Labor Market Effects of Offshoring Within and Across Firm Boundaries*

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Abstract

We adopt model of endogenous offshoring activities within and across multinational firm boundaries, à la Antras and Helpman (2004), in which offshore labor hiring by foreign affiliates is determined jointly with domestic hiring by the parent firm, in order to characterize endogeneity that typically plagues estimation of the local labor market consequences of offshoring. From the model we derive multi-tier 2SLS Bartik-style empirical strategy, which uses the implementation of new bilateral tax treaties as instruments for industry-time-country specific offshoring activity. The model also provides an explicit characterization of the margins on which productivity effects that benefit domestic hiring, and substitution effects that reduce domestic hiring, are observed and thus can be identified. Using BEA data for US multinational firms across two decades, we find that greater offshore hiring increases hiring *within* parent firms due to productivity effects, but has slightly less benefit for industry-wide employment, as substation effects observed *across* firms partially offset the gain observed within US multinational firms.

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1 Introduction

The consequences that the movement of US firms abroad has for US workers perennially receives attention from policy makers, popular media, and academic researchers. Yet, the selection of multinational enterprises (MNEs) into specific offshoring activities makes the identification of the causal impact of offshoring for workers difficult. Identifying the labor market consequences of offshoring is further complicated by the fact that the term 'offshoring' encompasses several different types of foreign activities that take place both within and outside the boundaries of US multinational firms. At best this fact makes typical estimates of the impact of offshoring difficult to interpret, but more importantly, it is extremely difficult to find valid instruments for loosely defined 'offshoring activities' so that estimates are likely to be biased.

We use a model of MNE's endogenous global sourcing strategies from Antras and Helpman (2004) to derive an empirical strategy that estimates the effect of falling offshoring costs on employment both within MNEs, and across all domestic and multinational firms operating in an industry. Incorporating the endogenous decision of firms to offshore production within an affiliate or to an arms-length supplier allows us to explicitly characterize the margins on which opposing gross effects of offshoring impact local hiring. One one hand, a reduction in offshoring costs benefits existing MNEs that source complementary inputs from offshore facilities, so that within the boundaries of these firms we expect to see local employment respond positively to offshore hiring. This effect is similar to the well-known *productivity effect* of offshoring put forth in Grossman and Rossi-Hansberg (2008). On the other hand, a reduction in offshoring costs may lead more firms to reorganize their global production strategies and begin to substitute foreign workers for those that had previously been hired locally. Looking across firms boundaries, such *substitution effects* have detrimental consequences for local employment. Recognizing that the positive productivity effects of offshoring activity are realized within the boundaries of existing MNEs, while potential negative effects occur across firms that alter their organizational structure, allows us to separately identify the margins on which offshoring impacts domestic employment, and quantitatively assess their respective magnitudes.

The empirical component of our analysis introduces a novel instrument for changes in offshoring activity, namely a bilateral tax treaty (BTT). The implementation of a new BTT can lead to a substantial reduction in offshoring costs for MNEs by reducing the effective tax rate for intra-firm transactions. From an empirical standpoint, the BTT is ideal for our purposes for several reasons. First, as shown by Blonigen, Oldenski, and Sly (2014) (BOS, henceforth) the institutional requirements in enforcing BTTs and differences in the physical requirements of the production processes across industries result in the effects of these agreements varying substantially across different sectors. Second, the date at which new treaties are signed and put into effect varies across countries.[1] Finally, BTTs reduce offshoring costs only for one type of offshoring - owning and operating a foreign affiliate. The reduction in effective tax rates following a BTT is realized via a reduction in the incidence of double taxation on related party transactions. Thus, the implementation of a new BTT yields a shock to offshoring costs that varies by time, by country, by industry, and by firm organization structure. To our knowledge, ours is the first study to use a plausibly exogenous source of variation in global policy to instrument for changes in offshoring activity to estimate the employment effects of offshoring.

Exploiting the variation in offshoring activity resulting from BTTs, we then use firm-level data from the US Bureau of Economic Analysis (BEA) on US multinationals to estimate the effects of offshoring on within-firm employment and wage outcomes across two decades. Finally, we incorporate information from the Current Population Survey (CPS) and use a two-sample IV strategy to estimate the labor market effects of offshoring across firms operating within the same industry. The information in the CPS also allows us to perform a Bartik-style analysis of the effects of offshoring on local labor markets at the MSA level, using each market's initial industry concentration of employment levels.

In line with our predictions we find that, within MNEs, an increase in foreign affiliate hiring due to exogenous reductions in offshoring costs increases hiring by the parent company in the US. Our estimates suggest that a 10% increase in hiring within an offshore affiliate tends to raise hiring in the US by 1.3%. The model predicts a specific pattern of heterogeneity across industries in the relationship between local and offshore hiring. Within industries that exhibit a high elasticity of substitution across the the varieties produced by different firms, the additional rents generated from a reduction in offshoring costs are relatively smaller. As a result we expect relatively

[1] Moreover, the implementation of a BTT requires that both countries sign an agreement, independently ratify it, and agree on its enforcement date - timing of which is likely exogenous to individual firms in either country.

smaller responses in local employment to offshore hiring within industries with high elasticities of substitution. The evidence confirms this prediction.

Looking across firm boundaries, a reduction in offshoring costs may induce new firms to substitute offshore employment for workers that were previously hired domestically. These substitution effects observed when looking across domestic firms and MNEs opening new affiliates mitigate the gains in employment observed within existing MNEs that benefit from a reduction in offshoring costs. Consistent with our predictions we find that the industry-level changes in employment responses to offshore hiring are much smaller than estimated within US MNEs. We find that a 10% increase in offshore hiring leads to only at 0.2% increase in total industry-employment. This estimated positive effect of offshoring activity is significant at high degrees of confidence, but its relatively small magnitude as compared to the within-firm effect of offshoring activity suggests that substitution effects are quantitatively significant.

This paper is related to a number of recent studies that have examined the relationship between offshoring, or trade more generally, and labor market outcomes. 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. Focusing on trade rather than offshoring, 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. Our approach differs from these previous works both in the use of our novel exogenous policy instrument and because we are able to test predictions about the relationship between offshoring and domestic employment both within and across firms that are derived from a model of endogenous firm production decisions.

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 our model, which generates predictions about the differential effects offshoring on employment both within and across firms. 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 adopt a model of multinational firm organization from Antras and Helpman (2004), and derive domestic and foreign hiring decisions to motivate our empirical strategy below. In our empirical analysis we instrument for endogenously chosen offshoring activity 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 within the countries entering the agreement. Consistent with this approach, the theory of the multinational firm in Antras and Helpman (2004) incorporates the endogenous choose of parent firms to integrate with, and thereby own, its foreign supplier. Hence, we will distinguish between the effect of changes in offshoring costs on domestic employment that result form reallocations *within* existing multinational firms, and from changes in the decision *across* firms to newly integrate with foreign suppliers.

