The Labor Market Effects of Offshoring by U.S. Multinational Firms*

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Abstract

Previous papers on the labor market effects of offshoring have found very different results in terms of both the sign and magnitude of the relationship. This is in large part because offshoring encompasses many different activities and likely affects different types of firms in different ways. We first present a model of global sourcing to show how the relationship between offshoring and domestic employment can be expected to vary within and across different types of firms. We then use firm-level data on offshoring by U.S. MNEs from the Bureau of Economic Analysis (BEA) to test the model's predictions at the firm, industry, and regional levels. Because the inherent simultaneity of multinational firms' domestic and foreign affiliate employment decisions complicates causal identification, we introduce a new instrument for offshore employment: Bilateral Tax Treaties (BTTs). These treaties reduce the effective cost of offshore activity and their implementation is uncorrelated with existing employment trends. We find substantial heterogeneity in effects based on offshoring margin and firm organizational structure. A 10 percent BTT-induced increase in affiliate employment drives a 1.8 percent increase in employment at the U.S. parent firm, with smaller effects at the industry and regional levels. In contrast, increased foreign affiliate activity in vertically oriented multinational firms drives declining employment among non-multinationals in the same industry, and multinational firms opening new affiliates exhibit much smaller domestic employment growth than those expanding existing affiliates. Overall, our results indicate that greater offshore activity modestly raises net employment by U.S. firms, albeit with underlying job loss and employment reallocation.

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1 Introduction

For more than a decade, the question of how offshoring affects domestic employment has been at the forefront of political and popular discussions of international economic policy. In spite of the salience of this question, there is little agreement among academic economists regarding the sign of offshoring's effects on domestic labor market outcomes, let alone the magnitude.[1] This is in large part because the term offshoring comprises many different activities. Offshoring may take place within a multinational firm or at arms length. Firms may relocate U.S. production to new plants in other countries, or they may increase their output at existing offshore locations. The work performed in the U.S. may be similar to or different from the work performed offshore. These different dimensions of offshoring decisions could have different effects not only on the workers at that firm doing the offshoring, but also on workers at competing firms within the same industry or in supporting industries within the same geographic location.

We use the global sourcing model of multinational firms developed by Antràs and Helpman (2004) to show how different margins of offshoring will affect domestic workers and to derive a panel difference-in-differences estimation strategy, with changes in effective tax rates of foreign affiliates serving as an instrument for offshore employment. By merging data on U.S. multinational enterprises (MNEs) from the U.S. Bureau of Economic Analysis (BEA) with County Business Patterns data, we are able to conduct our empirical analysis at different levels of aggregation and using different sets of firms to identify the various effects of offshoring on domestic employment within one consistent framework. We examine the effects on employment within U.S. multinational firms, for all workers in a given U.S. industry, and for all workers in a given region, highlighting substantial differences in the effects across industries (high vs. low differentiation), offshoring margin (extensive vs. intensive), and organizational form (domestic vs. multinational). Our results show that these distinctions matter. A 10 percent increase in affiliate employment drives a 1.8 percent increase in employment at the U.S. parent firm, with smaller effects at the industry and regional levels. In contrast, increased foreign affiliate activity in vertically oriented multinational firms drives declining employment among non-multinationals in the same industry, and multinational firms opening new affiliates exhibit much smaller domestic employment growth than those expanding existing affiliates. Overall, our results indicate that greater offshore activity modestly raises net employment by U.S. firms, albeit with underlying job loss and employment reallocation.

Any empirical analysis of the labor market effects of offshoring is complicated by the fact that

[1] For example, Desai, Foley, and Hines (2009) find a positive relationship between domestic labor market outcomes and offshoring activities of U.S. multinationals, while Muendler and Becker (2010) find negative effects for German multinational firms. Harrison and McMillan (2011) provide evidence from the U.S. that the association between offshore and domestic employment may depend on the type of offshoring activity. The destination of offshore activities may also alter the relationship between domestic and foreign employment; see Brainard and Riker (1997). Rather than positive or negative effects, several studies find null impacts of offshoring on domestic labor market outcomes, e.g. Slaughter (2000, 2001), Ottaviano, Peri, and Wright (2013), and Antràs, Fort, and Tintelnot (2017).

offshore activity and domestic employment both reflect choices made by firms, making it difficult to disentangle the causal relationships between the two phenomena. As an example, if a firm faces a positive demand shock for its output, it is likely that both domestic employment and employment at offshore affiliates will increase, yet this correlation teaches us little about the causal effects of offshoring on domestic employment.

To overcome this inherent simultaneity between domestic and offshore employment, we exploit a policy instrument that is exogenous to firm choices and drives permanent declines in the costs of offshore activity. In particular, we identify changes in the relative costs of offshore activity resulting from new bilateral tax treaties (BTTs). These treaties allow U.S. firms to avoid double taxation, in which foreign affiliate income is taxed in two jurisdictions due to constraints on the size of the foreign tax credit available to US-owned firms. BTTs make this constraint less likely to bind, lowering the average effective tax rate on income from foreign affiliates, hence lowering the overall cost of offshore activity. During our sample period of 1987-2007, countries accounting for 23 percent of total foreign affiliate employment of U.S. multinational firms received new BTTs with the U.S. We leverage variation in the timing of these treaties, the pre-existing country mix of multinational firms' affiliates, and the incidence of double taxation across industries to infer the causal effect of BTT-induced changes in foreign affiliate employment on changes in U.S. domestic employment.

We take care to ensure the exogeneity of BTTs with respect to counterfactual employment outcomes, ruling out confounding pre-trends and the influence of simultaneous policy reforms. For our exclusion restriction to hold, it must be the case that BTTs only impact the domestic hiring decisions of U.S. firms through their effect on foreign affiliates. We offer several pieces of evidence supporting this assumption. First, BTTs reduce the tax burden on foreign affiliate activities, leaving the taxation of domestic activity unchanged. Second, the vast majority of double-taxation cases involving U.S.-owned firms are raised in the foreign affiliate's country, suggesting that this is where the costs of double taxation are incurred (Ernst and Young 2015). Third, we show that firms in non-differentiated industries exhibit no reduced-form relationship between BTTs and U.S. employment, nor do they have significant first stage results linking BTTs with foreign affiliate employment. These relationships only exist for the sample of firms in highly differentiated industries, again supporting the exclusion assumption (Angrist and Pischke (2009) p.131). Finally, our IV estimates are significantly smaller than the corresponding OLS results and are less than one third the magnitude of estimates in the most closely related prior literature (Desai, Foley, and Hines 2009), which suggests that our instrument substantially ameliorates upward simultaneity bias.

We motivate our empirical analyses using the incomplete contracts model of multinational firms developed by Antràs and Helpman (2004).[2] This framework i) demonstrates the simultaneity of

[2]See Feenstra and Hanson (2005) and Defever and Toubal (2013) for empirical support of the property rights/incomplete contracts theory of multinational firms.

employment decisions at a domestic parent and its foreign affiliates, ii) characterizes the division of revenue between multinational parents and affiliates, which is necessary to address double-taxation, iii) characterizes sourcing decisions within and across both country and firm boundaries, dimensions of offshoring that have different implications for U.S. employment, and iv) yields a panel difference-in-differences estimation strategy, with changes in effective tax rates of foreign affiliates serving as an instrument for offshore employment.

We rule out the presence of confounding pre-trends using an event-study framework demonstrating similar employment trends for affected and unaffected firms prior to BTT implementation. This analysis also documents positive (reduced-form) effects of BTTs on domestic employment in multinational firms, with results concentrated in high differentiation industries. This is to be expected since the pre-treaty incidence of double-taxation is larger for firms in industries with more highly differentiated products.[3] We also find a strong positive (first-stage) effect of BTTs on foreign-affiliate employment, but only in high differentiation industries. The absence of effects in low differentiation industries helps rule out identification concerns regarding other policy reforms that might have occurred simultaneously with BTTs.

Given that BTTs only substantially affect affiliate employment in high differentiation industries, our main empirical results restrict attention to that subset of industries. We estimate the effects of expanding offshore affiliate employment on domestic employment using BTTs as an instrument for affiliate employment, finding that increased foreign affiliate employment drives economically modest but statistically significant positive effects on domestic employment at multinational parent firms. A 10 percent BTT-induced increase in affiliate employment drives a 1.8 percent increase in employment at the U.S. parent firm. This positive overall effect of BTTs suggests that, although domestic and offshore employment are substitutes in production, declining costs of offshore activity allow multinational firms to lower prices and expand output, and this scale effect more than offsets substitution effects. However, underlying this positive average effect is substantial heterogeneity across firms. For example, consistent with theoretical predictions, multinational firms expanding existing affiliates drive the positive effect on domestic employment while those opening new affiliates exhibit no change in U.S. employment in response to changes in affiliate activity.

We use County Business Patterns data to study employment outcomes for overall national industries and regional labor markets. The industry perspective allows us to capture two margins that are absent in the analysis of multinational firms alone. First, changes in employment at multinational parents may be partly offset by equilibrium employment adjustment at other domestic firms in the same industry. Second, declining costs of offshore activity will likely motivate some firms to become multinational firms by opening new affiliates. Both margins predict smaller effects at the industry level than at the multinational parent level, and this is what we find. The overall

[3] Blonigen, Oldenski, and Sly (2014) provides evidence that the effects of BTTs vary across U.S. industries according to the use of differentiated inputs, which we note is highly correlated with the industries that sell highly differentiated final products.

industry employment effect is less than one tenth as large as the effect within multinational parents, and employment at non-multinational firms significantly declines in response to increased offshore activity at vertically oriented multinational firms in the same industry, suggesting substitution of intermediate input purchases from domestic suppliers to foreign affiliates. Finally, we examine effects at the regional level, capturing potential spillovers across industries in the same metropolitan area. We generate a regional measure of offshoring exposure as a weighted average of industry-level foreign affiliate employment, with weights reflecting the market's initial industry mix, using a procedure similar to Topalova (2010), Autor, Dorn, and Hanson (2013), and Kovak (2013). As before, we instrument for observed affiliate employment using BTTs. The metro-area estimates are somewhat larger in magnitude than the industry results, consistent with the presence of cross-industry spillovers at the regional level.

Our paper contributes in a variety of ways to the large literature on the labor market effects of offshoring. We introduce Bilateral Tax Treaties as a new source of identifying policy variation in the effective cost of offshore activity. Although BTTs have been extensively studied in prior work, to our knowledge they had not been used to examine the domestic labor market effects of offshoring.[4] While many papers studying the labor market effects of offshoring rely on short-run variation in the costs or benefits of offshore activity, BTTs drive permanent reductions in the effective cost of offshore activity for multinational firms, which more closely parallels the secular declines in offshoring costs during recent decades.[5]

Other work has documented that the relationship between offshore and domestic employment varies according to the affiliate country (Brainard and Riker 1997) and the type of offshoring activity (Harrison and McMillan 2011). By examining outcomes at different levels of aggregation and for different subsamples, we are also able to capture heterogeneity in the effects of offshoring across firms with different organizational forms and different offshoring margins. For example, our parent-level analysis suggests that extensive-margin offshoring (opening new affiliates in response to cost reductions) reduces domestic employment within multinationals, while intensive-margin adjustments (increasing employment at existing affiliates) increases domestic employment. These findings suggest that there is not a single effect of increased offshore activity on domestic employment, but that the effects vary depending on the circumstances, potentially explaining differences in empirical findings across research papers.[6] This heterogeneity suggests that further parsing

[4]See, for example, Blonigen and Davies (2004), Davies (2004), di Giovanni (2005), Egger et al. (2006), Louie and Rousslang (2008), (Davies, Norback, and Tekin-Koru 2009), and Blonigen, Oldenski, and Sly (2014).

[5]Closely related prior work uses variation based at least partly on year-to-year changes in affiliate-country GDP (Desai, Foley, and Hines 2009) or wages (Brainard and Riker 1997; Slaughter 2000; Muendler and Becker 2010; Harrison and McMillan 2011).

[6]For example, we find more positive net effects on domestic employment than a recent paper by Boehm, Flaaen, and Pandalai-Nayar (2017), who find declining domestic employment in response to offshoring. Their analysis restricts attention to U.S. manufacturing establishments, omitting the headquarters establishments where positive scale effects are most likely to emerge. They also observe offshoring at arms-length and extensive margin offshoring at newly formed multinationals. Both of these margins likely contribute to domestic employment declines but are unobservable in the

differences in the effects by industry, firm structure, offshoring mode, and other dimensions is a productive avenue for future work.

This observation also has important implications for relating our findings to others in the broader literature on the effects of increased imports, which tends to find negative effects of total imports on labor market outcomes (e.g. Autor, Dorn, and Hanson (2013), and Hummels et al. (2014)). Total imports include final goods, inputs purchased abroad at arms-length, and inputs purchased from foreign affiliates of domestic multinationals. Each of these trade flows may have a different effect on domestic labor market outcomes and is subject to different policy interventions, meaning that there is value in carefully measuring the effects of each type of international economic activity. We focus on the effects of increased employment at foreign affiliates of U.S. multinational firms, both to take advantage of a compelling policy-based identification strategy and because the potential effects of offshoring by multinational firms have been the topic of much attention in political debates and the popular press, distinct from discussions of trade more broadly. Moreover, the U.S. Census Bureau reports that upwards of 40 percent of U.S. imports are between related parties, while Slaughter (2009) provides evidence that multinational enterprises account for approximately 20 percent of total employment in the U.S. Hence, the type of offshoring we consider here is of first-order importance to U.S. labor market outcomes.

Our research design explicitly measures the overall effects of declining costs of offshore activity, including potential substitution and scale effects. We find evidence that both effects are important, and that scale effects are larger on average, leading to a modest positive net impact of offshoring on domestic employment. This approach is distinct from that in a few papers estimating substitution parameters in multinational firm-level cost functions, which explicitly hold firm output fixed to isolate substitution effects.[7] In our framework, the key mechanism driving the positive relationship between domestic and offshore affiliate employment is that firms may expand output as offshoring costs fall, and thus increase domestic employment. Hence, our positive estimates are entirely consistent with prior work finding that foreign and domestic employment are substitutes, since our estimates reflect a combination of substitution and scale effects. Moreover, we find independent evidence for the quantitative importance of substitution effects by showing much smaller employment growth in firms opening new affiliates in BTT countries, a margin in which substitution effects are most important.

