Incomplete contracts and the labor market effects of offshoring

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Abstract

We develop an incomplete contracting model in which offshore labor hiring by US firms is determined jointly, but non-cooperatively, with domestic hiring. To address this endogeneity when assessing the impact of offshoring and US labor market outcomes, we instrument for offshoring using bilateral tax treaties. These treaties have been shown to impact offshoring in some industries but not others, making them an ideal instrument for examining the differential impacts of offshoring by industry. From the model we derive multi-tier 2SLS Bartik-style empirical strategy. Using BEA data for US multinational firms, we find that increases in offshore hiring raise parent firm hiring globally, and industry-wide employment domestically. We also find substantial heterogeneity in the effect of offshoring: despite the positive effect on local employment within firms that increase hiring (i.e., the intensive margin) in certain sectors the increase in the number of firms that move production units abroad (i.e., at the extensive margin) reduces domestic employment.

Keywords: Offshoring, FDI, wages, employment, differentiated goods, incomplete contracts
JEL Classification: F16, F23, F66, J20, J30

*The statistical analysis of firm-level data on U.S. multinational companies was conducted at the Bureau of Economic Analysis, U.S. Department of Commerce under arrangements that maintain legal confidentiality requirements. The views expressed are those of the authors and do not reflect official positions of the U.S. Department of Commerce. The authors would like to thank William Zeile and Raymond Mataloni for assistance with the BEA data.
1 Introduction

The impact of offshoring, and of foreign expansion by US firms more broadly, on US workers has received a lot of attention from policy makers and the media as well as academic researchers. However, the endogeneity of offshoring decisions and labor markets makes identifying causal effects extremely challenging. In this paper, we exploit differences in the feasibility of offshoring across industries to estimate the impact of offshoring by US firms on domestic US workers, introducing a new instrumental variable that varies at the industry and country level. We present a model of incomplete contracts, which shows that certain exogenous characteristics make offshoring easier in some industries than in others. Specifically, industries that require more differentiated inputs will have higher costs of offshoring due to difficulties associated with contracting out the production of these more complex inputs. This model leads us to a novel instrumental variable approach for empirically identifying the impact of offshoring on US employment and wages. Blonigen, Oldenski, and Sly (2013) have shown that bilateral tax treaties (BTTs) have a significant impact on the FDI activities of US firms, which is increasing in the intensity with which firms use differentiated inputs for which an arms-length price is difficult to observe. These treaties contain provisions that allow MNCs to consult with tax authorities of both countries in determining appropriate transfer prices for complex goods. Because the transfer pricing practices used to determine the allocation of earnings across countries for differentiated inputs are more difficult to establish, firms that use these inputs benefit much more from the tax relief provided by BTTs. Because BTTs are policy changes signed at the country level, they are exogenous to each individual firm. In addition, the importance of differentiated inputs is an exogenous characteristic of industries which impacts the extent to which BTTs will reduce the cost of offshoring in each industry. In this paper we take advantage of the different effects that these treaties have on the cost of offshoring across different industries to estimate the impact of an exogenous decrease in offshoring costs on US workers using firm-level offshoring data from the US Bureau of Economic Analysis (BEA).

Estimating the effects of offshoring separately for each industry is crucial for identifying impacts that may be masked by the aggregate data. We show that the costs of offshoring are initially higher for
more complex differentiated goods. However, these are also the goods for which the cost of offshoring falls the most when exposed to an exogenous shock in the form of a new bilateral tax treaty.

In addition to the industry-level variation, we also construct a measure of geographic location variation across industries within the US using County Business Patterns (CBP) data from the US Census Bureau. This dataset includes detailed information on employment, firm size, and payroll by county and industry for all US companies. Combining the data on domestic industry concentration with the BEA data on US investment abroad and information on the signing of BTTs gives us three sources of variation to exploit: (1) Multinational firms differ in terms of the countries in which they have affiliates, (2) A new BTT changes the incentives of offshore production to the treaty country, within a particular industry, across the dates of the treaty’s effectiveness, and (3) Geographic locations within the US differ in their concentrations of industry-level activity and employment across sectors.

From these sources of variation in the data, we build a triple difference strategy by looking at changes in localized labor employment within the US for given changes in treaty status across locations that differ in their concentrations of activity across industries that use homogeneous inputs with varying intensity.

We use this strategy to answer questions about the impact of offshoring on US labor markets, including the effect on employment by industry, employment by geographic area within the US, average wages, income distribution, and the displacement of workers.

The contributions of this paper are to (1) Address the endogeneity problem that has been plaguing the offshoring and wages literature by introducing a new exogenous instrument, (2) Exploit differences across industries in their exposure to offshoring to estimate differential effects of offshoring by industry, and (3) Model the impact of offshoring on wages in an imperfect contracting environment.

A number of recent papers have examined the relationship between offshoring and labor market outcomes. For example, Autor, Dorn, and Hanson (2013) study local labor markets within the US and find that increased manufacturing imports from China negatively impact the wages of US manufacturing workers who compete directly with these imports. Ebenstein et al. (2013) look at import competition from and MNC offshoring to both high and low income countries. They find
that offshoring to low wage countries is associated with wage declines for competing workers whereas offshoring to high wage countries is associated with wage increases in the US. Oldenski (2014) uses US firm-level data and finds that offshoring positively impacts US workers that perform nonroutine tasks, but negatively impacts those in more routine occupations. Hummels et al. (2013) use Danish matched worker-firm data and find that the effects of offshoring on workers depend on the the skill level of and tasks performed by workers. Desai, Foley, and Hines (2009) find that expansion abroad by US MNCs complements expansion at home. Using BEA firm-level data, they show that firms that increase their employment, wages, and capital expenditures abroad increase their employment, wages, and capital expenditures the US more than firms that do not expand abroad. Our approach differs from these previous works both in the use of our novel exogenous policy instrument and because we are able to use imperfect contracting theory to identify effects of offshoring that vary by industry.

