CESifo Working Papers

7173
2018

July 2018

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CESifo

**Impressum:**

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
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Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
www.cesifo-group.org/wp

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CESifo *Working Paper No. 7173*
*Category 8: Trade Policy*

# Offshoring under Uncertainty

## Abstract

We develop a theoretical framework to explain firms' offshoring decisions in the presence of uncertainty. This model highlights the role of labor market institutions in shaping a firm's ability to effectively react upon future shocks, yielding a sharp prediction of the prevalence of offshoring in a given industry: The propensity of firms to source intermediate inputs from foreign rather than domestic suppliers decreases in a foreign country's labor market rigidity, and this effect is particularly pronounced in industries with higher volatility. Combining industry-level data on the U.S. offshoring intensity with measures of labor market rigidity and industry volatility, we find empirical evidence strongly supportive of the model's predictions.

JEL-Codes: F140, F160, F230.

Keywords: offshoring, uncertainty, labor market rigidity, industry volatility.

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July 23, 2018
We thank Alejandro Cuñat and Peter Eppinger for detailed comments on an earlier version of this paper. Thanks are also due to seminar participants at the University of Graz and the University of Tuebingen for helpful discussions. Wilhelm Kohler is grateful for financial support received from Deutsche Forschungsgemeinschaft (DFG) under Grant No. KO 1393/2-1.

# 1 Introduction

Over the past four decades, advances in the technology of transportation and communication have enabled an unprecedented international fragmentation of production (see Johnson and Noguera, 2012, 2017). Production processes are spread across countries in a manner that reflects a trade-off between a foreign cost advantage for certain slices of the value added chain and the additional cost arising from 'slicing-up' the value chain. There is a large economic literature analyzing this trade-off using models inspired by established trade theory (see, e.g., Jones, 2000; Grossman and Rossi-Hansberg, 2008; Feenstra, 2010; Baldwin and Robert-Nicoud, 2014). Although these models have undoubtedly contributed to our understanding of the phenomenon of offshoring, they are typically built upon a simplifying assumption of deterministic outcomes. This assumption sits somewhat uncomfortably with recent empirical evidence showing that firms in a globalized world are increasingly exposed to uncertainty (see, e.g., Bloom, 2009; Baker et al., 2016). Accordingly, risk considerations should be a core element in firms' strategies of global sourcing. The aim of this paper is to enhance our understanding of offshoring decisions under uncertainty, both from a theoretical and an empirical perspective.

We develop a theoretical model in which final good producers decide whether to source intermediate inputs from domestic or foreign suppliers against the backdrop of demand or cost uncertainty. The key novel feature of this model is that firms choose whether to deal with their suppliers under a flexible or a rigid contractual arrangement. A *flexible* contract allows final good producers to determine a state-contingent quantity of intermediate inputs, but is associated with an additional cost from adjustment to the state of demand for the final good or the supplier's productivity. One can think of this cost as expenses needed for hiring additional employees in a 'good' state, or severance payments to laid-off workers in a 'bad' state. A *rigid* contract avoids the labor adjustment cost by stipulating a fixed quantity of intermediate inputs in the ex-ante agreement, but precludes the optimal adjustment to the state of nature. The optimal choice between a rigid and a flexible contract naturally depends on the rigidity of the labor market in the supplier's country, which determines the magnitude of the labor adjustment cost to the state of demand or productivity. Furthermore, this choice depends on the degree of volatility, measured by the difference between the 'good' and the 'bad' state.

We characterize the optimal sourcing strategies of firms that differ with respect to their productivities and operate in industries with varying degrees of volatility. Firms self-select into different sourcing destinations (domestic versus foreign) and contractual arrangements (rigid versus flexible). We show that under plausible conditions only the most productive firms are able to cover the cost associated with international fragmentation of production that comes with exploiting the foreign cost advantage. Moreover, among the firms that engage in offshoring only the most productive ones are willing to incur the labor adjustment cost that comes with flexible contracting, whereas less productive firms choose a rigid contract in order to govern production of inputs.

We use this model to study how a variation in the foreign country's labor market rigidity affects the offshoring intensity of an industry, defined as the share of imported inputs in the overall (i.e., foreign and domestic) input purchases. The model delivers the following two testable predictions: First, ceteris paribus, an increase in the rigidity of a foreign country's labor market decreases the offshoring intensity of any industry. Intuitively, as foreign labor market rigidity increases, offshoring firms engaged in flexible contracting experience a loss in expected profits. Moreover, some firms that have previously sourced their inputs under flexible agreements now enter a rigid contract. In the presence of uncertainty, these firms also experience a loss in expected profits, compared to the situation before the change, which in turn prompts them to reduce their foreign sourcing.

The second testable prediction suggests that the negative effect of foreign labor market rigidity on the offshoring intensity becomes stronger as the industry's volatility increases. The intuition behind this prediction is that the relative advantage of flexible versus rigid contracts weighs more heavily in volatile industries. Hence, if the foreign labor market rigidity increases, the aforementioned decrease in expected profits is more pronounced in volatile industries, and firms' reactions in terms of a reduced amount of imported inputs is particularly strong. To sum up, our model predicts a negative direct effect of a foreign country's labor market rigidity on the offshoring intensity in any given industry, and it predicts that this effect is amplified in industries with a high degree of volatility. Importantly, we show that these predictions hold regardless of whether we model uncertainty on the side of the final goods producer (state of demand) or on the side of the supplier (cost conditions).

In the empirical part of the paper, we test our theoretical predictions using U.S. industry-level panel data. The measure of U.S. offshoring intensity is drawn from Antràs (2015) who calculates it as the share of spending on imported inputs over total input purchases in a particular industry. This measure is available on a yearly basis for 253 manufacturing sectors (according to IO2002 industry classification) and 232 foreign countries for the period 2000-2011. We complement these data with a country-level measure of labor market rigidity drawn from the World Bank's Doing Business database.[1] This measure combines the difficulty of

[1] Since the seminal contribution by Cuñat and Melitz (2012), this measure has been frequently used in the literature as a proxy for labor market rigidity vs. flexibility, see Nunn and Trefler (2014).

hiring or firing a worker and the restrictions on expanding or contracting the number of working hours into a single score based on the methodology developed by Botero et al. (2004). It is available on a yearly basis for 180 countries during the period 2004-2009. Importantly, this measure exhibits sufficient variation over time in order to study the effect of *changes* in foreign labor market rigidity on offshoring intensity, while fully controlling for time-invariant country-level factors via country fixed effects (FE). To test our second key prediction, we use an industry-level proxy for volatility, drawn from Antràs (2015) and computed following the methodology by Cuñat and Melitz (2012) as the standard deviation of the annual growth rate of firm sales in the 1980-2004 Compustat data.

Our empirical analysis proceeds in two steps. In the first step, we explore the direct relationship between the variation in foreign labor market rigidity and the U.S. offshoring intensity. When doing so, we fully control for heterogeneity across countries and industries with respect to time-invariant factors through country and industry fixed effects. In the most stringent specifications, we further account for time-specific industry shocks and allow for a differential impact of the foreign country's factors across industries via industry/year and country/industry fixed effects, respectively. Controlling for all of these fixed effects as well as a range of time-varying country-specific factors, we find a negative and significant association between foreign countries' labor market rigidity and the U.S. offshoring intensity. This finding is consistent with the first of our two theoretical predictions mentioned above.

In the second step, we explore how the interaction between labor market rigidity and industry volatility plays out in determining the U.S. offshoring intensity. The fact that the explanatory variable now varies by country/industry/year allows us to control even more effectively for potential confounding factors using suitable fixed effects. Most importantly, by including country/year fixed effects, we account for all time-varying country-specific factors that might confounded the relationship between labor market rigidity and offshoring intensity in the first step of our empirical analysis. Controlling for a host of fixed effects and a range of country/industry/year-specific factors, we find a negative and significant interaction effect of labor market rigidity and industry volatility on the U.S. offshoring intensity. This effect is robust to correcting for potential sample selection bias by estimating a two-stage selection model along the lines of Heckman (1979). Following Levchenko (2007), we further allow for a differential impact of foreign countries' economic development across U.S. industries by adding a full set of interaction terms for the foreign country's GDP per capita with industry dummies. Throughout all specifications, we find strong empirical support for the second theoretical prediction stating that the negative effect of foreign labor market rigidity on offshoring intensity is more pronounced in industries with high volatility.

This paper relates to several recent strands of the literature. Our theoretical model builds on the offshoring framework developed by Antràs (2015) which features productivity-based self-selection of firms into domestic versus foreign sourcing. We extend this framework to include (demand and supply) uncertainty, thereby highlighting the trade-off between rigid and flexible contracting in dealing with this uncertainty. This allows us to derive novel testable predictions regarding the effect of foreign labor market rigidity and its interaction with industry volatility on the U.S. offshoring intensity. In so doing, we also relate to the work by Cuñat and Melitz (2012) who study the interaction effect between labor market flexibility and industry volatility on a country's comparative advantage. Extending a Ricardian model of trade with the notion of uncertainty, Cuñat and Melitz (2012) show that countries with more flexible labor markets specialize in sectors with higher volatility and export final goods from those sectors. We complement their findings by showing how the interaction between labor market rigidity and industry volatility affects the attractiveness of a country as an offshoring destination for intermediate input production.[2]

To the best of our knowledge, the only two theoretical contributions which consider offshoring under uncertainty are Bergin et al. (2011) and Benz et al. (2018). Both papers focus on the effect of offshoring on employment volatility. More specifically, Bergin et al. (2011) develop a stochastic model to explain the so-called 'offshoring volatility puzzle': maquiladora industries in Mexico exhibit larger employment volatility than the corresponding industries in the U.S., although Mexico has a more rigid labor market compared to the U.S., see Bergin et al. (2009). In their model, offshoring acts as transmission channel through which domestic booms or recessions are amplified in a foreign destination. Benz et al. (2018) develop a framework of intertemporal optimization to study how offshoring affects hiring and firing decisions of firms and, thus, employment volatility in the sourcing and the source country. The current paper differs from these contributions both in terms of focus and the underlying approach. Our aim is to better understand the role of labor market institutions on firms' offshoring decisions under uncertainty. In our framework, offshoring *per se* does not affect a firm's (employment) volatility. It is the combination of a foreign country's labor market rigidity and sector-specific exposure to uncertainty that drives firms' offshoring decisions and affects the variation in firm-level outcomes.

We further relate to the empirical literature which studies the role of (labor market) institutions in international transactions. In particular, Cuñat and Melitz (2012) provide empirical support for their key theoretical prediction: The exports of countries with more

[2] The role of uncertainty in international trade has been also analyzed by Albornoz et al. (2012), Carballo (2015), Handley and Limão (2015, 2017), Nguyen (2012), Segura-Cayuela and Vilarrubia (2008). In contrast to these contributions, we focus on offshoring relationships.

flexible labor markets are biased towards high-volatility sectors. This empirical regularity has subsequently been corroborated by Chor (2010) and Nunn and Trefler (2014). Consistent with our findings, Antràs (2015) reports a positive *interaction* between labor market flexibility from the year 2004 and industry volatility in determining the U.S. offshoring intensity. However, this interaction effect cannot be interpreted, in and of itself, without knowing whether the *direct* effect of labor market flexibility is positive or negative. To this end, we first thoroughly investigate the direct relationship between labor market rigidity and the U.S. offshoring intensity before turning to the interaction effect of labor market rigidity and industry volatility. An important feature which distinguishes our empirical analysis from Antràs (2015) is that we exploit the time variation of labor market rigidity index in a panel (rather than pooled OLS) setting. This approach allows us to identify the interaction effect of labor market rigidity and industry volatility on U.S. offshoring intensity, while controlling for potential country/year-specific confounding factors using fixed effects.

The remainder of the paper is structured as follows. Section 2 lays out the theoretical model of demand and supply uncertainty, discusses the equilibrium, and derives testable predictions. Section 3 brings these predictions to the data. Section 4 concludes.

# 2 Theoretical model

In this section, we propose a theoretical model of offshoring under uncertainty. In our framework, firms face uncertainty regarding the demand for their final goods or the supply (cost) of intermediate inputs. To develop our argument in the simplest possible manner, we examine the two types of uncertainty one at a time, starting with demand uncertainty in section 2.1, followed by supply uncertainty in section 2.2.

## 2.1 Demand uncertainty

### 2.1.1 Baseline set-up

Our point of departure is the canonical framework of offshoring presented in Chapter 2 of Antràs (2015). The domestic economy hosts several symmetric industries, each composed of firms producing differentiated varieties of a final good under monopolistic competition. For ease of notation, we abstain from indexing industries and focus on a single sector. Production of final goods involves two parties: the firm's headquarters, $H$, and a manufacturing supplier, $M$.[3] The headquarter provides headquarter services, $h$, while the supplier produces

[3] The manufacturing supplier may be either integrated into $H$'s boundaries or act as an independent subcontractor. Since organization of firms does not lie in the focus of our analysis, we abstract from

manufacturing components, $m$. The firm then combines both inputs to produce an output level $x$ according to a Cobb-Douglas production function:

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

where $\theta \in (0, \infty)$ represents the firm's productivity and $\eta \in (0, 1)$ is an industry-specific parameter capturing the relative importance of headquarter services in the production process, henceforth called the headquarter intensity. Each of the two inputs is produced under constant returns to scale using labor as the only factor of production.