The following section describes Bilateral Tax Treaties and the data we utilize to study their effects. Section 3 estimates the reduced-form effect of BTTs on domestic employment in multinational firms, emphasizing that the appearance of BTTs was uncorrelated with pre-existing firm

BEA data. In contrast,Suárez Serrato (2018) examines the effects of an effective tax increase on firms with existing affiliates, in which scale effects are most likely to dominate, finding domestic employment effects consistent with ours.

[7] e.g. Slaughter (2000) and Muendler and Becker (2010). Harrison and McMillan (2011) control for output by assuming that firm output depends only upon domestic and foreign prices and then empirically proxying for those prices using industry sales.

employment growth. Section 4 presents our main analysis, studying how increased offshore employment affects domestic employment. This includes the theoretical framework, analysis of how BTTs affect foreign affiliate employment, and results for the effects of offshoring at the multinational parent, industry, and regional levels. Section 5 concludes.

2 Background and Data

This paper identifies the effects of offshore employment on domestic employment using variation in offshore activity driven by Bilateral Tax Treaties (BTTs). BTTs resolve a problem called "double taxation," in which limits on the amount of foreign tax credits available to U.S. multinational firms result in the same income being taxed in two jurisdictions, potentially raising the effective tax rate for foreign affiliates well above the statutory level in either jurisdiction.

In particular, during our sample period the U.S. corporate tax applies to worldwide profits, meaning that profits resulting from a U.S. multinational firm's activities both at home and abroad are subject to the U.S. corporate tax. This is in contrast to territorial systems, in which foreign affiliate activity is only taxed by the country in which the affiliate is located. Under the U.S.'s worldwide system, any foreign tax on foreign affiliate activity would subject the firm to double taxation in the absence of some compensation. In an effort to limit this possibility, the U.S. government offers a foreign tax credit to U.S. firms to offset their foreign tax liabilities.[8] However, a U.S. multinational firm may not claim a foreign tax credit that exceeds the U.S. tax on foreign earned income, otherwise the U.S. IRS would implicitly subsidize the foreign tax authority. When foreign tax liability exceeds this limit, a portion of the firm's income is taxed by both the U.S. and foreign taxing authorities without an offsetting credit. Double taxation of this kind is most likely to arise when the foreign jurisdiction imposes a substantial tax on royalties, interest, or dividends, known as a "withholding tax." As discussed below, these rates can be quite high, such that the combined corporate income tax and withholding tax in many foreign jurisdictions can exceed the relatively high U.S. corporate tax rate. In this circumstance, the firm owes withholding taxes to the foreign tax authority without receiving a fully offsetting credit, resulting in double taxation and imposing additional costs on the foreign activities of the firm.[9]

Table 1 provides information on each of the U.S. BTTs that entered into force during our sample period.[10] These treaty partner countries account for 23 percent of total foreign affiliate employment

[8]See Desai, Foley, and Hines (2001) for a brief introduction to the U.S. foreign tax credit and Doernberg (2016) Chapter 8 and Misey and Schadewald (2015) Chapter 4 for detailed treatments.

[9]Desai, Foley, and Hines (2001) study the effects of this potential double taxation on dividend repatriation by U.S. multinational firms, relying on cross-sectional variation in corporate tax rates across foreign jurisdictions and differences in the incorporation status of foreign affiliates.

[10]Treaties are often signed in years prior to when they become effective, and several country pairs have also renegotiated their BTTs over time. We use the date in which the original signing entered into force to indicate when countries have a treaty in place. See IRS.gov, *United States Income Tax Treaties A-Z* for treaty text, including relevant dates. Our event-study analysis in Figure 2 below shows no sign of anticipatory effects, supporting this

of U.S. multinational firms during our sample period and cover many regions of the world.[11] Our sample covers 1987-2007, allowing us to observe many pre-BTT years for some countries and many post-BTT years for others, as shown in Figure 1. Table 1 also reports withholding tax rates on interest, dividend, and royalty income facing U.S. multinational firms just before and just after the relevant BTT entered into force. Note the withholding rates under the treaty are often substantially lower than they were prior to the treaty. By reducing these withholding rates, BTTs reduce the probability of double taxation, lowering the effective tax rate faced by multinational firms and incentivizing offshore activity in treaty countries.

Even though BTTs apply to all industries, the effects of BTTs on effective tax rates may vary by industry because of differences in the incidence of double taxation. For multinational firms in industries where products are highly differentiated, markups and royalties on intellectual property are higher, generating greater profits and financial flows to be taxed. Hence, for industries with relatively high levels of product differentiation we expect the effects of BTTs to be larger.[12] We verify this difference empirically by measuring industry product differentiation using the classification in Rauch (1999). We classify a 3-digit industry as "high differentiation" if and only if all of the associated 4-digit sub-industries are labeled as differentiated products by Rauch (1999) (i.e. neither exchange traded nor reference priced). 3-digit industries with any 4-digit sub-industries labeled as exchange traded or reference priced are classified as "low differentiation."[13]

Our empirical analyses examine the effects of BTTs on employment in U.S. multinational firms, their foreign affiliates, and the broader labor market. Information on multinational firms comes from the 1987-2007 Surveys of U.S. Direct Investment Abroad, collected by the Bureau of Economic Analysis (BEA). These data provide a quasi-exhaustive sample of U.S. multinational firms and their affiliates in foreign countries. Our analysis utilizes information on domestic employment at the U.S. parent firm and employment in each of its majority-owned foreign affiliates, along with information on each parent firm's 3-digit primary industry.[14] Firm-level data are ideal in this context, as they allow us to control for time-invariant unobservable firm or affiliate characteristics and to investigate heterogeneity in effects based on offshoring margin and firm organizational structure. We focus on firms in non-service sectors and omit imputed observations, yielding a set of 3,436 firms with 25,476 foreign affiliates spanning 62 3-digit industries and operating in 124 countries from 1987 to 2007.

timing definition.

[11]Authors' calculations using the 1987-2007 BEA Surveys of U.S. Direct Investment Abroad.

[12]Blonigen, Oldenski, and Sly (2014) make a similar argument in the context of BTTs' role in harmonizing tax rules, since tax authorities are more likely to disagree regarding the location of value added for differentiated products than for homogenous products with well defined market prices.

[13]In Appendix A.1, we show that this definition corresponds exactly with an alternative classification approach based on Nunn (2007), which combines the Rauch (1999) measure of product differentiation with information from the U.S. input-output system to produce a measure of the level of differentiation of inputs used in each industry, rather than the output produced by each industry.

[14]We classify affiliates based on their parent's primary industry. The BEA data use 3-digit SIC-based ISI codes for years prior to 1999. From 1999 onward, they use 4-digit NAICS-based ISI codes. For consistency, we convert the NAICS-based codes to 3-digit SIC-based ISI codes for the relevant years.

Additionally, in Section 4.2.3 and Appendix A.3 we present separate results for "vertically oriented" foreign affiliates, defined as those with nonzero sales to their U.S. parent firm.

After examining outcomes within multinational firms, we consider employment effects at the industry and regional levels using data on employment by industry and metropolitan statistical area (MSA) from the U.S. Census Bureaus's County Business Patterns (CBP). These data report total employment at private business establishments in covered industries by industry and county.[15] We aggregate industries to match the 3-digit classification used in the BEA data and aggregate counties to construct 304 time-consistent metropolitan areas spanning our sample period.

Throughout our analyses, we present specifications controlling for a standard set of time-varying country-level determinants of offshoring, using data compiled from several sources.[16] Control variable names appear in square brackets. To capture the regularities that greater national incomes promote foreign affiliate activity, while large differences in national income reduce it, we control for the log of the sum of U.S. and affiliate country's real GDP [$\ln(GDP_{us} + GDP_d)$] and the log of the squared difference in the two countries' GDPs [$\ln((GDP_{us} - GDP_d)^2)$]. Information regarding real GDP and trade costs come from the Penn World Tables, with national incomes expressed in trillions of U.S. dollars. Trade costs are measured using a standard definition of openness: the log of 100 minus the trade share of total GDP [ln(Trade Costs)]. The skill difference between the U.S. and a foreign affiliate country is measured as the log of the difference in average educational attainment [ln(Skill Difference)] from Barro and Lee (2010). Educational attainment measures are available every five years, so we linearly interpolate data for years between observations. Data indicating whether the U.S. has a bilateral investment treaty [BIT] with the destination country are from the United Nations Conference on Trade and Development. The presence of free trade agreements [FTA] across countries is available from the U.S. Trade Representative. Annual exchange rate data [Exchange Rate] are from the World Bank.

Table 2 reports summary statistics for the individual foreign affiliates in our sample, as well as for the U.S. parent firms that own them. The average firm in our sample has roughly 6 foreign affiliates with total foreign employment of 3,093 workers and total U.S. employment of 6,535 workers.

3 Effects of BTTs on Employment at U.S. Multinationals

Before moving on to our theoretically motivated IV estimates of the effects of offshoring on U.S. employment, we begin our empirical analyses by estimating the effect of BTTs on U.S. parent firm employment. This analysis represents a reduced form of the simultaneous equations frame-

[15] The CBP data provide full coverage in all industries except crop and animal production; rail transportation; National Postal Service; pension, health, welfare, and vacation funds; trusts, estates, and agency accounts; private households; and public administration.

[16] See Carr, Markusen, and Maskus (2001), di Giovanni (2005), and Blonigen, Oldenski, and Sly (2014) for papers motivating these controls.

work introduced in Section 4.1, and serves two additional purposes. First, the effect of BTTs on multinational firm hiring in the U.S. is of independent interest, as tax treaties are among the most commonly implemented international policy tools affecting the incentives to engage in cross-border production activities, and they can help inform us about the broader consequences of changes in effective tax rates for multinational firms. Second, this analysis allows us to rule out the presence of confounding trends, in which faster growing multinational firms are systematically more or less likely to have affiliates in countries signing new BTTs with the U.S.

We estimate the effect of BTTs on parent employment using a panel difference-in-differences research design (Bertrand, Duflo, and Mullainathan 2004). In order to have a single well-defined treatment period for each parent firm, we begin by focusing on the first BTT received by one of the parent's affiliates during our sample period (we incorporate information on later BTTs in a supplementary analysis, described below). A parent firm is treated when at least one of the countries hosting its affiliates has enacted a new BTT with the U.S. during our sample period. Define $\tilde{t}_f$ as the first year in which an affiliate of firm f receives a BTT, so the firm is treated when $t \geq \tilde{t}_f$. To account for differences in the relative importance of the first affiliate receiving a BTT, we scale the treatment indicator by that affiliate's pre-BTT share of the parent firm's total affiliate employment, $\tilde{\varphi}_f$.[17] We then estimate the following panel diff-in-diff specification.

$$\ln s_{ft} = \beta^{RF} \left[\tilde{\varphi}_f \mathbf{1}(t \geq \tilde{t}_f)\right] + \Gamma X_{ft} + \lambda_f + \nu_{it} + \epsilon_{ft}, \tag{1}$$

where s_{ft} is U.S. employment at parent firm f in year t; $\mathbf{1}(t \geq \tilde{t}_f)$ is a treatment indicator for years in which at least one of firm f's affiliates has received a BTT; this treatment indicator is scaled by that affiliate's initial employment share, $\tilde{\varphi}_f$; ΓX_{ft} is the vector of standard offshoring controls described in Section 2; λ_f are parent firm fixed effects; ν_{it} are industry-year fixed effects; and ϵ_{ft} is an error term. Because (1) includes fixed effects for each parent firm and for each industry-year combination, β^{RF} measures the (reduced form) difference in employment growth for parent firms in the same industry whose affiliates do and do not receive BTTs. We calculate two-way cluster-robust standard errors, clustering by parent firm and by year.

The results appear in Table 3. The first column includes firms from all industries, while columns (2) and (3) estimate the effects of BTTs within high differentiation industries and low differentiation industries separately. All point estimates for the BTT indicator's coefficient are positive, indicating that on average parent firms whose affiliates receive BTTs expand employment in comparison to

[17] To be precise, let t_c be the year in which country c enacts a BTT with the U.S., and $t_c = \infty$ if the country does not enact a BTT. C_f is the set of countries in which firm f initially has affiliates. Then $\tilde{t}_f \equiv \min_{c \in C_f} \{t_c\}$. Note that $\tilde{t}_f = \infty$ if none of f's affiliates have a BTT during our sample period, so $\mathbf{1}(t \geq \tilde{t}_f) = 0$, and f is not treated. Let $\tilde{c}_f \equiv \arg\min_{c \in C_f} \{t_c\}$ be the first of firm f's affiliate countries to receive a BTT. Affiliate $\tilde{c}_f$'s pre-BTT share of affiliate employment is then $\tilde{\varphi}_f \equiv (m_{f,\tilde{c}_f,\tilde{t}_f - 1}) / (\sum_{c \in C_f} m_{f,c,\tilde{t}_f - 1})$, where $m_{f,c,t}$ is employment at parent firm f's affiliate in country c in year t. We scale by the *pre-BTT* affiliate employment to avoid including any endogenous employment adjustments.

parents whose affiliates do not. The effect on all parents in column (1) is statistically insignificant.[18] However, when restricting the sample to parents in high differentiation industries, BTTs have large and statistically significant effects. This is expected since double taxation is more likely in these industries prior to BTT implementation. In contrast, the estimates for low differentiation industries are an order of magnitude smaller. Introducing additional controls in columns (4)-(6) has minimal effect on the results. The coefficient in column (5) implies that, in high differentiation industries, a BTT for a multinational firm with single affiliate increases domestic employment by 5.5 percent.[19]

In order to interpret the estimates from (1) as the causal effect of BTTs on multinational parent firm employment, it must be true that parents whose affiliates did and did not receive BTTs would have experienced equal average employment growth in the absence of new BTTs. We can test for pre-existing differences in employment trends using the event-study framework of Jacobson, LaLonde, and Sullivan (1993), in which we examine the employment effect of a parent's first new BTT in each year before and after it enters into force. The estimation equation, which strictly generalizes the difference-in-differences specification in (1), is

$$\ln s_{ft} = \sum_{j=-5}^{+5} \beta_j^{RF} \left[\tilde{\varphi}_f \mathbf{1}\left(t - \tilde{t}_f = j\right)\right] + \Gamma X_{ft} + \lambda_f + \nu_{it} + \epsilon_{ft}. \quad (2)$$

The estimates of β_j^{RF} measure the difference in employment growth for parent firms in the same industry whose affiliates do and do not receive new BTTs, in year j before or after the BTT was implemented. In order to rule out potentially confounding pre-BTT trends in parent firm employment growth, we expect $\beta_j^{RF} \approx 0 \ \forall j < 0$. We focus on high differentiation industries, since they exhibited substantial responses to BTTs in Table 3. Figure 2 plots the estimated coefficients along with their 95 percent confidence intervals, with the year before BTT implementation ($j = -1$) as the omitted category, equal to zero. The coefficients on the pre-BTT $\hat{\beta}_j^{RF}$ are flat and nearly identical to zero, and there is no sign of pre-BTT differences in employment growth for firms that would and would not later be treated. Only in the period of BTT introduction and later do treated and non-treated firms' employment growth rates diverge, as indicated by the jump in period 0, in which the BTT was implemented, and growth in the effects over the subsequent years. These results are consistent with prior evidence finding that increased multinational activity occurs only after BTTs enter into force (Blonigen, Oldenski, and Sly 2014), and show that BTT assignment was uncorrelated with preexisting firm performance.