This paper is also related to the literature on imperfect contracts and offshoring. Antras (2003), Nunn and Trefler (2008), Costinot, Oldenski, and Rauch (2011), and Oldenski (2012) show that imperfect contracting environments, combined with various industry characteristics such as level of differentiation, routineness, and capital intensity, lead firms in different industries to choose different international sourcing strategies. We build on those models by extending them to include implications for US labor markets.

The next section provides a model of imperfect contracts that generates predictions about the differential effects of BTTs on offshoring and labor market outcomes by industry. Sections 3 and 4 describe our estimation strategy, variable construction and data sources. Section 5 presents the key results and we conclude in section 6.
2 Theory

In this section we present a model of firm decisions to hire domestic and foreign labor to motivate our empirical strategy below. In our empirical analysis we instrument for changes in offshoring decisions using the signing of new BTTs, which influence the costs of offshoring only for firms that source products from affiliates that they own and operate. Consistent with this approach we adopt the setting studied by Antras and Helpman (2004), where multinational firms endogenously choose whether to integrate with, and thereby own, its foreign supplier.

2.1 Fundamentals

The world economy consists of two countries, North and South.\footnote{In our empirical analysis below we are careful to control for the fact that firms may own and operate affiliates in multiple countries, and how the multi-country setting may impact the estimated effects of offshoring on local labor demand and wages.} Consumers in each country are laborers who all have identical quasi-linear preferences over a homogeneous good, $x_0$ and a series composite goods across industries, $X_i$ given by

$$U = x_0 + \frac{1}{\mu} \sum_{i=1}^{I} X_i^{\mu} \quad 0 < \mu < 1$$

(1)

where consumers exhibit preferences over unique varieties, $h$, with a content elasticity of substitution:

$$X = \left[ \int x_i(h) \right]^{1/\alpha}, 0 < \mu < 1.$$  

(2)

It follows that differentiated firms within each sector face an inverse demand function given by

$$p_i(h) = X^{\mu-\alpha} x_i(h)^{\alpha-1} .$$

(3)

Labor is the only factor of production with a perfectly elastic supply in both countries, albeit with different wages. Let $\omega^N$ be the wage in the North country and $\omega^S$ be the wage in the South with $\omega^N > \omega^S$. Workers are hired by firms to perform either general labor services $s$ or to generate...
components used in assembly $m$. Each worker can produce a single unit of general labor services or components, and firms combine labor services and components according to

$$x_i(h) = \theta_h \left[ \frac{s(h)}{\eta_i} \right]^\eta \left[ \frac{m(h)}{1 - \eta_i} \right]^{1-\eta_i} \tag{4}$$

where $\theta_h$ is a firm-level productivity parameter (i.e., firm-level TFP). Generally, we are agnostic about the role of labor in performing each activity, but note that each labor activity, $s$ and $m$, cannot be separated geographically. For the sake of exposition we assume that general labor services are performed in the North country.$^2$

### 2.2 Foreign Sourcing

Although firms may source components from their foreign affiliates, there are two frictions which inhibit offshore production. The first is the incidence of double taxation, whereby firms that source inputs from abroad face relatively higher tax rates.$^3$ Second, multinational firms cannot write complete contracts with their supplier, so that the sourcing of components from abroad is subject to a hold-up problem.

Specifically, let $t_i$ indicate the relatively higher tax rate paid by firms that source components from foreign affiliates. We model $t_i < 1$ as ad valorem so that the purchase of one unit of a component abroad leaves $t_i$ units available for production. Note that the incidence of double taxation can differ across industries, even though the statutory tax rates are constant across industries.

The incomplete contracting environment follows Antras and Helpman (2004) and Grossman and Hart (1986). Though firms cannot write enforceable contracts, a parent firm can integrate with its supplier by purchasing the residual rights over its activities. Firms then engage in ex post bargaining over the surplus generated during production. We assume that the parent company receives a fraction

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$^2$In our empirical analysis we will consider the global hiring workers of multinational firm in addition to the offshoring of component fabrication to a particular country. Accordingly, it is important to note that the production technology in (4) is flexible enough that we could easily incorporate several types of inputs that may be sourced across several countries and the key insights of the model would be maintained.

$^3$Even though our sample comes from the US, where firms have a statutory right to claim a tax credit for foreign taxes paid, it is well-known that the differences in the application of tax rules across countries still leads to substantial double-taxation in practice.
\( \beta \) of the surplus, while the remaining fraction goes to the supplier.

Although owning the residual rights of may allow the parent firm to seize the components generated by the supplier, it cannot use them as effectively following seizing than when provided directly by the supplier. To be specific, the parent company of a multinational firm loses \((1 - \delta) < 1\) of total final good production if is chooses to seize inputs, rather than compensating the supplier for them. Thus, the outside option of a parent company \( h \) during negotiations of the supper is to seize the components manufactured by the supplier, and receives a fraction of revenue equal to \( \delta^\alpha \), and the surplus generated during production is the fraction \((1 - \delta^\alpha)\) of total revenue. It follows then that the problem the parent company solves is to maximize its share of total surplus, given its outside option of seizing components fabricated by the supplier, is given by

\[
\max_{s(h)} \left[ \delta^\alpha + \beta(1 - \delta^\alpha) \right] R(h) - \omega^N s(h),
\]

(5)

where the revenue earned during production in equilibrium is given by

\[
R(h) = \theta_h^\alpha X^{\mu - \alpha} \tau^{\alpha(1 - \eta)} \left[ \frac{s(h)}{\eta_1} \right]^{\alpha \eta_1} \left[ \frac{m(h)}{1 - \eta_1} \right]^{\alpha(1 - \eta_1)},
\]

(6)

where \( \tau_i = \frac{t_i}{1 - \eta_i} \).