By assumption, headquarters are always located in the domestic economy, while manufacturing inputs can be provided by domestic or foreign suppliers. In the former case we speak of domestic ($d$) sourcing, while the latter case is referred to as offshoring ($o$). Since our subsequent empirical analysis is focused on the U.S., we refer to the domestic economy as the U.S. In our baseline model, we consider a single foreign economy. For simplicity, we normalize the unit labor input requirement for domestic production of $h$ to unity and let $\ell$ denote the amount of labor needed to produce one unit of $m$, assumed to be the same in the domestic and foreign country. We normalize the domestic wage rate to unity and use $w$ to denote the foreign wage rate relevant for offshore production of $m$. Throughout the analysis, we assume a foreign wage advantage, i.e., $w < 1$. However, in case $H$ decides to source manufacturing inputs from a foreign supplier, this involves iceberg-type trade cost, $\tau > 1$. Moreover, offshoring of manufacturing production to a foreign destination entails additional fixed cost, incurred by $H$ in terms of domestic labor. Denoting the fixed cost of $m$-production by $F_z$, $z \in \{d, o\}$, we have $F_d < F_o$.

Assuming constant elasticity of substitution (CES) preferences, the revenue from selling a quantity $x$ of a representative variety of the final good may be written as

$$R = x^{\frac{\sigma-1}{\sigma}} A^{\frac{1}{\sigma}}, \tag{2}$$

where $\sigma > 1$ denotes the elasticity of substitution between any two differentiated varieties and $A := \beta E P^{\sigma-1}$ is a demand shifter, where $\beta \leq 1$ represents the fraction of consumers' total expenditures $E$ falling on differentiated varieties of the sector considered, and $P$ is this sector's CES price index (taken as given by profit maximizing firms), see Antràs (2015).

We depart from Antràs (2015) and the vast majority of the offshoring literature by allowing for uncertainty. In our baseline model, headquarters face uncertainty about the

modeling the "make-or-buy" decision.

state of demand for their final goods.[4] We model this uncertainty by assuming two states of nature, a good ($G$) state and a bad ($B$) state. Thus, we have $A = A_s$, where $s \in \{G, B\}$ and $A_G > A_B$. A good state of demand may be thought of as a high level of consumers' total expenditures $E$, a preference shift towards goods of a given sector affecting $\beta$, or a high level of the sector's price index $P$ (implying lower competition from rival firms). The probability of a good state $g \in (0, 1)$ is assumed to be known by firms.[5] For simplicity, we assume the same $g$, $A_G$, and $A_B$ for all firms within a given sector, but allow for cross-sectoral differences in volatility, defined further below. Importantly, we assume that courts can verify the state of the world, $s \in \{G, B\}$.

Unlike Antràs (2015), we assume that courts can verify and enforce contracts between $H$ and $M$.[6] In view of uncertainty, headquarters decide between two types of contract – a rigid ($r$) and a flexible ($f$) contract, indexed by $c \in \{r, f\}$. In a rigid contract, parties stipulate ex-ante (i.e., before the state of the world is realized) a fixed quantity of the manufacturing component, $m_z^r$, to be delivered by $M$ regardless of the state of demand. A flexible contract is a state-contingent agreement, which allows $H$ to stipulate the quantity of manufacturing inputs $m_{zs}^f$ after the state of demand $s \in \{G, B\}$ is revealed. As will become clear below, $H$ optimally chooses a high (low) amount of the manufacturing inputs in the good (bad) state of the world. To be able to promptly react at the headquarter's request after the state of nature is revealed, the supplier has to incur a cost of labor adjustment. We assume that these cost have a fixed and a variable component. One can think of the fixed labor $a$djustment cost, $F_{az} \geq 0$, as the overhead expenses needed to launch and maintain a hiring process involving high employment in the good state of the world and low employment in the bad state. The variable component reflects the fact that workers hired on a short-term notice may claim additional compensation, whereas laid-off workers might demand severance payments. To keep the analysis simple, we assume symmetry in the labor adjustment cost between states and let $\alpha_z \geq 1$ denote the (ad valorem) price premium that $H$ needs to pay $M$ for the latter to be willing to enter a flexible contract. Plausibly, the more flexible the labor market in the supplier's country, the lower the labor adjustment cost, reflected in lower $F_{az}$ and $\alpha_z$. Given that the U.S. has one of the most flexible labor markets in the world (see below), we assume $F_{ad} < F_{ao}$ and $\alpha_d < \alpha_o$. For simplicity, we normalize $F_{ad} = 0$ and simplify the notation by setting $F_{ao} := F_a > 0$. Moreover, we normalize $\alpha_d = 1$ and simplify by setting $\alpha_o := \alpha > 1$.

4 As mentioned above, the case of supply (cost) uncertainty is developed in section 2.2.

5 According to Knight (1921), the notion of risk differs from uncertainty in that the probability of a shock can be quantified in the former case. Throughout the paper, we use the two concepts interchangeably.

6 We make this assumption to focus on the novel feature of decision-making under uncertainty and abstract from the well-known hold-up inefficiencies that arise in an environment of contractual incompleteness.

In both countries, there is a large pool of potential suppliers with zero outside options. To secure participation of a supplier in a rigid contract, $M$ must be compensated by a per-unit payment $p_z^c$, which is equal to a supplier's variable production cost:

$$p_z^c = \begin{cases} \ell & \text{if } z = d \text{ and } c = f, r \\ \tau w \ell & \text{if } z = o \text{ and } c = r \\ \alpha \tau w \ell & \text{if } z = o \text{ and } c = f \end{cases} \tag{3}$$

We assume throughout that the effective unit cost of manufacturing inputs are lower under offshoring, i.e., $\tau w < 1$. In addition, to ensure a foreign supplier's participation under a flexible agreement, $H$ pays a premium on the per-unit price ($\alpha > 1$) and compensates for the fixed labor adjustment cost, $F_a$.

There are two stages of decision making. We refer to $t_1$ as the (ex-ante) period when decisions have to be made while the state of nature is still uncertain, while $t_3$ refers to the (ex-post) period when the state of nature is known. The sequencing of decisions is as follows:

$t_1$ The headquarter decides about the location of sourcing, $z$, and incurs the fixed cost $F_z$. In addition, $H$ decides whether to enter a rigid or a flexible contract, $c \in \{r, f\}$. Under a rigid contract, parties stipulate a fix amount of the manufacturing component, $m_z^r$. Under a flexible agreement, parties stipulate an amount of $m_{zs}^f$, contingent upon the realization of the state $s \in \{G, B\}$. Under either type of contract, $H$ commits to compensate $M$ by paying the price $p_z^c$ per unit of $m$, as given in equation (3) above. A flexible contract with a foreign supplier additionally involves $H$'s commitment to pay a fixed fee $F_a$, compensating $M$ for the above mentioned cost of maintaining a flexible hiring scheme allowing for a state-contingent quantity $m_{os}^f$.

$t_2$ The state of nature $s \in \{G, B\}$ is revealed.

$t_3$ Ex-ante contracts between $H$ and $M$ are fulfilled. In addition, $H$ chooses a profit-maximizing quantity of input $h$, given the state of nature and the contracted quantity of the input $m$. Specifically, having chosen a rigid contract in $t_1$, $H$ will determine a quantity $h_{zs}^r$, depending on $m_z^r$ and the state of nature $s$. Analogously, in case of a flexible contract, $H$ chooses $h_{zs}^f$.[7] Finally, given optimal input quantities, production of the final good takes place in line with equation (1) and revenue is generated according to equation (2).

[7] Even though $H$ chooses a state-specific amount of $h$ under either contractual form, these amounts depend on whether $M$ operates under a rigid or a flexible contract. For this reason, we distinguish $h$ with a superscript $c \in \{r, f\}$.

In what follows, we solve for the equilibrium using backward induction.

### 2.1.2 Equilibrium

**Domestic sourcing.** We begin our analysis by studying domestic sourcing, $z = d$. Consider first the case of a *flexible* contract. A flexible agreement effectively allows $H$ to simultaneously choose the levels of both inputs conditional on the state of demand $s \in \{G, B\}$. The corresponding maximization problem reads as

$$\max_{h,m} R_s - \ell m - h - F_d, \tag{4}$$

where $R_s$ is given by equation (2), and $\ell$ denotes the per-unit price of the domestically sourced manufacturing input, as specified in equation (3). The solution to this problem determines the state-contingent quantity $m^f_{ds}$ stipulated in the flexible contract in $t_1$, as well as the corresponding $h^f_{ds}$ chosen by $H$ in $t_3$. Using equations (1) and (2), these quantities and the associated state-dependent revenue can be derived as:

$$h^f_{ds} = \frac{\eta(\sigma-1)R^f_{ds}}{\sigma} \quad , \quad m^f_{ds} = \frac{(1-\eta)(\sigma-1)R^f_{ds}}{\ell\sigma} \quad , \quad R^f_{ds} = \sigma\ell^{-\gamma}\Theta\Gamma A_s. \tag{5}$$

In these expressions $\Theta := \theta^{\sigma-1}$ captures the firm's productivity level, while the terms $\Gamma := \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} > 0$ and $\gamma := (1-\eta)(\sigma-1) > 0$ are introduced for notational simplicity. Since $A_G > A_B$, the optimal amounts of both inputs are higher in the good state of demand than in the bad state. Plugging equation (5) into (4), we obtain the state-specific maximum profit from domestic sourcing under a flexible contract:

$$\pi^f_{ds} = \ell^{-\gamma}\Theta\Gamma A_s - F_d. \tag{6}$$

Hence, the expected profit from domestic sourcing under a flexible contract is given by

$$E(\pi^f_d) = \ell^{-\gamma}\Theta\Gamma\left[gA_G + (1-g)A_B\right] - F_d. \tag{7}$$

Next, consider a *rigid* contract. In $t_3$, $H$ chooses the amount of $h$ that maximizes

$$\max_{h} R_s - h - F_d, \tag{8}$$

conditional on the quantity $m^r_d$ chosen in period $t_1$, which enters $R_s$ according to equations (1) and (2). Note that the cost of the manufacturing input, while affecting profits, is irrelevant for optimization in $t_3$. The optimal quantity of $h$ chosen in $t_3$ and the associated revenue read as

$$h^r_{ds} = \frac{\eta(\sigma-1)R^r_{ds}}{\sigma} \quad , \quad R^r_{ds} = \left[\theta\left(\frac{\sigma-1}{\sigma}\right)^{\eta}\left(\frac{m^r_d}{1-\eta}\right)^{1-\eta}\right]^{\frac{\sigma-1}{\sigma(1-\eta)+\eta}} A_s^{\frac{1}{\sigma(1-\eta)+\eta}}. \tag{9}$$

In state $s$, $H$ receives the following revenue net ($n$) of the cost of headquarter services (henceforth, net revenue):

$$R^r_{dsn} := R^r_{ds} - h^r_{ds} = \frac{\sigma(1-\eta)+\eta}{\sigma} R^r_{ds}. \tag{10}$$

Expected net revenue from a rigid contract may be written as

$$E(R^r_{dsn}) = \frac{\sigma(1-\eta)+\eta}{\sigma}\left[gR^r_{dG} + (1-g)R^r_{dB}\right], \tag{11}$$

where $R^r_{ds}$ is given by the second expression in equation (9).

In $t_1$, $H$ stipulates the fixed amount of $m$ so as to maximize the expected net revenue:

$$\max_m E(R^r_{dsn}) - \ell m - F_d, \tag{12}$$

where we have again used equation (3) above. Using equations (9) and (11), this optimization problem can be solved to obtain the profit-maximizing fixed quantity of $m$ under a rigid contract:

$$m^r_d = \frac{(1-\eta)(\sigma-1)E(R^r_{dsn})}{\ell\left[\sigma(1-\eta)+\eta\right]}. \tag{13}$$

Inserting for $m^r_d$ in the expression for $R^r_{ds}$ in equation (9), and substituting this expression back into (11), we get

$$E(R^r_{dsn}) = \left[\sigma(1-\eta)+\eta\right]\ell^{-\gamma}\Theta\Gamma\left(gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right)^{\sigma(1-\eta)+\eta}. \tag{14}$$

Plugging equations (13) and (14) into equation (12), we finally arrive at the expected maximum profit from domestic sourcing under a rigid contract:

$$E(\pi^r_d) = \ell^{-\gamma}\Theta\Gamma\left(gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right)^{\sigma(1-\eta)+\eta} - F_d. \tag{15}$$

Completing backward induction, we can now state that risk-neutral headquarters engaged in domestic sourcing will choose a flexible contract if and only if $E(\pi^f_d) > E(\pi^r_d)$. Using equations (7) and (15), this condition can be written as

$$J := \frac{gA_G + (1-g)A_B}{\left[gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right]^{\sigma(1-\eta)+\eta}} > 1. \tag{16}$$

Note that $J = 1$ for $g = 0$, $g = 1$, or $A_G = A_B$. That is, firms are indifferent between the two contractual types in the absence of uncertainty. We show in Appendix A.1 that $J > 1$ for all $g \in (0,1)$ and $A_G > A_B$. That is, in the presence of demand uncertainty and in the absence of any ex-post labor adjustment cost, flexible contracts dominate rigid agreements. Further, we show that the attractiveness of flexible contracts increases in the degree of demand volatility. More specifically, let $v := (A_G - A_B)/A_G$ denote the sector-specific degree of volatility across states. Obviously, $v \in (0,1)$ if $A_G > A_B$, as assumed. Appendix A.1 also demonstrates that $J$ is increasing in $v$, which means that the advantage of flexible contracting increases in the degree of volatility in a given sector. These results are summarized in

**Lemma 1.** *(i) $J > 1$ for all $g \in (0,1)$ and $v > 0$. (ii) $J$ is monotonically increasing in $v$.*

*Proof.* See Appendix A.1. □

Bearing in mind that the labor adjustment cost in the domestic economy were assumed to be negligible, Lemma 1 implies that all firms engaged in domestic sourcing prefer flexible over rigid contracts.

