.2	5.81	-4.99	7.49	-6.86
Central Asia	0.28	3.79	-5.74	62.4	6.48	-5.74	5.77	-7.07
Eastern Asia	0.23	4.93	-6.37	47.5	7.42	-6.37	7.95	-8.33
South-Eastern Asia	0.46	17.53	-14.11	64.2	19.48	-14.11	42.33	-21.40
Southern Asia	0.41	9.69	-11.49	68.5	14.41	-11.49	11.07	-13.00
Europe	0.25	5.18	-6.96	44.7	8.15	-6.96	8.03	-8.82
Northern Europe	0.23	4.74	-6.77	41.8	7.87	-6.77	7.27	-8.40
Western Europe	0.20	4.24	-5.70	30.8	6.54	-5.70	6.87	-7.52
Eastern Europe	0.26	5.58	-7.05	54.8	8.30	-7.05	8.87	-9.11
Southern Europe	0.29	6.07	-8.17	48.7	9.72	-8.17	8.97	-10.08
Oceania	0.24	5.42	-7.25	34.2	8.40	-7.25	8.23	-9.40

Note: Table shows the average counterfactual welfare changes when enforcement costs (and hence contracting frictions) are eliminated altogether. Income groups are from the July 2013 World Bank income classifications; Regions are defined according to the UN geographical classification.

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Appendix A Proofs

Appendix A.1 Proof of Proposition 1

For the sake of ease of exposition, I will refer to the supplier as the 'seller', and the intermediary as the 'buyer'. A contract is a pair $(q^*, M(q))$ where $q^* \geq 0$ and $M : [0, q^*] \to R \backslash R^-$ is a nonnegative increasing function. I call a contract C *feasible* if there is a quantity $q \geq 0$ such that the ex-ante profit from the relationship to the seller if he produces q, $\pi_s(C, q)$, is nonnegative. Feasible contracts will be accepted by a potential supplier. Moreover, I call a quantity $\hat{q} \geq 0$ *implementable* if there is a feasible contract C such that the seller decides to produce $\hat{q}$ once he has accepted the contract (i.e. $\hat{q} = \arg\max_q \pi_s(C, q)$). Finally, a feasible contract C is *optimal* if the payoff to the buyer under the seller's optimal production choice is maximal in the class of feasible contracts (i.e. $\hat{C}$ is optimal if $\hat{C} = \arg\max_{C,\, C \text{ feasible}} \pi_b(C, \arg\max_q \pi_s(C, q))$).

Suppose the buyer and seller have signed a feasible contract C. Our first step is to find the payoff functions for the buyer and seller, π_b and π_s. Let q be the produced quantity. Distinguish two cases:

1. The seller decides to breach the contract by producing less than the stipulated quantity: $q < q^*$. The buyer will then hold up the seller by refusing to pay $M(q)$. I will show later that this is indeed optimal. If one of the two parties decides to go to court, the court would (i) order the buyer to pay the agreed fee $M(q)$ to the seller, (ii) order the seller to pay damages to compensate the buyer for the loss that has arisen due to breach. Under fulfillment of the contract, the buyer should receive the proceeds from selling q^* to the downstream firm, $R(q^*)$, minus the fee paid to the seller, $M(q^*)$. Thus, the amount of damages are

$$D(q, q^*) \equiv R(q^*) - M(q^*) - (R(q) - M(q)) \,. \qquad \text{(Appendix A.1)}$$

   The plaintiff also has to pay enforcement costs. In order to determine who the plaintiff would be, we need to distinguish between two subcases.

   (a) $M(q) - D(q, q^*) > 0$. In this case the fee that the seller would receive exceed the damages that he would have to pay, thus the seller would have an incentive to go to court. If he did that, he would receive the above amount minus enforcement costs, which amount to a fraction δ of the value of the claim. Thus, under enforcement, the supplier would get

$$(1 - \delta)\,(M(q) - D(q, q^*))\,, \qquad \text{(Appendix A.2)}$$

   whereas the intermediary would get the revenue from selling to the downstream firm,

net of fees $M(q)$ and plus damage payments

$$R(q) + D(q, q^*) - M(q). \qquad \text{(Appendix A.3)}$$

From the definition of the damages (Appendix A.1) it is easy to see that the latter equals $R(q^*) - M(q^*)$. Since enforcement entails a social loss of $\delta\left(M(q) - D(q, q^*)\right)$, the buyer and seller will bargain over the surplus and settle out of court. (Appendix A.2) and (Appendix A.3) are the seller's and buyer's outside options in the Nash bargaining. The symmetric solution in the bargaining leaves each party with its outside option and one-half of the quasi-rents (surplus minus the sum of outside options). Thus, the total payoffs under breach are, respectively

$$\begin{aligned} \pi_s(q) &= \left(1 - \frac{1}{2}\delta\right)\left(M(q) - D(q, q^*)\right) - cq \qquad \text{if } q < q^* \qquad \text{(Appendix A.4)} \\ \pi_b(q) &= R(q) - \left(1 - \frac{1}{2}\delta\right)\left(M(q) - D(q, q^*)\right) \qquad \text{if } q < q^* \end{aligned}$$

Comparing π_b here with the payoff in case the buyer did not hold up the seller, $R(q) - M(q)$, shows that it is preferable for the buyer to hold up. Note that since the buyer already has control over the produced goods, the seller cannot revert the production process.