2.1 Fundamentals

The world economy consists of two countries, North and South.[2] 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

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

where consumers exhibit preferences over unique varieties, h, among the total set of varieties in the same industry, H_i, with a constant elasticity of substitution:

$$X_i = \left[\int_{h \in H_i} x_i(h)^{\alpha_i} dh \right]^{1/\alpha_i} \qquad , 0 < \alpha_i < 1 \ . \tag{2}$$

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

$$p_i(h) = X^{\mu - \alpha_i} x_i(h)^{\alpha_i - 1} \quad . \tag{3}$$

[2] 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 relative prices in the multi-lateral setting may impact the estimated effects of offshoring on local labor demand and wages.

Labor is the only factor of production with a perfectly elastic supply in both countries, albeit with different wages. Let ω^N be the wage in the North country and ω^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 assmebly m. Each worker can produce a single unit of general labor services or components, and firms combine labor services and components according to

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

where θ_h is a firm-level productivity parameter (i.e., firm-level TFP). Generally, we are agnostic about the specific 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.[3]

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 effective tax rates.[4] 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 τ_i indicate the relatively higher tax rate paid by firms that source components from foreign affiliates. We model $\tau_i \geq 1$ such that the the hiring of τ_i workers abroad yields one unit of components for production. Note that the incidence of double taxation can differ across industries because of the relative difficulties in applying institutional tax rules across sectors, even thought the statuary tax rates are constant across industries (see Blonigen, Oldenski, and Sly (2014)).

The incomplete contracting environment in a global economy follows Antras and Helpman

[3] 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 equation (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.

[4] 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.

(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. Whether the parent and supplier integrate or operate at arms-lentgh, they engage in ex post bargaining over the surplus generated during production. We assume that the parent company receives a fraction β of the surplus generated during production, while the remaining fraction goes to the supplier.

Although owning the residual rights allows the parent firm to seize the components generated by the supplier, it cannot use them as effectively following seizure than when provided by the supplier voluntarily. 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 with the supplier is to seize the components manufactured by the supplier, thereby receiving a fraction of revenue equal to δ^{α} of the revenue that would be generated by fulfilling the terms of the contract. Then, the surplus generated during production when the parent compensates the supplier is the fraction $(1-\delta^{\alpha})$ of total revenue. It follows that the problem parent in the North solves is to make hiring decisions in order to maximize its share of total surplus, given its outside option of seizing components fabricated the affiliate supplier it owns and operates, which is given by

$$\max_{s(h)} \left[\delta^{\alpha} + \beta(1-\delta^{\alpha})\right] R(h) - w^{N} s(h) \ , \tag{5}$$

where the revenue earned during production in equilibrium is given by

$$R(h) = \theta_h^{\alpha} X^{\mu-\alpha} \left[\frac{s(h)}{\eta_i}\right]^{\alpha\eta_i} \left[\frac{m(h)}{1-\eta_i}\right]^{\alpha(1-\eta_i)} \quad . \tag{6}$$

The corresponding problem for the component supplier is

$$\max_{m(h)} (1-\beta) R(h) - w^{S} \tau_i m(h) \ , \tag{7}$$

where the term $\tau_i \geq 1$ reflects the fact that using labor in the South to produce components may subject the multinational firm to the incidence of double taxation.

2.3 Labor Demand Within Multinational Firms

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

$$\left[\frac{m(h)}{1-\eta_i}\right]^{\alpha_i(1-\eta_i)} = w^S(1-\beta')^{-1}(\alpha_i)^{-1}\theta_h^{-\alpha_i}X^{\alpha_i-\mu}\left[\frac{s(h)}{\eta_i}\right]^{1-\alpha_i\eta_i}\tau_i^{\alpha_i(\eta_i-1)} \quad , \tag{8}$$

which after taking logs and simplifying becomes

$$\begin{aligned}\ln m(h) = {} & \frac{\alpha_i-\mu}{(\alpha_i\eta_i-1)}\ln\theta_h - \frac{1}{(1-\alpha_i\eta_i)}\ln w^S \\ & + \frac{(\alpha_i\eta_i-1)}{\alpha_i(\eta_i-1)}\ln\eta_i + \ln(1-\eta_i) + \frac{\alpha_i-\mu}{\alpha_i(\eta_i-1)}\ln X + \frac{1}{\alpha_i(1-\eta_i)}\ln(1-\beta) \\ & + \frac{(\alpha_i\eta_i-1)}{\alpha_i(\eta_i-1)}\ln s^*(h) + (1-\alpha_i\eta_i)\ln\tau_i \ . \end{aligned}\tag{9}$$

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

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

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

Performing the same exercise (see appendix for full details), we derive the optimal hiring decisions of the parent company in the North, which yields

$$\ln s(h) = \psi_{hid} + \gamma_1' \ln m^*(h). \tag{11}$$

Again, the asterisk reflects the fact that offshore hiring decisions, m, are chosen endogenously and simultaneously with hiring at the parent company in the North. However, it is important to note that hiring decisions in the North do not depend explicitly on the effective tax rates for foreign sourcing behavior, but only implicitly depend on offshoring costs through the effect of τ_i on foreign hiring decisions $m^*(h)$. This exclusion of direct offshoring costs from the hiring decisions in the North is useful for our purposes as it will allow us to instrument for foreign hiring decisions using variation in τ_i. Our strategy will be to use predicted values of offshore employment from estimating (10), using only variation in τ_i that arises due to the exogenous signing of BTTs, and subsequently use these predicted values as instruments when estimating domestic employment outcomes in (11).

In equation (11), the parameter γ_1' is equal to $\frac{1-\alpha_i\eta_i}{\alpha_i(1-\eta_i)}$, which is strictly positive. Hence, the prediction is that increases in offshore hiring within affiliates in the South should positively impact hiring by parent companies in the North. Intuitively, greater amounts of component production by the affiliate are complemented by greater production of general labor services in the North so that employment at the parent should also rise. This positive association between local and offshore employment that occurs within multinational firms is similar to the productivity effect derived in Grossman and Rossi-Hansberg (2008), where a reduction in offshoring costs raises the return to hiring complementary inputs, and thereby partially improves domestic labor market outcomes.