The corresponding problem for the component supplier is

\[
\max_{m(h)} (1 - \beta) R(i) - \omega^S m(h).
\]

(7)

### 2.3 Labor Demand

We are now in a position to characterize both local and foreign labor demand for multinational firms. Solving the problem of the foreign affiliate in (7), we obtain optimal foreign hiring decisions

\[
\left[ \frac{m(i)}{1 - \eta_i} \right]^{\alpha(1 - \eta)} = w^S (1 - \beta')^{-1} (\alpha)^{1 - \eta} \theta_h^{-\alpha} X^{\alpha - \mu} \left[ \frac{s(i)}{\eta_i} \right]^{1 - \alpha \eta} \tau^{\alpha(1 - \eta)},
\]

(8)
which after taking logs and simplifying becomes

$$
\ln m(i) = + \frac{\alpha - \mu}{(\alpha \eta - 1)} \ln \theta_h - \frac{1}{(1 - \alpha \eta)} \ln w^S
$$

$$
+ \frac{(\alpha \eta - 1)}{\alpha(\eta - 1)} \ln \eta_i + \ln(1 - \eta_i) + \frac{\alpha - \mu}{\alpha(\eta - 1)} \ln X + \frac{1}{\alpha(1 - \eta_i)} \ln(1 - \beta)
$$

$$
+ \frac{(\alpha \eta_i - 1)}{\alpha(\eta_i - 1)} \ln s^*(i) + -(1 - \alpha \eta_i) \ln \tau . \quad (9)
$$

Notice that the terms on the first line of (9) are firm and destination specific parameters, while the second line contains only industry specific parameters. Hence, these terms collapse to a single firm×industry×destination fixed effect, $\varphi_{hdi}$. In the last line we see that the demand for labor at the foreign affiliate depends on firm-specific choices of general labor services in the North countries, $s^*$, in addition to the implied tax incidence, $\tau$. For exposition purposes we can rewrite equation (9) as

$$
\ln m(h) = \varphi_{hdi} + \gamma_1 \ln s^*(h) + \gamma_2 \ln \tau . \quad (10)
$$

The asterisk on $h$ reflects the fact that is is an endogenous choices made by the parent company, which is simultaneously determined with foreign affiliate labor hiring decisions. Thus, one should only consider changes in exogenous tax incidence to identify foreign labor demand, consistent with our empirical strategy using BTTs below.

A similar exercise yields the optimal labor demand for the parent company in the North:

$$
\ln s(h) = \varphi_{hdi} + \gamma'_1 \ln m^*(h) + \gamma'_2 \ln \tau . \quad (11)
$$

Again, the asterisk reflects the fact that $m$ is chosen chosen endogenously. Our strategy will be use predicted values of $m(h)$ from estimating (10), using only variation that arises due to the exogenous signing of BTTs, and subsequently use these predicted values to instrument for $m$ when estimating domestic firm-level labor demand in (11). Section 3 describes our multi-tier 2SLS approach in more detail.
2.4 Industry Labor Demand

Section under construction —

Two things to note:
1. Extensive Margin leads to even more hiring within an industry than suggested by the Intensive margin prediction from the last section, when firms switch to foreign integration from foreign outsourcing.
2. Extensive Margin leads to less hiring within an industry than suggested by the Intensive margin prediction from the last section, when firms switch to foreign integration from domestic sourcing.
(See Antras and Helpman (JPE, 2004).)

These facts have implications for our empirical strategy, as they suggest that the industry-specific effects of offshoring exhibit substantial heterogeneity. More importantly, the effect may be negative in some industries while being positive on average. Specifically, the increases in offshoring are more likely to have a negative effect on industry-wide domestic employment when the costs to engage in foreign production are initially high.

Relevant to our purposes here, Blonigen et al. (2014) and Keller & Yeaple (2013) provide direct evidence that the costs of foreign production are higher for industries that use differentiated inputs more intensively. Hence, in a general equilibrium setting, the relatively large growth in the use of foreign sources of production across firms leads to smaller, or even negative, effects of offshoring on domestic employment within these industries.

3 Empirical Approach

The model presented in Section 2 generated predictions about how offshoring costs vary across industries, as well as how the effects of exogenous changes to those costs will impact US workers differently depending on the degree to which their industries rely on differentiated inputs. In this section, we outline our strategy for empirically testing those predictions. Because offshoring and US labor market variables are endogenous, we instrument for offshoring using bilateral tax treaties (BTTs). Our
objective is to use variation in foreign activity driven by BTTs to understand how offshoring affects US employment and how those effects vary across different types of industries.

3.1 Strategy

Consider a multi-tiered two-stage least squares strategy with three different second stages:

The first stage uses the BEA firm-level data to estimate the effects of bilateral tax treaties on foreign affiliate activity. The initial second stage (stage 2a) uses these first stage estimates to identify the impact of offshoring on firm-level employment and wages separately for each industry. It is important to keep in mind that this is not equivalent to the effect on overall employment, as we are only looking at the behavior of multinational firms. Given estimates of these industry-specific effects, we can then explain heterogeneity in treatment effects of BTT’s across industries. Blonigen, Oldenski, and Sly (2013) (BOS) show that industry input differentiation is important for mediating the effects of BTT’s on foreign affiliate activity, but as motivated by theory, a variety of other industry characteristics are likely important as well.