(b) $M(q) - D(q, q^*) < 0$. In this case, the damages paid to the buyer exceed the fee that he would have to pay to the seller. The buyer thus has an incentive to enforce the contract in a court, and would have to pay the enforcement costs. Thus, under enforcement, the seller's payoff is

$$M(q) - D(q, q^*)$$

and the buyer's payoff is

$$R(q) + D(q, q^*) - M(q) - \delta\left(D(q, q^*) - M(q)\right).$$

The two parties settle outside of court using the symmetric Nash sharing rule; each receives its outside option (i.e. payoff under enforcement) plus one half of the quasi-rents (enforcement costs). Thus, the seller's ex-ante payoff is

$$\begin{aligned} \pi_s(q) &= M(q) - D(q, q^*) + \frac{1}{2}\delta\left(D(q, q^*) - M(q)\right) - cq \\ &= \left(1 - \frac{1}{2}\delta\right)\left(M(q) - D(q, q^*)\right) - cq < 0 \end{aligned}$$

Since the ex-ante payoff of the seller is negative and we are only considering feasible contracts (i.e. the seller's payoff function is nonnegative for some q), this case will

never be chosen by the seller.

2. Fulfillment of the contract, $q \geq q^*$. The supplier delivers q^* units and holds back the rest. The intermediary holds up the supplier by refusing to pay $M(q^*)$ (again, comparing this to the non-hold-up payoff shows that this is optimal). If the supplier goes to court to claim his payment, he would receive $M(q^*)$ minus the enforcement costs $\delta M(q^*)$. The court awards no damages, since there has not been any *loss in value*.[44] Since going to court entails a welfare loss, the parties are going to settle outside of court using the symmetric Nash sharing rule. Under the settlement the supplier receives $M(q^*) - \delta M(q^*) + \frac{1}{2}\delta M(q^*) = \left(1 - \frac{1}{2}\delta\right) M(q^*)$, and the buyer receives $R(q^*) - M(q^*) + \frac{1}{2}\delta M(q^*)$. Once this is done, there may be excess production $q - q^*$ left, which is still more valuable to the buyer than to the seller. Again, the two parties bargain over the surplus from these goods, which is the additional revenue from selling the excess production to the downstream firm, $R(q) - R(q^*)$. Since there is no contract governing the sale of these goods, the seller is left with the option to revert the production process if the bargaining breaks down, in which case he gets $\omega c\,(q - q^*)$ (whereas the buyer gets nothing[45]). The quasi-rents are the difference between the surplus and the sum of the outside options, $R(q) - R(q^*) - \omega c\,(q - q^*)$. Under the Nash sharing rule, the supplier receives in addition to his payoff from the settlement of the contract dispute

$$\omega c\,(q - q^*) + \frac{1}{2}\left(R(q) - R(q^*) - \omega c\,(q - q^*)\right) = \frac{1}{2}\left(R(q) - R(q^*) + \omega c\,(q - q^*)\right)$$

which means that his overall ex-ante payoff is

$$\pi_s(q) = \left(1 - \frac{1}{2}\delta\right) M(q^*) + \frac{1}{2}\left(R(q) - R(q^*) + \omega c\,(q - q^*)\right) - cq \quad \text{if } q \geq q^* \tag{Appendix A.5}$$

and the intermediary receives in the second settlement

$$\frac{1}{2}\left(R(q) - R(q^*) - \omega c\,(q - q^*)\right)$$

which means his total ex-ante payoff is

$$\pi_b(q) = R(q^*) - \left(1 - \frac{1}{2}\delta\right) M(q^*) + \frac{1}{2}\left(R(q) - R(q^*) - \omega c\,(q - q^*)\right) \quad \text{if } q \geq q^*.$$

We have now characterized the payoff functions for seller and buyer, for a given contract. Going back in time, the supplier chooses q optimally to maximize his ex-ante payoff π_s. Let's first establish the fact that the supplier's payoff function is continuous at q^*, which means that it is impossible to punish him for breaching the contract.

[44] Cf. Farnsworth (2004), §12.10 in US law.

[45] These payoffs are in addition to the payoffs from the first bargaining ($R(q^*) - \frac{1}{2}\delta M(q^*)$ and $(1 - \frac{1}{2}\delta)M(q^*)$ for the intermediary and supplier, respectively).

Lemma 6 *Let $(q^*, M(q))$ be a feasible contract. The supplier's payoff function π_s is continuous at q^*.*

Proof. The left-limit of π_s at q^* only exists if $q^* > 0$, in which case it is

$$\lim_{q \nearrow q^*} \pi_s(q) = \left(1 - \frac{1}{2}\delta\right) M(q^*) - cq^*$$

and the right-limit of $\pi_s(q)$ at q^* is

$$\lim_{q \searrow q^*} \pi_s(q) = \left(1 - \frac{1}{2}\delta\right) M(q^*) - cq^*$$

which is the same as the left-limit, thus π_s is continuous at q^*. ■

Let's now look at the set of implementable quantities. The seller's payoff maximization problem is

$$\max_q \pi_s(q) = \max\left(\max_{q, q<q^*} \pi_s(q), \max_{q, q\geq q^*} \pi_s(q)\right). \qquad \text{(Appendix A.6)}$$

Denote the interior maxima of (Appendix A.4) and (Appendix A.5) by q_δ and q_ω respectively. They satisfy the first-order conditions

$$\begin{aligned} R'(q_\delta) &= \frac{1}{1 - \frac{1}{2}\delta} c \\ R'(q_\omega) &= (2 - \omega_i)\, c. \end{aligned}$$

From (Appendix A.6) and the fact that both expressions $\pi_s(q)$ for $q < q^*$ and $q \geq q^*$ have unique maxima at q_δ and q_ω respectively, it is clear that the $\arg\max_q \pi_s(q)$ can only be either q_δ, q_ω, or q^*. Because of the continuity of π_s, q^* can only be implementable if either $q^* \leq q_\delta$ or $q^* \leq q_\omega$.[46] Also, note that both q_δ and q_ω do not depend on the contract $(q^*, M(q^*))$ – though whether they will be chosen by the supplier depends of course on the contract.