In Appendix A.2 we implement two alternative versions of this parent-level reduced form analysis. First, we remove the affiliate employment scaling factor, $\tilde{\varphi}_f$, and examine the effect of an average BTT irrespective of the relative size of the affected affiliate. The time pattern of results is

[18] Similarly, di Giovanni (2005), Blonigen and Davies (2005), and Davies, Norback, and Tekin-Koru (2009) find no robust relationship between BTTs and FDI activity at an aggregate level.

[19] $100 * (exp(0.054) - 1) = 5.5$.

very similar to those discussed here, while the coefficient magnitudes are smaller simply because the scale of the regressor is larger without the affiliate share adjustment. These results indicate that the scaling factor is not pivotal in yielding a lack of confounding pre-trends. Second, we implement an analysis utilizing information on all new BTTs experienced by a parent firm's affiliates, not just the first one. In particular, we measure the effect of changes in the share of initial affiliate employment covered by BTTs. Because in this analysis each parent may be "treated" multiple times, it does not fit neatly into a difference-in-differences or event study framework. However, using leads and lags of the BTT coverage measure, we can similarly rule out confounding pre-trends as in our event-study analysis here.

Together, the results in this section show that decreasing effective tax rates on foreign affiliate activity by enacting a BTT increases employment at the U.S. parent firm. As we will discuss in detail in the following section, these positive estimates suggest that scale effects, in which lower costs drive increases in overall firm activity, outweigh substitution effects, in which firms shift activity toward the newly cheaper affiliate activities. Statistically and economically significant results appear for parents in high differentiation industries, which benefit most from removing double taxation, while the effects in low differentiation industries are indistinguishable from zero.

These findings support the notion that BTTs are exogenous to counterfactual firm employment growth in a variety of ways. The lack of confounding pre-BTT trends in parent employment rules out concerns in which firms that were experiencing stronger employment growth were systematically more likely to have affiliates receiving BTTs. Such a situation might have arisen, for example, if successful firms were more able to lobby for treaties in their affiliates' countries.[20] The lack of pre-trends, however, does not rule out the possibility of other time-varying confounders that were correlated with BTTs. A potential example is that some countries listed in Table 1 (e.g. India) implemented other market-based policy reforms around the time their BTT entered into force, potentially confounding the effects of BTTs on employment growth. However, unlike BTTs, broader market reforms should have affected both high- and low-differentiation industries. The lack of any observed effect of BTTs in low differentiation industries rules out substantial confounding from simultaneous policy reforms. In the following section, we find that BTTs have no effect on affiliate employment in low differentiation industries. As Angrist and Pischke (2009) argue (p.131), the lack of reduced-form (parent) effect in a subsample with no first-stage (affiliate) effect helps reinforce the idea that BTTs satisfy the exclusion restriction required for the IV analysis in the following section.

[20]Given that BTTs must be ratified by both countries also generates substantial uncertainty regarding when a negotiated treaty will actually enter into force, with many treaties experiencing large delays between negotiation and implementation. This uncertainty makes it difficult for firms to time their lobbying efforts relative to their strategic objectives.

4 Effects of Offshore Employment on Domestic Employment

While the previous section examines the overall effect of bilateral tax treaties on parent employment, we now turn to studying the more general question of how changes in foreign affiliate activity affects domestic employment at multinational parent firms and in the broader U.S. labor market. Although this question has been the subject of prior research and is of interest to policy makers, it is difficult to answer credibly due to the inherent simultaneity between offshore and domestic activity.

4.1 Theoretical Framework

We utilize the Antràs and Helpman (2004) global sourcing model to motivate an estimation strategy using BTTs to resolve this simultaneity problem. This particular model suits our context for three reasons. First, it defines the boundary of the firm in an environment with incomplete contracts, allowing us to characterize how the effects of offshoring vary across firms with different organizational forms. Since BTTs only influence effective tax rates for integrated multinationals (not those transacting at arm's length), the firm boundary distinction is essential. Second, by specifying each agent's bargaining position, the framework describes the economic division of revenue across tax jurisdictions, thereby characterizing the respective tax liabilities, and subsequently the potential for double taxation. Finally, the model explicitly characterizes the simultaneity of parent and offshore affiliate employment, yielding a system of linear simultaneous equations justifying a panel difference-in-differences research design using variation in BTTs as an instrument for affiliate employment. Here, we review the main assumptions of the Antràs and Helpman (2004) model and derive its implications for our empirical analysis.

4.1.1 Fundamentals

The world economy consists of $C + 1$ countries, with one home country and C foreign countries. Consumers in all countries are laborers who all have identical quasi-linear preferences over a homogeneous good, x_{t0}, and a series of composite goods, X_{ti}, across industries $i = 1...I$. In particular,

$$U_t = x_{t0} + \frac{1}{\mu}\sum_{i=1}^{I} X_{ti}^{\mu}, \quad \text{with } 0 < \mu < 1. \tag{3}$$

Consumers have constant elasticity of substitution preferences over unique varieties, f, among the set F_{ti} of varieties available in industry i and period t:

$$X_{ti} = \left[\int_{f\in F_{ti}} x_{ti}(f)^{\alpha_i} df\right]^{1/\alpha_i}, \quad \text{with } 0 < \alpha_i < 1. \tag{4}$$

It follows that, within each period, monopolistically competitive firms each producing a unique variety, f, face an inverse demand function $p_{ti}(f) = X_{ti}^{\mu-\alpha_i} x_{ti}(f)^{\alpha_i - 1}$.

Labor is the only factor of production, with a perfectly elastic supply in all countries. Let ω be the wage in the home country and w_c be the wage in each Foreign country with $\omega > w_c$. Workers may either perform headquarters services, s, or assembly, m, in producing the variety of the final good sold by the firm. Each worker can provide a single unit of headquarters services or assembly services, and the final product for each firm is delivered to consumers by combining headquarters services and assembly according to

$$x_{ti}(f) = \theta(f) \left[\frac{s_t(f)}{\eta_i}\right]^{\eta_i} \left[\frac{m_{ct}(f)}{1-\eta_i}\right]^{1-\eta_i} \quad , \tag{5}$$

where $\theta(f)$ is a firm-level productivity parameter. Headquarters services, $s_t(f)$, can only be performed domestically, while assembly can take place at factories in the home country or in any foreign country $c \in C$.[21] Regardless of where assembly occurs, the process is firm-specific and cannot be used in producing alternative varieties of the final good.

4.1.2 Offshoring and Double Taxation in Integrated Multinationals

Firms face an inability to write ex-ante enforceable contracts over the delivery of specialized inputs like R&D, design, marketing, or the specific processes used during assembly at the factory. Instead, the parent firm and affiliate engage in Nash bargaining over the surplus from their relationship after goods are sold. A multinational enterprise is comprised of a parent firm that supplies headquarters services and integrates with its offshore assembly factory, giving the parent the right to seize outputs from the affiliate after they are produced. However, in the case of seizure the parent loses a share $(1-\delta_c) \in (0,1)$ of final output. This decline in output reflects lost cooperation from the affiliate and the inability to fully recover all assets, which varies by the location of offshore assembly c.[22] The parent's outside option is therefore to seize the goods produced and sell them directly, receiving only a proportion $\delta_c^{\alpha_i}$ of the revenue that would result had the parent not exercised its rights to claim the assembled output. Thus, the surplus generated by cooperation between the parent and affiliate is a fraction $(1 - \delta_c^{\alpha_i})$ of total revenue. The parent company receives a fraction β of this surplus, with the remainder going to the foreign affiliate supplier.

The parent's problem is therefore to choose its employment, equivalent to choosing its produc-

[21] For simplicity, we assume that domestic and offshore labor inputs are perfect substitutes in performing assembly. Muendler and Becker (2010) find that in the German context they are substitutes, but imperfect ones.

[22] As Antràs and Helpman (2004) emphasize, in order for integrated multinationals to exist in this model, there must be some loss to seizing assets from foreign affiliates. Otherwise, all agents would anticipate seizure and affiliates would refuse to produce.

tion of headquarters services $s_t(f)$, in order to maximize its profits:

$$\max_{s_t(f)} \left[\delta_c^{\alpha_i} + \beta(1-\delta_c^{\alpha_i})\right] r_{ti}(f) - \omega s_t(f), \tag{6}$$

where revenue is $r_{ti}(f) = \theta(f)^{\alpha_i} X_{ti}^{\mu-\alpha_i} \left[\frac{s_t(f)}{\eta_i}\right]^{\alpha_i\eta_i} \left[\frac{m_{ct}(f)}{1-\eta_i}\right]^{\alpha_i(1-\eta_i)}$. The corresponding problem for the affiliate performing assembly in foreign location c is

$$\max_{m_{ct}(f)} \left[(1-\beta)(1-\delta_c^{\alpha_i})\right] r_{ti}(f) - \tau_{cti} w_c m_{ct}(f) \ . \tag{7}$$

The term $\tau_{cti} \geq 1$ is our addition to the Antràs and Helpman (2004) model, reflecting the possibility that the multinational firm faces double taxation. We model double taxation such that the affiliate must hire $\tau_{cti} > 1$ workers to provide one unit of assembly services. The following subsection discusses the motivation for and implications of assuming that the incidence of double taxation falls on the affiliate while leaving the parent's problem unchanged. Note that τ_{cti} may vary by affiliate country, year, and industry, capturing variation in the timing and presence of BTTs with particular countries, and the fact that the incidence of double taxation is greater in industries with highly differentiated products.

4.1.3 Labor Demand Within Multinational Firms

A parent firm solves (6) by choosing its employment, $s_t(f)$, given its affiliate's employment, $m_{ct}(f)$. This yields the following best-response function for the parent.

$$\ln s_t(f) = \ln \eta_i + \frac{\ln\left[\delta_c^{\alpha_i} + \beta(1-\delta_c^{\alpha_i})\right] + \ln\alpha_i - \ln\omega + \alpha_i\left[\ln\theta(f) - (1-\eta_i)\ln(1-\eta_i)\right]}{1-\alpha_i\eta_i} - \frac{\alpha_i - \mu}{1-\alpha_i\eta_i}\ln X_{ti} + \frac{\alpha_i(1-\eta_i)}{1-\alpha_i\eta_i}\ln m_{ct}(f) \ . \tag{8}$$

Similarly, an affiliate in country c solves (7) by choosing its employment, $m_{ct}(f)$, given its parent's employment, $s_t(f)$, yielding its best-response function.

$$\ln m_{ct}(f) = \ln(1-\eta_i) + \frac{\alpha_i\left[\ln\theta(f) - \eta_i\ln\eta_i\right] + \ln(1-\delta_c^{\alpha_i}) + \ln(1-\beta) + \ln\alpha_i - \ln w_c}{1-\alpha_i(1-\eta_i)} - \frac{\alpha_i-\mu}{1-\alpha_i(1-\eta_i)}\ln X_{ti} + \frac{\alpha_i\eta_i}{1-\alpha_i(1-\eta_i)}\ln s_t(f) - \frac{1}{1-\alpha_i(1-\eta_i)}\ln\tau_{cti} \tag{9}$$

We can more concisely express these two best-response functions by grouping terms together into firm-industry-country fixed effects, ψ_{fci} and φ_{fci}, and industry-year fixed effects, ϑ_{ti} and ϕ_{ti}, yielding the following expressions.[23]

$$\ln s_t(f) = \psi_{fci} + \vartheta_{ti} + \gamma \ln m_{ct}(f) \ , \tag{10}$$

$$\ln m_{ct}(f) = \varphi_{fci} + \phi_{ti} + \zeta \ln s_t(f) - \nu \ln \tau_{cti}, \tag{11}$$

Equations (10) and (11) form a set of linear simultaneous equations for parent and affiliate employment, making clear the inherent challenge in estimating γ, the effect of affiliate employment on parent employment.[24] Estimating (10) by OLS overstates the effect of affiliate employment on parent employment because of the simultaneity induced by (11), in which $\zeta > 0$.[25] However, (10) and (11) also provide a solution to the simultaneity problem. Reductions in effective tax rates on offshore activity, τ_{cti}, shift out the affiliate employment profile in (11), while leaving the parent profile in (10) unchanged. Therefore, when analyzing the effect of affiliate employment on multinational parent employment, we utilize a panel difference-in-differences research design based upon (10) in which we instrument for affiliate employment using BTTs.

For this approach to succeed, τ_{cti} must be excluded from the parent's best-response function. In Appendix B.1 we explicitly model BTT-induced reductions in withholding tax rates in the context of the U.S. corporate tax system. There, we show that if multinational parents insulate themselves from changes in double taxation by adjusting transfers between themselves and their affiliates, then the implementation of a new BTT satisfies the exclusion restriction. Consistent with this assumption, the vast majority of double-taxation cases involving U.S. parent firms were raised in the foreign affiliate's country (Ernst and Young 2015). If instead new BTTs reduce the costs faced by both parents and affiliates, the IV estimates will not entirely resolve the simultaneity issue. In that case, some portion of the upward bias will remain, and our estimates will reflect an upper bound on the true effect of affiliate employment on domestic employment. However, as discussed below, our results are less than one third the magnitude of the most closely related estimates in the literature (Desai, Foley, and Hines 2009). Therefore, in spite of the potential theoretical concern regarding exclusion, our approach appears to substantially ameliorate the simultaneity issue in practice.