The value $\gamma_1' = \frac{1-\alpha_i\eta_i}{\alpha_i(1-\eta_i)}$ also predicts a specific pattern of heterogeneity across industries that exhibit different elasticities of substitution between varieties, $\sigma_i \equiv 1/(1-\alpha_i)$. Intuitively, when different varieties within an industry are highly substitutable, the additional rents generated by a fall in offshoring costs and the ensuing increase in hiring at the foreign affiliate are relatively smaller. Hence, the parent company of an MNE in the North responds to greater offshoring activity with a relatively smaller increase in hiring within industries that exhibit higher elasticities of substitution. The predicted heterogeneity in hiring response of MNEs to increased offshoring activity across industries that exhibit different elasticities of substitution yields a strategy to further verify the model of hiring and offshoring activity within the boundaries of multinational enterprises. For different sub-samples of industries that exhibit different elasticities of substitution, we will estimate the local hiring response of existing MNEs to increased offshoring activity, as induced by the implementation of a new BTT, and show that within industries with higher values of σ_i the estimated effect of increases of offshoring on local hiring is relatively smaller.

2.4 Labor Demand Within Non-Integrated Multinational Firms

Equations (8) and (11) explicitly demonstrate the simultaneity of hiring decisions at both the affiliate and parent company of an integrated multinational firm. It is this simultaneity that can lead to substantial bias when estimating the relationship between domestic employment and offshoring activity. However, it would be in error to think that offshoring activities that take place outside of the boundaries of a multinational firm are free of such concerns. Even those firms in the North that choose to source components from independent contractors in the South still make local hiring decisions simultaneously with offshore hiring decisions. In this section we characterize this source of bias explicitly.

Consider a firm in the North that chooses not to purchase the residual rights of the component maker in the South, allowing it to remain an independent supplier. Such a firm has no outside option to seize the components manufactured by the independent contractor, and since these components are required for production, the outside option of the non-integrated multinational firm is zero. During ex post negotiations over the surplus of production, the parent company is able to capture the fraction β of total revenues, while the remaining share of revenues goes to the component supplier. Thus, the problem faced by the parent in the North that does not integrate with its supplier is given by $\max_{s(h)} \beta R(h) - w^N s(h)$, and the respective problem for the offshore supplier is $\max_{m(h)} (1-\beta)R(h) - w^S m(h)$. It is clear that, even though foreign suppliers make offshore hiring decisions independently, they choose how many workers to employ in anticipation of hiring decisions in the North and the ex post bargaining over surplus that takes place with the firm. Thus, despite the fact that a firm in the North may purchase components from an independent contractor in the South, local and offshore hiring decision are still made simultaneously.

The problem of the non-integrated supplier differs from the integrated supplier's problem in (7), in that there is no potential for double taxation, τ_i, since both the parent and supplier operate independently in their respective tax jurisdictions. Specifically offshore hiring decisions for an independent supplier are given by $\ln \overline{m}(h) = \varphi_{hid} + \gamma_1 \ln \overline{s}^*(h)$, which does not depend on effective tax rates τ_i. Since our instrument for changes in offshoring costs, BTTs, impacts only the offshoring costs within integrated multinational firms that engage in transfer pricing, our empirical strategy for estimating firm-level employment uses only the sample of integrated multinational firms.

2.5 Labor Demand Within Newly Integrated Multinational Firms

The previous sections derived the hiring decisions of multinational enterprises that already offshore component manufacturing to the South, either within the boundaries of the firm or at arms-length from an independent supplier. However, when there is a policy shift that impacts the cost of sourcing components from offshore facilities, there may be some new multinational firms that decide to alter their global organizational structure. As a result, they may substitute foreign employment within an offshore affiliate for workers that previously manufactured components locally.

For a firm that initially hires workers for general labor services and components manufacturing in the North, a discrete shifts in its global organizational structure affects both components of it total firm-level labor demand $s(h)+m(h)$. First, when a firm chooses to integrate with a foreign affiliate following a reduction offshoring costs, its local hiring for general labor services, $s(h)$, unambiguously rises. Intuitively, a firm that finds it optimal to purchase the residual rights over the manufacture of components faces a relatively greater return to local hiring; the ownership of residual rights provides and additional outside option for the parent, increasing its share of surplus when negotiating with a supplier, and subsequently the marginal return to hiring.[5] However, a firm that begins to use an integrated offshore affiliate to manufacture components necessarily substitutes foreign labor $m(h)$, for workers that may have been hired locally, potentially offsetting the increases in $s(h)$.

Consider a firm that initially sources the manufacture of components from suppliers in the North or internally using workers in the North. Within these firms that switch to using an offshore affiliate, the increase of hiring within the offshore affiliate is a direct substitute for local employment. Next, consider a firm that initially sources the manufacture of components from an independent supplier in the South. Within these firms that switch to using an offshore affiliate after offshoring costs fall, there is no substitution of foreign labor for local employment, only a substitution of foreign labor outside the boundaries of the MNE for workers within the affiliate. Thus, we expect that among the set of MNEs that open a new affiliate when offshoring costs fall, the gains in within-firm employment are smaller (or no greater) than for the set of existing MNEs.[6]

[5] See the appendix for full details of the relationship between $s(h)$ and the improved outside option when the parent owns residual rights.

[6] Note that we do not observe if a new offshore affiliate is performing activities that previously took place where the parent resides, in the country of the affiliate but outside the boundaries of the firm, or in a different country entirely. As a result, the strongest prediction that we can make using our sample is the to compare the relative changes in employment within existing MNEs and within those that open new affiliates.

2.6 Industry Labor Demand Across All Firm Organizations

The previous sections all characterized labor demand *within* firms that choose different boundaries in which to operate in the global economy. In this section we look *across* firm boundaries and characterize an empirical strategy to estimate industry-level employment responses to offshoring activity. Total industry employment in the North includes hiring for general labor services $s(\cdot)$ across all firms, as well as any labor used to manufacture components $m(\cdot)$ domestically, either in house or at arms-length. Let, O_i be the set of firms in industry i that choose to offshore component production to an affiliate in the South, while A_i is the set of firms that offshore component production to an arms-length supplier in the South. Likewise let I_i denote the set of non-multinational firms that hire local workers in the North to manufacture components in house, while U_i is the set of firms that source production of components from local arms-length suppliers in the North. Summing across all firm organizational types, total employment for industry i in the North is given by

$$\begin{aligned} L_i^N = & \int\limits_{h \in O_i \subset H_i} s(h)\mathbf{Pr}(h \in O_i)dh + \int\limits_{h \in A_i \subset H_i} s(h)\mathbf{Pr}(h \in A_i)dh \\ & + \int\limits_{h \in I_i \subset H_i} [m(h) + s(h)]\mathbf{Pr}(h \in I_i)dh + \int\limits_{h \in U_i \subset H_i} [m(h) + s(h)]\mathbf{Pr}(h \in U_i)dh \ . \end{aligned} \tag{12}$$