We now turn to the optimal contracting problem. In a world where the Coase Theorem holds, the buyer would implement the efficient quantity $\tilde{q} = \arg\max_q R(q) - cq$ and appropriate all the rents from the relationship. In the world of my model, since the implementable quantities are all less or equal[47] $\tilde{q}$, a contract that implements the largest implementable quantity (either q_δ or q_ω) and leaves the full surplus from the relationship with the buyer will be an optimal contract. In the following I will construct such a contract. Distinguish two cases:

1. Case 1, $2 - \omega_i \geq 1/(1 - \frac{1}{2}\delta)$, or, equivalently, $q_\omega \leq q_\delta$. In this case, choosing q^* to be greater than q_δ and setting

$$M(q) = M(q^*) = \frac{1}{1 - \frac{1}{2}\delta} cq_\delta + R(q^*) - R(q_\delta)$$

[46] Suppose $q^* > q_\delta$ and $q^* > q_\omega$. Because of continuity of π_s and the fact that R is concave, either $\pi_s(q_\delta) > \pi_s(q^*)$ or $\pi_s(q_\omega) > \pi_s(q^*)$, thus q^* is not implementable.

[47] Equal if and only if either $\omega = 1$ or $\delta = 0$.

will implement q_δ. The seller's payoff under $q = q_\delta$ is then zero, and the buyer receives $R(q_\delta) - cq_\delta$.

2. Case 2, $2 - \omega_i < 1/(1 - \frac{1}{2}\delta)$, or, equivalently, $q_\omega > q_\delta$. The buyer wants to implement q_ω. Set $M(q^*) = 0$ and q^* such that

$$R(q_\omega) - (2 - \omega_i)\, q_\omega c = R(q^*) + \omega_i q^* c. \qquad \text{(Appendix A.7)}$$

Such a q^* exists because the RHS of this equation is zero for $q^* = 0$ and goes to infinity for $q^* \to \infty$, and is continuous in q^*, and the LHS is positive. Furthermore, it satisfies $q^* < q_\omega$. Distinguish two subcases.

(a) $q^* \geq q_\delta$. Then the greatest profit that could be obtained by breaking the contract is

$$\begin{aligned} & \left(1 - \frac{1}{2}\delta\right)(R(q_\delta) + M(q^*) - R(q^*)) - cq_\delta \\ = & \left(1 - \frac{1}{2}\delta\right)(R(q_\delta) - R(q^*)) - cq_\delta < 0 \end{aligned}$$

thus $q = q_\omega$ is incentive-compatible.

(b) $q^* < q_\delta$. Since $\pi_s(q)$ is increasing for all $q < q^*$, an upper bound for the profits that could be obtained by breaking the contract is

$$\left(1 - \frac{1}{2}\delta\right)(R(q^*) + M(q^*) - R(q^*)) - cq^* = -cq^* < 0$$

thus $q = q_\omega$ is incentive-compatible.

Thus, setting $M(q^*) = 0$ and q^* as in (Appendix A.7) implements q_ω with $\pi_s(q_\omega) = 0$.

Appendix A.2 Proof of Proposition 3

1. We have

$$p_{ni}(j) = \min\left(p^l_{ni}(j), p^x_{ni}(j)\right)$$

and

$$\begin{aligned} p^l_{ni}(j) &= \frac{w}{s_{ni}(j)} \\ p^x_{ni}(j) &= \frac{\sigma_n}{\sigma_n - 1}\frac{p_i d_{ni}}{z_{ni}(j)}. \end{aligned}$$

From the fact that $z_{ni}(j)$ follows a Frechet distribution,

$$P(z_{ni}(j) < z) = e^{-T_i z^{-\theta}}$$

we have that

$$P(p_{ni}^{l}(j) > c) = \exp\left(-S_n \left(\frac{w}{c}\right)^{-\theta}\right)$$

and analogous for $s_{ni}(j)$,

$$P(p_{ni}^{x}(j) > c) = \exp\left(-T_i \left(\frac{\sigma_n}{\sigma_n - 1}\frac{p_i d_{ni}}{c}\right)^{-\theta}\right)$$

$$\begin{aligned} P(p_{ni}(j) &< c) = 1 - P(p_{ni}(j) > c) = 1 - \exp\left(-S_n \left(\frac{w}{c}\right)^{-\theta} - T_i \left(\frac{\sigma_n}{\sigma_n - 1}\frac{p_i d_{ni}}{c}\right)^{-\theta}\right) \\ &= 1 - \exp\left(-\left(S_n w^{-\theta} + T_i \left(\frac{\sigma_n}{\sigma_n - 1} p_i d_{ni}\right)^{-\theta}\right) c^{\theta}\right) \\ &= 1 - e^{-\Phi_{ni} c^{\theta}} \end{aligned}$$

where

$$\Phi_{ni} = \left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right). \qquad \text{(Appendix A.8)}$$

and $\mu_n = \sigma_n / (\sigma_n - 1)$. Denote

$$Q_{ni} = \left(\int_0^1 q_{ni}(j)^{(\sigma_n - 1)/\sigma_n} dj\right)^{\frac{\sigma_n}{\sigma_n - 1}}$$

then

$$y_n = \left(\sum_{i=1}^{N} \gamma_{ni}^{1/\rho} Q_{ni}^{\frac{\rho-1}{\rho}}\right)^{\rho/(\rho-1)}$$