Stages 2b and 2c use the industry-level effects of BTT’s on foreign affiliate activity to examine the effects of offshoring on wage and employment outcomes for U.S. workers more broadly. First, we calculate industry-level offshoring shocks resulting from BTT’s based on the predicted increase in offshoring in each industry from the first step. We then examine the relationship between these BTT-induced offshoring shocks and U.S. industry employment outcomes using household survey data (stage 2b). This is an example of two-sample IV, where the first-stage uses data on MNCs and the second stage looks at US employment at both MNCs and purely domestic firms. Finally, in stage 2c we use a Bartik-style analysis to examine the effects of offshoring on local labor markets within the US, based each market’s initial industry mix of employment.
3.2 Stage 1: Identifying the Firm-Level Effects of BTTs

Observations represent parent, or headquarters, firm \((h)\), destination country \((d)\), industry \((i)\), time \((t)\) combinations.\(^4\) We measure the effect of BTT’s on log foreign affiliate employment, \(offshoring_{hdit}\). Define \(T_{dt}\) as an indicator for periods when the U.S. has a BTT with destination \(d\). Ignoring for now the possibility of heterogeneous treatment effects of BTTs across industries, the standard dif-in-dif regression (e.g. Bertrand, Duflo, and Mullainathan (2004) equation (1)) is

\[
offshoring_{hdit} = T_{dt} + \alpha_{it} + \Phi X_{hdit} + \epsilon_{hdt}.
\] (12)

This specification includes industry-time fixed effects, \(\alpha_{it}\), cross-sectional unit fixed effects, \(\varphi_{hdi}\), an indicator for when each cross sectional unit faces treatment, \(T_{hdit}\), which in this case reduces to \(T_{dt}\), and controls \(X_{hdit}\). The estimate of \(\beta\) describes how activity changes for an affiliate newly facing a BTT, compared to the change in activity for another affiliate not facing a new BTT in the same time period and industry and with similar controls.

We then integrate into this dif-in-dif structure the BOS finding on heterogeneous treatment effects across industries based on input differentiation. Define \(D_i\) to be the share of differentiated inputs used in industry \(i\),

\[
offshoring_{hdit} = \beta_1 T_{dt} + \beta_2 D_i T_{dt} + \varphi_{hdi} + \alpha_{it} + \Phi X_{hdit} + \epsilon_{hdt}.
\] (13)

Note that the level effect of \(D_i\) is subsumed by the cross-sectional fixed effects, \(\varphi_{hdi}\). In this specification, the estimate of \(\beta_1\) gives the treatment effect of a BTT in an industry with \(D_i = 0\) and the estimate of \(\beta_2\) gives the additional increment to the treatment effect for each unit increase in \(D_i\).

To study other sources of heterogeneity in treatment effect across industries, we generalize this approach to allow the treatment effect to vary arbitrarily by industry.

\[
offshoring_{hdit} = \sum_{i=1}^{I} \beta_i 1(i = i) T_{dt} + \varphi_{hdi} + \alpha_{it} + \Phi X_{hdit} + \epsilon_{hdt}.
\] (14)

In this case, the estimates of \(\beta_i\) give the treatment effects of BTTs in each industry, without restriction.

\(^4\)Hence we add the time dimension to the static model considered above.
This will capture any heterogeneity from input differentiation and any other industry features.

A potential concern with these approaches is that if parent firms have affiliates in multiple countries and substitute activity between their affiliates, the dif-in-dif counterfactual assumption may be violated. If a BTT in destination \( d \) reduces activity at its affiliate in \( d \), the parent firm may increase activity at its other affiliate in destination \( d' \). If so, the \( d' \) affiliate likely no longer yields a valid counterfactual for what would have happened to the \( d \) affiliate in the absence of a BTT. In fact, it likely biases the analysis toward finding a more negative effect of BTT’s. To address this concern, we will control for activity at all other affiliates of the same parent firm.

Our dif-in-dif strategy relies on the assumption that there is no meaningful difference in treated and non-treated countries prior to the signing of a BTT. Figure 1 illustrates relative foreign affiliate activities in homogeneous versus differentiated sectors separately for countries that enter a new BTT with the US (solid line), and for countries that do not (dashed line), across the time horizon four years prior to - and four years after - the date treaties enter into force, which we denote \( t_0 \).\(^5\) We delineate homogeneous and differentiated sectors according to the median observation in the sample; note that for confidentiality reasons with regard to the BEA data, we cannot illustrate relative foreign affiliate activities across industries at more disaggregate levels.

There are two important features of Figure 1. First, for countries that enter new treaties, relative foreign affiliate activities in differentiated sectors do not increase until after the treaties become effective; i.e., until after the period \( t_0 \). This fact assuages concerns about the presence of pre-existing trends in activity across sectors spuriously driving our regression results.\(^6\) Secondly, relative foreign affiliate activities in countries that do not enter a new BTT are stable across the entire sample period, similar to the flat trend in countries with new treaties prior to their entry into force. This fact mitigates concerns about differential trends across countries leading to spurious estimates of the impact of BTTs.

\[^5\]Several countries entered new treaties in years early in our sample, limiting the number of observations available for any dates five years prior to new treaties (i.e., \( t-5 \)).

\[^6\]We also note that the fact that the entirety of the literature on the effects of BTT has found no positive effect, which also suggests that there are no pre-trends in foreign affiliate activities that lead to spuriously positive estimated effects of BTTs.
3.3 Stage 2a: Firm-Level Effects of Offshoring