Equation (12) is the basis of our empirical strategy when estimating the effect of offshoring activity on industry-level employment. There are several features that warrant further discussion. First, in addition to the simultaneously determined employment levels within firms, total industry employment depends on the prevalence of each endogenously determined organizational structure across firms. Each firm chooses to source components in a manner that maximizes its expected payoff in anticipation of hiring decisions. Formally, let F_i^k be the industry-specific fixed costs associated with adopting organization structure $k \in \{O_i, A_i, I_i, U_i\}$, and let $\Pi_i^k(h)$ be the payoff to the parent firm producing variety h in industry i when it chooses to source components according to organizational structure k. The problem of the parent when choosing how and where to source the manufacture of components is $\max\limits_{k \in \{O_i, A_i, I_i, U_i\}} \Pi_i^k(h) - F_i^k$. Importantly, it is clear that the incidence of double taxation, τ_i, impacts firm organizational choices, and thus local employment outcomes, only through its anticipated effect on foreign hiring decisions; i.e., τ_i does not enter firms' organization decisions explicitly, but implicitly trough its effect on $m(h)$. This fact ensures that changes in effective tax rates due to the signing of a new BTT are a valid instrument when estimating the industry-level employment consequences of offshoring activity.[7]

A second issue to point out regarding equation (12) is that, because firms may choose to outsource component production to a local arms-length supplier, measuring total industry employment requires that we include domestic and non-integrated firms in the sample. Thus, our empirical strategy at the industry-level must be a two-sample 2SLS á la Angrist & Kruger (1992.).

Finally, it is important to note that the predicted effect of greater offshoring activity on industry-level employment is ambiguous. Differentiating (12) with respect to τ_i, and noting that the changes in the incidence of double taxation impact hiring only within integrated MNEs so that $\partial s(\cdot)/\partial\tau_i,\ \partial m(\cdot)/\partial\tau_i = 0$ for any firm that chooses organization $k \neq O_i$, the consequences of a change in offshoring costs for industry-level employment are characterized by

$$\begin{aligned}\frac{\partial L_i^N}{\partial \tau_i} = \int\limits_{h\in O_i\subset H_i} & \frac{\partial s(h)}{\partial \tau_i}\mathbf{Pr}(h\in O_i)dh \\ & + \int\limits_{h\in I_i\subset H_i} m(h)\frac{\partial\ \mathbf{Pr}(h\in I_i)}{\partial\tau_i}dh + \int\limits_{h\in U_i\subset H_i} m(h)\frac{\partial\ \mathbf{Pr}(h\in U_i)}{\partial\tau_i}dh\ . \end{aligned} \tag{13}$$

The two separate lines in equation (13) correspond to two separate effects of offshoring activity on industry-level employment. The term in the first line corresponds to the change in employment within existing MNEs that results from a change in offshoring costs. As disused above, for existing multinational firms a reduction in τ_i reduces the costs of offshore hiring for the manufacture of components, which complement local hiring. Like the well-known productivity effect in Grossman and Rossi-Hansberg (2008), a fall in offshoring costs are a boon to local hiring within existing MNEs. Formally, this is seen from equation (11) that $\frac{\partial s(\cdot)}{\partial \tau_i} > 0$.

The terms in the second line correspond to pure substitution effects. Anticipating lower costs for the sourcing of components from integrated offshore suppliers, some firms may begin to substitute

[7]The alternative to IV estimation of industry level employment in (12) is to impose structural assumptions about the ranking of fixed costs across industries and the distribution of firm-level productivities, and estimated the propensity of firms to adopt each respective organizational type. We prefer our IV approach as it does not require that we impose assumptions about firm organizational behavior within, nor across, industries.

offshore labor within new affiliates for workers that used to be hired locally, either in house (first term in the second line) or by a local arms-length supplier (second term). A discrete rise in offshore production of components that used to be produce domestically has negative consequences for local industry-level employment; i.e., $\frac{\partial \mathbf{Pr}(h \in k)}{\partial \tau_i} < 0$ for $k \in I_i, U_i$.[8]

It is then an empirical question how a reduction in offshoring costs influences local employment at the industry-level.[9] The US Census Bureau reports that as much as 40% of all US imports are between related parties, so that a reduction in the incidence of double taxation for within firm trading activity may have a substantial quantitative effect to boost local employment. On the other hand, evidence in Blonigen, Oldenski, and Sly (2014) shows that the signing of a new BTT has a significant impact on the propensity of MNEs to open new affiliates in treaty countries. Evidence in MONARCH suggest that plant closures due to new offshoring activity substantially reduce firm-level employment locally, and Autor, Dorn, and Hanson (2013) find that increased import activity has a detrimental impact on local employment conditions. If the margin of firms that begin to use foreign affiliates to manufacture components is large when offshoring costs fall, then the substitution of local employment across these firms may lead to significant negative employment consequences at the industry-level.

[8]For the sake of exposition, we have been parsimonious in our characterization of the tasks of production and organization types. It is also possible that MNEs reallocate a specific set of tasks to an existing foreign affiliate, which would also substitute foreign labor for local hiring. In our empirical analysis we account for this possibility as well.

[9]General Equilibrium Effects

3 Empirical Approach

The model presented in Section 2 generated predictions about the effects of exogenous changes to offshoring costs on US employment both within multinational firm boundaries and across all firms operating within the same industry. In this section, we provide full details of our strategy for empirically testing those predictions. Because offshoring activities, firm organizational structures, and US labor market variables are endogenous, we instrument for industry-specific offshoring costs using bilateral tax treaties. Our objective is to use variation in foreign activity driven by the implementation of new BTTs to understand how offshoring affects US employment outcomes.

3.1 Overview of Empirical 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 industry-specific effects of bilateral tax treaties on foreign affiliate activity, as described in equation (10).
- The initial second stage (stage 2a) uses these first stage estimates to identify the impact of offshoring on firm-level employment, as described in equation (11).
- Stage 2b estimates the relationship between BTT-induced offshoring shocks and U.S. industry employment outcomes using household survey data from the Current Population Survey (CPS), as described in equation (12). Hence, we implement a two-sample IV, where the first-stage uses data on MNEs and the second stage looks at US employment at both MNEs and domestic firms.
- Stage 2c uses a Bartik-style analysis to examine the effects of offshoring on local labor markets within the US at the MSA level, based each market's initial industry concentration of employment.