[23]Note that the coefficients γ, ζ, and ν in (10) and (11) all vary by industry i in equations (8) and (9). In the absence of industry-specific measures of the elasticity of substitution across varieties or the headquarters share of input costs, we restrict these to be equal across industries. However, we do stratify our results by high vs. low differentiation industries, effectively allowing the parameters to vary across these two groups of industries.

[24]In (5), we follow Antràs and Helpman (2004) by assuming a Cobb-Douglas production function. Under this assumption, $\gamma = \frac{\alpha_i(1-\eta_i)}{1-\alpha_i\eta_i)} > 0$. In Appendix B.2, we examine a more general model in which production is CES, with substitution elasticity $\sigma = \frac{1}{1-\rho}$. In that case, the sign of the effect of affiliate employment on parent employment corresponds to that of $(\alpha - \rho)$. Intuitively, expanding affiliate employment increases parent employment when the scale effect, determined by α is larger than the substitution effect, determined by ρ. With Cobb-Douglas production, $\rho = 0$, so $(\alpha - \rho)$ is always positive.

[25]The sign of additive simultaneity bias is given by the sign of ζ as long as the condition $\gamma\zeta < 1$ is satisfied. This condition is necessary for the existence of equilibrium, and is satisfied in our context, since $0 < \alpha_i, \eta_i < 1$.

4.1.4 Industry Labor Demand

Firms have several options for how and where to assemble their outputs other than using offshore affiliates. A firm may respond to changes in offshoring costs by altering its global sourcing strategy. Also, domestic firms may face competitive pressures if multinational firms in their industry realize lower costs as their effective tax rates change. Thus, when considering the industry-wide response of domestic employment to BTT-induced changes in offshore employment, we must take into account the possibility that some firms alter their sourcing strategies, while others simply adjust employment without changing their organizational form.

Total industry employment in the home country includes hiring for headquarters services s_t across all firms, along with domestic labor used in assembly, m_t, either in-house or at arm's length. Let O_{ti} be the set of firms in industry i that choose to offshore assembly within an affiliate in a foreign country during period t, while A_{ti} is the set of firms that source assembly services from an arms-length provider in a foreign country. Likewise let I_{ti} denote the set of non-multinational firms that hire local workers in the home country to assemble output in-house, while U_{ti} is the set of firms that source assembly from local arms-length providers in the home country.[26] Summing across all four organizational forms, total domestic employment for industry i is given by

$$L_{ti} \equiv \int\limits_{f\in O_{ti}\subset F_{ti}} s_t(f)df \;+ \int\limits_{f\in A_{ti}\subset F_{ti}} s_t(f)df \\ + \int\limits_{f\in I_{ti}\subset F_{ti}} [m_{ct}(f)+s_t(f)]df \;+ \int\limits_{f\in U_{ti}\subset F_{ti}} [m_{ct}(f)+s_t(f)]df\ . \quad (12)$$

Equation (12) shows that a decline in the effective cost of offshore activity resulting from a BTT ($d\tau_{cti} < 0$) may affect total industry employment, L_{ti}, in a variety of ways. First, existing integrated multinational firms (O_{ti}) will increase offshore employment with the decline in its effective cost, and this change will affect headquarters employment based on γ in (11). The sign of this effect depends upon whether scale effects or substitution effects dominate, but based on the positive reduced-form results for continuing multinational firms discussed in Section 3, this intensive margin effect is likely to increase domestic employment. Other firms will change organizational form to become new integrated multinationals. If these firms had previously assembled goods domestically (I_{ti} or U_{ti}), this extensive margin shift will lower domestic employment. We therefore expect to find more negative (less positive) domestic employment effects of increased offshore activity among firms opening new affiliates in BTT countries than among firms maintaining continuing affiliates. Finally, because the costs of production for integrated multinationals fall, other firms face stiffer

[26] Note that the subsets O_{ti}, A_{ti}, I_{ti}, U_{ti} partition the set of active firms, F_{ti}, and that each subset is either empty or a continuous segment of firms in productivity space, so the integrals in (12) are well defined. We leave the relative locations of these subsets in productivity space general rather than specifying a ranking of fixed costs across organizational forms, as in Antràs and Helpman (2004).

competition in product markets and may contract as a result (Groizard, Ranjan, and Rodriguez-Lopez 2015). Given the various positive and negative components, the overall effect on industry employment may be positive or negative. We therefore empirically examine both the overall effect on industry employment along with separate effects for existing multinationals, for firms opening new affiliates in BTT countries, and for non-multinationals, confirming the heterogeneity in effects just described.

4.2 Empirical Analysis

4.2.1 The Effect of BTTs on Foreign Affiliate Employment

Recall from the model that parent employment and affiliate employment are simultaneously determined, and that BTTs serve as an instrument for affiliate employment, resolving the simultaneity. We therefore begin by examining the first-stage effect of BTTs on foreign affiliate employment. Solving the system in (11) and (10) for affiliate employment yields an estimating equation of the following form.

$$\ln m_{at} = \beta^A BTT_{ct} + \Gamma X_{at} + \mathrm{a}_a + b_{ti} + \epsilon_{at}. \tag{13}$$

In the model, affiliates are defined based on parent f, country c, and industry i. We combine these subscripts into one subscript a indicating an individual affiliate.[27] m_{at} is employment for affiliate a, BTT_{ct} is an indicator for the presence of a BTT between the U.S. and affiliate country c in year t, and X_{at} is a vector of controls. a_a and b_{ti} are affiliate and industry-year fixed effects, and ϵ_{at} is an error term. We two-way cluster standard errors by affiliate country and by year. The coefficient of interest is β^A, reflecting the difference in employment growth for affiliates in the same industry, located in countries that do and do not receive BTTs during our sample period. Because BTTs lower the effective cost of offshore activity for integrated multinationals, we expect $\hat{\beta}^A > 0$, with effects appearing primarily in industries with highly differentiated products for which double taxation is most likely to be present before BTT implementation.

Table 4 reports the results of estimating (13). In column (1), we include all affiliates, and although the estimated effect of BTTs on affiliate employment is positive, it is not statistically significantly different from zero at conventional levels. Column (2) shows that BTTs significantly increase foreign affiliate employment in industries with high differentiation, reflecting the fact that double taxation is a more severe issue in these industries (confirming the results of Blonigen, Oldenski, and Sly (2014)). The effect in low differentiation industries in column (3) is statistically insignificant and economically small. Columns (4) - (6) introduce the standard controls discussed in Section 2, along with controls for BTTs in sibling affiliate countries, to control for potential spillovers across siblings. In particular, we define "Parent-Sibling BTTs" as the share of initial

[27] The BEA survey allows firms the option of aggregating sibling affiliates in the same industry and country when reporting, so we apply this aggregation to all firms for consistency.

sibling affiliate employment covered by a BTT with the U.S. in year t and "Affiliate-Sibling BTT" as the share of initial sibling affiliate employment covered by a BTT between country c and the countries in which affiliate a has siblings. In both cases, to avoid allowing endogenous shifts in the affiliate weights to affect these controls, the initial affiliate employment shares are fixed at their values in the first year the parent firm appears in our sample. These controls have minimal effects on the coefficients of interest. The coefficient estimate of 0.249 in column (5) indicates that in high differentiation industries, receiving a BTT increased affiliate employment by 28.3 percent, on average.[28]

The results in Table 4 imply that BTTs substantially increase affiliate employment by resolving double taxation, thereby lowering the effective tax rate on affiliate activity. This effect is only present in highly differentiated industries in which double taxation is most prevalent. Specification (13) represents the first stage of the instrumental-variables analysis in the following sections, and the first-stage partial F-statistics are large enough to rule out weak instruments concerns only in columns (2) and (5), for high differentiation industries.[29] This means that BTTs provide a policy experiment for evaluating the effects of foreign affiliate employment on domestic employment, but only in industries with high differentiation.[30] For this reason, we focus on high differentiation industries in the instrumental-variables analyses in the following sections. We also note that for the subsample of low differentiation industries in which we have no first-stage relationship in Table 4, we also have no reduced-form relationship in Table 3. The fact that the reduced-form relationship is absent precisely when the first-stage relationship is absent helps rule out potential concerns regarding violations of the exclusion restriction (Angrist and Pischke (2009) p.131).

4.2.2 The Effect of Offshoring on Multinational Firm Employment

We now utilize BTT-induced variation in foreign affiliate employment to measure its effect on domestic employment within U.S. multinational firms. Our objective is to estimate the following parent-level specification corresponding to equation (10).

$$\ln s_{ft} = \beta^P \ln M_{ft} + \Gamma X_{ft} + c_f + d_{ti} + \epsilon_{ft}, \tag{14}$$

[28] $100 * (exp(0.0.249) - 1) = 28.3$

[29] Stock and Yogo (2005) report that a first-stage F-statistic greater than 8.96 in columns (1)-(3) is sufficient to reject the null hypothesis that the actual size of a 5 percent test is greater than 15 percent, while an F-statistic greater than 22.3 in columns (4)-(6) is sufficient to reject the null hypothesis that the actual size of a 5 percent test is greater than 10 percent.

[30] Appendix A.1 provides information on these industries.

where s_{ft} is parent employment and $M_{ft} \equiv \sum_{a\in f} m_{at}$ is total affiliate employment for firm f.[31] X_{ft} is a vector of parent-level controls (described below), and c_f and d_{ti} are firm and industry-year fixed effects. We two-way cluster standard errors by parent and by year. The coefficient of interest, β^P, may be positive or negative, depending upon whether scale effects or substitution effects dominate.

As already emphasized, parent employment and affiliate employment are simultaneously determined, so we must instrument for affiliate employment using variation in BTTs. Because many parent firms have multiple affiliates, and the first-stage regression in (13) is at the affiliate level, we must aggregate the first-stage predicted values for affiliate employment up to the parent level. Since aggregating the predicted values for $\ln m_{at}$ to predict $\ln M_{ft}$ involves a nonlinear transformation of random variables, we perform the aggregation accounting for the sampling distribution of the affiliate-level predicted values.[32] This nonlinearity also implies that simply plugging the estimate $\widehat{\ln M_{ft}}$ into the second-stage regression in (14) is inappropriate. This would be an example of so-called "forbidden regression" in which a nonlinear first-stage estimate is plugged into a linear second stage (Wooldridge 2002; Angrist and Pischke 2009). Instead, we follow Wooldridge (2002) Procedure 18.1, estimating a standard IV regression for (14), with the predicted $\widehat{\ln M_{ft}}$ as an instrument for the observed $\ln M_{ft}$.[33]

We must similarly aggregate the controls, X_{at} in (13), from the affiliate to the parent level. We generate employment-weighted averages of the affiliate-level controls, using affiliate employment weights from the year before the parent's first affiliate receives a BTT ($\tilde{t}_f - 1$).

$$X_{ft} = \sum_{a\in f} \varphi_{a,\tilde{t}_f-1} X_{at} \qquad \text{where } \varphi_{a,\tilde{t}_f-1} \equiv \frac{m_{a,\tilde{t}_f-1}}{M_{f,\tilde{t}_f-1}} \tag{15}$$

Using pre-BTT employment shares mitigates endogeneity concerns, though controls with contemporaneous weights and unweighted averages yield very similar results, as do specifications omitting the controls.

Table 5 presents OLS and IV estimates of (14), measuring how changes in foreign affiliate employment affect employment at U.S. parent firms. Table 5 reports the first-stage partial F-statistics associated with Wooldridge (2002) Procedure 18.1, but the appropriate F-statistics to consider when evaluating weak instruments concerns are those for the affiliate-level first stage in Table 4.[34] Because we only have a strong first-stage relationship between BTTs and foreign affiliate

[31] Recent work by Antràs, Fort, and Tintelnot (2017) argues that the number of affiliates comprising a parent firm's total offshore employment likely influences the effects of offshore activity on parent firm productivity, which can subsequently impact the employment effects we estimate here. By simply summing employment across affiliates, we are abstracting from this mechanism.

[32] This procedure is known as "smearing" and addresses issues similar to Jensen's inequality. Our main results use a parametric smearing approach assuming normally distributed errors (see Appendix B.3), but a nonparametric version based on Duan (1983) and a naive plug-in estimate both yield similar results.

[33] Note that the parent-level IV standard errors are accurate in spite of the affiliate-level instrument generation procedure that precedes it (Wooldridge 2002).

[34] Note that very large F-statistics are common when implementing Wooldridge (2002) Procedure 18.1.

employment, we restrict our sample of parents in Table 5 to those in high differentiation industries.

Columns (1) and (2) of Table 5 implement naive OLS regressions of domestic parent employment on total foreign affiliate employment. The very large positive correlation between parent and affiliate employment likely reflects upward simultaneity bias, as discussed in Section 4.1.3. The IV results in columns (3) and (4) confirm this point, finding much smaller point estimates and rejecting the equality of OLS and IV results at conventional levels. The IV coefficient on $\ln M_{ft}$ in column (4) is positive and statistically significant, suggesting that a 10 percent increase in foreign affiliate employment drives a 1.8 percent increase in domestic employment at the U.S. parent firm. As shown in column (5) of Table 4, a new BTT increases employment at affected affiliates in highly differentiated industries by approximately 28.3 percent. Using the estimate from column (4) of Table 5, this corresponds to about a 5 percent increase in domestic employment, or about 394 new U.S. workers for the average parent firm. The coefficients of interest in columns (3) and (4) are quite similar, indicating that our results are robust to including or excluding the controls, X_{ft}.

As mentioned in Section 4.1.3, our instrumental variables strategy requires that BTTs shift affiliates' best response functions while leaving those of parents unchanged. If this assumption is violated, then the IV results in Table 5 may retain some upward bias. Yet, even in that case, the estimates remain informative. First, the IV estimates in columns (3) and (4) are significantly smaller than the OLS estimates in columns (1) and (2), implying that our IV strategy is substantively addressing the simultaneity between parent and affiliate employment. Second, the most closely related result in the prior literature is found in (Desai, Foley, and Hines 2009).[35] They find that a 10 percent increase in foreign affiliate employment drives a 6.55 percent increase in parent employment, an effect that is 3.5 times larger than our estimates in columns (3) and (4) of Table 5. Therefore, even if our estimates reflect an upper bound on the true effect of affiliate employment on parent employment, they are significantly below the OLS estimates and imply a much less positive effect than one would expect based upon prior work.