**Offshoring.** The case of offshoring can be solved by analogy to domestic sourcing, using the per-unit price $p_o^c$ from equation (3). Following the above approach, it is straightforward to show that offshoring under a *flexible* contract implies the following state-contingent quantity of the manufacturing input:

$$m_{os}^f = \frac{(1-\eta)(\sigma-1)R_{os}^f}{\sigma\alpha\tau w\ell} \quad , \quad R_{os}^f = \sigma\omega\Lambda\ell^{-\gamma}\Theta\Gamma A_s, \tag{17}$$

where $\omega := (\tau w)^{-\gamma}$ and $\Lambda := \alpha^{-\gamma}$ are defined for notational simplicity. Note that $\Lambda < 1$ for all $\alpha > 1$ and $\gamma > 0$. An increase in the variable labor adjustment cost, reflected in a higher $\alpha$, affects $m_{os}^f$ via two channels. First, the supplier charges a higher per-unit price (entering the denominator of equation (17)), which reduces the state-contingent quantity stipulated in the ex-ante contract. Second, the final good producer expects a lower revenue (since $\Lambda = \alpha^{-\gamma}$ decreases in $\alpha$), which further reduces $m_{os}^f$. The amount of manufacturing inputs sourced from a foreign supplier under a *rigid* contract reads as follows:

$$m_o^r = \frac{(1-\eta)(\sigma-1)R_o^r}{\sigma\tau w\ell} \quad , \quad R_o^r = \sigma\omega\ell^{-\gamma}\Theta\Gamma\left[gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right]^{\sigma(1-\eta)+\eta}. \quad (18)$$

The expected maximum profit from offshoring under a flexible contract is given by:

$$E(\pi_o^f) = \omega\Lambda\ell^{-\gamma}\Theta\Gamma\left[gA_G + (1-g)A_B\right] - F_o - F_a, \quad (19)$$

whereas the expected maximum profit under a rigid contract can be derived as:

$$E(\pi_o^r) = \omega\ell^{-\gamma}\Theta\Gamma\left[gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right]^{\sigma(1-\eta)+\eta} - F_o. \quad (20)$$

Comparing equations (19) and (20), the choice between flexible and rigid contracts under offshoring involves the following trade-off. On the one hand, since $J > 1$, a flexible agreement entails a gain in operating profits due to the ability to adjust to the realized state of demand (see Lemma 1). On the other hand, the labor adjustment cost associated with flexible contracting lead to a loss in firm profits (recall that $\Lambda < 1$ and $F_a > 0$). To allow for the coexistence of flexible and rigid contracting in equilibrium and to generate a non-trivial trade-off between domestic sourcing and offshoring, we make the following assumption:

**Assumption 1.** *(i)* $\frac{J(F_o - F_d)}{(\omega - J)F_d} > 1$; *(ii)* $\frac{(\omega - J)F_a}{\omega(J\Lambda - 1)(F_o - F_d)} > 1$.

This assumption ensures that $(i)$ domestic sourcing is not strictly dominated by offshoring, and $(ii)$ offshoring under a rigid contract is not strictly dominated by offshoring under a flexible contract. Based on these assumptions, Figure 1 depicts maximum profits under alternative sourcing strategies as a function of the productivity measure $\Theta$. The least productive firms with $\Theta < \Theta_d^f$ do not start producing; firms with $\Theta \in [\Theta_d^f, \Theta_o^r)$ source $m$ domestically; and high-productivity firms with $\Theta \geq \Theta_o^r$ are able to cover $F_o$ and engage in offshoring. Among the offshoring firms, those with $\Theta \in [\Theta_o^r, \Theta_o^f)$ source inputs under a rigid contract, while firms with $\Theta \geq \Theta_o^f$ incur $F_a$ and source manufacturing components under flexible contracts. Using equations (7), (19) and (20), one can easily derive these equilibrium productivity cutoffs:[8]

$$\Theta_d^f = \frac{F_d}{\ell^{-\gamma}\Gamma\left[gA_G + (1-g)A_B\right]}, \quad \Theta_o^r = \Theta_d^f\frac{J(F_o - F_d)}{(\omega - J)F_d}, \quad \Theta_o^f = \Theta_d^f\frac{JF_a}{\omega(J\Lambda - 1)F_d}. \quad (21)$$

[8] The cutoff $\Theta_d^f$ is obtained from $E(\pi_d^f) = 0$; the cutoff $\Theta_o^r$ from $E(\pi_d^f) = E(\pi_o^r)$; and the cutoff $\Theta_o^f$ from $E(\pi_o^r) = E(\pi_o^f)$. Assumption 1*(i)* ensures that $\Theta_o^r > \Theta_d^f$, while Assumption 1*(ii)* ensures that $\Theta_o^f > \Theta_o^r$.

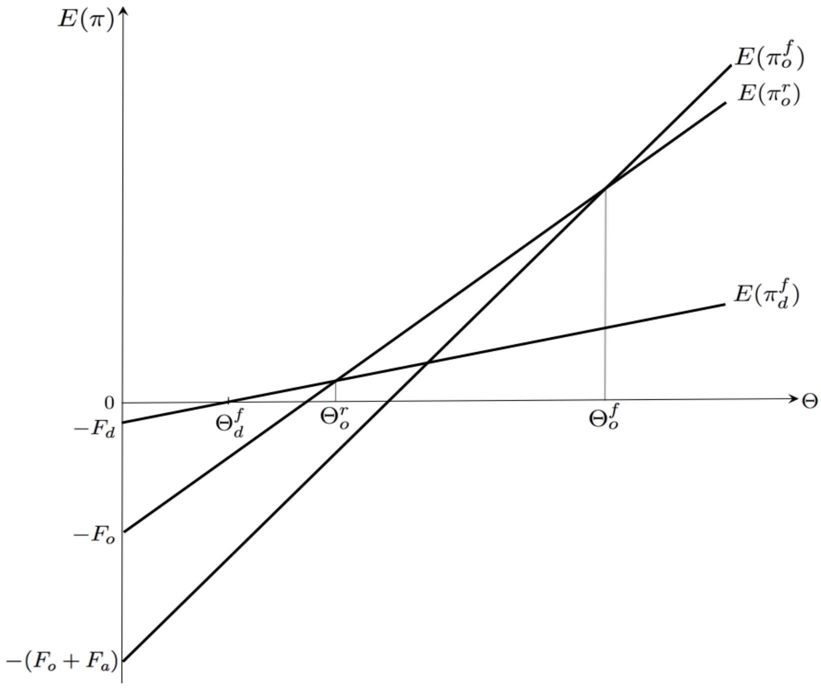


Figure 1: *Equilibrium sorting pattern under demand uncertainty.*

This completes the description of a firm's choice between domestic and foreign sourcing. Given that our empirical analysis of the determinants of offshoring is conducted using industry data, the following section derives testable industry-level predictions regarding the effect of the foreign country's labor market rigidity and its interaction with the sectoral volatility on the propensity of firms to source inputs from that country.

### 2.1.3 Testable predictions

Let $\Phi(\theta)$ denote the distribution function for firm productivity. Defining $\tilde{m}_z^f := gm_{zG}^f + (1-g)m_{zB}^f$, we can then express the share of imported input purchases in a given industry as

$$Y = \frac{\int_{\theta_o^r}^{\theta_o^f} p_o^r m_o^r \,\mathrm{d}\Phi(\theta) + \int_{\theta_o^f}^{\infty} p_o^f \tilde{m}_o^f \,\mathrm{d}\Phi(\theta)}{\int_{\theta_d^f}^{\theta_o^r} p_d^f \tilde{m}_d^f \,\mathrm{d}\Phi(\theta) + \int_{\theta_o^r}^{\theta_o^f} p_o^r m_o^r \,\mathrm{d}\Phi(\theta) + \int_{\theta_o^f}^{\infty} p_o^f \tilde{m}_o^f \,\mathrm{d}\Phi(\theta)}, \tag{22}$$

where $\theta_d^f = (\Theta_d^f)^{\frac{1}{\sigma-1}}$, $\theta_o^r = (\Theta_o^r)^{\frac{1}{\sigma-1}}$, and $\theta_o^f = (\Theta_o^f)^{\frac{1}{\sigma-1}}$. The cutoffs $\Theta_d^f$, $\Theta_o^r$ and $\Theta_o^f$ are given by equation (21); $p_z^c$ is given by equation (3); and $m_{ds}^f$, $m_{os}^f$ and $m_o^r$ are given by equations (5), (17), and (18), respectively. The numerator of $Y$ represents the value of inputs sourced from foreign suppliers (under rigid and flexible contracts), while the denominator denotes the total value of inputs sourced from domestic and foreign suppliers. In what follows, we refer to $Y$ as the (U.S.) offshoring intensity or, synonymously, as the offshoring propensity.

We follow a large part of the heterogenous firm literature in assuming that productivities are distributed Pareto (see Antràs, 2015; Melitz and Redding, 2014):

$$\Phi(\theta) = 1 - \left(\frac{\theta_{\min}}{\theta}\right)^{\kappa} \quad , \quad \theta \geq \theta_{\min} > 0 \quad , \quad \kappa > \sigma - 1, \tag{23}$$

where $\theta_{\min}$ is the lower bound of the support and $\kappa$ is a shape parameter of the productivity distribution. Utilizing (23) in (22) and simplifying the resulting expression we obtain

$$Y = \frac{\left(\frac{\Theta_o^f}{\Theta_o^r}\right)^{\frac{\kappa-(\sigma-1)}{\sigma-1}} + (J\Lambda - 1)}{\frac{J}{\omega}\left[\left(\frac{\Theta_o^f}{\Theta_d^f}\right)^{\frac{\kappa-(\sigma-1)}{\sigma-1}} - \left(\frac{\Theta_o^f}{\Theta_o^r}\right)^{\frac{\kappa-(\sigma-1)}{\sigma-1}}\right] + \left(\frac{\Theta_o^f}{\Theta_o^r}\right)^{\frac{\kappa-(\sigma-1)}{\sigma-1}} + (J\Lambda - 1)}, \tag{24}$$

where $J$ is given by equation (16) and the productivity cutoffs are given by equation (21).

Using equation (24), one can investigate the effect of an increase in labor market rigidity (measured by an increase in $\alpha$ and/or $F_a$) on the offshoring intensity. We derive the following

**Proposition 1.** *Under Assumption 1, $\frac{\partial Y}{\partial F_a} < 0$ and $\frac{\partial Y}{\partial \alpha} < 0$; an increase in the rigidity of the foreign country's labor market ceteris paribus decreases the U.S. offshoring intensity in a given industry.*

*Proof.* See Appendix A.2. □

The intuition behind this proposition can be obtained using Figure 1. Consider first the case of an increase in $\alpha$, which leads to a clock-wise pivot of the $E(\pi_o^f)$-line and has a two-fold effect on the offshoring intensity. First, since firms engaged in offshoring under a flexible contract must compensate their suppliers with a higher price, they expect lower operating profits and reduce the state-contingent quantities $m_{os}^f$, $s \in \{G, B\}$, stipulated in the ex-ante contract. Second, some offshoring firms that have previously chosen flexible contracting now switch to a rigid contract. Since, in the presence of uncertainty, those firms also suffer a loss in expected operating profits (as compared to the situation before an increase in $\alpha$), they choose lower import quantities. As a result of both effects, the offshoring intensity decreases. In Figure 1, a higher $F_a$ leads to a downward shift of the $E(\pi_o^r)$-line, which works in a way similar to the second of the above-mentioned effects of $\alpha$. More specifically, it induces some of the offshoring firms previously engaged in flexible contracting to enter a rigid contract. Since these firms also suffer a loss in expected operating profits, they stipulate lower input quantities, thereby decreasing the offshoring intensity.

