

# 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 closed-economy Eaton-Kortum-type 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 would increase real income by an average of 7.5 percent across all countries, and by an average of 15.3 percent across low-income countries. Hence, transaction costs and the determinants of firm boundaries are important for countries' aggregate level of development.

**JEL codes:** D23; F11; O43; L22

**Keywords:** Contract enforcement costs; Contracting frictions; Transaction costs; Outsourcing; Aggregate Productivity

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# 1 Introduction

Countries differ vastly in the speed and cost of formal contract enforcement procedures: while Icelandic courts often resolve commercial disputes within a few months, cases in India that are decades old are commonplace.<sup>1</sup> A large and prominent literature has argued that these institutional frictions constitute transaction costs between firms, which in turn affect their vertical integration decision (Williamson, 1985), and potentially even the pattern of development (North, 1990). The logic goes as follows: if enforcement of supplier contracts is costly or impossible, 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.<sup>2</sup> Higher production cost then feeds into higher input prices in downstream sectors, thus amplifying the distortions on the macroeconomic scale.<sup>3</sup>

This paper studies the quantitative importance of contract enforcement costs for *aggregate* outcomes using recently developed tools from quantitative trade theory, together with data on enforcement costs and intermediate input expenditure shares across countries. 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 is a bilateral measure means that I can control for cross-country heterogeneity in the upstream sectors, and 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 productiv-

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<sup>1</sup>Council of Europe (2005), Supreme Court of India (2009)

<sup>2</sup>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.

<sup>3</sup>Nunn (2007) shows that institutional quality affects comparative advantage of a country through this channel; see also the handbook chapter by Nunn and Trefler (2014). The idea of a 'multiplier effect' goes back to Hirschman (1958), with more recent applications to development patterns by Ciccone (2002) and Jones (2011a, 2011b).

ity and welfare. I do this by structurally estimating my model and simulating the aggregate variables in the absence of enforcement costs. Hence, the effects of contracting frictions on firm boundaries, such as those studied by organizational economists in general, and 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.<sup>4</sup> 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 (informal, 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.<sup>5</sup> 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 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

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<sup>4</sup>Enforcement costs include time costs, court fees, and fees for legal representation and expert witnesses.

<sup>5</sup>The 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 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.<sup>6</sup>

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 19.6 percent across all countries, and decrease consumer prices by an average of 11.9 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 7.5 percent across all countries, and on average 15.3 percent across low-income countries.

The paper contributes to the literature on legal institutions and their macroeconomic effects.<sup>7</sup> The challenges in this literature are twofold. First, it is hard to empirically identify 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

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<sup>6</sup>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.

<sup>7</sup>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), Djankov et al. (2003), Acemoglu and Johnson (2005), and many others. Recent country-specific work include Laeven and Woodruff (2007) and Chemin (2010) on judicial efficiency in Mexico and, respectively, India; Ponticelli (2015) on bankruptcy reform in Brazil, and Cole, Greenwood, and Sanchez (2012) on courts and technology adoption in Mexico.

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.<sup>8</sup> 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 draws heavily from the literature on contracting frictions and the sourcing decision in international trade;<sup>9</sup> however, it departs from it in two substantial ways that allow me to quantify the effect of contracting frictions. Firstly, by assuming that enforcement is costly and that courts only protect expectation interest (both of which can be observed in reality, and measured), I am able to move away from a world of stark contrasts, where contracts are either perfectly enforceable or not enforceable at all. The resulting setting nests both extreme cases, but also allows for intermediate situations in which enforcement institutions play a *quantitative*, not only qualitative, role.<sup>10</sup> Secondly, I choose to study only domestic buyer-seller relations. This has the advantage that I know the relevant jurisdiction (namely, the courts in that country), but mean that I potentially misestimate the true distortions coming from poor formal enforcement. This concern, however, is mitigated by two considerations. Much of the distortions are on the use of services inputs, which are particularly prone to hold-ups because the cost of investment is immediately sunk, but are typically performed within country borders. Moreover, any distortion to international trade due to contracting frictions cannot

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<sup>8</sup>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 intermediate input shares, but do not study its determinants.

<sup>9</sup>My paper builds on the literature on the property rights approach to international firm boundaries (see Antràs (2015) for a summary) and the literature on institutions and international trade, as surveyed in the Handbook chapter by Nunn and Trefler (2014). 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 (2015), and Arkolakis, Costinot, and Rodriguez-Clare (2012). Recently, Eaton, Kortum, and Kramarz (2015) provide a firm-level theory of international vertical linkages and the division of labor. Recent micro-level evidence comes from Alfaro et al. (2015a, 2015b).

<sup>10</sup>cf. North (1990): "A good deal of literature on transaction costs takes enforcement as a given, assuming either that it is perfect or that it is constantly imperfect. In fact, enforcement is seldom either, and the structure of enforcement mechanisms and the frequency and severity of imperfection play a major role in the costs of transacting and in the forms that contracts take."

cause a welfare loss greater than the overall gains from trade, which suggests that (at least for relatively large countries) my estimates cover the bulk of the relevant distortions.<sup>11</sup>

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 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 implications.

### 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 inputs  $\{(q_{ni}(j), j \in [0, 1])\}_{i=1, \dots, N}$  into output  $y_n$

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<sup>11</sup>Indeed, Irarrazabal et al. (2013) argue that exporting and multinational production are close substitutes. Garettto (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). Fally and Hillberry (2015) offer a related model, but focus on the tradeoff between intra-firm coordination costs versus inter-firm transaction costs instead of the institutional dimension.

according to the production function<sup>12</sup>

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

where  $\sum_i \gamma_{ni} = 1$  for all  $n = 1, \dots, N$ . 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  $i \in \{\text{metal, electricity, R\&D, } \dots\}$  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) in each basket  $(n, i)$ . The firm faces the outsourcing decision for every  $(n, i, j)$ : 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  $\gamma_{ni}$  captures the weight of the broad set of inputs  $i$  in the production process of sector  $n$ :  $\gamma_{cars, steel}$  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.<sup>13</sup> 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.<sup>14</sup> I discuss each of the two options in turn.

### 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,

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

<sup>12</sup>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  $i$ .

<sup>13</sup>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).

<sup>14</sup>This eliminates competition between the potential employees and the suppliers. Bernard et al. (2003) relax this assumption to obtain variable markups.

I assume that the  $s_{ni}(j)$  are independent across  $i, j$ , and  $n$ . The parameter  $S_n$  captures the overall productivity of in-house production by sector  $n$  firms: higher  $S_n$  will, on average, lead to higher realizations of the productivity parameters  $s_{ni}(j)$ . The parameter  $\theta$  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  $p_{ni}^l(j)$ . Then,

$$p_{ni}^l(j) = \frac{w}{s_{ni}(j)}. \quad (2.2)$$

### 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. The interaction between supplier and intermediary is the one that is subject to contracting frictions.

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.<sup>15</sup> Again I assume that  $z_{ni}(j)$  follows a Fréchet distribution,

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

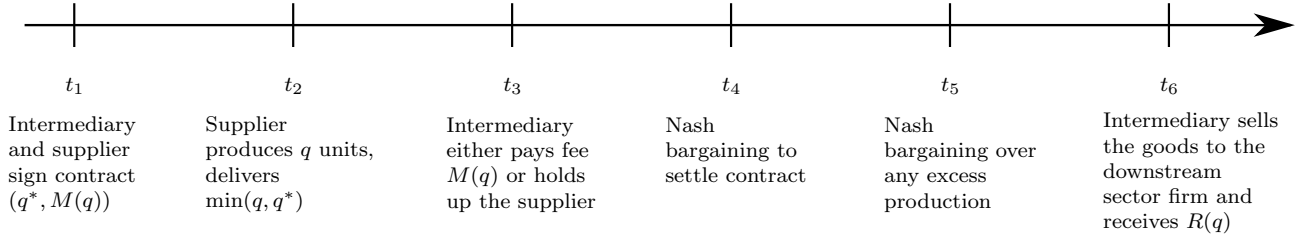
and independent across  $i, j$ , and  $n$ . The average productivity realization is increasing in the parameter  $T_i$ , which captures the upstream sector's overall capabilities (productivity, endowments, etc.). The supplier's cost of producing one unit of variety  $(n, i, j)$  is then  $c_{ni}(j) =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

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<sup>15</sup>The assumption that variety  $(n, i, j)$  is produced using sector  $i$  goods in the case of outsourcing means that the model exhibits input-output linkages across sectors. 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



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<sup>16</sup>, and  $M : [0, q^*] \rightarrow R \setminus R^-$  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”).<sup>17</sup> 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.
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.<sup>18</sup> A unit that has been delivered is under the control of the intermediary.

<sup>16</sup>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).

<sup>17</sup>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.

<sup>18</sup>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).

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.