In the BEA data one can only observe changes in employment for continuing multinational firms. As discussed in Section 4.1.4, we expect the expansion of existing affiliates to increase domestic employment because parent firms benefit from scale effects when the effective cost of their offshore activity falls with a BTT. However, extensive margin effects, in which firms shift activity from domestic to offshore locations, may decrease domestic employment within the U.S. parent firm. Although we cannot observe employment for newly formed multinational firms before they begin offshoring, we can examine effects for continuing multinationals that open or acquire new affiliates in BTT countries during our sample period. We expect the domestic employment growth to be smaller or even negative for these firms exhibiting extensive margin offshoring. This is precisely what we find in columns (5) and (6) of Table 5. When restricting attention to multinationals opening new affiliates in BTT countries (column (5)), the effect on domestic employment is not

[35] See Table 5, column (4) in (Desai, Foley, and Hines 2009).

statistically significant, while much larger positive effects appear for multinationals that exhibit only intensive margin behavior (column (6)). Although BTT-induced growth in affiliate employment increases domestic parent employment on average, there is substantial heterogeneity in these effects based on how firms' organizational forms respond to BTTs.

4.2.3 Industry Level Effects of Offshoring

On average, BTT-induced increases in offshore employment raise domestic employment at multinational parent firms, with larger positive effects for firms expanding existing affiliates and no significant effects for those opening or acquiring new affiliates. We now address the employment effects of offshoring on overall industry employment in the U.S. This broader analysis allows us to capture two margins that are absent when examining multinational firms alone. First, the changes in employment at multinational parents may be partly offset by equilibrium employment adjustment at other domestic firms in the industry. Second, declining costs of offshore activity will likely motivate some firms to become multinational firms by opening new affiliates. Since these firms are not available in the BEA data before they become multinational firms, we cannot observe their employment responses and therefore could not include them in the multinational parent level analysis in the previous section. Both of these margins contribute to industry-level employment responses. We measure U.S. industry employment using County Business Patterns data at the 3-digit SIC level and link to the BEA International Surveys Industry (ISI) classification, resulting in 62 consistently identifiable industries.

We study the relationship between log domestic employment and log total affiliate employment at the industry level using the following specification.

$$\ln L_{it} = \beta^I \ln M_{it} + \Gamma X_{it} + f_i + g_t + \epsilon_{it}, \tag{16}$$

where L_{it} is total domestic employment in industry i in year t, M_{it} is total foreign affiliate employment in the industry, and f_i and g_t are industry and year fixed effects. We calculate two-way clustered standard errors by industry and year. As with the parent-level regressions, we aggregate from the affiliate level to the industry level, taking care to address the nonlinearity of the aggregation. We then instrument for observed log industry affiliate employment $\ln M_{it}$, using predicted log industry affiliate employment $\widehat{\ln M_{it}}$. Because the increases in employment within continuing multinational firms may be partly or entirely offset by reductions in employment at newly offshoring firms or competing domestic firms, the estimate of β^I may be positive or negative. As in the previous section, because we only have a strong first-stage relationship between BTTs and affiliate employment in high differentiation industries (Table 4), we include only high differentiation industries in this analysis.

Table 6 shows the relationship between U.S. employment and offshore affiliate employment at the industry level. Columns (1) and (2) present the OLS results, and columns (3) and (4) show the instrumental variable results. As in the multinational parent-level analysis, the estimates are positive, implying that the various margins just discussed combine to yield modest increases in domestic industry employment when affiliates of multinational firms in that industry experience BTT-induced reductions in the cost of foreign affiliate activity. The IV estimates are less than one-fifth the size of the corresponding the OLS estimates, confirming the importance of appropriately addressing the simultaneity issue. The IV estimates are small in magnitude and close to the margin of statistical significance at the 5 percent level, suggesting that the positive and negative effects from the various margins of adjustment nearly offset one another at the industry level.

We can gain insight into these margins by contrasting the industry-level effects for multinational firm employment against the effects for non-multinational firms. We observe total multinational employment in the BEA data, and then calculate non-multinational employment as a residual, subtracting multinational employment from total industry employment, measured using County Business Patterns data. Table 7 columns (1) and (2) show that domestic employment in multinational firms increases in response to growth in affiliate employment. This is simply the industry-level analogue of the parent-level effect in Table 5. In contrast, the effects on industry-level non-multinational employment in columns (3) and (4) are extremely small and statistically indistinguishable from zero, implying that non-multinational firms do not share in the employment growth of multinational firms when the costs of offshore employment fall. Table 8 adds additional nuance to these findings by considering the effects of increased foreign affiliate employment only for vertically oriented foreign affiliates, those with sales to their U.S. parent firm.[36] We expect increased activity at vertically oriented affiliates to have more negative effects on domestic employment, since their activities are more likely to replace those of domestic suppliers of intermediate inputs. The effects on domestic employment in multinational firms, shown in columns (1) and (2), remains positive and statistically significant. However, increases in foreign affiliate employment among vertically oriented affiliates drive *decreases* in domestic employment among non-multinational firms in the same industry. Although small, these employment decreases likely reflect a combination of shifts in sourcing away from domestic suppliers and competition from multinational firms enjoying decreased costs of affiliate activity following the implementation of a BTT.

[36]We include all multinational affiliates, regardless of whether they have horizontal or vertical sales, in our main analysis because all affiliates are potentially subject to double taxation that could be reduced by BTTs. However, because vertically oriented affiliates may substitute more directly for U.S. production, we also repeat our analysis for this set of firms as a robustness check. Tables 7 and 8 show the only case in which the results for vertical affiliates qualitatively differ from those for all affiliates. Appendix A.3 reports all other results in the paper, restricting attention to vertically oriented foreign affiliates.

4.2.4 Regional Effects of Offshoring

Finally, we measure the domestic employment effects of offshoring at the regional level. This perspective adds yet another margin of labor market adjustment to the analysis by including potential employment spillovers across industries in the same region. Our unit of analysis is the metropolitan area, and we use 304 time-consistent metro areas, constructed from underlying county-level employment in the County Business Patterns data. Our metro-area estimation equation is

$$\ln L_{mt} = \beta^M \ln M_{mt} + h_m + k_t + \epsilon_{mt}, \tag{17}$$

where L_{mt} is metro area m employment in year t, and h_m and k_t are metro area and year fixed effects. Standard errors are two-way clustered by metro area and year. Our regional measure of offshoring exposure, M_{mt} is a weighted average of industry-level foreign affiliate employment. We construct industry-level foreign affiliate employment as described above, and the industry weights reflect the distribution of employment across covered industries in 1986, just before the start of our main analysis sample.

$$M_{mt} \equiv \sum_i \sigma_{mi}^{1986} M_{ti} \qquad \text{where } \sigma_{mi}^{1986} \equiv \frac{L_{mi}^{1986}}{\sum_{i'} L_{mi'}^{1986}} \tag{18}$$

This measure captures each metro area m's exposure to foreign affiliate employment, following a procedure similar to Topalova (2010), Autor, Dorn, and Hanson (2013), Kovak (2013), and others. We generate an instrument for $\ln M_{mt}$ by constructing an otherwise identical measure that replaces observed industry affiliate employment, M_{it}, with predicted industry affiliate employment, $\widehat{M_{it}}$, as in the industry-level analysis.

Table 9 shows the region-level results, with OLS estimates in columns (1) and (2) and IV estimates in columns (3) and (4). As with the aggregate industry-level results, the relationship between offshoring and employment is positive, and the IV estimates are smaller than the OLS results. The estimate in column (4) implies that a metro area whose industries experience on average a 10 percent increase in affiliate employment exhibit a 0.67 percent increase in metro area employment. While this is a modest positive effect, it is larger in magnitude than the industry-level results, suggesting the possibility of cross-industry spillovers, since the MSA level employment data include employment for all workers, not just those in manufacturing industries with highly differentiated products, which are the focus of the earlier analyses.

As in the industry-level analysis, the regional effects in Table 9 imply that, on average, the positive employment effects for multinational parent firms slightly outweigh the negative employment effects for non-multinational firms. However, it is important to emphasize that both effects are present, and that regions with few multinational firms are more likely to experience negative effects of increased foreign affiliate activity. In this sense, our work relates to earlier findings on the regional effects of import competition, such as Autor, Dorn, and Hanson (2013) and Hummels et al. (2014), arguing that increased import competition decreases regional manufacturing employment in the U.S. Imports include final goods, intermediate inputs purchased at arms-length, and inputs purchased from foreign affiliates of domestic multinationals. Each of these trade flows may have a different effect on domestic labor market outcomes, and those effects may depend upon firm structure and context. Rather than challenging the prior work on the effects of imports, our findings demonstrate the value of separately measuring the effects of different types of international economic activity and looking across regions that are differently exposed the substitution versus scale effects of increased offshoring activity.

5 Conclusion

The consequences of ever rising levels of offshoring activity by U.S. multinational firms are consistently a source of debate for both the public and policy makers. However, among other challenges, the fact that offshore hiring and domestic employment are determined simultaneously has made it difficult for economists to provide clear answers about the relationship between the two. We contribute to this discussion by providing estimates that rely on relevant and exogenous variation in offshoring costs, allowing us to infer the causal implications of greater offshore employment for U.S. labor market outcomes. We provide clear evidence that changes in the global tax structure influence the hiring activity of U.S. multinational firms both domestically and abroad, with spillover effects to regional U.S. employment outcomes. These changes in hiring activity demonstrate how shifts in global tax structure can alter the geographic distribution of economic activity both across and within national borders.

Our results also highlight important nuances in the effects of various international economic activities, demonstrating that the effects of offshoring differ across firms' organizational structures and across different margins of offshoring activities. Within existing multinationals, a fall in the cost of offshoring has a net positive effect on U.S. hiring. However, when the costs of offshore activity fall, some firms may alter their global sourcing strategies and begin to substitute offshore facilities for activities that had previously been completed locally. This substitution can adversely affect employment outcomes for U.S. workers. Among multinational firms that open new affiliates in countries that realize lower offshoring costs, we find that domestic employment responds only modestly to BTTs, suggesting that positive scale effects are largely offset by negative substitution effects in these firms. Moreover, while vertically oriented multinational firms expand their U.S. employment in response to a fall in offshoring costs, domestic firms that are not engaged in offshoring activity reduce their employment. Overall, these effects balance at the industry and region levels such that we find zero or small positive effects. Together, our results suggest that employment declines at some firms are offset by expanded employment at others, yielding a modest positive net effect of offshoring on U.S. employment, albeit with substantial employment dislocation and reallocation of workers.

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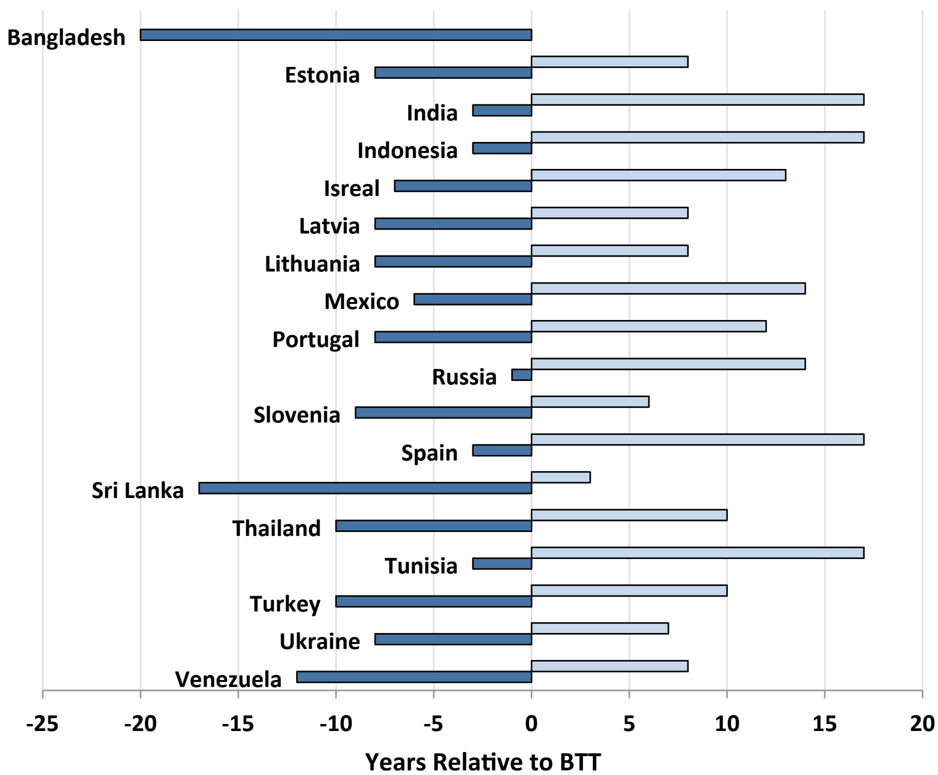
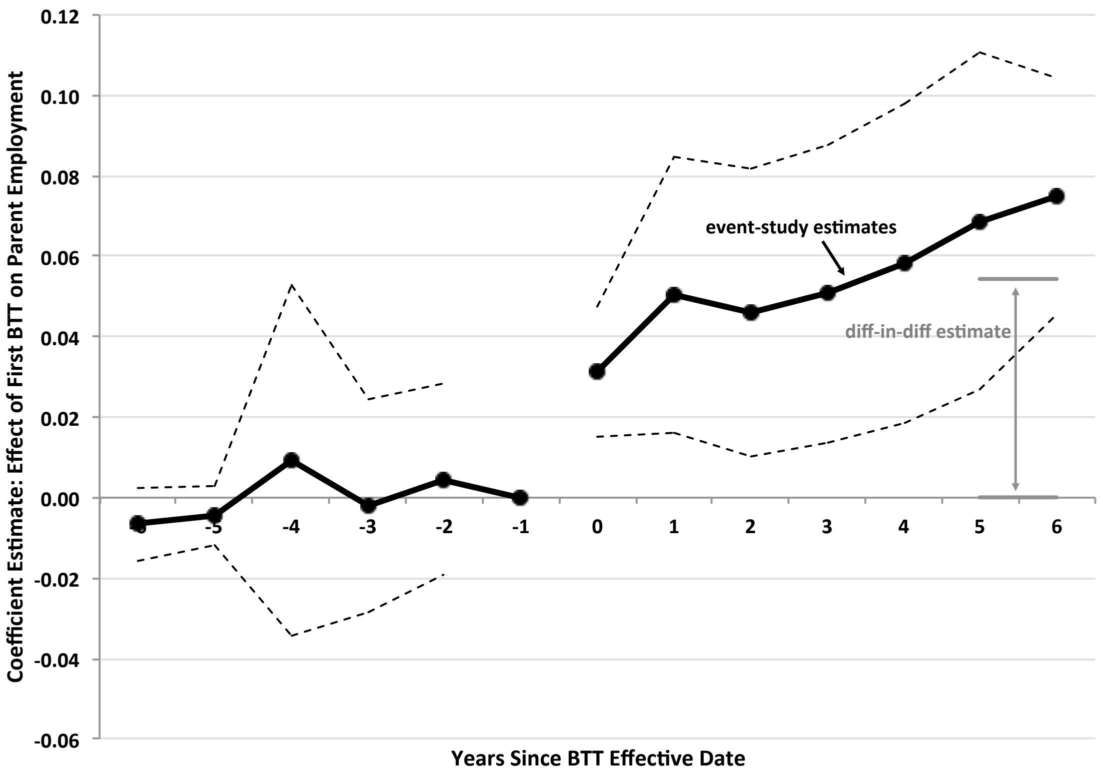
Figure 1: Sample Coverage Relative to BTT Implementation



Source: Authors' calculations based on BEA Annual Surveys of U.S. Direct Investment Abroad 1987-2007 and information from U.S. Treasury publications (see footnote 10). BTT implementation dates appear in Table 1. Each country shown has a new BTT during our sample period. Darker bars show the number of available years before the BTT and lighter bars show the number of available years after the BTT. Note that Estonia, Latvia, and Lithuania first appear in the BEA data in 1991, while Russia, Slovenia, and Ukraine first appear in 1992.