We further show that the foreign country's labor market rigidity has a differential impact on U.S. offshoring intensity depending on the industry's volatility, as summarized in the following

**Proposition 2.** *Under Assumption 1,* $\frac{\partial^2 Y}{\partial F_a \partial v} < 0$ *and* $\frac{\partial^2 Y}{\partial F_a \partial \alpha} < 0$*; the negative effect of foreign labor market rigidity on the U.S. offshoring intensity is more pronounced the higher an industry's volatility.*

*Proof.* See Appendix A.2. □

The intuition behind this proposition builds on Lemma 1, which asserts that the advantage of flexible contracting increases in the degree of volatility. Hence, the decrease in offshoring intensity caused by an increase in labor market rigidity (see Proposition 1) is particularly pronounced in highly volatile industries. To sum up, our model predicts a negative direct effect of the foreign country's labor market rigidity and a negative interaction between foreign labor market rigidity and an industry's volatility in their impact on the U.S. offshoring intensity. Before bringing these two predictions to the data, we briefly discuss the case of supply uncertainty to show that our two key propositions continue to hold under this alternative type of uncertainty.

## 2.2 Supply uncertainty

In this section, we provide an alternative version of our model with supply (rather than demand) uncertainty. More specifically, we now consider the risk associated with the production of manufacturing inputs $m$. As before, there are two states of nature, $s \in \{G, B\}$, which are verifiable by the courts. In the good (bad) state, a producer's unit labor requirement is $\ell_G$ ($\ell_B$, respectively), $\ell_B > \ell_G$, where $g \in (0, 1)$ denotes the probability of a good state. For simplicity, we assume the same $g, \ell_G$, and $\ell_B$ for both domestic and foreign suppliers in a given industry, but we allow for differences in volatility across industries.

The timing is as in Section 2.1.1. A *rigid* contractual arrangement means that in $t_1$ parties stipulate a fixed quantity $m_z^r$ of manufacturing components to be delivered for a fixed price $p_z^r$ in $t_3$. From $H$'s perspective, such a contract effectively removes all uncertainty, hence the input $h_z^r$ chosen in $t_3$ does not depend on $s$. In contrast, a *flexible* contract specifies a state-contingent amount and price of the manufacturing input chosen in $t_1$, $m_{zs}^f$ and $p_{zs}^f$. The headquarter input chosen in $t_3$, $h_{zs}^f$ also depends on the state $s$. The per-unit price of $m$ under the two contractual types is given by:

$$p_z^r = \begin{cases} g\ell_G + (1-g)\ell_B & \text{if } z = d \\ \tau w\left[g\ell_G + (1-g)\ell_B\right] & \text{if } z = o \end{cases} \quad , \quad p_{zs}^f = \begin{cases} \ell_s & \text{if } z = d \\ \alpha\tau w\ell_s & \text{if } z = o \end{cases} \tag{25}$$

That is, a risk-neutral supplier from $z = d, o$ is willing to accept a rigid contract if the price offered by $H$ is equal to her expected unit cost.[9] Under a flexible agreement, parties stipulate a state-contingent price which depends on the ex-post realization of a supplier's productivity level. As before, to secure a foreign supplier's participation under a flexible contract, $H$ has to compensate $M$'s variable and fixed labor adjustment cost, which is reflected in $\alpha > 1$ and $F_a > 0$. As in Section 2.1.1, we use backward induction to solve for the equilibrium.

We show in Appendix A.3 that this setup leads to the following set of expressions for maximum profits:

$$\pi_d^r = [g\ell_G + (1-g)\ell_B]^{-\gamma}\, \Theta\Gamma A - F_d, \tag{26}$$

$$E(\pi_d^f) = \left[g\ell_G^{-\gamma} + (1-g)\ell_B^{-\gamma}\right] \Theta\Gamma A - F_d, \tag{27}$$

$$\pi_o^r = \omega\,[g\ell_G + (1-g)\ell_B]^{-\gamma}\, \Theta\Gamma A - F_o, \tag{28}$$

$$E(\pi_o^f) = \omega\Lambda\left[g\ell_G^{-\gamma} + (1-g)\ell_B^{-\gamma}\right] \Theta\Gamma A - F_o - F_a. \tag{29}$$

To avoid cluttered notation, we use the same symbols to denote profits in the case of supply uncertainty as in the case of demand uncertainty considered in Section 2.1. Notice that, in contrast to the case of demand uncertainty, a rigid contract now effectively eliminates all uncertainty as far as $H$ is concerned. In a rigid contract, once the price is set to $p_z^r$, all risk is shifted to the supplier who, in turn, is assumed to hedge against this risk.

Comparing the two types of contacting, it is obvious that all firms sourcing domestically will choose a flexible contract. Indeed, redefining the term $J$ as

$$J := \frac{g\ell_G^{-\gamma} + (1-g)\ell_B^{-\gamma}}{[g\ell_G + (1-g)\ell_B]^{-\gamma}}, \tag{30}$$

and the volatility measure as $v := (\ell_B - \ell_G)/\ell_B$, it is straightforward to verify that a statement completely analogous to Lemma 1 also obtains for supply uncertainty. More specifically, one can show that *(i)* $J > 1$ for all $\ell_G < \ell_B$ and $g \in (0;1)$, i.e., for $v > 0$, and *(ii)* $J$ is monotonically increasing in $v$. Figure 1 may be used to illustrate the productivity-based sorting of firms into different sourcing locations and contractual arrangements, with $E(\pi_d^f)$ being replaced by $\pi_d^f$.[10] Under Assumption 1, we obtain the same sorting pattern as in the case of demand uncertainty: The least productive firms do not start producing, those with intermediate productivity levels source manufacturing inputs domestically, while only the

[9] The underlying assumption here is that a perfect insurance market allows the supplier to hedge against the risk involved in accepting such a contract. Specifically, a domestic supplier is assumed to be able to buy $m_z^r$ units of an asset paying out $\ell_B - p_z^r$ in the bad state, and sell the same amount of an asset which pays out $p_z^r - \ell_G$ in the good state. With probabilities $g$ and $1-g$ for the good and the bad state, a perfect insurance market implies that the payments for the first type of transaction is equal to the revenues from the second. A similar argument is invoked for foreign suppliers.

[10] Analytical expressions for the cutoffs $\Theta_d^f$, $\Theta_o^r$, and $\Theta_o^f$ are provided in equation (A.8) in Appendix A.3.

most productive firms engage in offshoring. Among the offshoring firms, the least productive ones source inputs under a rigid contract, while the most productive ones engage in flexible contracting.

The relative propensity of offshoring under supply uncertainty can be defined as:

$$Y = \frac{\int_{\theta_o^r}^{\theta_o^f} p_o^r m_o^r \,\mathrm{d}\Phi(\theta) + \int_{\theta_o^f}^{\infty} \widetilde{pm}_o^f \,\mathrm{d}\Phi(\theta)}{\int_{\theta_d^f}^{\theta_o^r} \widetilde{pm}_d^f \,\mathrm{d}\Phi(\theta) + \int_{\theta_o^r}^{\theta_o^f} p_o^r m_o^r \,\mathrm{d}\Phi(\theta) + \int_{\theta_o^f}^{\infty} \widetilde{pm}_o^f \,\mathrm{d}\Phi(\theta)}, \tag{31}$$

where $\widetilde{pm}_z^f := g p_{zG}^f m_{zG}^f + (1-g) p_{zB}^f m_{zB}^f$; $p_o^r$ and $p_{zs}^f$ are given by equation (25); and $m_d^f$, $m_{os}^f$ and $m_o^r$ are given by equations (A.3), (A.6), and (A.7), respectively. Moreover, $\theta_d^f = (\Theta_d^f)^{\frac{1}{\sigma-1}}$, $\theta_o^r = (\Theta_o^r)^{\frac{1}{\sigma-1}}$, and $\theta_o^f = (\Theta_o^f)^{\frac{1}{\sigma-1}}$, where the cutoffs $\Theta_d^f$, $\Theta_o^r$, and $\Theta_o^f$ are given by equation (A.8) in Appendix A.3. Assuming that firm productivities are distributed Pareto, we arrive at an expression for $Y$ which is identical to equation (24). This finally allows us to use the definition of $J$ from equation (30), in order to demonstrate that supply uncertainty leads to the same two Propositions as in the case of demand uncertainty above: The U.S. offshoring intensity in a given industry decreases in the rigidity of a foreign country's labor markets ($\frac{\partial Y}{\partial F_a} < 0$, $\frac{\partial Y}{\partial \alpha} < 0$), and this effect is particularly pronounced the higher an industry's volatility ($\frac{\partial^2 Y}{\partial F_a \partial v} < 0$, $\frac{\partial^2 Y}{\partial \alpha \partial v} < 0$). We now turn to the empirical implementation of these predictions.

# 3 Empirical implementation

## 3.1 Econometric Specifications

We bring our theoretical predictions to the data in a two-step approach. In the first step, we test our Proposition 1 by examining the relationship between a country's labor market rigidity and the intensity of U.S. offshoring to that country, using panel data. In the second step, we examine Proposition 2 by analyzing how this relationship depends on an industry's degree of volatility.

To examine the effect of foreign labor market rigidity on U.S. offshoring intensity, we estimate the following regression equation:

$$\ln Y_{lit} = \beta \, rigidity_{lt} + \boldsymbol{\phi} + \gamma \boldsymbol{X}_{lt} + \varepsilon_{lit}, \tag{32}$$

where $Y_{lit}$ measures the propensity of U.S. firms in industry $i$ and year $t$ to source manufacturing inputs from a foreign country $l$; $\boldsymbol{\phi}$ is a vector of fixed effects (FE) which may vary by specification and will be characterized below; $\boldsymbol{X}_{lt}$ is a vector of time-varying country-level controls, and $\varepsilon_{lit}$ is an error term. Our key explanatory variable in this specification is the rigidity of country $l$'s labor market institutions in year $t$. Based on Proposition 1, we expect a negative effect of the foreign country's labor market rigidity on the U.S. offshoring propensity, reflected in an estimate $\hat{\beta} < 0$.

We consider several variants of equation (32). In our baseline specification, the vector $\boldsymbol{\phi}$ contains dummies for countries ($\phi_l$), industries ($\phi_i$), and years ($\phi_t$). Country FE $\phi_l$ control for all time-invariant country-specific characteristics, such as geography (e.g., geographic distance, time difference, etc.), history (e.g., legal origin), as well as country-level factors that are relatively stable over time (e.g., institutions and culture). Industry FE $\phi_i$ account for relevant characteristics of the goods produced in a given sector, such as relationship-specificity, contractibility, etc. Year FE $\phi_t$ control for time-specific shocks (e.g., financial crisis). In alternative specifications, we also consider different combinations of fixed effects, including country/industry FE $\phi_{li}$ . These FE fully control for all effects of time-invariant country-specific factors across industry characteristics, which may potentially confound the effect of labor market rigidity (see, e.g., Chor, 2010; Eppinger and Kukharskyy, 2017; Nunn and Trefler, 2014).

In the second step, we investigate the differential effect of labor market rigidity across U.S. industries that differ in their volatility. To test our second key prediction, we estimate the following equation:

$$\ln Y_{lit} = \gamma\, rigidity_{lt} \times volatility_i + \boldsymbol{\varphi} + \zeta \boldsymbol{\chi}_{lit} + \epsilon_{lit}, \tag{33}$$

where $volatility_i$ captures the volatility of industry $i$; $\boldsymbol{\varphi}$ is a vector of fixed effects which may vary by specification; $\boldsymbol{\chi}_{lit}$ is a vector of industry-country-year controls; and $\epsilon_{lit}$ is an error term. Based on our Proposition 2, we expect a negative effect of the interaction between an industry's volatility and a country's labor market rigidity, reflected in $\hat{\gamma} < 0$. The fact that the key explanatory variable in this specification varies by country-industry-year, allows us to include country-year FE to control for all time-varying country-specific factors that might otherwise confound the role of labor market rigidity in equation (32).

An important issue in econometric models such as equations (32) and (33) is a possible selection bias. While our theoretical model focuses on the intensive margin of offshoring (i.e., the value of inputs sourced from a foreign destination relative to the total value of domestic and foreign sourcing), one might be concerned that the extensive offshoring margin (i.e., whether to offshore to a given foreign destination in the first place), too, is a function of a foreign country's labor market rigidity or it's interaction with an industry's volatility.

To correct for the potential sample selection bias, we estimate a two-stage selection model along the lines of Heckman (1979), to be described at length further below.

## 3.2 Data Sources

The proxy for the U.S. offshoring intensity, $Y_{lit}$ is drawn from Antràs (2015) who computes it as the ratio of U.S. imports from country $l$ in industry $i$ and year $t$ to total U.S. absorption. The latter is defined as the sum of shipments by U.S. producers in industry $i$ plus U.S. imports minus U.S. exports in that industry.[11] A higher U.S. offshoring share reflects a greater propensity of U.S. producers to source manufacturing inputs from suppliers of country $l$. This measure is available for 253 manufacturing sectors (according to the IO2002 Input-Output industry classification) and 232 foreign countries for the period 2000-2011.