Derive the demand function for sector n firms,

$$\min_{Q_{ni}} \sum_i P_{ni} Q_{ni} \quad \text{s.t. } y_n = 1$$

thus

$$\begin{aligned} P_{ni} &= \lambda \left(\sum_{i=1}^{N} \gamma_{ni}^{1/\rho} Q_{ni}^{\frac{\rho-1}{\rho}}\right)^{1/(\rho-1)} \gamma_{ni}^{1/\rho} Q_{ni}^{-\frac{1}{\rho}} \\ P_{ni} &= \lambda y_n^{1/\rho} \gamma_{ni}^{1/\rho} Q_{ni}^{-\frac{1}{\rho}} \end{aligned}$$

$$Q_{ni} = \gamma_{ni} \left(\frac{\lambda}{P_{ni}}\right)^{\rho} y_n \qquad \text{(Appendix A.9)}$$

From plugging this into the formula for y_n,

$$p_n \equiv \lambda = \left(\sum_{i=1}^{N} \gamma_{ni} P_{ni}^{1-\rho}\right)^{1/(1-\rho)}$$

and similarly

$$P_{ni} = \left(\int p_{ni}(j)^{1-\sigma_n} \right)^{1/(1-\sigma_n)}.$$

The latter becomes, using the distribution of $p_{ni}(j)$ above,

$$\begin{aligned}
P_{ni} = \left(\int_0^1 p_{ni}(j)^{1-\sigma_n} dj \right)^{1/(1-\sigma_n)} &= \left(\int_0^\infty \theta p_{ni}^{1-\sigma_n+\theta-1} \Phi_{ni} e^{-\Phi_{ni} c^\theta} dc \right)^{1/(1-\sigma_n)} = \\
\left(\int_0^\infty \theta \left(\Phi_{ni} c^\theta \right)^{(\theta-\sigma_n)/\theta} \Phi_{ni}^{\sigma_n/\theta} e^{-\Phi_{ni} c^\theta} dc \right)^{1/(1-\sigma_n)} &= \left(\int_0^\infty \theta t^{(\theta-\sigma_n)/\theta} \Phi_{ni}^{\sigma_n/\theta} e^{-t} \Phi_{ni}^{-1} \theta^{-1} c^{1-\theta} dt \right)^{1/(1-\sigma_n)} \\
\left(\Phi_{ni}^{(\sigma_n-1)/\theta} \int_0^\infty t^{\frac{1-\sigma_n}{\theta}} e^{-t} dt \right)^{1/(1-\sigma_n)} &= \left(\Gamma \left(\frac{1-\sigma_n+\theta}{\theta} \right) \right)^{\frac{1}{1-\sigma_n}} \Phi_{ni}^{-\frac{1}{\theta}}
\end{aligned}$$

Thus the cost of one unit of y_n is

$$p_n \equiv \left(\sum_{i=1}^N \gamma_{ni} \left(\alpha_n \Phi_{ni}^{-\frac{1}{\theta}} \right)^{1-\rho} \right)^{1/(1-\rho)}$$

where

$$\alpha_n \equiv \left(\Gamma \left(\frac{1-\sigma_n+\theta}{\theta} \right) \right)^{\frac{1}{1-\sigma_n}}$$

and Φ_{ni} as defined above.

2. The probability that activity (n, i, j) is outsourced is

$$\begin{aligned}
\pi_{ni}(j) &\equiv P(p_{ni}^x(j) \leq p_{ni}^l(j)) = \int_0^\infty \exp\left(-S_n \left(\frac{\sigma_n}{\sigma_n - 1} \frac{w}{p} \right)^{-\theta} \right) dF_{p^x}(p) \\
&= \int_0^\infty T_i \left(\frac{\sigma_n}{\sigma_n - 1} \right)^{-\theta} (p_i d_{ni})^{-\theta} \theta p^{\theta-1} \exp\left(-\Phi_{ni} p^\theta \right) dp \\
&= T_i \left(\frac{\sigma_n}{\sigma_n - 1} \right)^{-\theta} (p_i d_{ni})^{-\theta} \frac{1}{\Phi_{ni}} \int_0^\infty \theta p^{\theta-1} \Phi_{ni} \exp\left(-\Phi_{ni} p^\theta \right) dp \\
&= \frac{T_i (\mu_n p_i d_{ni})^{-\theta}}{\Phi_{ni}} = \frac{T_i (\mu_n p_i d_{ni})^{-\theta}}{S_n w^{-\theta} + T_i (\mu_n p_i d_{ni})^{-\theta}}
\end{aligned}$$

and because of a LLN, it is also the fraction of type-i varieties that sector n sources from sector i. The distribution of cost $p_{ni}(j)$ conditional on activity (n, i, j) being outsourced

is

$$
\begin{aligned}
p_{ni|x}(j) &\equiv P\left(p_{ni}(j) < p | p^x_{ni}(j) \leq p^l_{ni}(j)\right) = \frac{1}{\pi_{ni}(j)} \int_0^p \exp\left(-S_n \left(\frac{\sigma_n}{\sigma_n - 1}\frac{w}{z}\right)^{-\theta}\right) dF_{p^x}(z) \\
&= \frac{1}{\pi_{ni}(j)} \int_0^p T_i \left(\frac{\sigma_n}{\sigma_n - 1}\right)^{-\theta} (p_i d_{ni})^{-\theta} \theta z^{\theta-1} \exp\left(-\Phi_{ni} z^\theta\right) dz \\
&= \frac{T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}}{\pi_{ni}(j)} \frac{1}{\Phi_{ni}} \int_0^p \Phi_{ni} \theta z^{\theta-1} \exp\left(-\Phi_{ni} z^\theta\right) dz \\
&= 1 - e^{-\Phi_{ni} p^\theta} = P\left(p_{ni}(j) < p\right)
\end{aligned}
$$