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  $\delta$  of the value of the claim to him. The value of the claim is the net transfer to him that would arise under enforcement.<sup>19</sup> These costs include court fees, fees for legal representation

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<sup>19</sup>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.

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.<sup>20</sup> In line with the situation in the United States, I assume that enforcement costs cannot be recovered in court (Farnsworth, 2004, §12.8).<sup>21</sup>

**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

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

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

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

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

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<sup>20</sup>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.

<sup>21</sup>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.

to compensate the intermediary for forgone revenue means that the supplier internalizes the payoff to the intermediary. The enforcement costs  $\delta$  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. If enforcement costs  $\delta$  were zero, the expectations damages rule would ensure an outcome that is efficient within the bilateral relationship.<sup>22</sup>

**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

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

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  $\omega_{ni}$ , 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) 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  $\pi_s$ . 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  $\pi_b$  subject to participation by

<sup>22</sup>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 that the presence of proportional enforcement costs then leads to efficiency loss.

the supplier,

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

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

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  $\pi_b$  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*

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

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. 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  $\omega_{ni}$ ) 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  $\omega_{ni}$ ). Hence, the optimal contract maximizes the surplus by maximizing the producer's ex-post return on production.<sup>23</sup>

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

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<sup>23</sup>This is similar to the optimal allocation of property rights (Grossman and Hart, 1986, Hart and Moore, 1990).

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 contracts 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.<sup>24</sup>

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 counterpart to the theoretical concept 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  $\omega_{ni}$ ) 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) and (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 transaction by inserting the produced quantity into the inverse demand function:

$$p_{ni}^x(j) = \frac{\mu_n p_i d_{ni}}{z_{ni}(j)}$$

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

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

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<sup>24</sup>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.

is the resulting price distortion due to contracting frictions. The functional form of  $d_{ni}$  in terms of the parameters  $\omega_{ni}$  and  $\delta$  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,  $p_{ni}^l(j)$  and  $p_{ni}^x(j)$ . Given the perfect substitutability between the two options, the realized price of activity  $(n, i, j)$  is

$$p_{ni}(j) = \min(p_{ni}^l(j), p_{ni}^x(j)) \quad (2.10)$$

## 2.2 Households' Preferences and Endowments

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

$$U = \prod_{i=1}^N c_i^{\eta_i}, \quad (2.11)$$

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  $\Pi$ . 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 show existence and uniqueness. All proofs are in Appendix A.

To describe sectoral price levels and expenditure shares, some definitions are helpful. Let  $X_{ni} \equiv \int_0^1 p_{ni}(j) q_{ni}(j) \mathbf{1}_{\{j: p_{ni}^x(j) < p_{ni}^l(j)\}} dj$  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  $n$  satisfies*

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

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

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

$$\frac{X_{ni}}{X_n} = \gamma_{ni} \frac{T_i (\mu_n p_i d_{ni})^{-\theta}}{S_n w^{-\theta} + T_i (\mu_n p_i d_{ni})^{-\theta}} \quad (2.13)$$

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, through steel, machines, which in turn increases the cost of producing steel further due to the steel industry's dependence on machines.

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  $n$ ,  $\gamma_{ni}$ , 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  $\theta$  determines the magnitude of this effect.

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 iceberg trade costs. 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  $\theta$ , 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 the fact that they have monopoly power for their variety. Aggregate profits are

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

The markets for sectoral output clear

$$p_i c_i + \sum_n (X_{ni} - \Pi_{ni}) = X_i, \quad i = 1, \dots, N. \quad (2.15)$$

An equilibrium is then a vector of sectoral price functions  $(p_n(w))_{n=1, \dots, N}$  that satisfies (2.12). Given the sectoral prices, all other endogenous variables can be directly calculated: intermediate input shares  $(X_{ni}/X_n)_{n,i}$  from (2.13), and profits  $\Pi$  and gross output levels  $(X_n)_{n=1, \dots, N}$  from the linear system (2.14) and (2.15), where consumption levels are  $c_i = \eta_i (wL + \Pi) / p_i$ . Regarding

equilibrium existence and uniqueness, we obtain:

**Proposition 4** *Under constant returns to scale,  $\sum_i \gamma_{ni} = 1$  for all  $n$ , the equilibrium exists and is unique.*

The proof is straightforward: since  $\partial \log p_n / \partial \log p_i = X_{ni}/X_n$ , and  $\exists \bar{x} < 1$  such that  $\sum_i X_{ni}/X_n < \bar{x}$  for all  $n$ , the function defined by the right-hand side of (2.12) is a contraction mapping and has a unique fixed point.

### 3 Reduced-form Empirical Evidence

In this section I present empirical evidence that is consistent with the model's qualitative 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. Having support for the model's qualitative predications, I will then 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  $\delta$ .*

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  $\delta$  for sufficiently low  $\omega_{ni}$  (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:

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

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  $c$ ;  $\delta^c$  is a country-level measure of enforcement cost;  $1 - \omega_{ni}$  is the dependence on formal enforcement, such as what would arise when inputs are relationship-specific;  $\alpha_{ni}$  are sector-pair fixed effects;  $\alpha_i^c$  are upstream sector times country fixed effects, and  $\alpha_n^c$  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  $\beta$  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, or even measurement problems associated with particular inputs) 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

**Intermediate input expenditure shares** I use cross-country data on intermediate input expenditure from the Global Trade Analysis Project (GTAP) database, version 8 (Narayanan et al., 2012). It contains input-output tables on 109 countries, from varying years ranging from the beginning of the 1990's to mid-2000. These tables typically originate from national statistical sources, but have been harmonized by GTAP to make them comparable across countries. 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.<sup>25</sup> Table 1 contains summary statistics on expenditure shares at the country level.

**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

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<sup>25</sup>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, 2012). 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.

the claim. It includes court fees, fees for expert witnesses, attorney fees, and any costs that the seller must advance to enforce the judgment through 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 during the proceedings, assuming a three percent interest rate:<sup>26</sup>

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

I use the cost measures for the year 2005, or, depending on availability, the closest available year to 2005. Whenever  $\delta^c$  exceeds one, I set it equal to one. The resulting measure is weakly negatively correlated with the economy's overall intermediate input share (Figure 2).

While no measure of institutional quality is without drawbacks, there are two reasons why this particular measure lends itself very well to my purposes: firstly, it has a quantitative interpretation, and can be directly used as the parameter  $\delta$  of the contracting game; secondly, it is not based on observed litigation, and hence does not suffer from a potential bias due to the use of informal contracts when enforcement costs are too high.

**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 institutions: high rates of litigation imply that the scope for hold-up is large (be it through high relationship-specificity or the absence of relational contracts), and these are exactly the situations where enforcement costs – and the quality of legal institutions in general – matter.<sup>27</sup>

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

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<sup>26</sup>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.

<sup>27</sup>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.

enforcement costs are low, so that enforcement costs themselves are not censoring the prevalence of litigation in an asymmetric way across industries.<sup>28</sup> 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 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.<sup>29</sup> 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 US state court cases related to the sale of goods or provision of services between two non-individuals, 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  $z_{ni}^{(2)}$ .<sup>30,31</sup> 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  $z_{ni}^{(2)}$ .

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

My measure is conceptually different from existing measures of relationship-specificity/enforcement-intensity along three important dimensions.<sup>32</sup> First, the existing measures are only available for

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<sup>28</sup>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 use formal contracts in the first place depends on enforcement costs; hence, country-specific litigiousity 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 (2007), 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.

<sup>29</sup>See Appendix D for details on the construction of matches and matching statistics.

<sup>30</sup>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.

<sup>31</sup>Results are robust to using the number cases divided by the number of upstream sector firms as a measure of enforcement-intensity.

<sup>32</sup>There are three existing measures of enforcement-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.

physical goods, whereas my measures cover services sectors as well. Second, the existing measures depend on intermediate 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, and that the form of interaction varies with the trading partner. 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.

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. A similar ranking is usually regarded to apply to the degree of relationship-specificity of inputs (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. Hence, my measure is consistent with the view that enforcement-intensity is (at least to some extent) stemming from the degree of relationship-specificity of the input.

### 3.2 Cross-country Dispersion in Input-Output Tables

Table 4 shows the dispersion of intermediate input shares at the two-digit level from their respective means. 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 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 3 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 enforcement-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 alternative explanations.

### 3.3 Results

Table 6 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,  $\beta$ , 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. Overall, Table 6 shows that in countries where enforcement costs are high, firms use less intermediate inputs in sector-pairs where litigation is more prevalent in the United States. The estimates in columns (5) and (6), my preferred specifications, imply that a one-standard deviation increase in each of the interacted variables is associated with a decrease in the input share by .13 and .05 percentage points, respectively. I will return to the quantitative effects of enforcement costs in more detail in section 4, using my structural estimates.