The measure of labor market $rigidity_{lt}$ in country $l$ and year $t$ is drawn from the World Bank's Doing Business data set. Based on the methodology developed by Botero et al. (2004), this measure is constructed as an average of the following three sub-indices: difficulty of hiring a new worker, restrictions on expanding or contracting the number of working hours, and difficulty of dismissing a redundant worker.[12] These data are available for 180 countries for the period 2004-2009.[13] Original scores vary on the scale between 0 (flexible labor market) and 100 (rigid labor market). For expositional purposes, we rescale them to a unit interval and present them in Table B.1 in Appendix B. As can be seen from this table, the U.S. has the third-lowest average labor market rigidity, with lower values observed only for Hong Kong and Singapore. Summary statistics for the main estimation sample are provided in Table B.3.

The proxy for $volatility_i$ of industry $i$ is drawn from Antràs (2015) who computes it following the methodology of Cuñat and Melitz (2012). The measure is constructed as the employment-weighted standard deviation of the annual growth rate of firm sales in the 1980-2004 Compustat sample and is available for all manufacturing sectors (according to the IO2002 industry specification) for which we have information on the offshoring intensity (see above). Table B.2 in Appendix B presents the ten industries with the lowest and highest value of this index, respectively. As can be seen from this Table, the industry-level volatility

11 U.S. import and export data stem from the U.S. Census, and information on total shipments is drawn from the NBER-CES Manufacturing database (for 2000-09) and the Annual Survey of Manufacturing (for 2010-11), see Antràs (2015) for the details on the construction of this measure.

12 Following the seminal contribution by Cuñat and Melitz (2012), the inverse of this index has been widely used in the international economics literature as a proxy for labor market flexibility, see, e.g., Antràs (2015), Chor (2010), and Nunn and Trefler (2014). The yearly country scores, along with a more detailed description of their collection, are available online at http://www.doingbusiness.org/reports/global-reports/doing-business-2004.

13 The World bank stopped reporting the index of labor market rigidity from 2010 onwards.

varies between 0.0838 (Frozen food manufacturing) and 0.4155 (Computer storage device manufacturing). Our model defines volatility as the difference between a high and a low value of a demand shifter (demand uncertainty) or, alternatively, of an input cost shifter (supply uncertainty). Both types of volatility are inherently unobservable. However, in the model, both affect offshoring in the same way, qualitatively, through their impact on firm revenues (see equations (5) and (A.3)). For this reason, we measure volatility using variation in firm sales.

Our baseline vector of time-varying country-level controls, $\boldsymbol{X}_{lt}$, includes the following six covariates: To account for the foreign country's market size, we control for the log of the country's real GDP in a given year, $\ln GDP_{lt}$, as reported in the Penn World Tables (version 8.1, see Feenstra et al. (2013)). We further include the log of GDP per capita, $\ln(GDPpc)_{lt}$, taken from the Penn World Tables, as a proxy for a country's overall economic development. Clearly, labor market institutions constitute just one dimension of a country's institutional environment. Legal and financial institutions have been identified as further important sources of a country's comparative advantage, see Antràs (2015), Chor (2010), Nunn (2007), and Nunn and Trefler (2014). Following this literature, we utilize the following two well-established institutional proxies: To control for the quality of legal institutions, we use the 'Rule of Law' index, $rule_{lt}$, reported in the World Bank's Worldwide Governance Indicators (see Kaufmann et al., 2010); as a proxy for financial development, we use the log of private credit by deposit money banks and other financial institutions as a percentage of GDP, $\ln(credit/GDP)_{lt}$, taken from the World Bank's Global Financial Development Database. To ensure that the effect of labor market institutions is not confounded by a country's physical and human capital abundance, we draw the following two controls from the Penn World Tables: log of physical capital stock per capita, $\ln(K/L)_{lt}$, and human capital stock, $H_{lt}$, calculated as the average years of schooling (see Barro and Lee, 1996). In the robustness checks, we consider further country-level controls introduced below.

The vector of industry-level characteristics, denoted by $\boldsymbol{\chi}_{lit}$ in equation (33), is drawn from Antràs (2015). Since the suitability of these proxies and their construction has been discussed at length in the original source, their introduction in the current paper is deliberately brief: $specificity_i$ captures the degree of relationship-specificity of goods produced in industry $i$ and is measured as the fraction of an industry's products that are neither reference-priced nor traded on an organized exchange according to Rauch's (1999) 'liberal' classification; $dependence_i$ is the measure of industry dependence on external finance introduced by Rajan and Zingales (1998) and computed as the fraction of total capital expenditures not financed by internal cash flow; $Kintensity_i$ measures capital intensity and is calculated as the log of the real capital per worker in a given industry; $Sintensity_i$ proxies the skill intensity in a given industry and is computed as the log of the number of non-production workers divided by total employment. In the robustness checks, we consider additional industry characteristics introduced further below. We interact the above-mentioned industry characteristics with the relevant country/year-specific factors to construct country/industry/year-specific controls $\boldsymbol{\chi}_{lit}$.

## 3.3 Estimation Results

### 3.3.1 Labor Market Rigidity and Offshoring Intensity

Table 1 summarizes our estimation results for different specifications of equation (32). Column 1 reports a negative and significant relationship between the U.S. offshoring intensity and a foreign country's labor market rigidity, controlling for country, industry, and year fixed effects. In column (2), we add control variables for time-varying foreign countries' characteristics.[14] The relationship between the U.S. offshoring intensity and the foreign country's GDP per capita appears to be positive but only weakly significant. Yet, the negative coefficient of foreign labor market rigidity remains fairly robust in size and is significant at the level of five percent. These results suggest that, in line with our Proposition 1, U.S. firms tend to offshore less to countries with rigid labor markets.

We now discuss two limitations of the data and explore the robustness of our findings to the appropriate corrections. First, recall that our dependent variable is measured as the ratio of U.S. imports to total U.S. absorption in a given industry. Clearly, this measure potentially contains not only intermediate inputs purchases – which lie at the heart of our theoretical model – but also final good imports. To isolate the intermediate input component of U.S. imports, we follow Antràs (2015) by considering an alternative measure of U.S. offshoring shares using the method developed by Wright (2014). More specifically, this method utilizes the Input-Output industrial categorization from the U.S. Bureau of Economic Analysis, to categorize highly disaggregated U.S. imports (classified according to the ten-digit Harmonized System, HS) into final goods and intermediate products. Removing from the sample all ten-digit HS codes primarily associated with final good production and (re)aggregating the data to the IO2002 level, Antràs (2015) provides an adjusted proxy for U.S. intermediate input imports, used for the construction of $\ln(\text{U.S. offshoring intensity})_{lit}$ in column (3).[15] This sample restriction leads to the loss of observations in industries that

[14] Note that time-invariant country characteristics are fully controlled for via country fixed effects.

[15] See the data appendix in Antràs (2015) for a detailed discussion of the methodology and its implementation.

Table 1: U.S. offshoring intensity and foreign labor market rigidity.

| | Dependent variable: ln(U.S. offshoring intensity)$_{lit}$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $rigidity_{lt}$ | -0.407** | -0.451** | -0.496** | -0.492** | -0.587*** | -0.585*** | -0.556** |
| | (0.183) | (0.203) | (0.233) | (0.239) | (0.216) | (0.214) | (0.264) |
| $\ln GDP_{lt}$ | | -0.727 | -1.052 | -1.047 | -1.186 | -1.116 | -1.132 |
| | | (0.681) | (0.749) | (0.752) | (0.776) | (0.793) | (0.847) |
| $\ln(GDPpc)_{lt}$ | | 1.323* | 1.906** | 1.926** | 2.043** | 1.977** | 2.215** |
| | | (0.672) | (0.747) | (0.750) | (0.792) | (0.803) | (0.878) |
| $rule_{lt}$ | | -0.003 | -0.036 | -0.043 | -0.349** | -0.356** | -0.176 |
| | | (0.128) | (0.142) | (0.145) | (0.155) | (0.157) | (0.173) |
| $\ln(credit/GDP)_{lt}$ | | -0.126 | -0.196* | -0.198 | -0.274** | -0.268** | -0.224* |
| | | (0.101) | (0.112) | (0.120) | (0.124) | (0.123) | (0.135) |
| $\ln(K/L)_{lt}$ | | 0.038 | 0.098 | 0.110 | -0.001 | 0.004 | 0.074 |
| | | (0.192) | (0.212) | (0.225) | (0.218) | (0.216) | (0.252) |
| $H_{lt}$ | | 0.483 | 0.384 | 0.311 | 0.081 | 0.008 | -0.020 |
| | | (0.759) | (0.805) | (0.830) | (0.817) | (0.815) | (0.804) |
| Country FE | yes | yes | yes | yes | yes | yes | nested |
| Industry FE | yes | yes | yes | yes | yes | nested | nested |
| Year FE | yes | yes | yes | yes | yes | nested | yes |
| Industry/year FE | no | no | no | no | no | yes | no |
| Country/industry FE | no | no | no | no | no | no | yes |
| Sample restr. (Wright) | no | no | yes | yes | yes | yes | yes |
| Sample restr. (NT) | no | no | no | yes | yes | yes | yes |
| Sample selection corr. | no | no | no | no | yes | yes | yes |
| Observations | 105,938 | 92,697 | 66,214 | 62,493 | 62,225 | 62,221 | 59,879 |
| R-squared | 0.604 | 0.590 | 0.619 | 0.617 | 0.616 | 0.621 | 0.934 |

Note: The table reports OLS-estimates of equation (32) with ln(U.S. offshoring intensity)$_{lit}$ as a dependent variable. All specifications include country, industry, and year fixed effects (FE). Standard errors are clustered at the country level and presented in parentheses. *, **, *** indicate significance at 1, 5, 10%-level, respectively.

consist entirely of final goods (e.g., 'Dog and cat food manufacturing'), which explains the drop in observations in column (3). Nevertheless, the relationship between the offshoring intensity and labor market rigidity continues to be negative and significant at the 5% level.

The second limitation of the data is that it does not allow us to distinguish between imports by U.S. headquarters and shipments from foreign headquarters to their U.S. affiliates. Since our theoretical model is set up to characterize the former rather than the latter relationships, we follow Nunn and Trefler (2013) in applying the second (NT) sample restriction. Using information on ownership links from the global database by the Bureau van Dijk, the authors trace all headquarter-subsidiary pairs in which either the headquarter or the subsidiary is from the U.S. and identify five countries for which the share of pairs with a U.S. parent is below 50 percent: Iceland, Italy, Finland, Liechtenstein, and Switzerland. Arguably, U.S. imports from those countries are driven by shipments from foreign headquarters to their U.S. affiliates and, therefore, are less likely to reflect U.S. offshoring intensity. As can be seen from column (4) of Table 1, removing these five countries from the sample has virtually no effect on the coefficient of labor market rigidity.

Although the log-linear specification in equation (32) is standard in the literature, it has a shortcoming of discarding all observations with zero U.S. import flows. Given that 57% of country/industry/year observations for which we have information on foreign labor market rigidity feature a zero U.S. offshoring intensity, this is a serious concern. To correct for a possible selection bias, we follow the approach suggested by Wooldridge (2010) and estimate (for each year $t$) the following Probit model: $\Pr(y = 1|\boldsymbol{x}) = Z(\boldsymbol{x}\psi)$, where the binary dependent variable $y$ is equal to one if the U.S. offshoring intensity $Y_{lit}$ in a given year is positive, and zero otherwise. The symbol $\boldsymbol{x}$ stands for a vector of controls containing $rigidity_{lt}$, $rigidity_{lt} \times volatility_i$, industry FE, the vector of country/year covariates $\boldsymbol{X}_{lt}$ from equation (32), and a set of bilateral (gravity) controls $\boldsymbol{X}_{l,US}$. These controls are drawn from the CEPII database by Head et al. (2010), and they include the distance between the U.S. and the foreign country in log kilometers (as a proxy for transportation cost), the time difference in hours, and indicator variables for sharing a common border and the official language (English). In addition, following the approach by Helpman et al. (2008), we include in $\boldsymbol{X}_{l,US}$ a measure of religious distance, drawn from Spolaore and Wacziarg (2016). The idea behind the latter approach is that religious beliefs may affect a firm's decision whether to offshore to a given market. And yet, once the entry decision was made, the choice of *how much* to source from that country is likely to be independent of religious distance. Given that the religious distance variable is excluded in the second-stage, it contributes to identification. From the above-mentioned Probit regressions we obtain country/industry/year-specific inverse Mills ratios, $\hat{\lambda}_{lit}$, which we add to equation (32) to account for the possibility of a sample selection bias.

As can be seen from column (5) in Table 1, the coefficient of labor market rigidity slightly increases after sample selection correction but remains significant at the 5% level.[16] A quantitative interpretation of our preferred specification in column (7) is that an increase in the labor market rigidity index by one standard deviation is associated with a lower U.S. offshoring intensity by approximately 1 percentage point.