From this, it follows that the fraction of expenditure on outsourced type-i activities in total expenditure on type-i activities is also $\pi_{ni}(j)$,

$$
\frac{\int_0^1 \pi_{ni}(j) p_{ni|x}(j) q_{ni}(j) dj}{\int_0^1 p_{ni}(j) q_{ni}(j)} = \pi_{ni}(j) = \pi_{ni}.
$$

Let's calculate the expenditure on outsourced type-i activities in total expenditure. From (Appendix A.9), the expenditure share on type-i activities is

$$
\frac{P_{ni} Q_{ni}}{p_n y_n} = \gamma_{ni} \left(\frac{P_{ni}}{p_n}\right)^{1-\rho}.
$$

where $P_{ni} = \alpha_n \Phi_{ni}^{-\frac{1}{\theta}}$. Thus, the expenditure share on outsourced type-i activities is

$$
\begin{aligned}
\frac{X_{ni}}{p_n y_n} &= \gamma_{ni} \alpha_n^{1-\rho} \left(\frac{\left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right)^{-1/\theta}}{p_n}\right)^{1-\rho} \frac{T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}}{S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}} \\
&= \gamma_{ni} \alpha_n^{1-\rho} p_n^{\rho-1} \frac{T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}}{\left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right)^{1+(1-\rho)/\theta}}.
\end{aligned}
$$

I provide here a brief sketch of the proof of X_{ni}/X_n being decreasing in d_{ni}. Note that

$$
\frac{X_{ni}}{X_n} = \gamma_{ni} \alpha_n^{1-\rho} \left(\frac{\left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right)^{-1/\theta}}{p_n}\right)^{1-\rho} \frac{T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}}{S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}}
$$

(Appendix A.10)

We now look at the log-derivative of each of these terms and determine their sign. Since $\partial \log p_i / \partial \log d_{ni} > 0$, we have that

$$
\frac{\partial \log \left(T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right)}{\partial \log d_{ni}} < 0
$$

and thus the second fraction of (Appendix A.10) is decreasing in d_{ni}. By the same argument, $\left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right)^{-1/\theta}$ is increasing in d_{ni}. Since p_n is a harmonic mean of the aforementioned and other expressions, p_n must rise less than $\left(S_n w^{-\theta} + T_i \left(\mu_n p_i d_{ni}\right)^{-\theta}\right)^{-1/\theta}$ to any change in d_{ni} (intuitively, the firms can substitute away). Thus, since $\rho > 1$, the second term in (Appendix A.10) is also decreasing in d_{ni}.

Appendix A.3 Proof of Proposition 4

Lemma 7 *Suppose*

$$f_n(z) = \sum_i^N \left(a_{ni} + b_{ni} z_i^{\eta}\right)^{\frac{1}{\eta}}$$

with $1 > \eta > 0$, *and*

$$\rho(B^{1/\eta}) < 1$$

where $B^{1/\eta} = \left(b_{ni}^{1/\eta}\right)_{n,i}$ *and* $\rho(\cdot)$ *is the spectral radius. Then* $f(z)$ *has a unique fixed point* z^*, *and* $z^* = \lim_{n\to\infty} f^{(n)}(z)$.

Proof. The Jacobian is

$$\begin{aligned}
\frac{\partial f_n}{\partial z_i} &= \left(a_{ni} + b_{ni} z_i^{\eta}\right)^{\frac{1}{\eta}-1} b_{ni} z_i^{\eta-1} = \frac{b_{ni}}{\left(a_{ni} + b_{ni} z_i^{\eta}\right)^{1-1/\eta} z^{1-\eta}} = \frac{b_{ni}}{\left(a_{ni} z_i^{-\eta} + b_{ni}\right)^{1-1/\eta}} \\
&= \left(b_{ni}^{\frac{\eta}{1-\eta}} a_{ni} z_i^{-\eta} + b_{ni}^{\frac{1}{1-\eta}}\right)^{1/\eta-1} = \left(b_{ni}^{-1} a_{ni} z_i^{-\eta} + 1\right)^{1/\eta-1} b_{ni}^{\frac{1}{\eta}}
\end{aligned}$$

We have that, if $\eta < 1$

$$\lim_{z_i\to 0} \frac{\partial f_n}{\partial z_i} = \infty, \qquad \lim_{z_i\to\infty} \frac{\partial f_n}{\partial z_i} = b_{ni}^{1/\eta}$$

The second derivatives are

$$\frac{\partial^2 f_n}{\partial z_i^2} = -\eta\left(1/\eta - 1\right)\left(b_{ni}^{-1} a_{ni} z_i^{-\eta} + 1\right)^{1/\eta-2} b_{ni}^{-1} z_i^{-\eta-1} a_{ni} b_{ni}^{\frac{1}{\eta}} < 0$$

and 0 for the cross derivatives, thus f_n is globally concave, with the Jacobian converging monotonically to $B^{1/\eta}$ for $z \to \infty$. Since the space is finite-dimensional, this convergence is uniform.