3.2 Stage 1: Identifying the Firm-Level Effects of BTTs

Observations represent parent (h), destination country (d), industry (i), time (t) combinations.[10] We measure the effect of BTT's on log foreign affiliate employment, $offshoreEmp_{hdit}$ correspond-

[10] Hence we add the time dimension to the static model considered above.

ing to $m(\cdot)$ in the model above. Define T_{dt} as an indicator for periods when the U.S. has a BTT with destination d. For illustration purposes, we first abstract from potential heterogeneous treatment effects of BTTs across industries. Then the standard dif-in-dif regression corresponding to equation (10) above is[11]

$$OffshoreEmp_{hdit} = \beta T_{dt} + \varphi_{hid} + \alpha_t + \Phi X_{hdit} + \epsilon_{hdt} \ . \tag{14}$$

This specification includes time fixed effects, α_t, cross-sectional unit fixed effects, φ_{hid}, an indicator for when each cross sectional unit faces treatment, T_{hdit}, which in this case reduces to T_{dt}, as well as controls X_{hdit}. The estimate of β describes how employment activity changes for an affiliate newly facing a new BTT, compared to the change in activity for another affiliate not facing a new BTT in the same time period.

We then incorporate the evidence from BOS of heterogeneous treatment effects of BTTs across industries based on input differentiation into the dif-in-dif structure. Following BOS, define D_i to be the share of differentiated inputs required for an unit of production within industry i,

$$OffshoreEmp_{hdit} = \beta_1 T_{dt} + \beta_2 D_i T_{dt} + \varphi_{hid} + \alpha_{it} + \Phi X_{hdit} + \epsilon_{hdt}. \tag{15}$$

Note that the level effect of D_i is subsumed by the cross-sectional fixed effects, φ_{hid}. In this specification, the estimate of β_1 gives the treatment effect of a BTT in an industry with $D_i = 0$ and the estimate of β_2 gives the additional treatment effect for each unit increase in D_i.

To study more general sources of heterogeneity in treatment effect across industries, we allow the treatment effect to vary arbitrarily by industry and estimate the following:

$$OffshoreEmp_{hdit} = \sum_{\iota=1}^{I} \beta_i \mathbf{1}(i = \iota) T_{dt} + \varphi_{hid} + \alpha_{it} + \Phi X_{hdit} + \epsilon_{hdt}. \tag{16}$$

In this case, the estimates of β_i give the treatment effects of BTTs in each industry, without restriction. This will capture heterogeneity from the institution constraints across production modes that require various amounts of differentiated inputs, as well as any other industry features.

A potential concern with these approaches is that if parent firms have affiliates in multiple

[11](e.g. Bertrand, Duflo, and Mullainathan (2004))

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.

3.3 Stage 2a: Employment Effects of Offshoring Within Firm Boundaries

In Stage 2a we are concerned with the effect of increased offshoring activities on employment within US MNE firm boundaries, using the predicted offshoring values from Stage 1 as instruments for offshore employment by US MNEs. Building from equation (11) above, our estimating equation is

$$y_{ht} = \beta ln(Off\widehat{shore}Emp)_{hdit} + \gamma ln(OffshoreEmp)_{hd't} + \varphi_{hid} + \alpha_t + \Phi X_{hdit} + \epsilon_{hdt} \ , \qquad (17)$$

where y_{ht} is the log number of US employees of parent firm p in year t, $ln(Off\widehat{shore}Emp)_{hdit}$ 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 estimation. 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 $ln(OffshoreEmp)_{hd't}$.

The model above predicts that there are heterogeneous effects of changing offshore employment for firms that operate in industries that exhibit different elasticities of substitution between varieties within that sector, as well as heterogeneous effects within MNEs that open new offshore affiliates and those that previously operate them prior to changes in offshoring costs. We will estimate (17) for different sub-samples to explore this heterogeneity. First, we separately estimate the within-firm employment effects of offshore employment for high and low elasticity of substitution industries, using the procedure described in Soderbery (2014) to estimate the respective elasticities. Second, we separately estimate the within-firm employment effects of offshore employment for the set of firms that open a new affiliate in a country that enters a new BTT with the US, and compare the estimated effects with the sample including all existing MNEs.

3.4 Stage 2b: Employment Effects of Offshoring Across Firm Boundaries – Industry-Level Analysis

To the extent that workers can move between MNEs and domestic firms, we expect that offshoring by MNEs should affect employment in each industry as a whole, not just with the firms engaged in offshoring activity. To measure this effect, we use a two-sample IV, where the first-stage uses data on MNEs and the second stage looks at US employment at both MNEs and purely domestic firms. Using a log-linearized specification of equation (13), the second stage estimating equation for local industry employment is

$$Emp_{it} = \beta \sum_{it} ln(Off\widehat{shoreE}mp_{hdit}) + \varphi_i + \alpha_t + \epsilon_{it}. \tag{18}$$

Where Emp_{it} is the total number of US workers employed in industry i in year t from the Current Populations Survey (CPS). $ln(Off\widehat{shoreE}mp_{hdit})$ is the predicted employment by firm h in country d, industry i, and year t estimated in Stage 1. We sum these predicted values over all foreign affiliates of parents operating in industry i in year t to capture the total offshoring shock to that industry.

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.

$$Emp_{rt} = \beta ln(o\widehat{ffshor}ing)_{rt} + \varphi_r + \alpha_t + \epsilon_{rt}. \tag{19}$$

We measure each region's exposure to offshoring using the share of local employment in each industry in 1986 as weights. 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.

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 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.[12] 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.[13] 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.

[12]See IRS.gov, *United States Income Tax Treaties A-Z.*

[13]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

Country	Date	Country	Date
Bangladesh	2007	Russia	1993
Estonia	1999	Slovenia	2001
India	1990	Spain	1990
Indonesia	1990	Sri Lanka	2004
Israel	1994	Thailand	1997
Latvia	1994	Tunisia	1990
Lithuania	1994	Turkey	1997
Mexico	1993	Ukraine	2000
Portugal	1995	Venezuela	1999

Our key industry characteristic is the share of inputs traded on an organized exchange or with a 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.[14]

Out model also delivers predictions about how the domestic effects of offshoring differ for firms with different elasticities of substitution. We will test these predictions using elasticities computed using the methodology described in Soderbery (2014).

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

[14]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.

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. Table 2 provides summary statistics for each variable used to estimate the impact of BTTs.

5 Results

This section presents the results of the first stage estimation of the relationship between offshore employment activity and the implementation of new BTTs across countries, time, and industries, followed by our second stage estimates of the relationship between offshore employment and local employment outcomes.