In order to interpret the correlation shown in 6 as evidence in support of Corollary 5, we need to discuss the extent to which we the dependent variables and explanatory variables capture the corresponding theoretical counterpart in the model. One potential concern is that my dependent variable, the expenditure share on intermediate inputs, does not correctly measure outsourcing of production steps to another firm. 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.<sup>33</sup> 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

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<sup>33</sup>That said, Atalay et al. (2003) show evidence that shipments of physical goods between vertically integrated plants in the U.S. are very 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.

being within the firm boundaries is much lower. The first two columns in Table 7 show that the resulting point estimates are still statistically significant at the 5 percent level.

A second concern is that observed litigation may not accurately capture the dependence of an industry-pair on formal enforcement, such as what would arise when products are specific to the buyer-supplier relationship. If some product specifications are inherently hard to describe, or if even courts in the United States do not possess the capabilities to understand and hence enforce contracts, then the same will most likely apply to courts in other, including less developed, countries. Hence, these factors would reduce external intermediate input use in all countries, and will therefore be taken out by the sector-pair fixed effect.

The model does not capture the possibility that firms start to use relational contracts when enforcement costs are prohibitively large. If this was a perfect substitute for formal enforcement in courts, then coefficient on the interaction term should be zero. More generally, when firms respond to high enforcement costs by finding ways that avoid the use of formal enforcement institutions, the estimate of the coefficient on the interaction term in equation (3.1) should be biased towards zero.

There is an extensive and growing literature that documents that social capital, particularly trust, may help in overcoming frictions.<sup>34</sup> 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 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 7. 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 7, I include an interaction of  $I_{ni}^{US}$  with enforcement costs, and with trust. The key explanatory variable, the

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<sup>34</sup>See Algan and Cahuc (2013) for a survey of the relationship between trust and growth.



interaction of enforcement cost with enforcement-intensity, remains statistically significant.<sup>35</sup>

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 8 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, but remain statistically significant. Overall, I interpret the correlation exhibited by Tables 6 to 8 as being in line with the model predictions.

## 4 Quantitative Evaluation of Enforcement Costs

In this section I return to my model from Section 2 and quantitatively evaluate the importance of enforcement costs. I first build intuition for how changes in transaction costs affect the aggregate variables by using the “exact hat algebra” developed by Dekle et al. (2008) and Arkolakis et al. (2012). I then estimate the model parameters from its predictions for intermediate input use, and simulate the welfare gains that would arise if countries reduced their enforcement costs.

### 4.1 The welfare gains from eliminating enforcement frictions

We now take a closer look at the welfare gains from reducing enforcement frictions. My measure of welfare is real income per capita. Since households receive both labor income and the profits of intermediaries, and the wage is the numeraire, we have

$$\frac{Y}{PL} = \frac{1 + \Pi/L}{P} \quad (4.1)$$

Welfare gains hence arise from a drop in the the consumer price level  $P$  and an increase in profits per capita  $\Pi/L$ , as more tasks become outsourced. Taking the total differential of the sectoral price levels  $p_n$  in equation (2.12), and holding constant the  $T$  and  $S$  parameters, we obtain

$$d \log p_n = \sum_i \frac{X_{ni}}{X_n} (d \log p_i + d \log d_{ni}). \quad (4.2)$$

Enforcement costs affect the sector's price index both directly through the multiplicative distortion  $d_{ni}$ , and indirectly through the price level of its upstream sectors. The strength of the input-output linkages is given by the expenditure shares  $X_{ni}/X_n$ . Writing this in matrix notation,

$$d \log p = (I - \Xi)^{-1} \text{diag} \left( \Xi (d \log d_{ni})'_{n,i} \right) \quad (4.3)$$

where  $\Xi = (X_{ni}/X_n)_{n,i}$  denotes the matrix of expenditure shares. We see that the impact of distortions on sectoral price levels is determined by the Leontief inverse  $(I - \Xi)^{-1}$ , as in

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<sup>35</sup>Results are very similar when including the US input-output expenditure shares interacted with enforcement costs, instead of  $I_{ni}^{US} \delta^c$ .

standard sectoral models with input-output linkages. What is new, however, is that the expenditure shares, and hence the Leontief inverse, are endogenously determined by the cost of in-house production versus outsourcing. Hence, equations (4.2) and (4.3) are only first-order approximations which hold exactly only for small changes in  $\log d_{ni}$ . Note, in particular, that the first-order effects do not depend on the elasticity  $\theta$ ; it matters only for the change in the multiplier (i.e. the second-order effects).

## 4.2 Taking the model to the data

How do we take the model to a cross-country setting? I assume that the enforcement cost  $\delta$  may vary across countries, as well the sectoral productivity vectors  $T$  and  $S$  (which, similar to the linear fixed effects in Section 3, capture not only physical productivity but also a host of other factors that govern the cost of production). The technological parameters  $\gamma_{ni}$ , and the parameters that govern the dependence on enforcement, are taken as constant across countries.

I then take the model to the data by calibrating some of the parameters and estimating the remaining ones. The World Bank's measures of enforcement cost by country (as described in Section 3.1) map directly into the model's enforcement cost parameters  $\delta^c$ : they give the cost of enforcing a standardized supplier contract as a fraction of the value of the claim. It is worth noting that this measure is not based on observed cases, and hence does not suffer from bias due to firms substituting into informal contracts whenever such agreements are preferable.

Next, I calibrate the parameters governing the dependence on formal enforcement by sector pair,  $\omega_{ni}$ , using the litigation-intensity measures  $z_{ni}$ . The idea is that litigation can only be observed when firms use formal contracts, which is more common when  $\omega_{ni}$  is low, and this is when enforcement costs matter for performance in the bilateral buyer-seller relationship.<sup>36</sup> I set

$$\omega_{ni} = 1 - \frac{1}{m} z_{ni} \quad (4.4)$$

and estimate the parameter  $m$ . This strategy can also be motivated from theory: assume that in each sector-pair, a small (measure zero) fraction of firms receive a shock that sets their enforcement cost  $\delta^c$  to be such that their distortion in the formal contract case,  $1/(1 - \frac{1}{2}\delta^c)$ , is uniformly distributed between 1 and 2. Then, the probability that these firms will use a formal contract is  $1 - \omega_{ni}$ . Assuming furthermore that with probability  $m$  they cannot settle in the ex-post Nash bargaining and initiate litigation, the probability of observing litigation is  $m(1 - \omega_{ni})$ . Equation (4.4) sets this probability equal to the observed litigation ratio,  $z_{ni}$ .

Figure 4 shows the first-order approximation to the consumer price reductions from reducing enforcement costs to US levels, as given by equation (4.3), as a function of the probability that

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<sup>36</sup>More precisely, when we observe litigation, we *know* that firms rely on formal contracts, and hence enforcement costs will matter for performance in their relationships. If we do not observe litigation, they *may* matter (such as when firms decide use formal contracts and always decide to settle out of court), but also may not matter (when they use informal contracts). Hence, by assuming that enforcement costs do not matter when we do not observe litigation, my estimate for the importance of enforcement costs becomes a lower bound for the true importance.

firms cannot settle,  $m$ . A lower  $m$  means that the observed amount of cases indicates a higher prevalence of formal contracting relationships, which is exactly when enforcement costs matter more. Hence, a lower parameter  $m$  will lead to a larger implied first-order effect of enforcement cost reduction.

Finally, I calibrate the within-basket elasticity of substitution  $\sigma_n$  to equal 3.5, which implies markups of 40%, and the consumer's Cobb-Douglas utility function parameters  $\eta_i^c$  to equal the corresponding country-specific household expenditure shares, as measured by GTAP.

### 4.3 Estimation

I use the same dataset as in the reduced-form regressions of Section 3. My estimating equation is the model's expression for intermediate input expenditure shares, with an additive error term with zero conditional mean,

$$\frac{X_{ni}^c}{X_n^c} = \gamma_{ni} \frac{T_i^c (\mu_n p_i^c d_{ni}^c)^{-\theta}}{S_n^c + T_i^c (\mu_n p_i^c d_{ni}^c)^{-\theta}} + \varepsilon_{ni}^c \quad (4.5)$$

where the parameter restrictions for constant returns to scale,  $\sum_i \gamma_{ni} = 1$  for all  $n$ , are imposed. One can re-write this equation in a form that is similar to the well-known logit form,

$$\frac{X_{ni}^c}{X_n^c} = \gamma_{ni} \frac{1}{1 + \exp(\alpha_n^c - \alpha_i^c + \theta \log d_{ni}^c)} + \varepsilon_{ni}^c \quad (4.6)$$

where, in a slight abuse of notation,  $\alpha_n^c = \log(S_n^c / \mu_n^{-\theta})$  and  $\alpha_i^c = \log(T_i^c (p_i^c)^{-\theta})$ . Note that this mapping is invertible, so that conditionally on having calibrated  $\mu_n$  through  $\sigma_n$ , the  $T_i^c$  and  $S_n^c$  parameters are exactly identified.