In columns (6) and (7), we consider alternative compositions of the vector of fixed effects, $\boldsymbol{\phi}$. In particular, column (6) includes industry/year FE (which absorb industry and year FE from column (5)). In so doing, we allow time-specific shocks to vary differentially across

[16] We have further experimented with a log-linear specification along the lines of equation (32) and the dependent variable defined as $\ln(0.001 + Y_{lit})$, where $Y_{lit}$ includes zero U.S. offshoring shares. In this specification, the size of the coefficient of labor market rigidity drops by an order of magnitude, but remains negative and significant at the five percent level. Given that our theoretical predictions are derived under the assumption of non-zero offshoring intensity (see Assumption 1 and Fig. 1), we do not report the results from this alternative specification but provide them upon request.

industries. For instance, firms in some industries may be stronger affected by the financial crisis than in others. Our key variable of interest remains virtually unaffected by this modification. In the second step, we include country/industry FE (which absorb country and industry FE from column (5)). In so doing, we control for a differential effect of time-invariant country-specific factors across industry characteristics. For instance, the impact of cultural distance on firms' global sourcing decisions may depend on industry-specific factors, such as relationship-specificity or capital-intensity (see, e.g., Gorodnichenko et al., 2018). As can be seen from column (7), the goodness of fit significantly increases, from $R^2 = 0.621$ in column (6) to $R^2 = 0.934$ in column (7).[17] Yet, the coefficient of $rigidity_{lt}$ remains robust in size and significance to this stringent test.

### 3.3.2 Labor Market Rigidity, Industry Volatility, and Offshoring Intensity

Table 2 presents the results from testing Proposition 2 based on equation (33). An important feature of this equation is that it allows for the inclusion of country/year FE, which fully account for all time-varying country-specific characteristics that might confound the role of labor market rigidity. Controlling for country-year and industry FE, we find a negative and highly significant interaction effect of the foreign country's labor market rigidity and the industry-level volatility on the U.S. offshoring intensity, see column (1). That is, in line with the second theoretical prediction, the negative effect of labor market rigidity on offshoring intensity is particularly pronounced in highly volatile industries.

In column (2), we add a set of time-varying country/industry-specific control variables. The rationale behind the inclusion of these interaction terms is as follows: While the FE in column (1) control for unobservable time-varying characteristics of countries and industries, it is conceivable that country- and industry-specific factors *interact* in their impact on offshoring intensity. We aim to account for these potential confounding factors by including a set of interaction terms that have been suggested in the empirical literature as important determinants of international transactions.[18] More specifically, $rule_{lt} \times specificity_i$ controls for the possibility that a variation in the foreign country's legal institutions may have a differential impact on the U.S. offshoring intensity depending on the degree of specificity of U.S. industries; $\ln(credit/GDP)_{lt} \times dependence_i$ controls for a differential impact of the foreign country's financial development on U.S. offshoring in industries that differ in their

[17] The number of observations declines with more demanding FE due to a drop in observations that are fully explained by the FE (so-called singletons).

[18] In particular, previous empirical studies have identified interaction effects between the rule of law and relationship-specificity (Nunn, 2007), financial development and external financial dependence (Manova, 2013), capital abundance and capital intensity, as well as skill abundance and skill intensity (Costinot, 2009) on international trade. See Nunn and Trefler (2014) for an overview of this literature.

Table 2: U.S. offshoring intensity, labor market rigidity, and industry volatility.

| | Dependent variable: ln(U.S. offshoring intensity)$_{lit}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $rigidity_{lt} \times volatility_i$ | -9.464*** | -5.981*** | -5.945*** | -7.027*** | -4.423** | -2.318*** |
| | (1.606) | (1.713) | (1.698) | (1.849) | (2.044) | (0.456) |
| $rule_{lt} \times specificity_i$ | | 0.578*** | 0.651*** | 0.859*** | 0.851*** | -0.056 |
| | | (0.053) | (0.089) | (0.114) | (0.115) | (0.089) |
| $\ln(credit/GDP)_{lt} \times dependence_i$ | | 0.454*** | 0.172*** | 0.310*** | 0.296*** | -0.199** |
| | | (0.039) | (0.052) | (0.060) | (0.060) | (0.080) |
| $\ln(K/L)_{lt} \times Kintensity_i$ | | 0.079*** | -0.214*** | -0.056 | -0.062 | 0.007 |
| | | (0.021) | (0.069) | (0.093) | (0.094) | (0.020) |
| $H_{lt} \times Sintensity_i$ | | 0.932*** | 0.112 | 0.356** | 0.351** | 0.165 |
| | | (0.089) | (0.127) | (0.145) | (0.146) | (0.280) |
| Country/year FE | yes | yes | yes | yes | yes | no |
| Industry/year FE | yes | yes | yes | yes | yes | no |
| Country/industry FE | no | no | no | no | no | yes |
| Year FE | no | no | no | no | no | yes |
| Industry dummies×ln($GDPpc$)$_{lt}$ | no | no | yes | yes | yes | yes |
| Sample restr. (Wright) | no | no | no | yes | yes | yes |
| Sample restr. (NT) | no | no | no | yes | yes | yes |
| Sample selection corr. | no | no | no | no | yes | yes |
| Observations | 105,932 | 92,694 | 92,694 | 62,473 | 62,205 | 59,884 |
| R-squared | 0.610 | 0.608 | 0.632 | 0.653 | 0.652 | 0.932 |

Note: The table reports OLS estimates of equation (33) with ln(U.S. offshoring intensity)$_{lit}$ as a dependent variable. Standard errors are clustered at the country-industry level and presented in parentheses. *, **, *** indicate significance at 1, 5, 10%-level, respectively.

degree of external financial dependence; $\ln(K/L)_{lt} \times Kintensity_i$ and $H_{lt} \times Sintensity_i$ control for standard Heckscher-Ohlin effects suggesting that a relatively capital abundant country will specialize (and export) capital-intensive goods, and a human capital abundant country will specialize on the provision of skill-intensive goods. After the inclusion of the above-mentioned country/industry/year-specific factors, the coefficient of $rigidity_{lt} \times volatility_i$ is reduced in size but remains highly significant, see column (2).

While the results from column (2) are reassuring, one may still be concerned about omitted variables that vary by country/industry/year.[19] To address the remaining concerns related to omitted variables bias, column (3) follows the approach suggested by Levchenko (2007) in adding a full set of interaction terms of GDP per capita, $\ln(GDPpc)_{lt}$, with industry dummies.[20] The rationale behind including these interaction terms in the current paper is twofold. First, recall from Table 1 that $\ln(GDPpc)_{lt}$ is the only country-level control variable which retains significance at the 5% level in the most stringent specification of column (7). Second, and perhaps more importantly, given that GDP per capita reflects not only a country's economic well-being but is likely to be correlated with (unobserved) institutional

[19] Notice that we cannot fully account for these factors using FE as our main explanatory variable varies by country/industry/year.

[20] This robustness check has been also exploited by Antràs (2015) in a context similar to our paper.

quality, it serves as a proxy for a country's overall economic as well as its institutional development. Hence, by including the above-mentioned interaction terms, we allow the effect of a country's development on U.S. offshoring intensity to differ arbitrarily across industries. As can be seen from column (3), the negative interaction effect of the foreign labor market rigidity and the industry volatility remains significant at the one percent level. Furthermore, it remains fairly robust to the Wright and NT sample restrictions in column (4), as well as to the correction for a potential sample selection bias in column (5).[21] Finally, we control for a differential impact of a foreign country's factors depending on industries' characteristics by including country/industry FE. The specification in column (6) effects explains 0.93 percent of country/industry/year variation in U.S. offshoring intensity. The coefficient of $\mathit{rigidity}_{lt} \times \mathit{volatility}_i$ drops in size by roughly one half but remains highly significant. Among all country/industry/year controls, only $\ln(\mathit{credit/GDP})_{lt} \times \mathit{dependence}_i$ remains significant in column (6). However, this interaction effect does not allow for a clear interpretation given that its coefficient changes sign from positive in columns (2)-(5) to negative in column (6).

As a further robustness test, we examine additional pathways through which a country's contracting and financial institutions may affect the U.S. offshoring intensity, and thereby confound the role of labor market institutions. To this end, Table 3 augments our preferred specification from column (6) Table 2 by adding further country/industry/year controls using alternative proxies for the contractibility of an industry's goods, constructed using the methodologies suggested by Nunn (2007), Levchenko (2007), Costinot (2009), and Bernard et al. (2010). The proxies are drawn from Antràs (2015) and each of them is interacted with $\mathit{rule}_{lt}$.[22] Thus, we allow for a differential impact of the foreign country's contracting institutions depending on the degree of contractibility of an industry's goods.[23]

Furthermore, in column (5) of Table 3, we interact an industry-level measure of asset $\mathit{tangibility}_i$, constructed according to the methodology suggested by Braun (2002) and drawn from Antràs (2015), with $\ln(\mathit{credit/GDP})_{lt}$. The idea behind this interaction term is that tangible assets can be used as collateral and, hence, firms in sectors with a high asset tangibility will be less affected by financial constraints. Following Manova (2013), we thus allow the foreign country's financial development to differentially affect U.S. offshoring intensity,

[21] As before, we verify that our results are robust to an alternative definition of the dependent variable which includes zero offshoring shares, $\ln(0.001 + Y_{lit})$.

[22] Given that the construction of contractibility measures and their justification is discussed at length by Antràs (2015), our description of these proxies is deliberately brief: $\mathit{contractibility}_i$(Nunn) is calculated as one minus weighted average specificity of the inputs used by a given industry; $\mathit{contractibility}_i$(Levchenko) is the Herfindahl index of intermediate input use; $\mathit{contractibility}_i$(Costinot) is measured as the complexity of the production process, where the latter is captured by the length of time needed for a new worker to be fully trained for a given job; lastly $\mathit{contractibility}_i$(Bernard) is computed as a weighted average of the wholesale employment share of firms importing a particular product.

[23] To economize on space, we do *not* report the estimates of control variables from column (6) of Table 2.

depending on the extent to which firms in a given sector are affected by financial constraints. Finally, in column (6) of Table 3, we jointly include all above-mentioned interaction terms. As can be seen from Table 3, the coefficient of $rigidity_{lt} \times volatility_i$ remains highly robust to the inclusion of additional interaction effects.

Extending our robustness checks, we have further augmented our specification by including alternative country/industry/year controls based on different country-level measures of legal institutions drawn from the World Bank. All of these specifications yield a negative and significant estimated interaction effect of a foreign country's labor market flexibility and an industry's volatility on U.S. offshoring intensity. The results are available upon request. In summary, the empirical evidence lends strong support for our two theoretical predictions: U.S. firms tend to offshore less to countries with rigid labor markets and this effect is particularly pronounced in industries with a high degree of volatility.

Table 3: U.S. offshoring intensity, labor market rigidity, and industry volatility (robustness).

| | Dependent variable: ln(U.S. offshoring intensity)$_{lit}$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $rigidity_{lt} \times volatility_i$ | -1.990*** | -2.003*** | -1.975*** | -1.984*** | -1.966*** | -1.999*** |
| | (0.456) | (0.455) | (0.456) | (0.455) | (0.455) | (0.455) |
| $rule_{lt} \times contractibility_i$(Nunn) | -0.526** | | | | | 0.412 |
| | (0.215) | | | | | (0.412) |
| $rule_{lt} \times contractibility_i$(Levchenko) | | -2.450*** | | | | -3.053*** |
| | | (0.599) | | | | (0.961) |
| $rule_{lt} \times contractibility_i$(Costinot) | | | 0.391 | | | 0.088 |
| | | | (0.265) | | | (0.302) |
| $rule_{lt} \times contractibility_i$(Bernard) | | | | -1.051** | | -0.193 |
| | | | | (0.451) | | (0.717) |
| $\ln(credit/GDP)_{lt} \times tangibility_i$ | | | | | -0.538*** | -0.518*** |
| | | | | | (0.184) | (0.184) |
| Observations | 59,063 | 59,063 | 59,063 | 59,063 | 59,063 | 59,063 |
| R-squared | 0.929 | 0.929 | 0.929 | 0.929 | 0.929 | 0.929 |

Note: The table reports OLS estimates of equation (33). All specifications include the full set of controls, fixed effects, and sample corrections as in column (6) of Table 2. Standard errors are clustered at the country-industry level and presented in parentheses. **, *** indicate significance at 5, 10%-level, respectively.

# 4 Concluding Remarks

This paper develops a theoretical framework of offshoring under uncertainty about final demand and the cost of intermediate input production. In our model, firms decide whether to source intermediate inputs from domestic or foreign suppliers, and whether to engage with a given supplier under a rigid or flexible contract. A flexible contract specifies the volumes of intermediate inputs contingent on the state of nature (demand or cost conditions), whereas a rigid contract stipulates fixed quantities based on expected demand or cost conditions. The trade-off in contractual choice derives from the efficiency advantage of flexible input adjustment coupled with the cost of this adjustment caused by rigid labor markets in the foreign country. Firms select themselves into different patterns of sourcing based on their productivity levels.