This stage uses the predicted offshoring values from Stage 1 as instruments for offshoring by US MNCs. We use these IVs to estimate the effect of offshoring by US firms on domestic US employment and average wages at the same firms that are doing the offshoring. The estimating equation is:

\[ y_{ht} = \beta \ln(o_{fshoring})_{hdit} + \gamma \ln(o_{fshoring})_{hd't} + \varphi_{hd't} + \alpha_t + \Phi X_{hdit} + \epsilon_{hdt}. \]  

(15)

Where \( y_{ht} \) is either the log number of US employees of parent firm \( p \) in year \( t \) or the log average wage paid by parent firm \( p \) to its US employees in year \( t \). \( \ln(o_{fshoring})_{hdit} \) is the predicted value of employment at affiliates of parent firm \( p \) in destination country \( d \), industry \( i \), and year \( t \) from the first stage regressions. Because shocks to the cost of offshoring may induce firms to reallocate production across affiliates rather than just between their US and foreign locations, we also control for employment at all other affiliates of parent firm \( j \) in countries \( d' \neq d \) in year \( t \) using \( \ln(o_{fshoring})_{hd't} \).
3.4 Stage 2b: Offshoring’s Effect on Labor Market Outcomes at the Industry Level

To the extent that workers can move between MNCs and domestic firms, we expect that offshoring by MNCs should affect employment and wages in each industry as a whole, not just at the firms doing the offshoring. To measure this effect, we use a two-sample IV, where the first-stage uses data on MNCs and the second stage looks at US employment at both MNCs and purely domestic firms. The second stage equation is:

\[ y_{it} = \beta \sum_{t} \ln(\text{offshoring})_{h_{dit}} + \varphi_i + \alpha_t + \epsilon_{it}. \]  \hspace{1cm} (16)

3.5 Stage 2c: Regional Labor Market Effects of Offshoring

We are also interested in understanding how different geographic locations within the US are impacted differently by offshoring. We exploit the fact that geographic locations differ in their concentrations of industry-level activity and employment across sectors. This variation allows us to measure the different impacts that offshoring has on local labor markets within the US. Using each local market’s initial industry mix of employment, we construct a geographic measure of exposure to offshoring based on our first stage results. The second stage of this approach estimates the impact on employment and wages in each region, \( r \), within the US.

\[ y_{rt} = \beta \ln(\text{offshoring})_{rt} + \varphi_r + \alpha_t + \epsilon_{rt}. \]  \hspace{1cm} (17)

We measure each region’s exposure to offshoring using the share of local employment in 1986 in each industry as weights in local weighted average. We then construct weighted offshoring shocks for each region using the predicted offshoring values at the industry level weighted by the share of local employment in 1986 in each industry. The dependent variables are total employment or average wages from the County Business Patterns (CBP) by Metropolitan Statistical Area (MSA) and year.
4 Data

The Bureau of Economic Analysis (BEA) collects firm-level data on US multinational company operations in its annual surveys of US direct investment abroad. We use data on total employment by foreign affiliates of US owned firms from these surveys as our measure of FDI activity. Firm-level data has two distinct advantages for our purpose. First, BEA firm-level data indicate if there is trade of inputs between U.S. parents and their foreign affiliates. Our instrumental variable strategy relies on tax treaties that impact within firm trade, and thus we focus on multinational that engage in vertical trade. Second, the likelihood of offshoring may differ across firms, and failing to account for such unobserved firm-level characteristics may lead us to mis-identify the effects of offshoring. Each affiliate is assigned an industry classification based on its primary activity according to the BEA International Surveys Industry (ISI) system, which closely follows the 3-digit Standard Industrial Classification (SIC) system. We focus on non-service sectors, giving us a set of firms spanning 73 3-digit industries and operating in 174 countries from 1987 to 2007.

Information about international tax treaties signed by the US that we use to construct our instrument come from Internal Revenue Service and Treasury Department publications.\(^7\) The text of each treaty provides the signature date, ratification date, the general effective date, and the date of revisions if applicable. Treaties are often signed in years previous to when they become effective and several country-pairs have also renegotiated their BTT over time. We use the effective date of the original signing to indicate when countries have a treaty in place. Measuring the presence of a treaty this way works against us finding a significant impact on foreign investment if there is anticipated FDI into a treaty partner prior to the effective date of a new BTT.\(^8\) Table 1 provides a list of countries that have a new BTT with the US during our sample, and the corresponding year it became effective. The set of new treaties signed by the US covers many regions of the world, with nations that differ substantially in size and volumes of FDI activities.

Our key industry characteristic is the share of inputs traded on an organized exchange or with a

\(^7\)See IRS.gov, United States Income Tax Treaties A-Z.

\(^8\)Davies (2003) considers revisions to tax treaties and, similar to previous studies, finds no impact on foreign investment activity.
Table 1: Countries with New Treaties in Effect

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<th>Country</th>
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<td>Bangladesh</td>
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<td>Russia</td>
<td>1993</td>
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<tr>
<td>Estonia</td>
<td>1999</td>
<td>Slovenia</td>
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<td>India</td>
<td>1990</td>
<td>Spain</td>
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<td>Indonesia</td>
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<td>Sri Lanka</td>
<td>2004</td>
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<td>Israel</td>
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<td>Thailand</td>
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<td>Latvia</td>
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<td>Portugal</td>
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<td>Venezuela</td>
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published reference price. There are two components to these data. First, Rauch (1999) documented which goods are traded on an organized exchange, are exchanged through specific contracts, and which are offered at referenced prices. Products are classified at a highly disaggregated level. Second, Nunn (2007) uses US input-output tables to measure the intensity with which each input is used in the industry-specific production process. These data provide detailed information about the variation factor usages by their level of product differentiation.