The problem of choosing a suitable estimator for the parameters in (4.6) shares many similarities with the choice of an estimator for gravity equations in international trade (see Head and Mayer, 2014). The nonlinear least squares estimator would place much weight on large observations and suffers from numerical problems due to nonconvexities. These difficulties would be resolved when estimating the equation in logs. However, a NLS estimator on the log of (4.6) would place much weight on the many intermediate input share observations that are close to zero in levels, and deeply negative in the log. Instead, I use a Poisson pseudo-maximum likelihood (PPML) estimator, which emerges as a compromise between placing weight on large and small observations, while still being numerically feasible. The PPML has been widely used to estimate gravity-type equations since being recommended by Santos Silva and Tenreyro (2006). Mathematically, the estimator is defined as

$$\left( \hat{m}, \hat{\theta}, \hat{\gamma}, \hat{\mathbf{T}}, \hat{\mathbf{S}} \right) = \arg \max_{m, \theta, \gamma, \mathbf{T}, \mathbf{S}} \sum_{n,i,c} \left( \frac{X_{ni}^c}{X_n^c} \log g(m, \theta, \gamma, \mathbf{T}, \mathbf{S}) - g(m, \theta, \gamma, \mathbf{T}, \mathbf{S}) \right) \quad (4.7)$$

where  $g(m, \theta, \gamma, \mathbf{T}, \mathbf{S}) = \gamma_{ni} / (1 + \exp(\alpha_n^c - \alpha_i^c + \theta \log d_{ni}^c))$  and the maximization is subject to the constraints  $\sum_i \gamma_{ni} = 1$  for every  $n = 1, \dots, N$ . The PPML is consistent if the conditional

mean of the intermediate input shares is as described by the model equation. Numerically, the estimator turns out to be friendly for the above functional form: for a given  $(m, \theta)$ , the maximization converges to a unique solution, hence it is easy to find a global maximum by searching over the  $(m, \theta)$  space.

The two most interesting parameters are  $m$  and  $\theta$ , because they govern, respectively, the magnitude of the first-order and second-order welfare effects. Table 5 shows their estimates, 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 of the input share,  $\theta$ , are 2.81 and 3.06, respectively, which is below the trade elasticities typically estimated using structural gravity equations (Head and Mayer, 2014). The point estimates for both  $\theta$  and  $m$ , which governs the degree of the dependence on formal enforcement, are significant at the 1% level. This means that the cross-country variation in intermediate input expenditure shares cannot be explained purely through country- and sector-specific productivity parameters; instead the contracting frictions term  $(d_{ni}^c)^{-\theta}$  has explanatory power as well, much like the interaction term has explanatory power in the linear regressions in Section 3. The term  $(d_{ni}^c)^{-\theta}$  itself is parameterized through  $m$  and  $\theta$ , and the fact that  $m$  is estimated to be small means that the estimator attributes a large portion of the variation in the input share to the contracting frictions term. Indeed, if I set  $d_{ni}^c$  to 1, the intermediate input shares would increase on average (across countries and sector-pairs) by 21 percent (25 percent when estimating the model with  $\omega_{ni}^{(2)}$ ).

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 yields similar welfare implications.

## 4.4 Welfare Analysis

With the model estimated, we are now able to evaluate the importance of enforcement frictions. In the first counterfactual, I take the estimated model, and set each country's enforcement costs to the level of the United States (17%), a level that is low in international comparison but still possible to achieve for most countries through judicial reform. Table 9 shows the increase in real income and decrease in the consumer's price index that are associated with this change. 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 average increase in real output per capita would be 7.5%, and the average drop in the consumer price level would be 4.6%. Figure 5 summarizes these welfare gains in a scatter plot, with counterfactual consumer price level changes (in (a), real income per capita changes in (b)) on the vertical axis, and actual enforcement costs on the horizontal axis. A fitted OLS regression line suggests that a reduction in enforcement costs by one percentage point leads roughly to a 0.47% increase in real income and 0.23% drop in the consumer price level. Since the estimate of  $\theta$  is low, the first-order effects from reducing  $\delta$  to US levels, as described by equation (4.3), account for most of the total effect (93% on average

across countries, and around 60% for the countries with the highest enforcement costs).

To assess the overall impact of bilateral contracting frictions, I also perform a counterfactual where I completely abolish enforcement costs (columns four and five of Table 9). The average increase in real per-capita income would be 19.6%, and the average decrease in the consumer's price level would be 11.9%. These numbers are large: when enforcement costs fall to very low levels, even bilateral relationships that were formerly conducted using informal contracts become formal and experience reductions in efficiency loss. Columns six and seven of Table 9 show that results are very similar when using the alternative measure for enforcement intensity,  $z_{ni}^{(2)}$ . Table 10 shows the average welfare changes for different groups of countries. Enforcement costs are particularly damaging in Africa and South-Eastern Asia. The key message from these two exercises is that enforcement frictions have implications for aggregate variables that are relevant on a macroeconomic scale.

## 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 cost of sourcing intermediate 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, more general lesson is that economists should take great care when interpreting input-output tables. Input-output tables differ *systematically* and *significantly* across countries.

They differ systematically across countries in the sense that they are correlated with institutions and patterns of dependence on formal enforcement, and significantly, because the fraction of the variation that is explained by these frictions suggest that the welfare gains from removing them are large. Hence, intermediate input expenditure shares are not mere 'technical coefficients', but are instead the endogenous outcome of firm's outsourcing decisions. In particular, economists should be cautious of using the United States' input-output table to describe input use patterns in other countries.

The third lesson is one for policy. My findings highlight 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 0.47 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.

# A Proofs

## 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  $M : [0, q^*] \rightarrow R \setminus R^-$  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,  $\pi_b$  and  $\pi_s$ . 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

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

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  $\delta$  of the value of the claim. Thus, under enforcement, the supplier would get

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

whereas the intermediary would get the revenue from selling to the downstream firm, net of fees  $M(q)$  and plus damage payments

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

From the definition of the damages (A.1) it is easy to see that the latter equals

$R(q^*) - M(q^*)$ . Since enforcement entails a social loss of  $\delta(M(q) - D(q, q^*))$ , the buyer and seller will bargain over the surplus and settle out of court. (A.2) and (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

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

Comparing  $\pi_b$  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

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

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

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

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*.<sup>37</sup> 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  $M(q^*) - \delta M(q^*) + \frac{1}{2}\delta M(q^*) = (1 - \frac{1}{2}\delta)M(q^*)$ , 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<sup>38</sup>). 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

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

which means that his overall ex-ante payoff is

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

and the intermediary receives in the second settlement

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

which means his total ex-ante payoff is

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

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  $\pi_s$ . 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.

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

<sup>37</sup>Cf. Farnsworth (2004), §12.10 in US law.

<sup>38</sup>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).

**Proof.** The left-limit of  $\pi_s$  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  $\pi_s$  is continuous at  $q^*$ . ■

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

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

Denote the interior maxima of (A.4) and (A.5) by  $q_\delta$  and  $q_\omega$  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 (A.6) and the fact that both expressions  $\pi_s(q)$  for  $q < q^*$  and  $q \geq q^*$  have unique maxima at  $q_\delta$  and  $q_\omega$  respectively, it is clear that the  $\arg \max_q \pi_s(q)$  can only be either  $q_\delta$ ,  $q_\omega$ , or  $q^*$ . Because of the continuity of  $\pi_s$ ,  $q^*$  can only be implementable if either  $q^* \leq q_\delta$  or  $q^* \leq q_\omega$ .<sup>39</sup> Also, note that both  $q_\delta$  and  $q_\omega$  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<sup>40</sup>  $\tilde{q}$ , a contract that implements the largest implementable quantity (either  $q_\delta$  or  $q_\omega$ ) 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  $q_\delta$  and setting

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

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

<sup>39</sup>Suppose  $q^* > q_\delta$  and  $q^* > q_\omega$ . Because of continuity of  $\pi_s$  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.

<sup>40</sup>Equal if and only if either  $\omega = 1$  or  $\delta = 0$ .

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

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

Such a  $q^*$  exists because the RHS of this equation is zero for  $q^* = 0$  and goes to infinity for  $q^* \rightarrow \infty$ , 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 (A.7) implements  $q_\omega$  with  $\pi_s(q_\omega) = 0$ .