Figure 2: Effect of BTTs on U.S. Multinational Firm Employment
in High Differentiation Industries



Source: Authors' calculations based on BEA Annual Surveys of U.S. Direct Investment Abroad 1987-2007. Sample restricted to firms in industries producing highly differentiated products. Each point on the black line represents a coefficient estimate from the event study specification in (2). Dashed lines reflect 95 percent confidence intervals for these event-study estimates when clustering standard errors by both parent firm and year. Gray lines reflects the diff-in-diff estimate described in (1), located so the lower line corresponds to the average of pre-BTT event study coefficients. Both specifications include firm and industry × time fixed effects and a full set of controls, as in column (5) of Table 3.

Table 1: Countries with New Treaties in Effect During Sample Period (1987-2007)

Treaty	Year BTT	Pre-Treaty Rates			Post-Treaty Rates		
Partner	Entered into Force	Dividends	Interest	Royalties	Dividends	Interest	Royalties
India	1990	25	25	30	15	15	20
Indonesia	1990	20	20	20	15	0, 15	10, 15
Spain	1990	25	25	25	10, 15	10	5-10
Tunisia[a]	1990	-	-	-	-	-	-
Mexico	1993	0	15-35	15-35	5-15	10, 15	10
Russia	1993	15	15	20	5, 10	0	0
Israel	1994	25	25	25	12.5-25	10, 17.5	10, 15
Portugal	1995	25, 30	20	15	15	10	10
Thailand	1997	10	15	15	10	10, 15	5, 8, 15
Turkey	1997	20,22	13.2	22	15,20	15	5, 10
Estonia	1999	26	26	15	0,5,15	10	5, 10
Latvia	1999	10	0, 5, 10	5, 15	10	0, 5, 10	2, 5, 10
Lithuania	1999	29	24-29	24-29	15	10	10
Venezuela[b]	1999	-	-	-	5,15	0, 4.95, 10	0, 5, 10
Ukraine	2000	15	0, 15	0	5,15	0	10
Slovenia[a]	2001	25	-	-	5,15	5	5
Sri Lanka	2004	10	15	15	15	10	5, 10
Bangladesh[a]	2007	-	-	-	-	-	-

Sources: Year BTT entered into force determined from tax treaty text, available from *IRS United States Income Tax Treaties - A to Z*. Note that Russia had been covered by a pre-existing tax treaty between the U.S. and U.S.S.R., but this treaty did not include standard measures to reduce double taxation, so we count the 1993 treaty with Russia as a new treaty. Tax rates from Price Waterhouse Coopers (PwC) publications, *Corporate Taxes: A Worldwide Summary*, across various years. When multiple rates apply in different circumstances, each rate or a range is reported. Pre- and post-treaty data are from publications in the following years for each country: India (1990,1991), Indonesia (1990,1991), Spain (1990,1991), Mexico (1993,1994), Russia (1993,1994), Israel (1995,1995), Portugal (1995,1996), Thailand (1997,1999-2000), Turkey (1999-2000,1999-2000), Estonia (1997, 2001-2002), Latvia (1999-2000,2003-2004), Lithuania (1999-2000,2001-2002), Venezuela (1999-2000,2004), Ukraine (1999-2000,2001-2002), Slovenia (2000-2001,2004), Sri Lanka (2004,2005). Note that Israel reports 1995 non-treaty rate for the pre-treaty period (doesn't appear in prior issues), and Turkey reports 1991-2000 non-treaty rate for the pre-treaty period. [a] Tunisia and Bangladesh are omitted from the PwC publications, as are Slovenia's pre-treaty withholding tax rates for interest and royalties. [b] Venezuela's pre-treaty withholding tax structure is too complex to report with a simple set of rates.

Table 2: Summary Statistics.

	N. Obs	Mean	Std. Dev.	Min	Max
FOREIGN AFFILIATES					
Employment	171016	554.48	1997.206	(confidential)	
ln(Employment)	171016	4.78	1.872	(confidential)	
Av. Annual Emp Growth (%)	171016	0.083	0.796	(confidential)	
BTT	171016	0.805	0.396	0	1
Differentiated Input Share	171016	0.56	0.223	0.169	0.947
Parent-Sibling BTTs[a]	171016	0.283	0.368	0	1
Affiliate-Sibling BTTs[b]	171016	0.126	0.178	0	1
$\ln(GDP_{us} + GDP_d)$	171016	9.323	0.212	8.867	10.093
$\ln(GDP_{us} - GDP_d)^2$	171016	18.185	0.519	14.841	18.933
ln(Skill Difference)	171016	1.130	0.752	0	2.485
ln(Trade Cost)	171016	2.791	2.286	0	4.594
BIT	171016	0.052	0.222	0	1
FTA	171016	0.0133	0.340	0	1
Exchange Rate	171016	153.425	884.518	0	16105.13
US PARENT FIRMS					
Foreign Affiliate Employment	30419	3093.02	13155.18	(confidential)	
ln(Aff Emp)	30419	5.820	2.180	(confidential)	
Av Annual Aff Emp Growth (%)	30419	0.118	0.907	(confidential)	
US Employment	30419	6535.11	19022.51	(confidential)	
ln(US Employment)	30419	7.224	1.937	(confidential)	
Number of Affiliates	30419	5.998	10.814	(confidential)	
$\ln(GDP_{us} + GDP_d^c$	30419	7.811	3.383	0	29.618
$\ln(GDP_{us} - GDP_d)^{2c}$	30419	15.212	6.592	0	58.087
ln(Skill Difference)[c]	30419	0.881	0.631	0	4.240
ln(Trade Cost)[c]	30419	2.461	1.885	0	10.940
BIT[c]	30419	0.019	0.102	0	1
FTA[c]	30419	0.194	0.347	0	1
Exchange Rate[c]	30419	64.059	393.291	0	23573.6

Authors' calculations from BEA Annual Surveys of U.S. Direct Investment Abroad 1987-2007 and various other data sources, described in Section 2. [a]Weighted average share of total sibling employment covered by a BTT with the US, using fixed affiliate employment shares. [b]Weighted average share of total sibling employment covered by a BTT with the affiliate's country, using fixed affiliate employment shares. [c]Parent-level versions of affiliate country controls are aggregated from the country to the parent firm level using a weighted average, using fixed affiliate employment shares as weights.

Table 3: Reduced Form Difference-in-Differences Analysis:
The Effect of BTTs on Parent Employment

Dependent variable: log parent employment: $\ln(s_{ft})$

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	All	High dif	Low dif	All	High dif	Low dif
BTT $\left[\tilde{\varphi}_f \mathbf{1}(t \geq \tilde{t}_f)\right]$	0.020	0.046***	0.006	0.023	0.054***	0.012
	(0.034)	(0.013)	(0.012)	(0.043)	(0.017)	(0.025)
$\ln(GDP_{us} + GDP_d)$				0.002	-0.006	0.007
				(0.015)	(0.016)	(0.020)
$\ln((GDP_{us} - GDP_d)^2)$				-0.0003	0.003	-0.003
				(0.008)	(0.008)	(0.010)
ln(Skill Difference)				-0.004	0.002	-0.007
				(0.006)	(0.008)	(0.007)
ln(Trade Costs)				0.003	0.004	0.003
				(0.002)	(0.003)	(0.003)
FTA				0.001	-0.014	-0.002
				(0.008)	(0.013)	(0.011)
Exchange Rate				1.13e-5	5.91e-6	9.57e-6
				(7.60e-6)	(2.57e-5)	(8.08e-6)
BIT				0.028*	0.082***	0.001
				(0.016)	(0.021)	(0.018)
Parent FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
N:	30419	13422	16997	30419	13422	16997
R-sq	0.062	0.065	0.058	0.073	0.079	0.076

Notes: Documents the effect of newly-signed Bilateral Tax Treaties (BTTs) on parent employment in U.S. multinational enterprises. "High dif" and "Low dif" respectively refer to firms in high and low differentiation industries (see Appendix A.1 for details). Sample covers 1987-2007. Standard errors clustered by both parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 4: Foreign Affiliate-Level Analysis:
The Effect of BTTs on Offshore Employment

Dependent variable: log affiliate employment: $\ln(m_{at})$

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	All	High dif	Low dif	All	High dif	Low dif
BTT	0.157*	0.356***	0.045	0.087	0.249***	-0.003
	(0.090)	(0.092)	(0.099)	(0.084)	(0.092)	(0.094)
$\ln(GDP_{us} + GDP_d)$				5.70**	4.61	6.39***
				(2.61)	(3.22)	(2.34)
$\ln(GDP_{us} - GDP_d)^2$				0.335*	0.260	0.389**
				(0.172)	(0.212)	(0.178)
ln(Skill Difference)				-0.162	-0.182	-0.118
				(0.112)	(0.125)	(0.097)
ln(Trade Costs)				0.028	0.035	0.022
				(0.036)	(0.042)	(0.032)
FTA				0.023	-0.019	-0.038
				(0.100)	(0.108)	(0.097)
Exchange Rate				1.78e-6	-7.67e-5	1.46e-5
				(69.6e-6)	(8.19e-5)	(6.32e-5)
BIT				-0.567**	-0.748**	-0.498**
				(0.266)	(0.364)	(0.247)
Parent-Sibling BTTs				-0.119**	-0.037	-0.163**
				(0.061)	(0.086)	(0.069)
Affiliate-Sibling BTTs				0.040***	0.092***	0.0004
				(0.015)	(0.023)	(0.016)
Affiliate FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
N	171016	71818	99198	171016	71818	99198
R-sq	0.0008	0.003	0.0001	0.012	0.016	0.019
F-Statistic	3.07	14.94	0.21	11.21	28.09	5.53

Notes: Documents the effect of newly-signed Bilateral Tax Treaties (BTTs) on foreign affiliate employment. "High dif" and "Low dif" respectively refer to firms in high and low product differentiation industries (see Appendix A.1 for details). Sample covers 1987-2007. Standard errors clustered by both affiliate country and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 5: U.S. Parent-Level Analysis:
The Effect of Offshore Employment on Domestic MNE Employment

Dependent variable: log parent employment: $\ln(s_{ft})$

	(1)	(2)	(3)	(4)	(5)	(6)
Specification:	OLS	OLS	IV	IV	IV	IV
Sample:					New Aff	Cont Aff
log affiliate employment:	0.362***	0.365***	0.183***	0.183***	0.082	0.196***
$\ln(M_{ft})$	(0.021)	(0.021)	(0.030)	(0.031)	(0.059)	(0.033)
$\ln(GDP_{us} + GDP_d)$		-0.126		-0.144*	-0.388**	-0.087
		(0.077)		(0.079)	(0.167)	(0.090)
$\ln(GDP_{us} - GDP_d)^2$		0.070*		0.079**	0.208**	0.049
		(0.039)		(0.040)	(0.084)	(0.045)
ln(Skill Difference)		-0.082**		-0.089**	-0.224***	-0.068*
		(0.036)		(0.038)	(0.081)	(0.039)
ln(Trade Costs)		0.011		-0.015	0.041	0.011
		(0.009)		(0.009)	(0.029)	(0.009)
FTA		-0.038**		-0.044	-0.044	-0.037
		(0.041)		(0.043)	(0.119)	(0.043)
Exchange Rate		1.82e-5		1.4e-5	33.9e-5	-3.55e-5
		(7.26e-5)		(7.17e-5)	(26.6e-5)	(5.79e-5)
BIT		-0.248		-0.266*	0.117	-0.388**
		(0.157)		(0.160)	(0.318)	(0.180)
Parent FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	13422	13422	13422	13422	2738	10684
R-sq	0.306	0.310	0.303	0.307	0.437	0.258
First Stage F-Stat	-	-	404.63	441.04	219.11	286.73
Endog Test P-Val	-	-	0.0014	0.0016	0.0018	0.0013

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment of multinational firms in high differentiation industries. Columns (5) and (6) respectively restrict the sample to parent firms that did and did not open new affiliates in countries newly receiving a BTT. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Sample covers 1987-2007. Standard errors clustered by parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 6: U.S. Industry-Level Analysis:
The Effect of Offshore Employment on U.S. Industry Employment

Dependent variable: log industry employment: $\ln(L_{it})$

	(1)	(2)	(3)	(4)
Specification:	OLS	OLS	IV	IV
industry log affiliate employment	0.064	0.076*	0.014*	0.014**
($\ln M_{it}$)	(0.051)	(0.045)	(0.007)	(0.006)
$\ln(GDP_{us} + GDP_d)$		-0.711**		-0.068**
		(0.288)		(0.028)
$\ln(GDP_{us} - GDP_d)^2$		0.365**		0.035**
		(0.143)		(0.014)
ln(Skill Difference)		-0.199		-0.023
		(0.280)		(0.026)
ln(Trade Costs)		0.093**		0.010***
		(0.038)		(0.004)
FTA		-0.913**		-0.092**
		(0.402)		(0.041)
Exchange Rate		-1.77e-4		-2.33e-5
		(2.44e-4)		(2.45e-5)
BIT		2.85		0.292
		(1.79)		(0.183)
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	397	397	397	397
R-sq	0.702	0.747	0.697	0.743
First Stage F-Stat	-	-	83.42	88.34
Endog Test P-Val	-	-	0.0129	0.0145