The original industry-level data on factor usages correspond to the 4-digit SITC revision 2 classification system, which we convert to 3-digit SIC-based ISI codes using correspondences available from the US Bureau of Economic Analysis. When the 3-digit level spans observations for several 4-digit industries, we use the average fraction of inputs traded on an organized exchange or with an available reference price. Data on industry-level characteristics are limited to observations from the US for a single year, and so we must treat them as constant across all countries and years. After aggregating we have coverage for 73 separate industries concentrated in non-service sectors.\footnote{The use of aggregated sector data in driven completely by data constraints. It is worth noting that this aggregation limits the variation in the measures of inputs traded on organized exchanges, in addition to generating substantial measurement error surrounding firm-level use of differentiated inputs supplied by affiliates. However, each of these features only work against obtaining significant estimates of the impacts of treaties across industries.}

We measure labor market outcomes using data from the Current Populations Survey (CPS), Displaced Workers Survey, and County Business Patterns. Average wages by industry are calculated by dividing total annual payroll by the number of employees.

Country-level data are compiled from several sources. Information regarding real GDP and trade
barriers come from the Penn-World tables. National incomes are expressed in trillions of US dollars. Trade costs are measured using standard definitions of openness: 100 minus the trade share of total GDP. Skill differences across country-pairs are measured using estimates of average educational attainment by Barro and Lee (2010). Observations of educational attainment in each country are available every five years; we interpolate data for years between observations on a linear scale. Our country-level data contain observations for 137 countries.

We also control for other factors that may influence foreign affiliate sales. Data indicating whether the US has a bilateral investment treaty with the destination country are from the United Nations Conference on Trade and Development (UNCTAD). The incidence of free trade agreements across countries are available from the US Trade Representative. Annual exchange rate data are from the World Bank.

5 Results

5.1 Sign Tests

Before implementing the empirical analysis described in Section 3, we begin with a simple test to see if there is a relationship between BTT-induced offshoring and domestic outcomes at US parent firms. We consider only firms with affiliates in countries that have signed a new BTT. We consider every possible pair of two firms in each treaty country and ask whether the firm with the greater share of differentiated inputs increase (or decrease) domestic employment relatively more when a treaty is signed. We define increases (or decreases) in domestic employment as the percentage change in the number of US workers at each firm in the year after a treaty was signed relative to the year prior to the treaty signing.

Table (2) shows the results of this exercise. We first consider only firms that use vertical FDI. There are 35,376 possible pairs of firms with vertical affiliates in countries with new BTTS. For only 46 percent of these pairs, the firm that uses a greater share of differentiated inputs has a greater increase in US employment after a treaty is signed. This means that in the majority of cases it is the firm
in the less differentiated industry that experiences a greater increase (or lower reduction) in domestic employment. In other words, firms with a higher fraction of differentiated inputs are statistically more likely to reduce domestic US employment (or increase it less) relative to firms that use a lower share of differentiated inputs when hit with an exogenous shock that reduces the cost of FDI relatively more for more differentiated inputs.

The average wage results are less pronounced and move in the opposite direction. Firms that rely more heavily on differentiated inputs are more likely to see an increase in the average wage paid to their US workers post-treaty relative to firms that rely less on differentiated inputs.

The difference in the employment and average wage effects is not surprising when considered in the context of previous literature on offshoring and wage inequality. For example, Feenstra and Hanson (1996) show that when US manufacturing firms increase the share of production that they perform offshore, the average skill level of workers employed at their US headquarters goes up, increasing the average wage paid in the US. The results of this sign test are consistent with that finding. To the extent that reductions in domestic employment by US firms induced by a fall in the cost of offshoring primarily impact lower wage workers, it is not surprising that employment would fall while average wages of the remaining workers increase.

The lower panel of Table (2) shows the results of the sign test using firms that only have horizontal, rather than vertical, FDI sales. The results look much different. For horizontal FDI, firms the use a
larger share of differentiated inputs have greater employment growth in the US relative to those that use a lower share of differentiated inputs. There is no systematic difference in the percentage change in average US wages paid by horizontal firms.

We view these initial results as extremely promising. These simple sign tests do not control for any characteristics of countries, industries, or firms other than the BTTs and share of differentiated inputs. The fact that the patterns predicted by our theory exist in the data serves as motivation for our more careful empirical analysis. The difference in results for vertical versus horizontal firms is particularly reassuring evidence that our proposed mechanism is at work. If it were simply the case that, for example, firms in industries that rely more heavily on differentiated inputs grew faster or slower overall then we should see similar sign test results for both horizontal and vertical firms. Similarly, if there was something about the time periods in which treaties were signed that was associated with different employment and wage patterns across the more and less differentiated firms, then these should impact vertical and horizontal firms in the same way. BTT’s, however, impact transfer pricing of intermediate inputs shipped within firms, and thus we should only observe the predicted impact for firms engaging in vertical FDI.

Though promising, these sign tests are very simple and do not take into account a number of important factors. To address these, we now turn to our two-stage regressions.

5.2 First Stage Results

In this section, we estimate the relationship between BTTs and offshoring using Equations (12), (13), and (14)

Consistent with Blonigen, Oldenski, and Sly (2013), Column I of Table (3) shows that the average effect of BTTs on affiliate activity is not significant. However, this aggregate result masks important industry-level differences. Column II of Table (3) shows that these treaties have a positive and significant impact for firms in industries that use differentiated inputs more intensively. As demonstrated by Blonigen, Oldenski, and Sly (2013), the industry level difference in treaty effects stems from transfer pricing provisions that disproportionately benefit firms in industries that use inputs for which an
Table 3: The Relationship between BTTs and Offshoring.