## A.2 Proof of Proposition 3

1. We have

$$p_{ni}(j) = \min(p_{ni}^l(j), p_{ni}^x(j))$$

and

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

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

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

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

$$y_n = \prod_i Q_{ni}^{\gamma_{ni}}$$

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

$$P_{ni} Q_{ni} = \lambda \gamma_{ni} \quad (\text{A.9})$$

From plugging this into the formula for  $y_n$ ,

$$p_n \equiv \lambda = \prod_{i=1}^N \left(\frac{P_{ni}}{\gamma_{ni}}\right)^{\gamma_{ni}}$$

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,

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

Thus the cost of one unit of  $y_n$  is

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

where

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

and  $\Phi_{ni}$  as defined above.

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

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

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

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

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 (A.9), the expenditure share on type- $i$  activities is

$$\frac{P_{ni} Q_{ni}}{p_n y_n} = \gamma_{ni}.$$

Thus, the expenditure share on outsourced type- $i$  activities is

$$\frac{X_{ni}}{p_n y_n} = \gamma_{ni} \frac{T_i (\mu_n p_i d_{ni})^{-\theta}}{S_n w^{-\theta} + T_i (\mu_n p_i d_{ni})^{-\theta}} \quad (\text{A.10})$$

which is decreasing in  $d_{ni}$ .

## B Extensions

### 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

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

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

The first-order conditions for this problem are

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

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

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

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

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

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

$R'(d) > (2-\omega)c$  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  $\frac{1}{2} (R'(d) + \omega c) < c$ , then  $x = 0$  and  $d$  satisfies  $(1 - \frac{1}{2}\delta) R'(d) = c$  thus  $d = q_\delta$ .

If (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  $q_\delta$  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

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

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

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

where  $d$  satisfies equation (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  $R'(d+x) = (2-\omega)c$ .

## C Further robustness checks

### C.1 Results when using Rauch classification

Table 11 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 12 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.

## D Data Description

### 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.<sup>41</sup> 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.<sup>42</sup> I use a Fellegi-Sunter matching algorithm that compares the occurrence 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 handwritten concordance table, which is partly based on the definition of the GTAP sectors in terms of CPC or ISIC codes<sup>43</sup>, 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

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<sup>41</sup>I thank Jinesh Patel and the legal team at LexisNexis UK for permission to automatically retrieve and process the LexisLibrary data.

<sup>42</sup>This includes many US subsidiaries of foreign firms. The total number of US firms in my version of Orbis is 21,014,945.

<sup>43</sup>See <https://www.gtap.agecon.purdue.edu/databases/contribute/concordinfo.asp>



contain the same trade name ('bank', 'architects', etc.), I also regard the pair as matched even if their matching score is below the threshold.

Table 13 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.<sup>44</sup> 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.

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<sup>44</sup>See US Department of Justice (1996) for a description. In calculating the figures in Table 13 I exclude cases that pertain to mortgage foreclosure, rental agreements, fraud, and employment.

## References

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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.

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	$\overline{z_{ni}^{(2)}} \cdot 10^4$	Upstream sector	$\overline{z_{ni}^{(2)}} \cdot 10^4$
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 4: CROSS-COUNTRY DISPERSION IN TWO-DIGIT INTERMEDIATE INPUT SHARES

<i>I. Average standard deviations of intermediate input expenditure shares</i>		
	$\bar{\sigma}$	
All sector pairs	.023	
Goods-producing upstream sectors only	.020	
Services-producing upstream sectors only	.028	
<i>II. Frequency distribution of standard deviations of input expenditure shares, <math>\sigma_{ni}</math></i>		
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 5: PPML ESTIMATES OF  $m$  AND  $\theta$

	$d_{ni}^{(1)}$	$d_{ni}^{(2)}$
$\log_{10} m$	-3.55** (0.03)	-3.62** (0.02)
$\theta$	2.81** (0.99)	3.06** (1.17)
$N$	133525	133525
Pseudo- $R^2$	0.79	0.79

Note: The table shows partial results from the estimation problem (4.7), using  $z_{ni}^{(1)}$  and  $z_{ni}^{(2)}$ , respectively, to construct  $\omega_{ni}^{(1)}$  and  $\omega_{ni}^{(2)}$ . Robust asymptotic standard errors are in parentheses. Pseudo- $R^2$  is  $1 - RSS/TSS$ . \*  $p < 0.05$ , \*\*  $p < 0.01$



Table 6: THE DETERMINANTS OF EXPENDITURE SHARES ON INTERMEDIATES: BENCHMARK RESULTS

Dependent variable: Expenditure share of sector $n$ on intermediate inputs from sector $i$ , $X_{ni}^c/X_n^c$						
	(1)	(2)	(3)	(4)	(5)	(6)
Contract enforcement interaction : $\delta^c(\#Cases_{ni}/\sqrt{\#Firms_n\#Firms_i})$	-71.78*** (15.39)		-101.0*** (24.07)		-120.3*** (28.53)	
Contract enforcement interaction : $\delta^c(\#Cases_{ni}/\#Firms_n)$		-9.246 (4.829)		-14.42*** (3.987)		-15.35*** (4.176)
Upstream $\times$ Downstream fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Upstream $\times$ Country fixed effects			Yes	Yes	Yes	Yes
Downstream $\times$ 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  $c$ .

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

Table 7: THE DETERMINANTS OF EXPENDITURE SHARES ON INTERMEDIATES: ROBUSTNESS

Dependent variable: Expenditure share of sector $n$ on intermediate inputs from sector $i$ , $X_{ni}^c/X_n^c$						
	(1)	(2)	(3)	(4)	(5)	(6)
Contract enforcement interaction : $\delta^c(\#Cases_{ni}/\sqrt{\#Firms_n\#Firms_i})$	-90.24*** (25.01)		-72.24** (23.29)		-123.6*** (30.24)	
Contract enforcement interaction : $\delta^c(\#Cases_{ni}/\#Firms_n)$		-7.871* (3.796)		-12.65** (3.191)		-15.71*** (4.635)
Trust interaction : $trust^c(\#Cases_{ni}/\sqrt{\#Firms_n\#Firms_i})$			29.99 (43.62)		4.808 (54.78)	
Trust interaction : $trust^c(\#Cases_{ni}/\#Firms_n)$				0.692 (5.996)		-7.113 (8.099)
High US expenditure share $\times$ enforcement cost: $I_{ni}^{US}\delta^c$					-0.0082 (0.004)	-0.011* (0.0048)
High US expenditure share $\times$ trust: $I_{ni}^{US}trust^c$					-0.0007 (0.005)	-0.0006 (0.005)
Upstream $\times$ Downstream fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Upstream $\times$ Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Downstream $\times$ 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).

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

Table 8: THE DETERMINANTS OF EXPENDITURE SHARES ON INTERMEDIATES: DOMESTIC INPUTS ONLY

Dependent variable: Expenditure share of sector $n$ on domestic intermediate inputs from sector $i$ , $X_{ni,dom}^c/X_n^c$						
	(1)	(2)	(3)	(4)	(5)	(6)
Contract enforcement interaction : $\delta^c(\#Cases_{ni}/\sqrt{\#Firms_n\#Firms_i})$	-45.14** (13.37)		-63.46*** (17.58)		-72.11*** (21.68)	
Contract enforcement interaction : $\delta^c(\#Cases_{ni}/\#Firms_n)$		-7.713 (4.531)		-10.75*** (2.882)		-10.80*** (2.971)
Upstream $\times$ Downstream fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Upstream $\times$ Country fixed effects			Yes	Yes	Yes	Yes
Downstream $\times$ 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 7.