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment at the industry level for high differentiation industries. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Sample covers 1987-2007. Standard errors clustered by industry and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 7: U.S. Industry Level Analysis:
The Effect of Offshore Employment on U.S. MNE vs. non-MNE Employment

Dependent variable: log industry employment: $\ln(L_{it})$

	(1)	(2)	(3)	(4)
Specification:	IV	IV	IV	IV
Sample:	MNE	MNE	non-MNE	non-MNE
industry log affiliate employment	0.088***	0.088***	0.001	-0.007
$(\ln M_{it})$	(0.005)	(0.005)	(0.017)	(0.012)
$\ln(GDP_{us} + GDP_d)$		-0.010		-0.110***
		(0.027)		(0.040)
$\ln(GDP_{us} - GDP_d)^2$		0.004		0.057***
		(0.012)		(0.019)
ln(Skill Difference)		-0.054***		-0.043
		(0.019)		(0.035)
ln(Trade Costs)		0.017**		0.018**
		(0.008)		(0.009)
FTA		-0.027		-0.122**
		(0.036)		(0.048)
Exchange Rate		4.63e-5		-6.38e-5
		(5.11e-5)		(5.95e-5)
BIT		-0.054		0.762*
		(0.291)		(0.408)
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	397	397	397	397
R-sq	0.752	0.771	0.621	0.661
First Stage F-Stat	58.76	62.40	114.59	105.84
Endog Test P-Val	0.0169	0.0176	0.0252	0.0287

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment at the industry level for high differentiation industries. Columns (1) and (2) examine employment for multinational parents in the U.S. industry while columns (3) and (4) examine all other employment in each industry. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Sample covers 1987-2007. Standard errors clustered by industry and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 8: U.S. Industry Level Analysis:
The Effect of Offshore Employment at Vertically Oriented Affiliates
on U.S. MNE vs. non-MNE Employment

Dependent variable: log industry employment: $\ln(L_{it})$

	(1)	(2)	(3)	(4)
Specification:	IV	IV	IV	IV
Sample:	V-MNE	V-MNE	non-MNE	non-MNE
industry log vertical affiliate	0.123***	0.113***	-0.038*	-0.044**
employment ($\ln M_{it}$)	(0.023)	(0.014)	(0.021)	(0.022)
$\ln(GDP_{us} + GDP_d)$		0.474		-0.009
		(0.307)		(0.403)
$\ln(GDP_{us} - GDP_d)^2$		-0.244		-0.002
		(0.152)		(0.201)
ln(Skill Difference)		-0.111***		0.060*
		(0.032)		(0.036)
ln(Trade Costs)		0.039***		0.003
		(0.008)		(0.024)
FTA		0.087		0.038
		(0.121)		(0.232)
Exchange Rate		0.455e-5		1.31e-5
		(1.06e-5)		(2.2e-5)
BIT		0.484		0.244
		(0.314)		(0.339)
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	395	395	395	395
R-sq	0.1386	0.5015	0.4138	0.4357
First Stage F-Stat	42.66	60.35	29.27	66.99
Endog Test P-Val	0.0063	0.0036	0.0168	0.0155

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment at foreign affiliates that have non-zero sales to their U.S. parent on domestic employment at the industry level for high differentiation industries. Columns (1) and (2) examine employment for multinational parents in the U.S. industry while columns (3) and (4) examine all other employment in each industry. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Sample covers 1987-2007. Standard errors clustered by industry and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 9: U.S. Metro Area Level Analysis:
The Effect of Offshore Employment on U.S. Regional Employment

Dependent variable: log regional employment: $\ln(L_{mt})$

	(1)	(2)	(3)	(4)
Specification:	OLS	OLS	IV	IV
regional log affiliate employment	0.076***	0.081***	0.061***	0.067***
$(\ln M_{mt})$	(0.021)	(0.020)	(0.017)	(0.016)
$\ln(GDP_{us} + GDP_d)$		-2.04**		-1.37***
		(0.821)		(0.521)
$\ln(GDP_{us} - GDP_d)^2$		1.06**		0.716***
		(0.424)		(0.269)
ln(Skill Difference)		-0.334		-0.243*
		(0.207)		(0.130)
ln(Trade Costs)		-0.046		0.31
		(0.119)		(0.077)
FTA		0.319***		0.213
		(0.237)		(0.155)
Exchange Rate		5.27e-4		3.47e-4
		(4.35e-4)		(2.85e-4)
BIT		-2.34		-1.47
		(2.17)		(1.43)
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	6359	6359	6359	6359
R-sq	0.728	0.735	0.728	0.734
First Stage F-Stat	-	-	537.99	625.31
Endog Test P-Val	-	-	0.0285	0.0331

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment at the region level. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Sample covers 1987-2007. Standard errors clustered by parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Online Appendices

(Not for publication)

A Data, Definitions & Supplemental Empirical Results

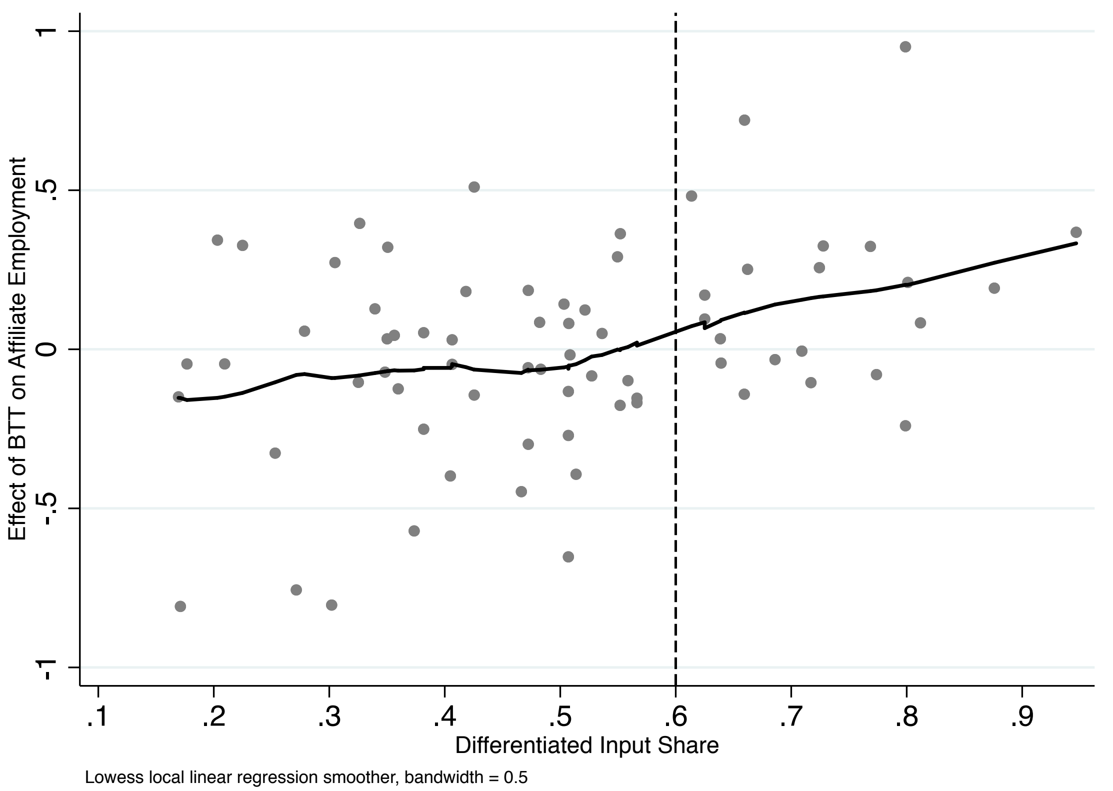
A.1 Product Differentiation

As discussed in Section 2, double taxation is more likely to occur in industries selling highly differentiated products, where markups and hence the potential rents earned are much higher, and withholding taxes on royalties, interest, and dividends are larger. Limits on the foreign tax credit available to U.S. multinational firms are more likely to bind when the amount of income subject to taxation by the foreign governemt is high, making double taxation more likely in sectors with high product differentiation. Appendix B.1 formally demonstrates this argument in the context of the Antràs and Helpman (2004) model of multinational firms. The purpose of this section is to provide empirical evidence that supports our classification of high versus low product differentiation.

Rauch (1999) provides a classification of 3-digit SITC products into homogenous products, those traded on an organized exchange or traded at reference prices, and differentiated products. As discussed in Section 2, we classify 3-digit industries as high differentiation iff all of the associated 4-digit sub-industries are labeled as "high differentiation" products by Rauch (1999). 3-digit industries with any 4-digit sub-industries labeled as non-differentiated (exchange traded or reference priced) are classified as "low differentiation."

An alternative approach to classifying industry differentiation focuses on inputs rather than outputs. Nunn (2007) combines the Rauch (1999) classification with the 1997 U.S. input-output Use Table to calculate the share of input value in each industry coming from differentiated products. We use a data-driven procedure to split the continuous distribution of input differentiation into high and low differentiation groups. We estimate specification (13) separately for each industry, yielding an estimate of BTTs' effect on foreign affiliate employment in each industry. Figure A1 plots each of these estimates against the differentiated input share in the relevant industry. The line shows a nonparametric regression using a "lowess" locally weighted linear regression smoother with a bandwidth of 0.5. Although the estimates are noisy due to the relatively small sample in each industry, there is a clear increasing relationship, confirming our expectation that BTTs have larger effects in industries with more differentiated inputs. There is also a visible jump in the scatterplot at a differentiated input share of 0.6. Given this natural break in the data, we choose 0.6 as the cutoff defining high and low input differentiation industries. Doing so yields precisely the same classification of industries into "high" and "low" differentiation as the output-based approach using the Rauch (1999) classification alone.

Figure A1: Determining Input Differentiation Cutoff Value



Each point corresponds to an individual 3-digit SIC industry. The y-axis reports the industry-specific regression coefficient capturing the effect of BTTs on affiliate employment as in (13). The x-axis reports the industry's differentiated input share. The bold line is a nonparametric regression line using a "lowess" locally weighted linear regression smoother with a bandwidth of 0.5. The vertical dashed line shows the chosen input-differentiation cutoff value of 0.6.

Table A1: Differentiated Input Share by 3-Digit SIC Industry

SIC	Industry	Input Differentiation
335	Nonferrous Rolling and Drawing	0.17
287	Agricultural Chemicals	0.18
204	Grain Mill Products	0.20
	…	
369	Misc. Electrical Equipment + Supplies	0.56
352	Farm and Garden Machinery	0.57
359	Industrial Machinery, NEC	0.57
275	Commercial Printing	0.61
363	Household Appliances	0.63
364	Electric Lighting and Wiring Equipment	0.63
	…	
272	Periodicals	0.80
371	Motor Vehicles and Equipment	0.81
366	Communication Equipment	0.88

3-Digit SIC industries with the lowest differentiated input share, those around the cutoff value of 0.6, and those with the highest differentiated input share.

A.2 Alternative Specifications for BTTs' Effects on Employment at U.S. Multinationals

This section presents two alternative reduced-form specifications examining the effects of BTTs on domestic employment at U.S. multinational firms. The main results use the specifications in equations (1) and (2), with results in Table 3 and Figure 2.

Our first alternative specification drops the affiliate employment rescaling term, $\tilde{\varphi}_f$ from the BTT indicator, so the variable of interest is simply $\mathbf{1}(t \geq \tilde{t}_f)$. The difference-in-difference and event study results appear in Table A2 and Figure A2. As in the main specification, the effect of BTTs is positive, and significant only for high differentiation firms. The scale of the coefficients is smaller however, reflecting the fact that the scale of the regressor is larger without the affiliate employment share adjustment. As in the main specification, there is no sign of pre-BTT differential employment growth between firms with and without affiliates receiving a BTT, and the employment effects emerge in the period of BTT implementation ($t = 0$ in Figure A2).

Our second alternative integrates information from all BTTs faced by firm affiliates during our sample period, not just the first one as in the main analysis or the previous alternative. For a given multinational firm f, we examine the share of initial affiliate employment covered by BTTs in year t (see footnote 17 for notation definitions).

$$\overline{BTT}_{ft} \equiv \sum_{c \in C_f} \varphi_{f,c} \mathbf{1}(t \geq t_c), \qquad \varphi_{f,c} \equiv \frac{m_{f,c,\tilde{t}_f - 1}}{\sum_{c' \in C_f} m_{f,c',\tilde{t}_f - 1}} \tag{19}$$

$\varphi_{f,c}$ is affiliate c's initial share of firm f's total affiliate employment. We measure affiliate employment in the year prior to the first BTT faced by the firm ($\tilde{t}_f - 1$) to avoid including any endogenous employment adjustments. Because a given parent firm may be "treated" multiple times by receiving BTTs in multiple affiliate countries over time, we can not implement a traditional event study, as we did when focusing only on the first BTT a firm experiences. However, we can use a similar approach to rule out the presence of confounding pre-BTT trends by including leads and lags of the BTT coverage measure in (19). Figure A3 plots the associated coefficients, confirming the similarity of pre-existing employment growth rates for firms that would and would not later experience increases BTT coverage.