This model suggests that (i) an increase in the rigidity of the foreign country's labor market, other things equal, decreases the offshoring intensity in a given industry and (ii) this effect is more pronounced in industries with a higher degree of volatility. Combining data on the U.S. offshoring intensity with measures of labor market rigidity and industry volatility, we find empirical evidence supportive of the model's predictions. Our empirical findings are robust to controlling for unobserved heterogeneity across countries and industries using fixed effects, as well as to correcting for potential sample selection bias.

Our analysis leaves an important question open for future research. In order to focus on the choice between domestic and foreign sourcing, this paper assumes ex ante enforceable contracts. Allowing for incomplete contracts, one must expect the existence of uncertainty to also affect a firm's decision whether to integrate a given supplier into its boundaries or to cooperate with the supplier at arm's-length. Introducing this internalization margin into the current framework and bringing its novel predictions to the data would provide a more comprehensive understanding of the role of labor market rigidity and industry volatility in firms' global sourcing decisions under uncertainty.

# A Mathematical Appendix

## A.1 Proof of Lemma 1

Taking the first-order derivative of $J$ from equation (16) with respect to $A_G$ yields after simplification:

$$\frac{\partial J}{\partial A_G} = \frac{g(1-g)\left(A_G A_B^{\frac{1}{\sigma(1-\eta)+\eta}} - A_G^{\frac{1}{\sigma(1-\eta)+\eta}} A_B\right)}{A_G\left(gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right)^{\sigma(1-\eta)+\eta+1}},$$

where $\frac{\partial J}{\partial A_G} > 0$ if and only if $A_G A_B^{\frac{1}{\sigma(1-\eta)+\eta}} > A_G^{\frac{1}{\sigma(1-\eta)+\eta}} A_B$. The latter inequality is fulfilled if and only if $\left(\frac{A_B}{A_G}\right)^{-\frac{(1-\eta)(\sigma-1)}{\sigma(1-\eta)+\eta}} > 1$, which holds true for all $A_G > A_B$, $\eta \in (0,1)$, and $\sigma > 1$. Since $J = 1$ if $A_G = A_B$ and $\frac{\partial J}{\partial A_G} > 0$ for all $A_G > A_B$, we have $J > 1$ for all $A_G > A_B$.

Using the definition of $v$ from the main text, we have $A_B = A_G(1-v)$. Substituting the latter in equation (16) and differentiating the resulting expression with respect to $v$ yields after simplification:

$$\frac{\partial J}{\partial v} = \frac{g(1-g)A_G\left(((1-v)A_G)^{\frac{1}{\sigma(1-\eta)+\eta}} - (1-v)A_G^{\frac{1}{\sigma(1-\eta)+\eta}}\right)}{(1-v)\left(gA_G^{\frac{1}{\sigma(1-\eta)+\eta}} + (1-g)A_B^{\frac{1}{\sigma(1-\eta)+\eta}}\right)^{\sigma(1-\eta)+\eta+1}},$$

where $\frac{\partial J}{\partial v} > 0$ if and only if $((1-v)A_G)^{\frac{1}{\sigma(1-\eta)+\eta}} > (1-v)A_G^{\frac{1}{\sigma(1-\eta)+\eta}}$. The latter inequality is fulfilled if and only if $(1-v)^{-\frac{(1-\eta)(\sigma-1)}{\sigma(1-\eta)+\eta}} > 1$, which holds true for all $v, \eta \in (0,1)$, and $\sigma > 1$. We thus have $\frac{\partial J}{\partial v} > 0$.

## A.2 Proof of Proposition 1 and 2

To simplify on notation, we employ the following three definitions:

*(i)* $K := \frac{\kappa-(\sigma-1)}{\sigma-1}$, where $K > 0\ \forall \kappa > \sigma - 1$, see definition of $\Phi(\theta)$ in equation (23);

*(ii)* $\Psi := \frac{\Theta_o^f}{\Theta_o^r}$, where $\Psi > 1\ \forall \Theta_o^f > \Theta_o^r$, see Assumption 1*(ii)*;

*(iii)* $\Omega := \frac{\Theta_o^f}{\Theta_d^f}$, where $\Omega > \Psi\ \forall \Theta_o^r > \Theta_d^f$, see Assumption 1*(i)*.

It should be further noted that Assumption 1 implicitly applies $\omega > J$ and $J\Lambda > 1$.

The first-order derivative of $Y$ from equation (24) with respect to $F_a$ reads after simplification:

$$\frac{\partial Y}{\partial F_a} = -\frac{\omega K J (J\Lambda - 1)\left(\Omega^K - \Psi^K\right)}{F_a\left[(\omega - J)\Psi^K + J\Omega^K + \omega(J\Lambda - 1)\right]^2} < 0, \tag{A.1}$$

where the sign of this derivative follows immediately from $J\Lambda > 1$ and $\Omega > \Psi$. Similarly, differentiating $Y$ with respect to $\alpha$ yields:

$$\frac{\partial Y}{\partial \alpha} = -\frac{\gamma\omega(1+K)J^2\Lambda(J\Lambda-1)\left(\Omega^K-\Psi^K\right)}{\alpha\left[(\omega-J)\Psi^K+J\Omega^K+\omega(J\Lambda-1)\right]^2} < 0, \tag{A.2}$$

where the sign of this derivative follows immediately from $J\Lambda > 1$ and $\Omega > \Psi$. This completes the proof of Proposition 1.

Consider next the proof or Proposition 2. Notice that volatility $v$ enters $Y$ only via $J$. Bearing in mind that $J'(v) > 0$ (see Lemma 1), $\frac{\partial^2 Y}{\partial F_a \partial J} < 0$ is a sufficient condition for $\frac{\partial^2 Y}{\partial F_a \partial v} < 0$, while $\frac{\partial^2 Y}{\partial \alpha \partial J} < 0$ is a sufficient condition for $\frac{\partial^2 Y}{\partial \alpha \partial v} < 0$. Using equation (A.1), the cross-partial derivative of $Y$ with respect to $F_a$ and $J$ is given by:

$$\frac{\partial^2 Y}{\partial F_a \partial J} = -\frac{\omega K \Upsilon}{F_a(\omega-J)\left[(\omega-J)\Psi^K+J\Omega^K+\omega(J\Lambda-1)\right]^3},$$

where

$$\begin{aligned}\Upsilon :=\ & \Psi^K\{\Omega^K[\omega^2(1+K)(2J\Lambda-1)+2J^2(1+K)-\omega J(J\Lambda(2+K)+2K-1)]\\ & +\omega(J\Lambda-1)((KJ\Lambda+1)\omega-J(1+K))\}+\Omega^K(\omega-J)(1+K)(J\Omega^K-\omega(J\Lambda-1))\\ & +\Psi^{2K}(J-\omega)(J(1+K)-\omega(J\Lambda(2+K)-1)).\end{aligned}$$

In the following, we prove that $\Upsilon > 0$ for all permissible parameter values. Taking the first-order derivative of $\Upsilon$ with respect to $\Omega$ yields after simplification:

$$\frac{\partial \Upsilon}{\partial \Omega} = K\Omega^{K-1}T,$$

where

$$\begin{aligned}T :=\ & \Omega^K 2J(\omega-J)(1+K)-\omega(J\Lambda-1)(\omega-J)(1+K)\\ & +\Psi^K\left[\omega^2(1+K)(2J\Lambda-1)+2J^2(1+K)-\omega J(J\Lambda(2+K)+2K+1)\right].\end{aligned}$$

Note that the sign of $\frac{\partial \Upsilon}{\partial \Omega}$ is equal to the sign of $T$. To see that $T > 0$ for all permissible parameter values, note that $T$ is increasing in $\Omega$ (since $\omega > J$). Hence, if $T$ is positive for the lowest possible $\Omega = \Psi$, it is positive for all $\Omega > \Psi$. Substituting $\Omega = \Psi$ in $T$ yields after simplification:

$$T|_{\Omega=\Psi} = \omega\left(\Psi^K X-(\omega-J)(J\Lambda-1)(1+K)\right),$$

where

$$X := J(1+2\omega\Lambda(1+K))-J^2\Lambda(2+K)-\omega(1+K).$$

To establish the sign of $T|_{\Omega=\Psi}$, we first show that $X$ is positive for all permissible parameter values. The first-order derivative of $X$ with respect to $\omega$ reads after simplification $\frac{\partial X}{\partial \omega} = (1+K)(2J\Lambda - 1)$, which is strictly positive for all $J\Lambda > 1$. Hence, if $X$ is larger than zero for the lowest possible $\omega = J$, it is strictly positive for all $\omega > J$. Substituting $\omega = J$ in $X$ yields after simplification $X|_{\omega=J}= JK(J\Lambda - 1)$, which is larger than zero for all $J\Lambda > 1$. Since $X > 0$ for all permissible parameter values, $T|_{\Omega=\Psi}$ is non-decreasing in $\Psi$. Hence, if $T|_{\Omega=\Psi}> 0$ holds for the lowest possible $\Psi = 1$, it holds a fortiori for all $\Psi > 1$. Evaluating $T|_{\Omega=\Psi}$ at $\Psi = 1$ reads

$$T|_{\Omega=\Psi,\Psi=1}= J\omega(\Lambda(\omega - J) + K(\omega\Lambda - 1)) > 0,$$

where the sign of this expression follows immediately from $\omega > J$ and $J\Lambda > 1$, which jointly implies $\omega\Lambda > 1$.

So far, we have shown that $\Upsilon$ increases in $\Omega$, i.e., $\frac{\partial \Upsilon}{\partial \Omega} > 0$. Hence, if $\Upsilon$ is positive for the lowest possible $\Omega = \Psi$, we have $\Upsilon > 0$ for any $\Omega > \Psi$. Evaluating $\Upsilon$ at $\Omega = \Psi$ reads:

$$\Upsilon|_{\Omega=\Psi}= \Psi^K K\omega^2(J\Lambda - 1)\left((J\Lambda - 1) + \Psi^K\right) > 0,$$

where the sign of this expression follows immediately from $J\Lambda > 1$. We thus have shown that $\frac{\partial^2 Y}{\partial F_a \partial J} < 0$ and, therefore, $\frac{\partial^2 Y}{\partial F_a \partial v} < 0$. Following the above approach one can also prove $\frac{\partial^2 Y}{\partial \alpha \partial J} < 0$ (derivations available upon request), which immediately implies $\frac{\partial^2 Y}{\partial \alpha \partial v} < 0$.

### A.3 Derivations from section 2.2

Consider first domestic sourcing. Under a flexible contract, $H$ chooses state-specific amounts of $h$ and $m$ that solve the problem $\max_{h,m} R - \ell_s m - h - F_d$. Using equations (1) and (2), profit-maximizing state-specific input quantities and revenues are

$$h^f_{ds} = \frac{\eta(\sigma-1)R^f_{ds}}{\sigma} \quad , \quad m^f_{ds} = \frac{(1-\eta)(\sigma-1)R^f_{ds}}{\ell_s \sigma} \quad , \quad R^f_{ds} = \sigma \ell_s^{-\gamma}\Theta\Gamma A, \tag{A.3}$$

where $\Theta$, $\gamma$, and $\Gamma$ are defined as in section 2.1.2. Note that the optimal amount of manufacturing components in the good (bad) state of the world is high (low, respectively). The maximum profit in state $s$ is given by $\pi^f_{ds} = \ell_s^{-\gamma}\Theta\Gamma A - F_d$, and the expected maximum profit from domestic sourcing under a flexible contract is given by equation (27) in the main text.

Consider now a rigid contract. In $t_3$, $H$ chooses the amount of headquarter services that maximizes $\max_h R - h - F_d$. Using equations (1) and (2), the optimal quantity of $h$ and the associated revenue read

$$h_d^r = \frac{\eta(\sigma-1)R_d^r}{\sigma} \quad , \quad R_d^r = \left(\theta\left(\frac{\sigma-1}{\sigma}\right)^{\eta}\left(\frac{m_d^r}{1-\eta}\right)^{1-\eta}\right)^{\frac{\sigma-1}{\sigma(1-\eta)+\eta}} A^{\frac{1}{\sigma(1-\eta)+\eta}}. \tag{A.4}$$

Notice from the comparison of equations (9) and (A.4) that, in contrast to the case of demand uncertainty, the optimal amount of headquarter services is no longer state-specific. The net revenue from a rigid contract reads $R_{dn}^r = \frac{\sigma(1-\eta)+\eta}{\sigma} R_d^r$, where $R_d^r$ is given by the second expression in equation (A.4). In $t_1$, $H$ stipulates a fixed amount of $m$ that solves $\max_m R_{dn}^r - [g\ell_G + (1-g)\ell_B]m - F_d$. Using equation (A.4), the optimal amount of manufacturing inputs stipulated under a rigid contract can be calculated as

$$m_d^r = \frac{(1-\eta)(\sigma-1)[g\ell_G + (1-g)\ell_B]^{-\gamma}\Theta\Gamma A}{g\ell_G + (1-g)\ell_B}, \tag{A.5}$$

and the associated profit under a rigid contract is given by equation (26) in the main text.