Since the spectral radius is a continuous mapping, we can find a $\underline{z}$ such that $\rho\left(\frac{Df}{Dz}(z)\right) \leq r < 1$ for all $z \geq \underline{z}$. Let $Z \equiv \{z \in R^N : z \geq \underline{z}\}$. Given the concavity of f_n, there is a $z^* \in Z$ such that

$$|f_n(z') - f_n(z)| \leq \sum_i \frac{\partial f_n}{\partial z_i^*} |z_i' - z_i|$$

with $\rho\left(Df/dz^*\right) \leq r$. Thus f is a Df/dz^*-contraction on Z and by Theorem 13.1.2 in Ortega and Rheinboldt (1970) $\lim_{n\to\infty} f^{(n)}(z)$ is the unique fixed point of f. ■

Proposition 8 *Assume that*

$$\rho\left(\left(\alpha_n^{1-\rho}\gamma_{ni}\right)^{\frac{\theta}{\rho-1}} T_i\mu_n^{-\theta}\right) < 1.$$

and that $0 < \theta/(\rho-1) < 1$. *Then, for all* $(d_{ni})_{n,i}$ *with* $d_{ni} \geq 1$ *for all* n, i, *an equilibrium price vector* p *exists and is unique.*

Proof. The price vector satisfies the system of equations

$$p_n \equiv \alpha_n \left(\sum_{i=1}^{N} \gamma_{ni} \left(\left(S_n w^{-\theta} + T_i \left(p_i \mu_n d_{ni}\right)^{-\theta}\right)^{-1/\theta}\right)^{1-\rho}\right)^{1/(1-\rho)} \qquad \text{(Appendix A.11)}$$

which can be rewritten

$$z_n \equiv \sum_{i=1}^{N} \left(\gamma_{ni}^{\theta/(\rho-1)} \alpha_n^{-\theta} S_n w^{-\theta} + \gamma_{ni}^{\theta/(\rho-1)} \alpha_n^{-\theta} T_i \left(\mu_n d_{ni}\right)^{-\theta} z_i^{\eta}\right)^{1/\eta} \qquad \text{(Appendix A.12)}$$

with $z_n = p_n^{1-\rho}$ and $\eta = \frac{\theta}{\rho-1}$. We have that $\rho\left(\left(\alpha_n^{1-\rho}\gamma_{ni}\right)^{\frac{\theta}{\rho-1}} T_i\mu_n^{-\theta} d_{ni}^{-\theta}\right) \leq \rho\left(\left(\alpha_n^{1-\rho}\gamma_{ni}\right)^{\frac{\theta}{\rho-1}} T_i\mu_n^{-\theta}\right) < 1$ and $0 < \eta < 1$, and by Lemma 7 there exists a unique z that satisfies (Appendix A.12) and thus a unique p that satisfies (Appendix A.11). ■

Appendix B Extensions

Appendix B.1 A model with a delivery decision

Consider a model that differs from the one in Section 2 in the following way. After production has taken place, the seller faces the decision of how much of the produced goods to deliver to the buyer. Denote this quantity by d. Once delivered, the goods cannot be retrieved anymore. The stipulated quantity q^* in the contract is the quantity to be delivered. Both buyer and the court have no way of verifying that any goods in excess of d have been produced. The enforcement of the contract is as described in Section 2. Once the parties have settled, the seller and the buyer may bargain over the surplus from the excess production, with the control over the goods being with the seller (i.e. he can partially revert the production process in case the bargaining breaks down). Again the settlement is as described in Section 2.

First, note that the seller will not deliver more than q^* to the buyer: the contract and the court will not reward him for producing/delivering more than q^*. Suppose now that the seller delivers $0 \leq d \leq q^*$ and holds back $x \equiv q - d \geq 0$. Then his payoff is

$$\left(1 - \frac{1}{2}\delta\right)\left(R(d) - R(q^*) + M(q^*)\right) + \frac{1}{2}\left(R(d+x) - R(d) + \omega c x\right) - c\left(d + x\right).$$

and his profit maximization problem consists of maximizing this expression subject to the constraints $d \geq 0$, $d \leq q^*$, and $x \geq 0$. Note that if $\delta < 1$, the first constraint is never binding,

since $\lim_{d\to 0} R(d) = \infty$.

The first-order conditions for this problem are

$$\left(1-\frac{1}{2}\delta\right) R'(d) + \frac{1}{2}\left(R'(d+x) - R'(d)\right) = c \qquad \text{(Appendix B.1)}$$

$$\frac{1}{2}\left(R'(d+x) + \omega c\right) = c \qquad \text{(Appendix B.2)}$$

Let's discuss all cases. For q^* sufficiently high, we have that (Appendix B.1) holds. If

$$\frac{1}{2}\left(R'(d) + \omega c\right) > c$$

then the seller holds back some production ((Appendix B.2) holds), and we have

$$\begin{aligned} R'(d+x) &= (2-\omega)\, c \\ R'(d) &= \frac{\omega c}{1-\delta}. \end{aligned} \qquad \text{(Appendix B.3)}$$

$R'(d) > (2-\omega)\, c$ and $R'(d) = \frac{\omega c}{1-\delta}$ implies that $\frac{\omega c}{1-\delta} > (2-\omega)\, c$ and thus $q_\omega > q_\delta$. Thus, this case can only happen if the latter holds. On the other hand, if $\frac{1}{2}\left(R'(d) + \omega c\right) < c$, then $x = 0$ and d satisfies $\left(1-\frac{1}{2}\delta\right) R'(d) = c$ thus $d = q_\delta$.

If (Appendix B.1) does not hold, then $d = q^*$. As above, if $R'(d) > (2-\omega)\, c$ then $R'(d+x) = (2-\omega)\, c$, otherwise $x = 0$, and $d < q_\delta$.

To summarize, it is impossible to implement a higher quantity than $\max(q_\delta, q_\omega)$. It remains to show that there is a contract that implements $\max(q_\delta, q_\omega)$ and where the seller is pushed down to his participation constraint.