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable: ln(foreign affiliate emp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTT</td>
<td>0.057</td>
<td>-0.191***</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.068)</td>
</tr>
<tr>
<td>BTT * dif</td>
<td></td>
<td>0.469***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.113)</td>
</tr>
<tr>
<td>lsgdp</td>
<td>3.946***</td>
<td>3.938***</td>
</tr>
<tr>
<td></td>
<td>(0.915)</td>
<td>(0.916)</td>
</tr>
<tr>
<td>lgdfsq</td>
<td>0.105</td>
<td>0.105</td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.081)</td>
</tr>
<tr>
<td>lskldf</td>
<td>-0.063***</td>
<td>-0.062***</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>ltcost</td>
<td>-0.010</td>
<td>-0.010</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>BIT</td>
<td>-0.078</td>
<td>-0.080</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.062)</td>
</tr>
<tr>
<td>FTA</td>
<td>-0.039</td>
<td>-0.040</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.051)</td>
</tr>
<tr>
<td>exrate</td>
<td>1.04e-06</td>
<td>1.31e-06</td>
</tr>
<tr>
<td></td>
<td>(2.8e-05)</td>
<td>(2.8e-05)</td>
</tr>
<tr>
<td>industry-year FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>firm FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N</td>
<td>94617</td>
<td>5658</td>
</tr>
<tr>
<td>R-sq</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: *, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively. Standard errors clustered by country are in parentheses.

arm-length price is not easily observable.

We also estimate the impact of BTTs on foreign affiliate activity by industry. There is a tremendous amount of variation in both the sign and significance of the relationship between BTTs and offshoring. However, these industry-level effects vary predictably with the complexity of inputs. Figure (2) plots the coefficients for each of the industry-BTT interactions against the share of differentiated inputs used in that industry. The upward sloping line shows that industries that use differentiated inputs more intensively are more likely to increase their FDI activities in response to a BTT.
5.3 The Impact of Offshoring on Firm-Level Employment and Wages

We now turn to the second stage results using the estimated offshoring from Section 5.2 as instruments. We begin by considering the impact of offshoring by a US firm on the domestic employment and wages of that same firm in the US. Subsequent sections will look at US labor markets more broadly.

Table (4) shows the second stage results using the estimated offshoring from the specification described in Equation (14) and presenting in Column II of Table (3). This specification aggregates the predicted values of affiliate employment over all affiliates of the same US parent firm. These results consider the impact of an exogenous increase in offshoring by a US firm on the domestic US employment and wages of that same firm. The net effects on both employment and wages at the parent firm are positive.

Unfortunately the BEA data do not allow us to observe wages paid to workers in different occupations or skill levels. Thus we are unable to distinguish whether the increases in employment and
average wages are due to an increase in demand for the same mix of workers, or whether it represents a compositional effect in which offshoring leads to more high skilled/high wage jobs relative to low skilled/low wage jobs at the offshoring firms.

Table 4: Stage 2: The Relationship between Offshoring, Employment, and Wages (Parent Level)

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(domestic emp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>∑ ln(offshoring)</td>
<td>0.0004***</td>
<td>0.00009***</td>
</tr>
<tr>
<td></td>
<td>(0.00002)</td>
<td>(9.56e-06)</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Firm FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N</td>
<td>35146</td>
<td>35137</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.020</td>
<td>0.264</td>
</tr>
</tbody>
</table>

Notes: *** and ** indicate significance at the 10, 5 and 1 percent levels, respectively. Robust standard errors are in parentheses.

5.4 Aggregate Industry Level Effects of Offshoring on Employment and Wages

The results presented in Section 5.3 only consider the impact of offshoring on employment and wages of the firm doing the offshoring. However, to the extent that workers can move between jobs at MNCs and domestic firms, we would expect the labor market effects of offshoring to extend beyond the MNCs themselves. In this section we use CPS data on employment and wages by industry to estimate the relationship between offshoring and labor market outcomes of workers beyond just those employed by MNCs.

Table (5) shows the relationship between offshoring and wages at the industry level. Columns I and II present the results of OLS regressions that do not use the BTT instrument described in Section 3. Columns III and IV follow Equation (16).

Both the OLS and 2SLS specifications show a positive and significant relationship between offshoring and US domestic employment and wages. However, the magnitude of the effect is much smaller when the BTT instrument is used to correct for endogeneity.
Table 5: Stage 2: The Relationship between Offshoring, Employment, and Wages (Industry Level)

<table>
<thead>
<tr>
<th>Depvar:</th>
<th>OLS</th>
<th>2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(offshoring)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(emp)</td>
<td>0.530***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>0.262***</td>
</tr>
<tr>
<td>ln(average wage)</td>
<td>0.373***</td>
<td>0.012***</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Industry FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N:</td>
<td>1227</td>
<td>1192</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.264</td>
<td>0.475</td>
</tr>
</tbody>
</table>

Notes: ***, ** and *** indicate significance at the 10, 5 and 1 percent levels, respectively. Standard errors clustered by industry are in parentheses.

The aggregate results presented in Table 5 mask important differences across industries in the relationship between offshoring and US labor market outcomes. The model presented in Section 2 shows that offshoring impacts domestic labor demand through both complementary and substitution channels. The initial decision to offshoring certain tasks results in a substitution away from US labor. However, once the initial offshoring decision has been made, any fall in the cost of offshoring will increase the returns to the firm, creating greater rewards for both the US parent firm and the foreign affiliate and increasing the investment in labor in both locations. Blonigen, Oldenski, and Sly (2013) have shown that the Bilateral Tax Treaty instrument affects both the extensive and the intensive margin. These effects differ depending on the level of differentiated input intensity. Thus we would expect that the relative importance of complementarities versus substitution may be different for industries that use different shares of differentiated inputs.