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

Table 9: WELFARE AND PRODUCTIVITY COUNTERFACTUALS, BY COUNTRY

	Using enforcement-intensity $\omega_{ni}^{(1)}$					Using $\omega_{ni}^{(2)}$	
	$\delta$	To US levels		To zero		To US levels	
		$\Delta y$ , in %	$\Delta P$ , in %	$\Delta_0 y$ , in %	$\Delta_0 P$ , in %	$\Delta y$ , in %	$\Delta P$ , in %
Albania	0.42	12.4	-7.2	25.7	-14.3	12.2	-6.7
Argentina	0.21	1.9	-1.2	11.8	-7.1	2.2	-1.3
Armenia	0.21	2.2	-2.2	12.9	-11.8	2.2	-2.0
Australia	0.24	4.2	-2.9	17.7	-11.3	4.7	-3.1
Austria	0.16	-0.4	0.3	9.8	-7.2	-0.5	0.4
Azerbaijan	0.21	2.2	-1.9	14.3	-11.2	2.7	-2.2
Bahrain	0.20	0.8	-0.6	6.0	-4.6	0.8	-0.6
Bangladesh	0.75	28.1	-16.8	43.2	-24.8	26.8	-15.4
Belarus	0.19	0.7	-0.6	7.1	-5.5	0.7	-0.6
Belgium	0.22	3.0	-2.6	16.4	-12.7	3.2	-2.7
Bolivia	0.38	11.5	-6.4	26.9	-14.2	12.2	-6.6
Botswana	0.36	5.2	-3.7	11.7	-8.7	5.6	-3.8
Brasil	0.23	2.1	-1.5	10.2	-7.2	2.4	-1.7
Bulgaria	0.28	6.0	-4.1	18.2	-11.8	6.2	-4.0
Cambodia	1.00	42.2	-22.2	66.0	-31.9	40.5	-21.5
Cameroon	0.53	14.1	-7.9	27.5	-14.7	13.9	-7.7
Canada	0.27	6.1	-4.0	20.8	-12.4	6.7	-4.2
Chile	0.33	10.9	-6.6	30.8	-16.2	12.6	-7.1
China PR	0.14	-1.0	0.8	8.3	-6.2	-1.2	0.8
Colombia	0.59	17.9	-9.8	32.3	-16.9	17.7	-9.2
Costa Rica	0.32	5.7	-4.9	14.9	-12.3	6.4	-5.3
Cote d'Ivoire	0.48	16.8	-10.4	31.4	-18.7	17.9	-10.9
Croatia	0.18	0.8	-0.6	13.6	-9.1	1.0	-0.6
Cyprus	0.22	2.6	-2.0	13.0	-9.1	2.7	-1.9
Czech Republic	0.39	15.2	-9.6	36.0	-19.5	15.5	-9.3
Denmark	0.28	6.1	-4.6	19.3	-13.2	6.5	-4.7
Ecuador	0.32	5.3	-3.5	13.8	-9.1	5.6	-3.6
Egypt	0.35	6.5	-4.1	16.0	-9.9	6.5	-3.8
El Salvador	0.26	3.3	-2.0	12.6	-7.7	3.8	-2.4
Estonia	0.18	0.7	-0.6	11.0	-8.6	0.8	-0.6
Ethiopia	0.21	0.9	-0.8	5.7	-5.2	0.9	-0.8
Finland	0.15	-0.7	0.6	8.0	-6.8	-0.8	0.7
France	0.20	1.6	-1.4	12.4	-9.5	1.8	-1.4
Georgia	0.44	15.2	-10.8	32.2	-20.1	16.0	-10.9
Germany	0.18	0.3	-0.3	9.2	-6.7	0.4	-0.3
Ghana	0.28	5.8	-4.2	17.6	-12.9	6.5	-4.6
Greece	0.21	1.7	-1.3	9.7	-7.1	1.7	-1.2
Guatemala	0.38	10.7	-6.3	24.1	-13.6	11.2	-6.4
Honduras	0.43	12.8	-8.0	27.1	-16.1	13.9	-8.1
Hong Kong	0.23	2.2	-2.0	9.5	-8.2	2.5	-2.1
Hungary	0.18	0.5	-0.4	12.7	-8.5	0.6	-0.4
India	0.51	18.4	-9.9	34.6	-17.7	18.4	-9.3
Indonesia	1.00	53.6	-20.8	94.4	-31.5	58.8	-21.3
Iran	0.21	1.4	-0.9	8.7	-5.5	1.6	-0.9
Ireland	0.31	8.5	-5.5	23.5	-14.2	9.4	-5.8
Israel	0.33	12.1	-8.4	32.4	-19.3	12.8	-8.5
Italy	0.41	17.4	-10.9	37.6	-20.8	17.4	-10.4
Japan	0.35	10.4	-7.2	25.1	-15.6	10.8	-7.3
Kazakhstan	0.25	3.7	-2.8	13.5	-9.8	3.8	-2.8
Kenya	0.38	7.9	-5.2	18.0	-11.6	7.6	-4.8
Kuwait	0.23	1.5	-1.2	6.6	-5.2	1.8	-1.3
Kyrgyzstan	0.31	8.2	-6.1	21.2	-14.3	7.2	-4.5
Laos	0.35	6.9	-7.6	15.5	-15.5	5.6	-5.7
Latvia	0.19	0.8	-0.6	9.6	-6.8	0.9	-0.6
Lithuania	0.25	2.8	-1.9	10.9	-7.3	3.3	-2.1
Luxembourg	0.11	-2.4	2.4	6.1	-5.7	-2.7	2.5
<i>mean</i>	0.33	7.5	-4.6	19.6	-11.9	7.8	-4.6

Continued on the next page

Table 9: WELFARE AND PRODUCTIVITY COUNTERFACTUALS, BY COUNTRY (*ctd.*)

	$\delta$	Using enforcement-intensity $\omega_{ni}^{(1)}$				Using $\omega_{ni}^{(2)}$	
		To US levels		To zero		To US levels	
		$\Delta y$ , in %	$\Delta P$ , in %	$\Delta_0 y$ , in %	$\Delta_0 P$ , in %	$\Delta y$ , in %	$\Delta P$ , in %
Madagascar	0.50	18.8	-11.7	34.8	-21.0	18.0	-11.0
Malawi	1.00	31.9	-15.7	50.7	-23.4	36.4	-17.4
Malaysia	0.32	10.6	-6.9	28.6	-16.9	11.5	-7.0
Malta	0.40	9.3	-6.6	18.5	-12.9	8.9	-6.1
Mauritius	0.24	2.0	-1.6	8.2	-6.7	2.0	-1.5
Mexico	0.35	5.1	-3.5	12.0	-8.2	6.0	-4.0
Mongolia	0.33	5.7	-4.7	13.5	-10.6	6.2	-5.1
Morocco	0.29	5.5	-4.0	16.6	-11.1	5.6	-3.6
Mozambique	1.00	20.0	-10.2	31.4	-15.9	19.4	-9.3
Namibia	0.38	11.6	-7.3	26.4	-16.0	12.4	-7.4
Nepal	0.35	5.7	-4.3	12.3	-9.5	7.8	-7.5
Netherlands	0.29	6.2	-4.7	18.0	-12.8	6.5	-4.8
New Zealand	0.24	4.1	-2.9	18.0	-11.7	4.5	-3.1
Nicaragua	0.31	7.5	-4.4	21.0	-11.7	7.7	-4.4
Nigeria	0.38	4.4	-3.0	9.0	-6.2	4.1	-2.6
Norway	0.12	-2.4	1.8	8.6	-6.3	-2.8	2.1
Oman	0.18	0.4	-0.3	5.2	-3.9	0.4	-0.3
Pakistan	0.31	5.8	-3.5	15.9	-9.4	6.1	-3.5
Panama	0.56	22.3	-13.6	39.8	-22.3	22.3	-13.0
Paraguay	0.35	6.4	-4.4	15.2	-10.5	7.3	-4.6
Peru	0.40	10.4	-6.4	23.2	-13.5	10.1	-5.6
Philippines	0.32	7.4	-4.6	20.4	-11.8	8.0	-4.4
Poland	0.20	2.1	-1.6	16.6	-11.1	2.2	-1.6
Portugal	0.19	1.1	-0.9	12.2	-9.5	1.2	-1.0
Qatar	0.26	1.7	-1.2	6.0	-4.4	2.0	-1.3
Romania	0.24	3.6	-2.5	15.0	-9.7	3.8	-2.4
Russia	0.16	-0.6	0.4	11.5	-6.5	-0.8	0.4
Saudi Arabia	0.33	3.7	-2.5	9.2	-6.2	4.3	-2.9
Senegal	0.33	5.5	-3.5	13.8	-8.8	5.8	-3.6
Singapore	0.19	1.4	-0.9	17.9	-10.8	1.6	-1.0
Slovakia	0.30	8.2	-5.6	24.2	-14.7	8.9	-5.8
Slovenia	0.32	9.5	-6.4	26.7	-15.9	10.2	-6.5
South Africa	0.38	11.3	-7.4	25.6	-15.7	12.2	-7.8
South Korea	0.12	-2.8	2.1	10.2	-6.9	-3.0	2.2
Spain	0.21	2.2	-1.7	12.8	-9.2	2.5	-1.8
Sri Lanka	0.34	5.9	-3.7	14.6	-9.0	5.8	-3.4
Sweden	0.35	7.5	-6.0	17.0	-12.8	7.9	-6.2
Switzerland	0.25	3.8	-2.8	14.9	-10.4	4.1	-3.0
Taiwan	0.22	2.2	-1.5	12.5	-8.1	2.6	-1.7
Tanzania	0.18	0.4	-0.3	7.7	-6.3	0.5	-0.4
Thailand	0.18	0.6	-0.4	10.8	-6.7	0.7	-0.4
Tunisia	0.26	4.4	-3.1	15.3	-10.2	4.7	-3.1
Turkey	0.31	4.9	-3.0	13.6	-8.2	5.4	-3.1
Uganda	0.49	12.0	-6.6	23.5	-12.7	12.3	-6.5
Ukraine	0.44	32.7	-17.1	82.2	-31.7	34.2	-17.6
United Arab Emirates	0.31	3.5	-2.5	9.3	-6.7	3.8	-2.5
United Kingdom	0.25	3.5	-2.8	12.8	-9.4	3.9	-2.9
United States	0.17	0.0	0.0	9.1	-6.2	0.0	0.0
Uruguay	0.25	4.3	-2.6	17.9	-9.9	4.6	-2.9
Venezuela	0.48	18.5	-9.9	38.0	-18.6	18.8	-9.6
Vietnam	0.34	8.0	-5.3	19.3	-12.1	7.7	-4.6
Zambia	0.43	12.9	-7.2	28.2	-15.1	13.4	-7.0
Zimbabwe	0.35	7.5	-6.5	17.2	-14.0	6.5	-5.0
<i>mean</i>	0.33	7.5	-4.6	19.6	-11.9	7.8	-4.6