Equilibrium input quantities and profits under offshoring can be derived by analogy. In particular, the amount of manufacturing inputs offshored under a flexible contract in state $s$ is given by

$$m_{os}^f = \frac{(1-\eta)(\sigma-1)\omega\Lambda\ell_s^{-\gamma}\Theta\Gamma A}{\tau w \ell_s}, \tag{A.6}$$

where $\omega$ and $\Lambda$ are defined as in section 2.1.2, and the amount of $m$ offshored under a rigid agreement reads:

$$m_o^r = \frac{(1-\eta)(\sigma-1)\omega[g\ell_G + (1-g)\ell_B]^{-\gamma}\Theta\Gamma A}{g\ell_G + (1-g)\ell_B}. \tag{A.7}$$

The expected maximum profits from offshoring under a flexible and rigid contract are given by equations (29) and (28), respectively. By analogy to the case of demand uncertainty, one can use maximum profits from equations (27) through (29) to calculate the equilibrium cutoffs:

$$\Theta_d^f = \frac{F_d}{[g\ell_G + (1-g)\ell_B]^{-\gamma}\Gamma A}, \quad \Theta_o^r = \Theta_d^f \frac{J(F_o - F_d)}{(\omega - J)F_d}, \quad \Theta_o^f = \Theta_d^f \frac{JF_a}{\omega(J\Lambda - 1)F_d}. \tag{A.8}$$

Note that these cutoffs are isomorphic to the ones from equation (21) and the relationship $\Theta_d^f < \Theta_o^r < \Theta_o^f$ continues to hold under Assumption 1.

# B Tables

Table B.1: List of countries by labor market rigidity, averaged over 2004-2009.

| Rank | Country | Rigidity | Rank | Country | Rigidity | Rank | Country | Rigidity |
|---|---|---|---|---|---|---|---|---|
| 1 | HKG | 0.000 | 61 | GMB | 0.260 | 121 | LTU | 0.445 |
| 2 | SGP | 0.000 | 62 | MUS | 0.262 | 122 | CIV | 0.447 |
| 3 | USA | 0.010 | 63 | ISR | 0.263 | 123 | RWA | 0.452 |
| 4 | MHL | 0.022 | 64 | LSO | 0.272 | 124 | TJK | 0.455 |
| 5 | PLW | 0.032 | 65 | AZE | 0.275 | 125 | IRQ | 0.456 |
| 6 | BRN | 0.047 | 66 | CHN | 0.277 | 126 | TUR | 0.457 |
| 7 | MDV | 0.050 | 67 | OMN | 0.277 | 127 | ITA | 0.458 |
| 8 | UGA | 0.055 | 68 | ISL | 0.284 | 128 | DJI | 0.460 |
| 9 | CAN | 0.057 | 69 | URY | 0.288 | 129 | FIN | 0.462 |
| 10 | JAM | 0.060 | 70 | BLR | 0.288 | 130 | BDI | 0.462 |
| 11 | LCA | 0.067 | 71 | BGD | 0.293 | 131 | BEN | 0.467 |
| 12 | TTO | 0.070 | 72 | LBR | 0.297 | 132 | NPL | 0.467 |
| 13 | NZL | 0.070 | 73 | JOR | 0.298 | 133 | IDN | 0.470 |
| 14 | AUS | 0.072 | 74 | ZWE | 0.302 | 134 | KHM | 0.470 |
| 15 | TON | 0.082 | 75 | LKA | 0.302 | 135 | CPV | 0.470 |
| 16 | FSM | 0.086 | 76 | SVK | 0.303 | 136 | DEU | 0.473 |
| 17 | MYS | 0.088 | 77 | MNE | 0.308 | 137 | DZA | 0.480 |
| 18 | WSM | 0.096 | 78 | AFG | 0.310 | 138 | MLI | 0.483 |
| 19 | ATG | 0.100 | 79 | SLV | 0.315 | 139 | TUN | 0.487 |
| 20 | BLZ | 0.112 | 80 | MNG | 0.317 | 140 | MDA | 0.493 |
| 21 | SAU | 0.120 | 81 | HUN | 0.322 | 141 | LVA | 0.493 |
| 22 | PNG | 0.120 | 82 | COL | 0.327 | 142 | MEX | 0.497 |
| 23 | GBR | 0.132 | 83 | BGR | 0.327 | 143 | ECU | 0.500 |
| 24 | KWT | 0.132 | 84 | YEM | 0.328 | 144 | UKR | 0.502 |
| 25 | KNA | 0.135 | 85 | GTM | 0.330 | 145 | PER | 0.510 |
| 26 | DNK | 0.135 | 86 | SYR | 0.330 | 146 | PRT | 0.510 |
| 27 | VCT | 0.142 | 87 | ARM | 0.332 | 147 | BRA | 0.513 |
| 28 | SWZ | 0.142 | 88 | POL | 0.338 | 148 | TWN | 0.517 |
| 29 | BHS | 0.150 | 89 | NIC | 0.338 | 149 | HRV | 0.523 |
| 30 | SLB | 0.158 | 90 | GHA | 0.338 | 150 | CMR | 0.528 |
| 31 | CHE | 0.163 | 91 | CRI | 0.342 | 151 | EST | 0.533 |
| 32 | BHR | 0.165 | 92 | DOM | 0.345 | 152 | MOZ | 0.537 |
| 33 | DMA | 0.165 | 93 | KGZ | 0.347 | 153 | MRT | 0.552 |
| 34 | FJI | 0.166 | 94 | SCG | 0.348 | 154 | GAB | 0.555 |
| 35 | KIR | 0.170 | 95 | ALB | 0.352 | 155 | TCD | 0.562 |
| 36 | GRD | 0.195 | 96 | SYC | 0.355 | 156 | BFA | 0.568 |
| 37 | BEL | 0.195 | 97 | ETH | 0.357 | 157 | GRC | 0.577 |
| 38 | QAT | 0.200 | 98 | VNM | 0.358 | 158 | ROU | 0.578 |
| 39 | GEO | 0.200 | 99 | AUT | 0.358 | 159 | MDG | 0.578 |
| 40 | JPN | 0.203 | 100 | PHL | 0.373 | 160 | SVN | 0.583 |
| 41 | BWA | 0.205 | 101 | UZB | 0.377 | 161 | PRY | 0.585 |
| 42 | HTI | 0.207 | 102 | RUS | 0.378 | 162 | FRA | 0.587 |
| 43 | NGA | 0.207 | 103 | LAO | 0.380 | 163 | ESP | 0.598 |
| 44 | THA | 0.208 | 104 | TLS | 0.384 | 164 | LUX | 0.600 |
| 45 | ARE | 0.210 | 105 | KOR | 0.388 | 165 | SLE | 0.603 |
| 46 | GUY | 0.212 | 106 | ARG | 0.395 | 166 | SEN | 0.617 |
| 47 | ERI | 0.214 | 107 | EGY | 0.400 | 167 | STP | 0.624 |
| 48 | KAZ | 0.222 | 108 | IND | 0.402 | 168 | TGO | 0.630 |
| 49 | CHL | 0.222 | 109 | IRN | 0.412 | 169 | MAR | 0.632 |
| 50 | MWI | 0.223 | 110 | SDN | 0.412 | 170 | TZA | 0.635 |
| 51 | KEN | 0.225 | 111 | SWE | 0.417 | 171 | PAN | 0.638 |
| 52 | SUR | 0.225 | 112 | HND | 0.423 | 172 | BOL | 0.648 |
| 53 | IRL | 0.232 | 113 | GIN | 0.428 | 173 | GNB | 0.658 |
| 54 | NAM | 0.233 | 114 | MKD | 0.428 | 174 | GNQ | 0.660 |
| 55 | CYP | 0.240 | 115 | BIH | 0.430 | 175 | CAF | 0.662 |
| 56 | ZMB | 0.248 | 116 | NOR | 0.433 | 176 | VEN | 0.662 |
| 57 | VUT | 0.250 | 117 | NLD | 0.433 | 177 | AGO | 0.673 |
| 58 | CZE | 0.250 | 118 | ZAF | 0.440 | 178 | COG | 0.727 |
| 59 | LBN | 0.252 | 119 | COM | 0.445 | 179 | COD | 0.760 |
| 60 | BTN | 0.258 | 120 | PAK | 0.445 | 180 | NER | 0.775 |

Note: The table lists ISO3 country codes sorted in ascending order by the index of labor market rigidity.

Table B.2: Ten industries with the lowest and highest degree of volatility.

| $volatility_i$ | 10 industries with the lowest degree of volatility |
|---|---|
| 0.0838 | Frozen food manufacturing |
| 0.0956 | Photographic and photocopying equipment manufacturing |
| 0.1034 | Vending, commercial, industrial, and office machinery manufacturing |
| 0.1046 | Stationery product manufacturing |
| 0.1046 | All other converted paper product manufacturing |
| 0.1046 | Coated and laminated paper, packaging paper and plastics film manufacturing |
| 0.1078 | Breweries |
| 0.1135 | All other paper bag and coated and treated paper manufacturing |
| 0.1146 | Other concrete product manufacturing |
| 0.1146 | Ready-mix concrete manufacturing |
| ... | |
| | 10 industries with the highest degree of volatility |
| 0.2873 | Fluid milk and butter manufacturing |
| 0.3004 | Storage battery manufacturing |
| 0.3004 | Primary battery manufacturing |
| 0.3060 | Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing |
| 0.3060 | Electron tube manufacturing |
| 0.3119 | Irradiation apparatus manufacturing |
| 0.3127 | Bare printed circuit board manufacturing |
| 0.3360 | Switchgear and switchboard apparatus manufacturing |
| 0.3992 | Biological product (except diagnostic) manufacturing |
| 0.4155 | Computer storage device manufacturing |

Table B.3: Summary statistics for the main estimation sample.

| Variable | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| ln(U.S. offshoring intensity)$_{lit}$ | 62,225 | -9.387 | 3.401 | -21.268 | -0.146 |
| $rigidity_{lt}$ | 62,225 | 0.363 | 0.182 | 0.000 | 0.900 |
| $\ln GDP_{lt}$ | 62,225 | 12.447 | 1.595 | 7.501 | 16.154 |
| $\ln(GDPpc)_{lt}$ | 62,225 | 9.389 | 0.998 | 5.732 | 11.733 |
| $rule_{lt}$ | 62,225 | 0.371 | 0.987 | -1.843 | 2.000 |
| $\ln(credit/GDP)_{lt}$ | 62,225 | 3.972 | 0.856 | 0.063 | 5.568 |
| $\ln(K/L)_{lt}$ | 62,225 | 10.441 | 1.123 | 6.696 | 12.546 |
| $H_{lt}$ | 62,225 | 2.719 | 0.469 | 1.174 | 3.536 |
| $corruption_{lt}$ | 62,225 | 0.391 | 1.052 | -1.571 | 2.549 |
| $effectiveness_{lt}$ | 62,225 | 0.536 | 0.935 | -1.769 | 2.430 |
| $stability_{lt}$ | 62,225 | 0.023 | 0.908 | -2.627 | 1.514 |
| $quality_{lt}$ | 62,225 | 0.536 | 0.870 | -2.210 | 1.991 |
| $voice_{lt}$ | 62,225 | 0.376 | 0.893 | -1.775 | 1.826 |
| $rigidity_{lt} \times volatility_i$ | 59,063 | 0.067 | 0.039 | 0.000 | 0.328 |
| $rule_{lt} \times specificity_i$ | 59,063 | 0.305 | 0.853 | -1.787 | 2.000 |
| $\ln(credit/GDP)_{lt} \times dependence_i$ | 59,063 | 1.135 | 1.957 | -6.147 | 16.464 |
| $\ln(K/L)_{lt} \times Kintensity_i$ | 59,063 | 49.403 | 9.551 | 20.996 | 89.989 |
| $H_{lt} \times Sintensity_i$ | 59,063 | -3.320 | 1.221 | -8.172 | -0.428 |
| $rule_{lt} \times contractibility$(Nunn)$_i$ | 59,063 | 0.180 | 0.501 | -1.569 | 1.938 |
| $rule_{lt} \times contractibility$(Levchenko)$_i$ | 59,063 | 0.048 | 0.152 | -0.968 | 1.050 |
| $rule_{lt} \times contractibility$(Costinot)$_i$ | 59,063 | -0.216 | 0.574 | -2.000 | 1.843 |
| $rule_{lt} \times contractibility$(Bernard)$_i$ | 59,063 | 0.148 | 0.382 | -1.157 | 1.418 |
| $\ln(credit/GDP)_{lt} \times tangibility_i$ | 59,063 | 1.133 | 0.459 | 0.012 | 3.529 |

Note: The table reports summary statistics for the main estimation sample used in Tables 1, 2, and 3.

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