Table 6 separates the industry-level results by level of differentiated input intensity. The results presented in Table 6 show that the positive aggregate results are being driven by industries that fall in the middles of the differentiated input intensity distribution. Industries that rely the most heavily on differentiated inputs have a negative relationship between offshoring and US employment. The least differentiated input intensive industries show no relationship, but the second lowest category of
Table 6: Stage 2: The Relationship between Offshoring and Employment (Industry Level by Differentiated Input Quintiles)

<table>
<thead>
<tr>
<th>Quintile:</th>
<th>Depvar:</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
<td>ln(emp)</td>
<td>0.078</td>
<td>-0.363***</td>
<td>0.927***</td>
<td>0.089*</td>
<td>-0.284**</td>
</tr>
<tr>
<td>Second</td>
<td>ln(emp)</td>
<td>(0.121)</td>
<td>(0.051)</td>
<td>(0.087)</td>
<td>(0.047)</td>
<td>(0.129)</td>
</tr>
<tr>
<td>Middle</td>
<td>ln(emp)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Fourth</td>
<td>ln(emp)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Highest</td>
<td>ln(emp)</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N:</td>
<td></td>
<td>314</td>
<td>230</td>
<td>236</td>
<td>282</td>
<td>130</td>
</tr>
<tr>
<td>R-sq:</td>
<td></td>
<td>0.557</td>
<td>0.756</td>
<td>0.438</td>
<td>0.803</td>
<td>0.588</td>
</tr>
</tbody>
</table>

Notes: *** and ** indicate significance at the 10, 5 and 1 percent levels, respectively. Standard errors clustered by industry are in parentheses.

differentiation has a negative relationship. Table 7 shows the pattern for average wages by industry.

The U-shaped results across quintiles of differentiated input intensity are not surprising given the various effects found in the theoretical model presented in Section 2. The intensive and extensive margin effects resulting from a fall in the cost of offshoring to a foreign affiliate move in opposite directions. The intensive margin is always positive, as firms that are already sourcing internationally within firm experience a reduction in offshoring costs, which increases their total surplus and leads to more hiring both at home and in the foreign country. The extensive margin effect could be negative if affiliate sourcing substitutes away from domestic sourcing. Or it could be zero if firms are shifting away from arms-length foreign sourcing towards sourcing from affiliates. The sign of this effect will depend on the level of differentiation of the good (see Keller and Yeaple (2013), Blonigen, Oldenski and Sly (2014), or Costinot, Oldenski, and Rauch (2011)).

5.5 Geographic Variation in the Effects of Offshoring on Employment and Wages

We are also interested in estimating how offshoring impacts different local labor markets within the US. Geographic locations within the US differ in their concentrations of industry-level activity and employment across sectors. This variation allows us to measure the different impacts that offshoring
Table 7: Stage 2: The Relationship between Offshoring and Wages (Industry Level by Differentiated Input Quintiles)

<table>
<thead>
<tr>
<th>Quintile:</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depvar:</td>
<td>ln(avg wage)</td>
<td>ln(avg wage)</td>
<td>ln(avg wage)</td>
<td>ln(avg wage)</td>
<td>ln(avg wage)</td>
</tr>
<tr>
<td>ln(offshoring)</td>
<td>-0.046**</td>
<td>0.025***</td>
<td>-0.023</td>
<td>0.020**</td>
<td>0.065**</td>
</tr>
<tr>
<td>(0.020)</td>
<td>(0.007)</td>
<td>(0.015)</td>
<td>(0.010)</td>
<td>(0.026)</td>
<td></td>
</tr>
<tr>
<td>Industry FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N:</td>
<td>314</td>
<td>230</td>
<td>236</td>
<td>282</td>
<td>130</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.927</td>
<td>0.961</td>
<td>0.803</td>
<td>0.956</td>
<td>0.949</td>
</tr>
</tbody>
</table>

Notes: *** and ** indicate significance at the 10, 5 and 1 percent levels, respectively. Standard errors clustered by industry are in parentheses.

has on local labor markets within the US. Using each local market’s initial industry mix of employment, we construct a geographic measure of exposure to offshoring based on our first stage results. The second stage of this approach estimates the impact on employment and wages in different regions within the US.

Table 8: Stage 2: The Relationship between Offshoring, Employment, and Wages (Regional Level)

<table>
<thead>
<tr>
<th>Depvar:</th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(employment)</td>
<td>ln(avg wage)</td>
<td>ln(avg wage)</td>
</tr>
<tr>
<td>ln(offshoring)</td>
<td>0.021***</td>
<td>0.010***</td>
</tr>
<tr>
<td>(0.003)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Region FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>N:</td>
<td>6384</td>
<td>6384</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.728</td>
<td>0.963</td>
</tr>
</tbody>
</table>

Notes: *** and ** indicate significance at the 10, 5 and 1 percent levels, respectively. Standard errors clustered by MSA are in parentheses.

Table 8 shows the preliminary MSA-level results. As with the aggregate industry-level results, the relationships between offshoring and both employment and average wages are positive. Future
versions of this paper will more rigorously examine the factors that determine whether a given MSA is likely to see positive or negative labor market effects from offshoring.

6 Conclusions

Identifying the effects of offshoring on employment and wages is complicated by a number of issues, including endogeneity and industry-level variation. We show theoretically how failing to account for the differential consequences of falling offshoring costs across industries due to issues of contractibility can bias the estimated labor market consequences. We then take these differential effects into account using a new instrumental variable that varies across industries in a way that is consistent with our imperfect contracting model of offshoring. The results show that offshoring has a positive aggregate impact on US labor markets, but the impact varies substantially across sectors.

7 Conclusions

References