† '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 AND PRODUCTIVITY COUNTERFACTUALS, AVERAGES

	Using enforcement-intensity $\omega_{ni}^{(1)}$					Using $\omega_{ni}^{(2)}$	
	$\delta$	To US levels		To zero		To US levels	
		$\Delta y$ , in %	$\Delta P$ , in %	$\Delta_0 y$ , in %	$\Delta_0 P$ , in %	$\Delta y$ , in %	$\Delta P$ , in %
High income: OECD	0.24	4.59	-3.14	17.56	-11.46	4.88	-3.18
High income: non-OECD	0.24	2.35	-1.67	11.07	-7.48	2.53	-1.72
Upper middle income	0.31	6.51	-4.13	17.68	-11.03	6.79	-4.10
Lower middle income	0.39	11.42	-6.63	25.70	-14.10	11.96	-6.57
Low income	0.54	15.30	-8.86	27.64	-15.87	15.31	-8.68
Africa	0.42	9.78	-5.92	20.77	-12.60	10.10	-5.85
Northern Africa	0.30	5.46	-3.72	15.94	-10.38	5.60	-3.50
Eastern Africa	0.48	11.43	-6.58	22.55	-13.19	11.70	-6.38
Middle Africa	0.53	14.13	-7.90	27.45	-14.69	13.94	-7.74
Western Africa	0.37	8.12	-5.29	17.95	-11.63	8.56	-5.41
Southern Africa	0.37	9.33	-6.14	21.24	-13.48	10.08	-6.36
Americas	0.35	8.56	-5.21	21.13	-12.32	9.03	-5.27
Northern America	0.22	3.03	-2.00	14.98	-9.32	3.37	-2.12
Central America	0.37	9.63	-6.11	21.65	-13.14	10.17	-6.22
South America	0.35	8.93	-5.23	22.01	-12.34	9.37	-5.23
Asia	0.33	8.10	-4.87	19.90	-11.86	8.38	-4.82
Western Asia	0.27	4.24	-3.03	13.39	-9.21	4.57	-3.12
Central Asia	0.28	5.96	-4.45	17.36	-12.05	5.48	-3.67
Eastern Asia	0.23	2.78	-2.08	13.17	-9.27	3.01	-2.18
South-Eastern Asia	0.46	16.34	-8.58	34.11	-17.16	16.80	-8.25
Southern Asia	0.41	10.88	-6.51	21.57	-12.63	11.09	-6.67
Europe	0.25	4.90	-3.20	17.81	-11.16	5.10	-3.18
Northern Europe	0.23	2.99	-2.19	13.41	-9.49	3.23	-2.25
Western Europe	0.20	1.73	-1.30	12.38	-9.30	1.84	-1.34
Eastern Europe	0.27	7.60	-4.56	24.83	-13.22	7.92	-4.58
Southern Europe	0.29	6.79	-4.45	19.60	-12.34	6.89	-4.28
Oceania	0.24	4.15	-2.89	17.86	-11.53	4.59	-3.08

*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: RESULTS WHEN USING RAUCH CLASSIFICATION OF GOODS

Dependent variable: Intermediate Input Expenditure Share $X_{ni}^c/X_n^c$				
	(1)	(2)	(3)	(4)
Contract enforcement interaction : $\delta^c r_i^{(\text{con})}$	-0.00862 (0.00446)		-0.00862 (0.00453)	
Contract enforcement interaction : $\delta^c r_i^{(\text{lib})}$		-0.00674 (0.00422)		-0.00674 (0.00428)
Upstream $\times$ Downstream fixed effects	Yes	Yes	Yes	Yes
Downstream $\times$ 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 12: ROBUSTNESS: WITHOUT TOP 3 ENFORCEMENT INTENSIVE INPUT SECTORS

Dependent variable: Intermediate Input Expenditure Share $X_{ni}^c/X_n^c$				
	(1)	(2)	(3)	(4)
Contract enforcement interaction : $\delta^c z_{ni}^{(2)}$	-139.8** (44.22)		-178.0** (55.59)	
Contract enforcement interaction : $\delta^c z_{ni}^{(1)}$		-24.20** (7.834)		-27.52** (8.246)
Upstream $\times$ Downstream fixed effects	Yes	Yes	Yes	Yes
Upstream $\times$ Country fixed effects	Yes	Yes	Yes	Yes
Downstream $\times$ 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 7, except that Insurance, Business Services, and Financial Services upstream sectors are not included.

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

Table 13: MATCHING PLAINTIFFS AND DEFENDANTS TO ORBIS FIRMS: STATISTICS

		Plaintiffs		Defendants		All	
		<i>number</i>	<i>in pct</i>	<i>number</i>	<i>in pct</i>	<i>number</i>	<i>in pct</i>
Handmatched:		169		223		392	
Population:		34388	100.0	50822	100.0	85210	100.0
Matches:	perfect matches	1649	4.8	1666	3.3	3315	3.9
	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 businesses						53.9 49.6



Figure 1: TIMELINE OF THE CONTRACTING GAME

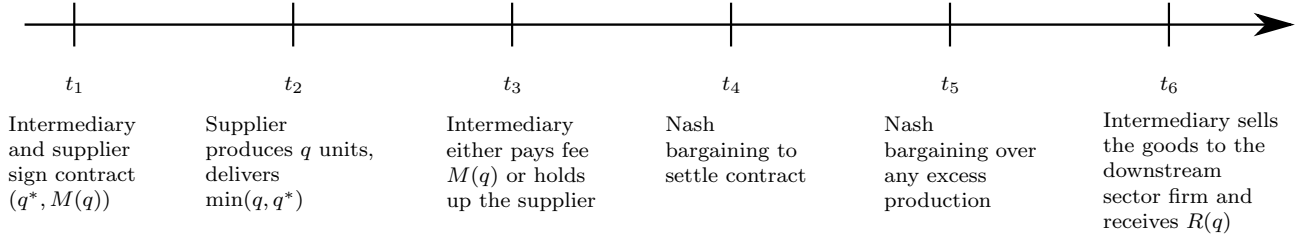
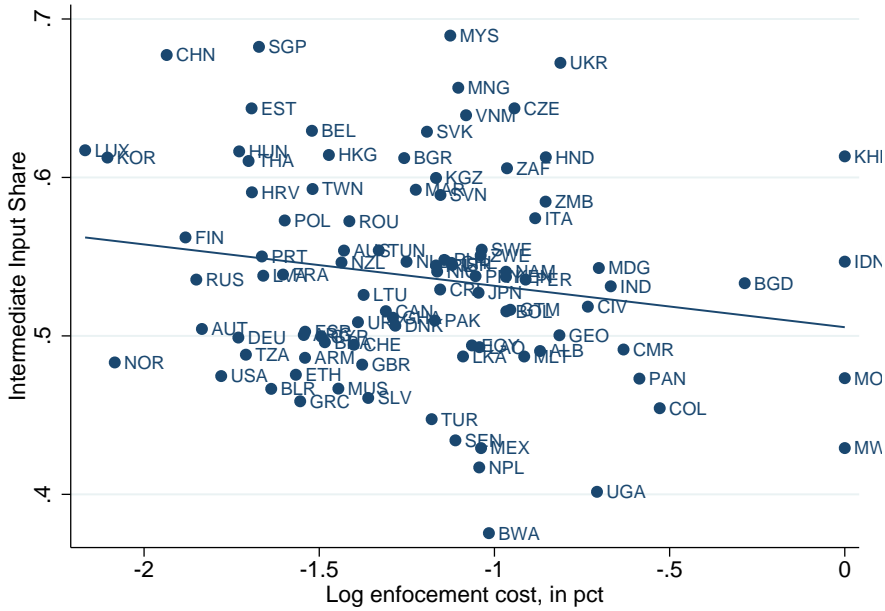