5.1 First Stage Results

Our empirical strategy relies on the assumption that there is no meaningful difference in treated and non-treated countries prior to the signing of a BTT. Consistent with the evidence in BOS and the first-stage estimation strategy in (15), 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 $t0$.[15] We delineate

[15]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).

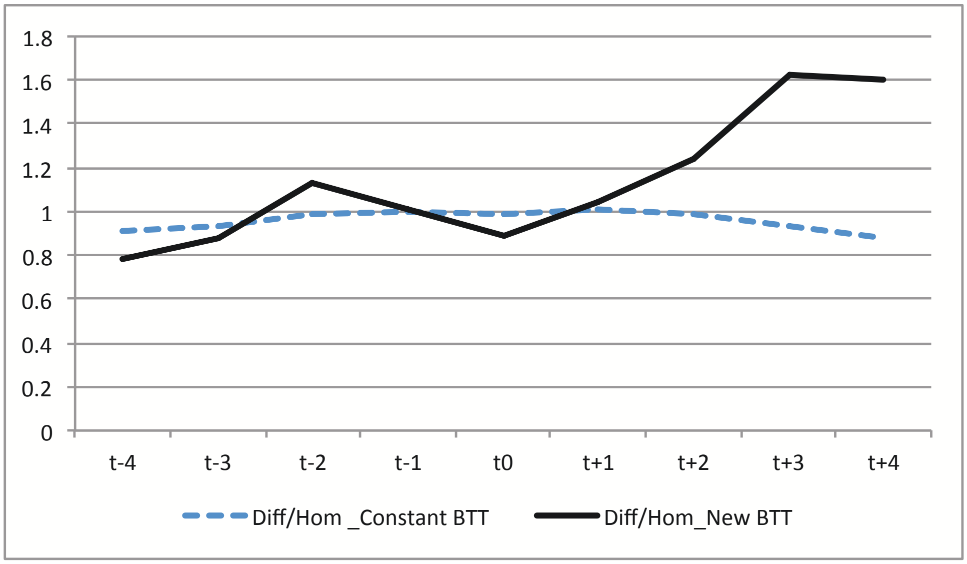

Figure 1: Relative Foreign Affiliate Activities Across Treaty Status and Time

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 $t0$. This fact assuages concerns about the presence of pre-existing trends in activity *across sectors* spuriously driving our regression results.[16] 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.

Figure 2 presents an event study graph of the coefficients on BTTs for the three years prior to and after their signing. As is clear from the graph, there do not appear to be any pre-trends in the relationship between BTTs and FDI leading up to the signing of a new treaty. This is evidence that our first stage results on the relationship between BTTs and FDI are not spuriously picking up on an underlying relationship in the data that would have existed absent the treaties.

[16] 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.

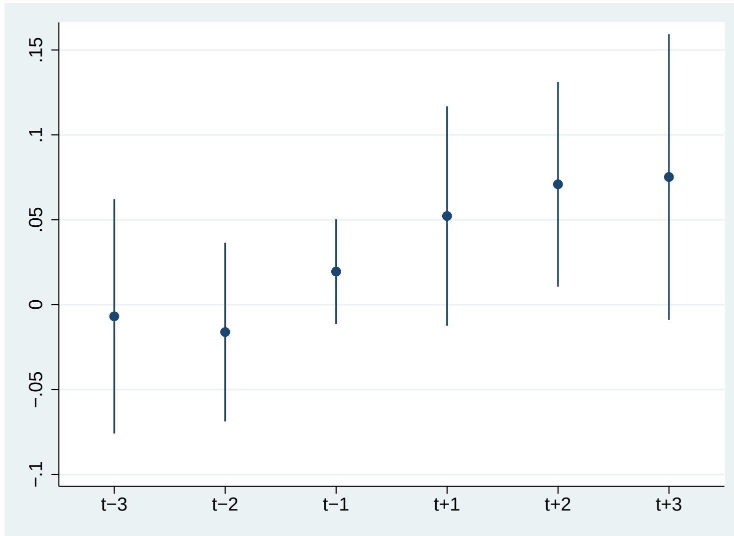

Figure 2: Event Study Regression Results

We next estimate the relationship between BTTs and offshoring using Equations (14), (15), and (16).

The theoretical results derived in Section (2) are based on a two-country model. However, most of the firms in our sample have multiple affiliates in different countries. We refer to affiliates of the same parent as "siblings." When the country in which an affiliate is located signs a treaty with the US, this may impact siblings in other countries, as well as the affiliate in the treaty country. Moreover, treaties between two siblings could also facilitate the shifting of production between affiliate countries for tax purposes. To address these concerns, our preferred empirical approach controls for the signing of new BTTs between the US and an affiliate's sibling countries (*sibling-parent btt*), as well as new treaties between the affiliate country and its sibling countries (*affiliate-sibling btt*).

Consistent with Blonigen, Oldenski, and Sly (2014), Table (2) shows that the average effect of BTTs on affiliate activity is not significant. However, this aggregate result masks important industry-level differences. Table (3) shows that these treaties have a positive and significant impact for firms in industries that use differentiated inputs more intensively. Intensive use of differentiated inputs (*High dif*) is defined as having a share of differentiated inputs that is above that of the median industry. As demonstrated by Blonigen, Oldenski, and Sly (2014), the industry level difference in treaty effects stems from transfer pricing provisions that disproportionately benefit

Table 2: The Relationship between BTTs and Offshoring.

Model :	1	2	3
Depvar:	ln(emp)	ln(emp)	ln(emp)
btt	0.063	0.065	0.068
	(0.041)	(0.040)	(0.045)
sibling-parent btt		0.014***	0.012**
		(0.005)	(0.005)
affiliate-sibling btt		0.023**	0.018**
		(0.010)	(0.008)
lsgdp			3.374***
			(0.984)
lgdfsq			0.073
			(0.085)
lskldf			-0.056***
			(0.019)
ltcost			-0.012
			(0.008)
bit			-0.072
			(0.057)
fta			-0.057
			(0.046)
exrate			0.000
			(0.000)
Affiliate FE	YES	YES	YES
Year FE	YES	YES	YES
N:	98265	98265	96276
R-sq	0.005	0.006	0.012

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

firms in industries that use inputs for which an 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 across industries. However, these industry-level effects vary predictably with the complexity of inputs. Figure 3 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.

Table 3: The Relationship between BTTs and Offshoring by Differentiated Input Intensity.