- Case 1, $2-\omega_i \geq 1/(1-\frac{1}{2}\delta)$, or, equivalently, $q_\omega \leq q_\delta$. In this case, choosing q^* to be greater than q_δ and setting

  $$M(q) = M(q^*) = \frac{1}{1-\frac{1}{2}\delta} c q_\delta + R(q^*) - R(q)$$

  will implement $d = q_\delta$, since $R'(d) = 1/(1-\frac{1}{2}\delta)$ and thus $R'(d) < 2-\omega$ means $x = 0$.

- Case 2, $2-\omega_i < 1/(1-\frac{1}{2}\delta)$, or, equivalently, $q_\omega > q_\delta$. Total payoff to seller is

  $$\left(1-\frac{1}{2}\delta\right)\left(R(d) - R(q^*) + M(q^*)\right) + \frac{1}{2}\left(R(q_\omega) - R(d) + \omega c(q_\omega - d)\right) - c q_\omega$$

  Set $M(q^*) = 0$ and q^* such that

  $$\left(1-\frac{1}{2}\delta\right)\left(R(d) - R(q^*)\right) + \frac{1}{2}\left(R(q_\omega) - R(d) + \omega c(q_\omega - d)\right) = c q_\omega$$

  where d satisfies equation (Appendix B.3). The q^* is greater than d. Since $2-\omega_i < 1/(1-\frac{1}{2}\delta)$, we have that $R'(d) > (2-\omega)\, c$, thus $q > d$ and $R'(d+x) = (2-\omega)\, c$.

Appendix B.2 How important are Input-Output Linkages?

In order to get a sense of how much the input-output linkages between sectors contribute to the welfare gains from reducing enforcement costs, I discuss here a version of the model without linkages.

Assume that the production function in the case of outsourcing is linear in labor instead of sector i output,

$$q_{ni}(j) = z_{ni} l(n, i, j)$$

where $l(n, i, j)$ denotes labor input, and z_{ni} is the Frechet-distributed productivity realization as in section 2.1.2. Then, the equations for sectoral price levels and input expenditure shares, (2.12) and (2.13), become

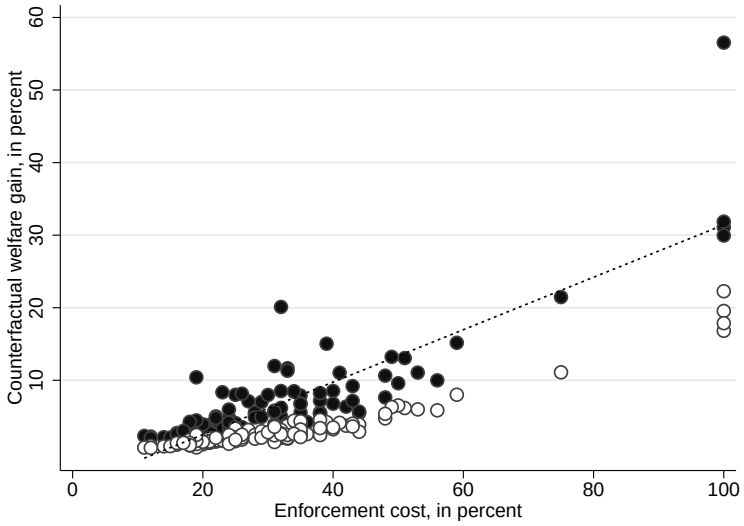
$$p_n = \left(\sum_{i=1}^{N} \gamma_{ni} \left(\alpha_n \left(S_n w^{-\theta} + T_i \left(w \mu_n d_{ni} \right)^{-\theta} \right)^{-\frac{1}{\theta}} \right)^{1-\rho} \right)^{1/(1-\rho)} \tag{Appendix B.4}$$

$$\frac{X_{ni}}{X_n} = \gamma_{ni} \alpha_n^{1-\rho} p_n^{\rho-1} \frac{T_i \left(\mu_n w d_{ni} \right)^{-\theta}}{\left(S_n w^{-\theta} + T_i \left(\mu_n w d_{ni} \right)^{-\theta} \right)^{1+(1-\rho)/\theta}}. \tag{Appendix B.5}$$

The estimation of equations (Appendix B.4) and (Appendix B.5) yields exactly the same point estimates as in the main text, since p_i and T_i only appear together in (2.12) and (2.13) and are thus not separately identified.

I then calibrate the remaining parameters and perform the welfare counterfactuals as described in Section 4.1, using the baseline specifications (Broda-Weinstein elasticities, $\omega_{ni}^{(1)}$). Figure B1 compares the welfare increases in the model without input-output linkages (white dots) with the baseline model (black dots), when enforcement costs are reduced to zero. The welfare gains in the model without intersectoral linkages are roughly half as big as in the baseline model, which implies that the I-O linkages magnify the macroeconomic importance of transaction costs by a factor of two.

Figure B1: Welfare gains with and without I-O linkages



Note: Welfare gains with I-O linkages in black, without I-O linkages in white. Both are calculated using the benchmark specification (Broda-Weinstein elasticities, $\omega_{ni}^{(1)}$).