Figure 2: ENFORCEMENT COSTS AND INTERMEDIATE INPUT SHARES ARE NEGATIVELY CORRELATED

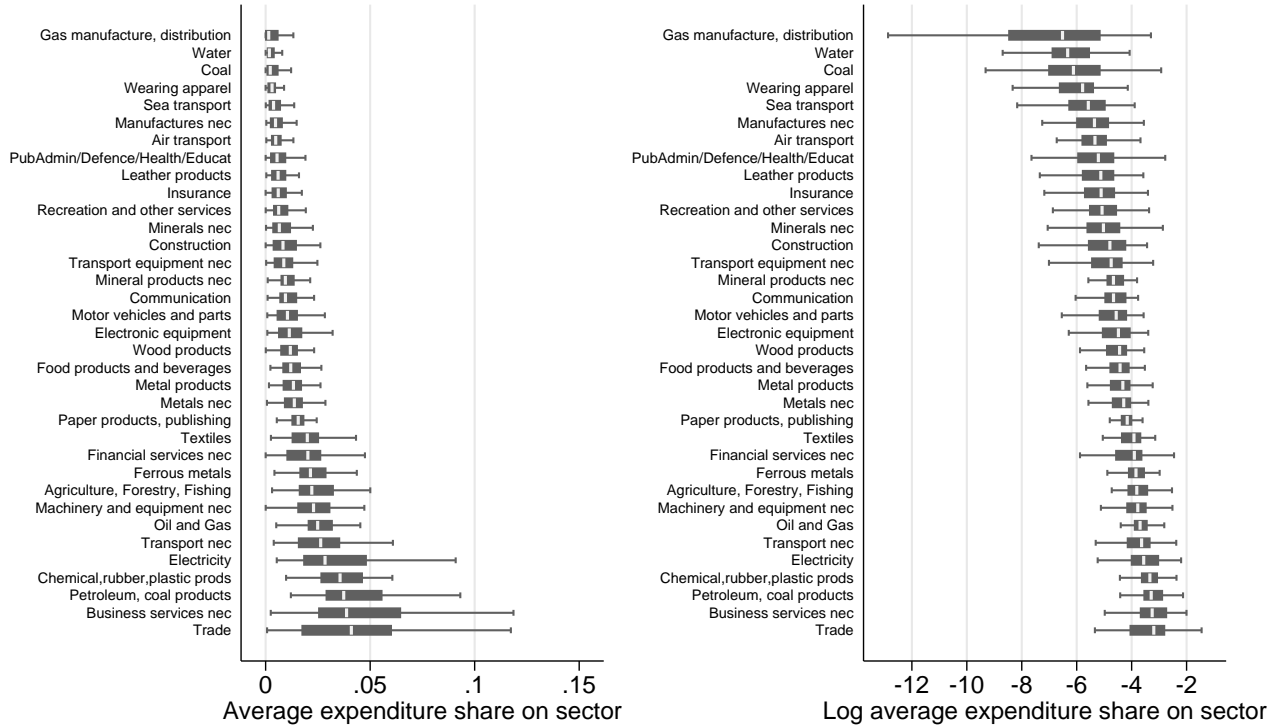


Note: Variable on the vertical axis is the total expenditure on intermediate inputs, across all sectors, divided by gross output. Variable on the horizontal axis is  $\log \delta^c$ . Figure excludes OPEC countries and other countries where oil rents exceed 20% of GDP in 2011, as reported by the World Bank WDI.

Figure 3: CROSS-COUNTRY DISTRIBUTION OF INPUT SHARES BY UPSTREAM SECTOR

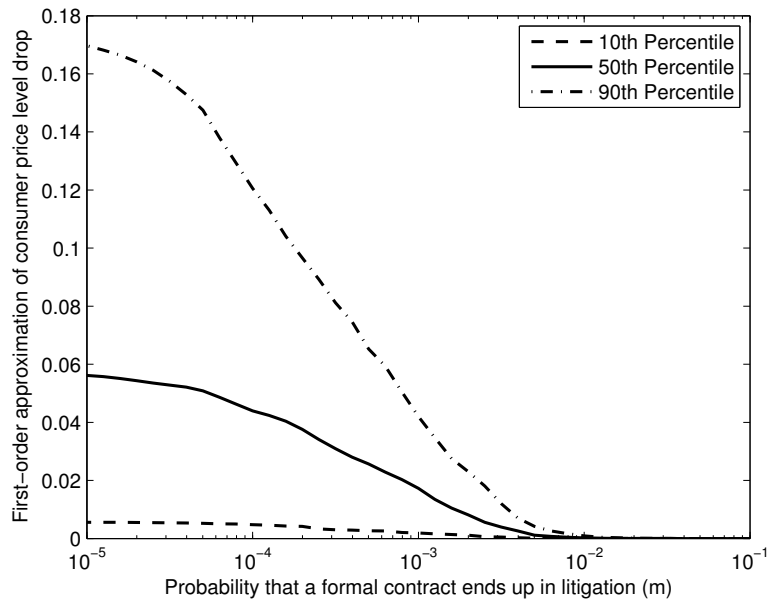
## Cross-country distribution of input shares by upstream sector

Unweighted averages across downstream sectors



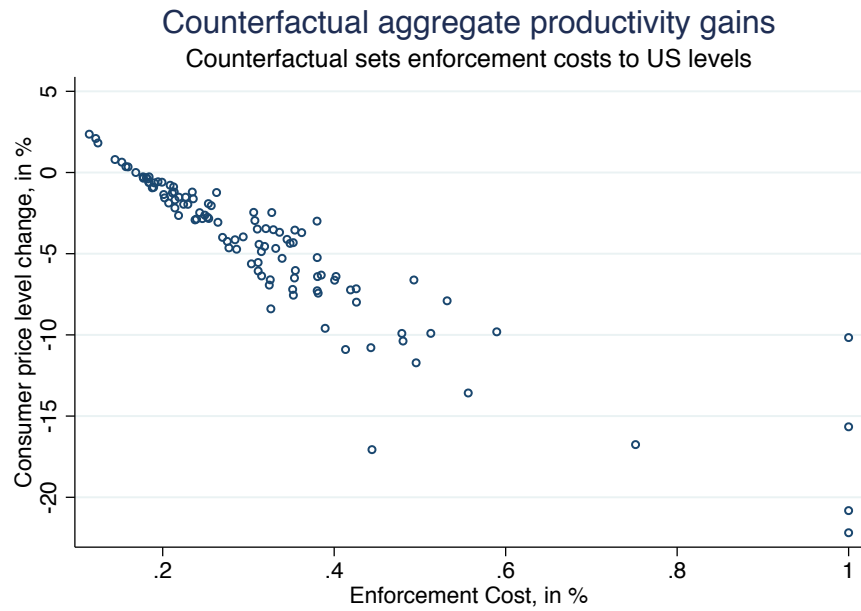
Source: Author's calculations from GTAP 8 data. Excludes outliers.

Figure 4: FIRST-ORDER WELFARE EFFECTS DEPEND ON THE PARAMETER  $m$

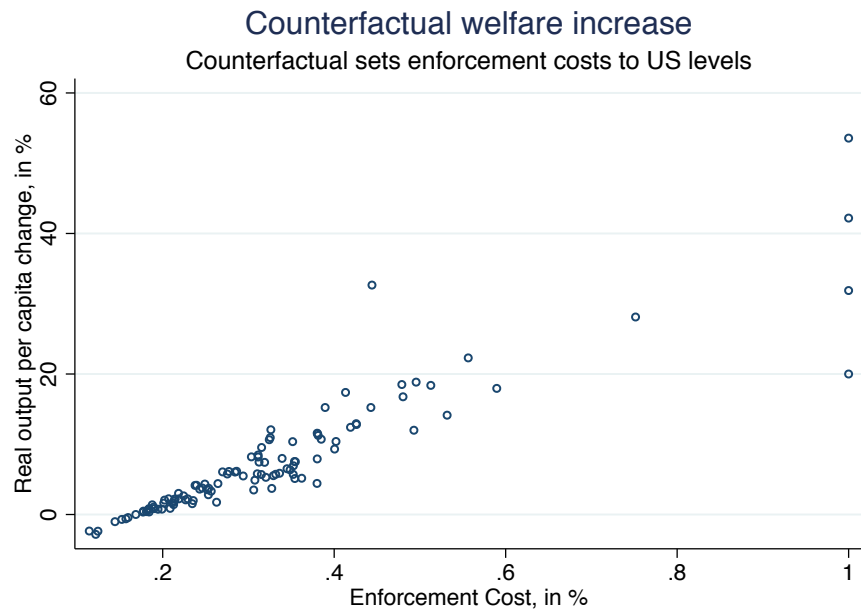


Note: The counterfactual is to set enforcement costs to US levels. Vertical axis is the first-order approximation to the consumer price level drop (in percent) as implied by equation (4.3), with using the observed input-output shares  $\Xi$ . Lines refer to the percentiles of the distribution of price drops across countries.

Figure 5: COUNTERFACTUAL PRODUCTIVITY AND WELFARE GAINS



(a)



(b)