	1	2	3	4	5	6
Sample:	High dif	Low dif	High dif	Low dif	High dif	Low dif
Depvar:	ln(emp)	ln(emp)	ln(emp)	ln(emp)	ln(emp)	ln(emp)
btt	0.157***	-0.029	0.157***	-0.022	0.145***	-0.006
	(0.043)	(0.055)	(0.044)	(0.053)	(0.047)	(0.052)
sibling-parent btt			0.011	0.018***	0.010	0.015***
			(0.008)	(0.005)	(0.009)	(0.004)
affiliate-sibling btt			0.020	0.023**	0.012	0.020**
			(0.016)	(0.011)	(0.013)	(0.010)
lsgdp					3.939***	2.617**
					(0.922)	(1.374)
lgdfsq					0.113	0.023
					(0.082)	(0.118)
lskldf					-0.076**	-0.031
					(0.029)	(0.025)
ltcost					-0.020*	-0.003
					(0.011)	(0.010)
bit					-0.080	-0.072
					(0.121)	(0.045)
fta					-0.016	-0.098***
					(0.058)	(0.036)
exrate					0.000	0.000
					(0.000)	(0.000)
Affiliate FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N:	52041	46224	52041	46224	51103	45173
R-sq	0.008	0.005	0.008	0.007	0.015	0.010

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

5.2 The Impact of Offshoring on Firm-Level Employment and Wages

We now turn to the second stage results using the estimated offshoring from Section 5.1 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 (16) and presenting in Columns 5 and 6 of Table (3). These results consider

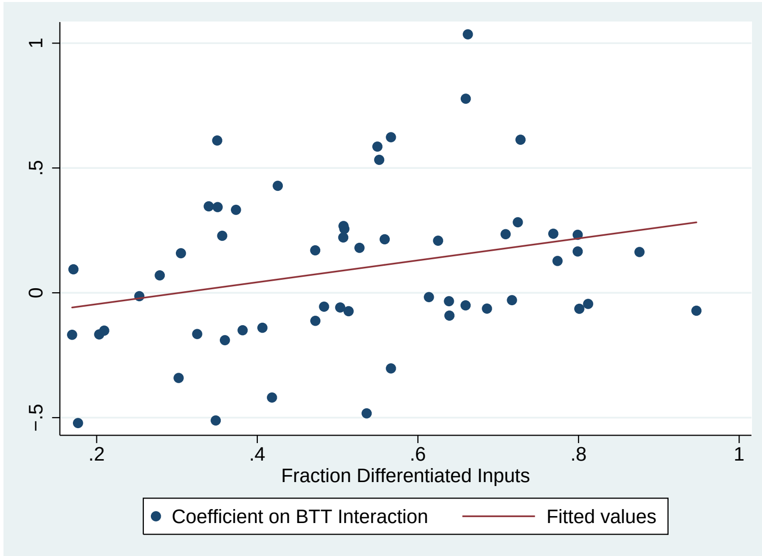

Figure 3: Coefficients on BTT interactions by fraction of differentiated inputs.

the impact of an exogenous increase in offshoring by a US firm on the domestic US employment and wages of that same firm. The positive coefficient on $ln(\widehat{offshoring})$ in Column 1 suggests that an increase in employment at foreign affiliates induced by new BTTs is associated with an increase in employment at the firms US locations. This result is consistent with the theoretical framework presented in Section 2.

However, the employment effects may not just take place between the multinational parents and their affiliates in the country with which the BTT was signed. Most of the firms in our sample have affiliates in more than one country. It is also possible that BTTs may induce shifts across affiliates of the same parent that are located in different countries. For this reason, we also control for employment at other affiliates of the same firm and report these results in column 2 of Table 4. The positive relationship between offshoring and domestic employment still holds.

Note that the offshoring measure used in these regressions is at the affiliate level, but the outcome variable is parent-level employment, where each parent may have multiple affiliates. The interpretation is as follows: A one percent increase in employment at a single affiliate of a given US parent results in a 0.2 percent increase in employment at that US parent. However, this is not the total effect of all offshoring by a given firm, as the average firm in our sample has affiliates in multiple countries.

Table (5) aggregates the predicted values of affiliate employment over all affiliates of the same

Table 4: Second Stage: Affiliate Level

Model :	1	2
Depvar:	ln(par emp)	ln(par emp)
$ln(\widehat{offshoring})$	0.156***	0.194***
	(0.044)	(0.046)
ln(sibling emp ind)		0.106***
		(0.002)
lsgdp	-2.266***	-2.316***
	(0.272)	(0.277)
lgdfsq	-0.110***	-0.126***
	(0.024)	(0.024)
lskldf	0.008	0.006
	(0.007)	(0.007)
ltcost	-0.002	0.0004
	(0.002)	(0.002)
bit	-0.019	0.004
	(0.018)	(0.018)
fta	-0.002	0.011
	(0.007)	(0.008)
exrate	-0.00001	-0.00001
	(0.00001)	(0.00001)
Affiliate FE	YES	YES
Year FE	YES	YES
N:	97010	82284
R-sq	0.023	0.058

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

US parent firm. As with the affiliate-level results, the net effect on employment at the parent firm is positive. This is consistent with the intensive margin predictions described in Section 2.

The model presented in Section 2 predicts specific patterns of heterogeneity in the effects of offshore employment, in which the magnatude of the productivity effect depends on the elasticity of substitution, σ. Intuitively, when different varieties within an industry are highly substitutable, the additional rents generated by a fall in offshoring costs and the resulting increases in hiring at the foreign affiliate are relatively smaller. Hence, the parent company of an MNE in North responds to greater offshoring activity with a relatively smaller increase in hiring within industries that exhibit higher elasticities of substitution. Within industries with higher values of σ_i the estimated effect

Table 5: Second Stage: Parent Level

Model	1	2	3	4
Sample	All	σ Blw Med	σ Abv Med	New Aff Post-BTT
Depvar:	ln(par emp)	ln(par emp)	ln(par emp)	ln(par emp)
$ln\sum(\widehat{offshoring})$	0.134***	0.156***	0.112***	0.092***
	(0.006)	(0.009)	(0.009)	(0.014)
Parent FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N:	22976	10028	9785	3901
R-sq	0.022	0.025	0.024	0.006

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

of increases of offshoring on local hiring should be relatively smaller. Columns 2 and 3 of Table 5 present results consistent with those predictions.

As shown in Section 2, in addition to the positive productivity effects of offshoring, there may also be negative substitution effects. Some multinational firms may decide to alter their global organizational structure in response to the lower cost of offshoring. As a result, they may substitute foreign employment within an offshore affiliate for workers that previously manufactured components in the US.