Appendix C Further robustness checks

Appendix C.1 Results when using Rauch classification

Table C1: Results when using Rauch classification of goods

Dependent variable: Intermediate Input Expenditure Share X^c_{ni}/X^c_n	(1)	(2)	(3)	(4)
Contract enforcement interaction : $\delta^c r_i^{(\text{con})}$	-0.00862		-0.00862	
	(0.00446)		(0.00453)	
Contract enforcement interaction : $\delta^c r_i^{(\text{lib})}$		-0.00674		-0.00674
		(0.00422)		(0.00428)
Upstream × Downstream fixed effects	Yes	Yes	Yes	Yes
Downstream × Country fixed effects			Yes	Yes
N	122080	122080	122080	122080
R^2	0.534	0.534	0.541	0.541

Standard errors in parentheses, clustered at the country level
Note: Independent variable is an interaction of enforcement cost with the fraction of the upstream sector's goods that are traded on an organized exchange or reference-priced in trade publications (according to Rauch's (1999) liberal and conservative classifications).
* $p < 0.05$, ** $p < 0.01$

Table C1 shows the results from running specification (3.1) where the enforcement-intensity variable is replaced by a measure of relationship-specificity that is constructed from the Rauch (1999) classification of goods: r_i measures the fraction of sector i's products that are traded on an organized exchange or where reference prices are listed in trade publications. The resulting measure is hence similar to what Nunn (2007) uses to describe relationship-specificity.

The point estimates of the interaction term coefficient come out as marginally insignificant at the 5% level. This may be due to the presence of unobserved heterogeneity across upstream sectors and countries, a problem that can be avoided by using the bilateral enforcement-intensity measure.

One potential concern may be that the results of section 3 are driven by individual sectors. Indeed, Table 3 shows that the numerical values for enforcement-intensity are particularly high for the top three sectors. Table C2 runs specification (3.1) without observations where the upstream sector is one of the top three enforcement-intensive sectors, as measured by $z_{ni}^{(2)}$ (Insurance, Business Services, Financial Services). The estimates of the interaction term remain statistically significant at the 5% level.

Table C2: Robustness: Without top 3 enforcement intensive input sectors

Dependent variable: Intermediate Input Expenditure Share X^c_{ni}/X^c_n	(1)	(2)	(3)	(4)
Contract enforcement interaction : $\delta^c z^{(2)}_{ni}$	-139.8**		-178.0**	
	(44.22)		(55.59)	
Contract enforcement interaction : $\delta^c z^{(1)}_{ni}$		-24.20**		-27.52**
		(7.834)		(8.246)
Upstream × Downstream fixed effects	Yes	Yes	Yes	Yes
Upstream × Country fixed effects	Yes	Yes	Yes	Yes
Downstream × Country fixed effects			Yes	Yes
N	122080	122080	122080	122080
R^2	0.534	0.534	0.541	0.541

Standard errors in parentheses, clustered at the country level

Note: Dependent variable is the expenditure of sector n in country c on domestically and internationally sourced intermediate inputs from sector i, divided by the total gross output of sector n in country c. Sample is the same as in Table 6, except that Insurance, Business Services, and Financial Services upstream sectors are not included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix D Data Description

Appendix D.1 Construction of the enforcement-intensity measures

I start off with all cases in the 'Federal and State court cases' repository from LexisLibrary that are between January 1990 and December 2012 and include 'contract' as one of their core terms.[48] I then exclude all cases that are filed in a court of appeals, or a higher court. If there have been any counterclaims, I treat them as separate cases. This leaves me with 23261 cases that span 34219 plaintiffs and 50599 defendants.

I match the plaintiffs and defendants to the universe of US firms that are contained in the Orbis database of firms, based on the name strings.[49] I use a Fellegi-Sunter matching algorithm that compares the occurence of bigrams in each possible pairing. The first four characters are weighted more heavily. If the score is above a threshold (0.92), I consider the match to be successful. I then match the SIC classifications from Orbis to GTAP sectors, using a hand-written concordance table, which is partly based on the definition of the GTAP sectors in terms of CPC or ISIC codes[50], and partly on the description of the sectors. Since I am only interested in the industry of the plaintiff and defendant firms, if both firm names in a candidate pair contain the same trade name ('bank','architects', etc.), I also regard the pair as matched even if their matching score is below the threshold.

[48] I thank Jinesh Patel and the legal team at LexisNexis UK for permission to automatically retrieve and process the LexisLibrary data.

[49] This includes many US subsidiaries of foreign firms. The total number of US firms in my version of Orbis is 21,014,945.

[50] See https://www.gtap.agecon.purdue.edu/databases/contribute/concordinfo.asp

Table D3 summarizes the results of the matching process. I manage to associate 52.2 percent of all parties to firms in Orbis. In order to see whether the fraction of matched entries is close to the number of possible matches, one needs to know the fraction of businesses (or at least non-individuals) among the plaintiffs and defendants. This information is not available in LexisLibrary. However, I compare the matching rates with the fraction of business plaintiffs and defendants in an auxiliary dataset, the Civil Justice Survey of State Courts 1992, which covers (among other things) a sample of 6,802 contract cases in state courts.[51] In that dataset, 53.9 percent of all parties are non-individuals, and 49.6 percent are businesses. Even though it is likely that parties in federal courts are more likely to be businesses and organizations rather than individuals, I view this comparison as supporting the view that I am able to match most of the relevant parties.

Table D3: Matching Plaintiffs and Defendants to Orbis Firms: Statistics

		Plaintiffs		Defendants		All	
		number	*in pct*	*number*	*in pct*	*number*	*in pct*
Handmatched:		169		223		392	
Population:		34388	100.0	50822	100.0	85210	100.0
	perfect matches	1649	4.8	1666	3.3	3315	3.9
Matches:	above threshold	13058	38.0	25838	50.8	38896	45.6
	based on trade name	839	2.4	1419	2.8	2258	2.6
Total matches:		15546	45.2	28923	56.9	44469	52.2
Civil Justice Survey:	non-individuals						53.9
	businesses						49.6

[51] See US Department of Justice (1996) for a description. In calculating the figures in Table D3 I exclude cases that pertain to mortgage foreclosure, rental agreements, fraud, and employment.