Consider a firm that initially sources the manufacture of components from suppliers in the North or internally using workers in the North. Within these firms that switch to using an offshore affiliate, the increase of hiring within the offshore affiliate is a direct substitute for local employment. Next, consider a firm that initially sources the manufacture of components from an independent supplier in the South. Within these firms that switch to using an offshore affiliate after offshoring costs fall, there is no substitution of foreign labor for local employment, only a substitution of foreign labor outside the boundaries of the MNE for workers within the affiliate. Thus, we expect that among the set of MNEs that open a new affiliate when offshoring costs fall, the gains in within-firm employment are smaller (or no greater) than for the set of existing MNEs. Unfortunately, we do not observe if a new offshore affiliate is performing activities that previously took place where the parent resides, in the country of the affiliate but outside the boundaries of the firm, or in a different country entirely. As a result, the strongest prediction that we can make using our sample is the to compare the relative changes in employment within existing MNEs and within those that open new affiliates. To do this, we restrict our sample to include only firms that opened a new affiliate in a BTT country. These results are presented in column 4 of table 5. As predicted, the coefficient on $ln \sum (\widehat{offshoring})$ for this set of firms is smaller than for the full sample.

5.3 Aggregate Industry Level Effects of Offshoring on Employment and Wages

The results presented in Section 5.2 only consider the impact of offshoring on employment and wages of the firm doing the offshoring. However, the model presented in Section 2 shows that a fall in offshoring costs can also impact firms that had previously bee purely domestic firms but then became MNEs due to the fall in the cost of offshoring. Thus we would expect the labor market effects of offshoring to extend beyond the MNEs 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 MNEs.

Table (6) shows the relationship between offshoring and wages at the industry level. Column 1 presents the results of an OLS regression that does not use the BTT instrument described in Section 3. Columns 2 follows the two-sample-IV strategy.[17]

Both the OLS and 2SLS specifications show a positive and significant relationship between offshoring and US domestic employment and wages. However, comparing Columns 1 and 2 shows that the magnitude of the effect is much smaller when the BTT instrument is used to correct for endogeneity. This points to the importance of using a valid instrument when estimating the impacts of offshoring on US workers. There is a great deal of endogeneity between offshoring and domestic labor market outcomes, which implies that OLS estimates will vastly overstate the positive effects of offshoring. Note also that the magnitude of the relationship between offshoring and domestic US employment is much smaller at the industry level than at the firm level. That is because the industry level results capture the substitution effects as well as the productivity effects.

[17]Because this is a two-sample least squares framework, future versions of this paper will present bootstrapped standard errors.

Table 6: Second Stage: Industry and MSA Level

	1	2	3
Specification:	OLS	2SLS	2SLS
Depvar:	ln(industry emp)	ln(industry emp)	ln(msa emp)
ln(offshoring)	0.530***		
	(0.031)		
$ln \sum (\widehat{offshoring})$		0.027**	0.050***
		(0.013)	(.010)
Industry FE	YES	YES	-
MSA FE	-	-	YES
Year FE	YES	YES	YES
N:	2527	2527	6384
R-sq	0.264	0.349	0.724

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

5.4 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 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.

Column 3 of Table 6 shows the preliminary MSA-level results. As with the aggregate industry-level results, the relationship between offshoring and employment is positive. Future versions of this paper will more rigorously examine the factors that determine whether a given industry or 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 the endogeneity of offshoring decisions and differences between offshoring within and across firm boundaries. We present a theoretical model of endogenous global sourcing by MNEs that allows us to separately identify the within and across firm effects. This model leads us to a new instrumental variable that varies across industries, countries, firm organization structures, and time in a way that is consistent with our model. Our results show that offshoring has a positive aggregate impact on US labor markets, but the impact is much greater within versus across firms.

Appendix

Section 2.3 describes the optimal hiring decisions of parent companies and their affiliates. He we provided the details of the solution to the parent company's problem problem in (5). The first order condition for optimal hiring decisions $s(\cdot)$ at parent firm h that sources inputs from its affiliate in the south is given by

$$\left[\frac{s(h)}{\eta_i}\right]^{\alpha(1-\eta_i)} = w^N \left[\delta^{\alpha_i} + \beta(1-\delta^{\alpha_i})\right]^{-1} (\alpha_i)^{-1} \theta_h^{-\alpha_i} X^{\alpha_i-\mu} \left[\frac{m(h)}{1-\eta_i}\right]^{1-\alpha_i\eta_i} .$$

Note that the term $w^N \left[\delta^{\alpha_i}\beta(1-\delta^{\alpha_i})\right]^{-1} (\alpha_i)^{-1}\theta_h^{-\alpha_i} X^{\alpha_i-\mu}$ is only a function of firm, industry and country characteristics. Thus we can denote this group of parameters as $\overline{\Psi}_{hid}$. In the text we log-linearize this solution and use the notation $\psi_{hid} = \ln \overline{\Psi}_{dhi}$ to denote the firm $\times$ industry $\times$ country effect that influences the level of parent hiring.

Now, substituting optimal hiring decisions by the affiliate $m(h)$ from equation (8) yields

$$s^*(h) = \left[\overline{\Psi}_{dhi}(1-\eta_i)^{\frac{\alpha_i(1-\eta_i)}{\alpha_i\eta_i-1}} \Psi^{\frac{\alpha_i(\eta_i-1)}{\alpha_i\eta_i-1}} \eta^{\frac{\alpha_i(\eta_i-1)}{\alpha_i\eta_i-1}\frac{\alpha_i\eta_i}{\alpha_i(1-\eta_i)-1}} \tau_i^{\frac{\alpha_i(\eta_i-1)}{(\alpha_i\eta_i-1)(\alpha_i(1-\eta_i)-1)}}\right]^{\frac{\alpha_i(1-\eta_i)-1}{\alpha_i-1}} \tag{A.1}$$

which can be simplified to $s^*(h) = \overline{\sigma}_{dhi}\ \tau_i^{\xi_1}$.

It is then straightforward to solve for optimal hiring decisions by the affiliate by substituting the parent's choice $s(h)^* = \overline{\sigma}_{dhi}\ \tau_i^{\xi_1}$. We obtain

$$m^*(h) = \Psi_{dhi}\eta^{\frac{\alpha\eta_i}{\alpha_i(1-\eta_i)-1}} \left[\overline{\sigma}_{dhi}\ \tau_i^{\xi_1}\right]^{\frac{-\alpha\eta_i}{\alpha_i(1-\eta_i)-1}} \tau_i^{\frac{1}{\alpha_i(1-\eta_i)-1}} \tag{A.2}$$

which can then be simplified to $m^*(h) = \sigma_{dhi}\ \tau_i^{\xi_2}$.

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