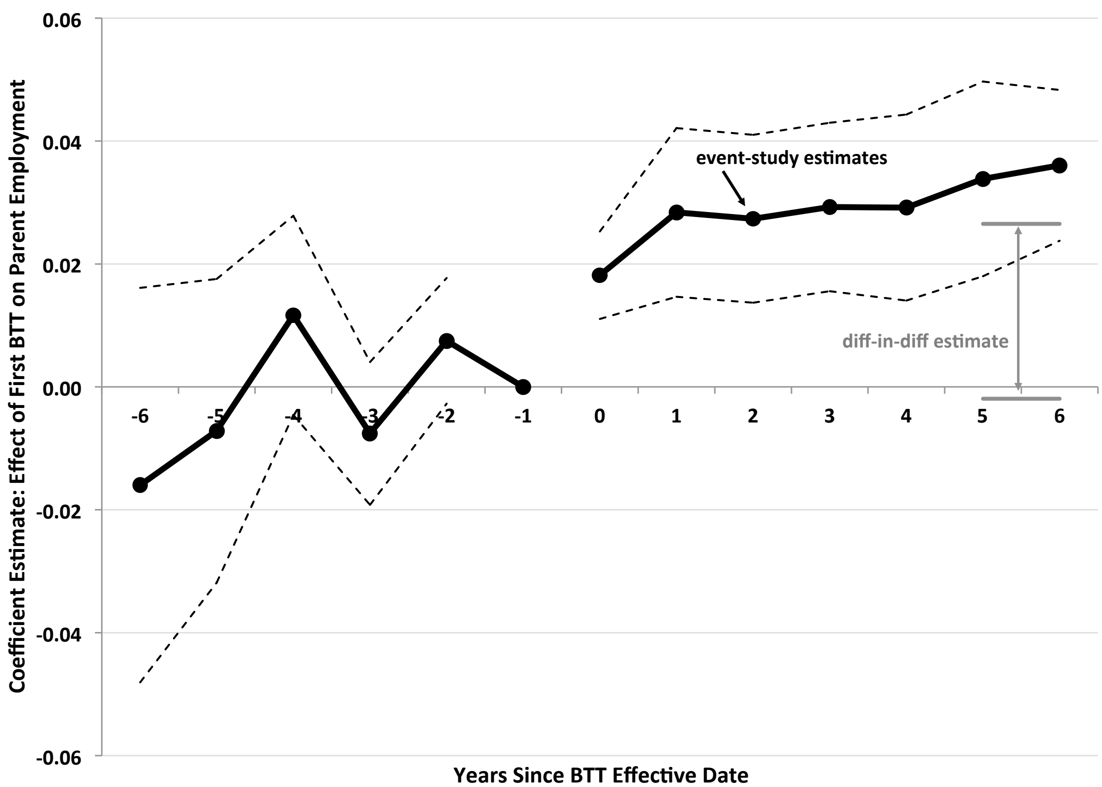
Table A2: Reduced Form Difference-in-Differences Analysis Without Affiliate Scaling: The Effect of BTTs on Parent Employment

Dependent variable: log parent employment: $\ln(s_{ft})$

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	All	High dif	Low dif	All	High dif	Low dif
BTT $\left[\mathbf{1}(t \geq \tilde{t}_f)\right]$	0.001	0.022***	0.001	0.001	0.028***	0.001
	(0.001)	(0.005)	(0.001)	(0.002)	(0.007)	(0.002)
$\ln(GDP_{us} + GDP_d)$				0.001	-0.008	0.008
				(0.015)	(0.017)	(0.020)
$\ln((GDP_{us} - GDP_d)^2)$				0.001	0.005	-0.003
				(0.008)	(0.008)	(0.010)
ln(Skill Difference)				-0.005	0.000	-0.008
				(0.006)	(0.008)	(0.007)
ln(Trade Costs)				0.003	0.004	0.002
				(0.002)	(0.003)	(0.003)
FTA				-0.004	-0.017	-0.008
				(0.009)	(0.014)	(0.011)
Exchange Rate				1.17e-5	-7.67e-6	1.07e-5
				(7.85e-6)	(2.61e-5)	(8.55e-6)
BIT				0.027	0.079***	-0.000
				(0.016)	(0.021)	(0.018)
Parent FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
N	30419	13422	16997	30419	13422	16997
R-sq	0.0821	0.0777	0.0873	0.0923	0.0978	0.0974

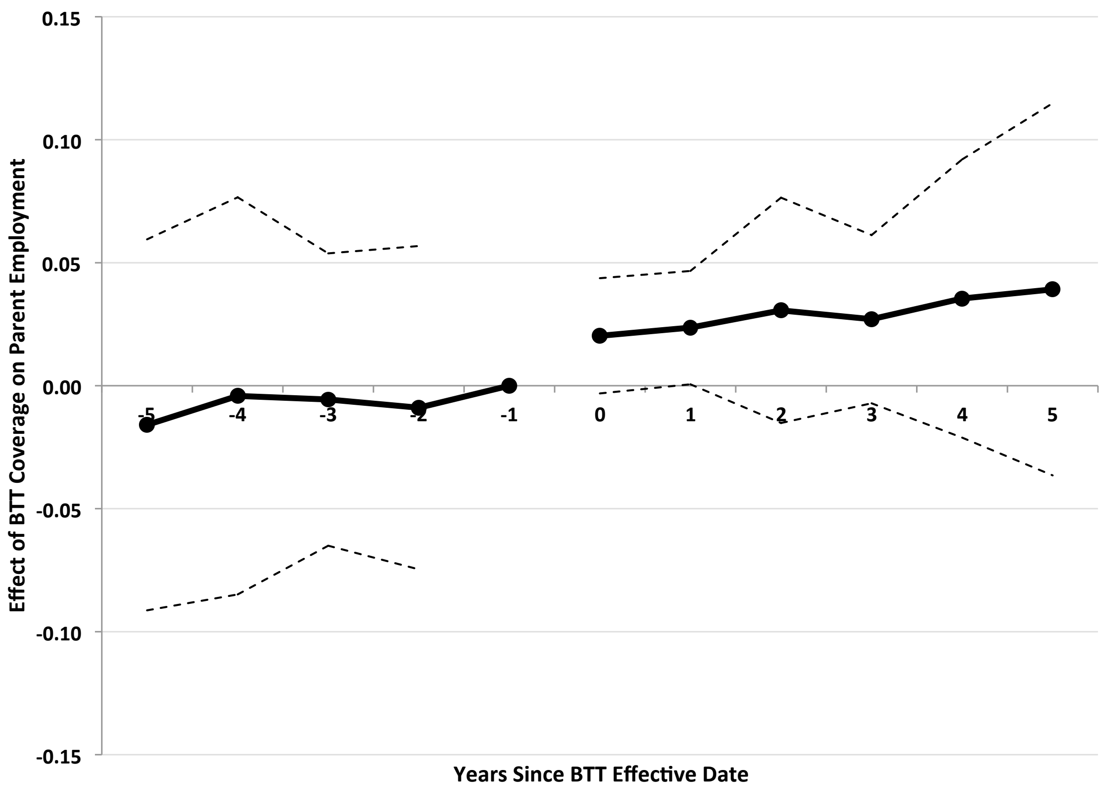
Notes: Documents the effect of newly-signed Bilateral Tax Treaties (BTTs) on parent employment in U.S. multinational enterprises. "High dif" and "Low dif" respectively refer to firms in high and low product differentiation industries, indicated by differentiated-good input shares above or below 0.6. (See Appendix A.1 for details.) Standard errors clustered by both parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Figure A2: Effect of BTTs on U.S. Multinational Firm Employment Without Affiliate Scaling in High Differentiation Industries



Source: Authors' calculations based on BEA Annual Surveys of U.S. Direct Investment Abroad. Sample restricted to firms in industries producing highly differentiated products, i.e. those with differentiated-good input share of 0.6 or greater. Each point on the black line represents a coefficient estimate from the event study specification in (2). Dashed lines reflect 95 percent confidence intervals for these event-study estimates when clustering standard errors by both parent firm and year. Gray lines reflects the diff-in-diff estimate described in (1), located so the lower line corresponds to the average of pre-BTT event study coefficients. Both specifications include firm and industry × time fixed effects and a full set of controls, as in column (5) of Table 3.

Figure A3: Effect of BTTs on U.S. Multinational Firm Employment Using All BTTs in High Differentiation Industries



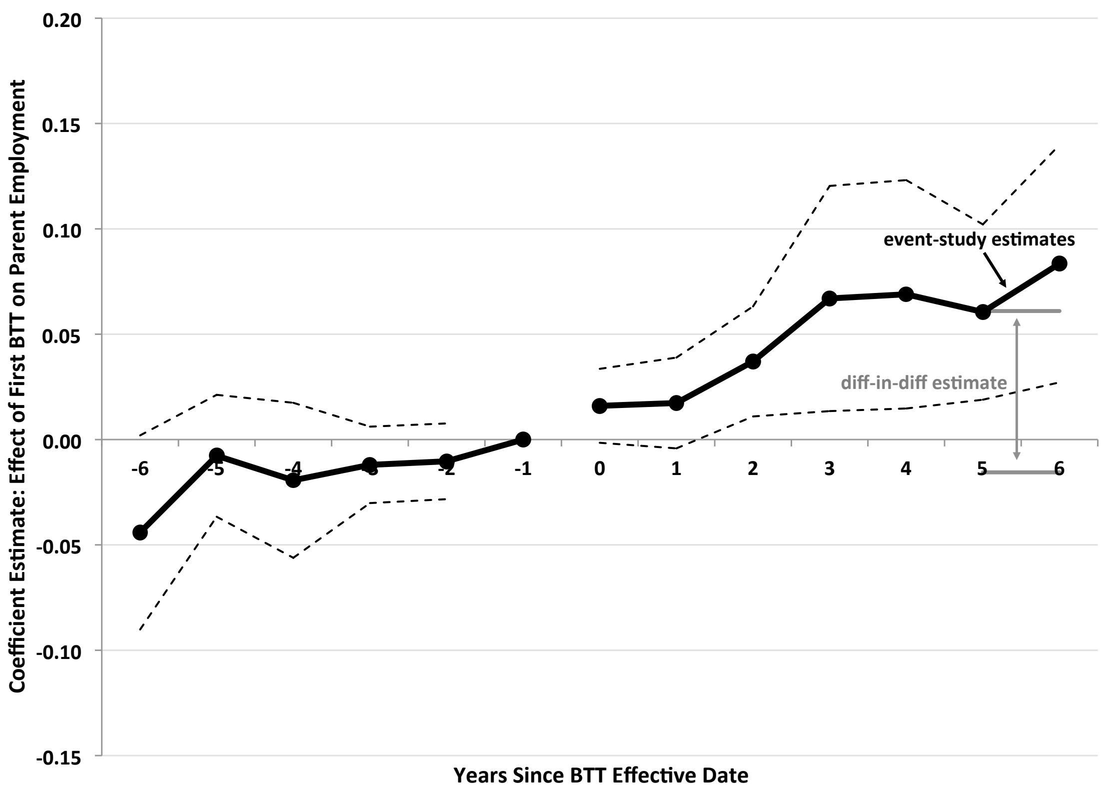
Source: Authors' calculations based on BEA Annual Surveys of U.S. Direct Investment Abroad. Sample restricted to firms in industries producing highly differentiated products, i.e. those with differentiated-good input share of 0.6 or greater. Each point on the black line represents a coefficient estimate on leads or lags of the BTT coverage measure in (19). Dashed lines reflect 95 percent confidence intervals for these estimates when clustering standard errors by both parent firm and year. The regressions include firm and industry × time fixed effects and a full set of controls, as in column (5) of Table 3.

A.3 Empirical Results for Vertically Oriented Multinational Firms

This appendix replicates the empirical results in the main text for a subsample of vertically oriented multinational firms, i.e. those whose foreign affiliates exhibit sales back to the U.S. parent. The results are similar to those in the main text, which use the full sample of multinationals irrespective of vertical or horizontal orientation. The exception to this rule relates to the industry-level effect of offshoring activity on non-multinational firm employment, which is why we include the effects for vertically oriented firms in Table 8 in the main text, and discuss the differences in Section 4.2.3.

For reference, Appendix Figure A4 corresponds to Figure 2 in the main text, Table A3 corresponds to Table 2, Table A4 corresponds to Table 3, Table A5 corresponds to Table 4, Table A6 corresponds to Table 5, Table A7 corresponds to Table 6, and Table A8 corresponds to Table 9.

Figure A4: Effect of BTTs on Vertically Oriented U.S. Multinational Firm Employment in High Differentiation Industries



Source: Authors' calculations based on BEA Annual Surveys of U.S. Direct Investment Abroad. Sample restricted to firms in industries producing highly differentiated products, i.e. those with differentiated-good input share of 0.6 or greater. Each point on the black line represents a coefficient estimate from the event study specification in (2). Dashed lines reflect 95 percent confidence intervals for these event-study estimates when clustering standard errors by both parent firm and year. Gray lines reflects the diff-in-diff estimate described in (1), located so the lower line corresponds to the average of pre-BTT event study coefficients. Both specifications include firm and industry × time fixed effects and a full set of controls, as in column (5) of Table 3.

Table A3: Summary Statistics for Vertically Oriented Multinational Firms.

	N. Obs	Mean	Std. Dev.	Min	Max
FOREIGN AFFILIATES					
Employment	96276	748.319	2310.622	(confidential)	
ln(Employment)	96276	5.454	1.484	(confidential)	
Av. Annual Emp Growth (%)	96276	0.074	0.587	(confidential)	
BTT	96276	0.801	0.399	0	1
Differentiated Input Share	96276	0.547	0.202	0.169	0.947
Parent-Sibling BTTs[a]	96276	0.279	0.360	0	1
Affiliate-Sibling BTTs[b]	96276	0.095	0.169	0	1
$\ln(GDP_{us} + GDP_d)$	96276	9.277	0.212	8.867	10.093
$\ln(GDP_{us} - GDP_d)^2$	96276	18.092	0.491	14.841	18.933
ln(Skill Difference)	96276	1.130	0.721	0	2.485
ln(Trade Cost)	96276	2.866	2.249	0	4.594
BIT	96276	0.030	0.171	0	1
FTA	96276	0.142	0.349	0	1
Exchange Rate	96276	124.981	700.521	1.27E-09	16105.13
US PARENT FIRMS					
Foreign Affiliate Employment	18747	3522.88	12801.78	(confidential)	
ln(Aff Emp)	18747	6.355	1.899	(confidential)	
Av Annual Aff Emp Growth (%)	18747	10.313	0.678	(confidential)	
US Employment	18747	8645.468	22063.59	(confidential)	
ln(US Employment)	18747	7.755	1.686	(confidential)	
Number of Affiliates	18747	4.688	7.150	(confidential)	
$\ln(GDP_{us} + GDP_d^c$	18747	9.292	0.191	8.905	10.093
$\ln(GDP_{us} - GDP_d)^{2c}$	18747	18.127	0.400	14.841	18.928
ln(Skill Difference)[c]	18747	1.032	0.502	0	2.480
ln(Trade Cost)[c]	18747	2.824	1.694	0	4.479
BIT[c]	18747	0.017	0.085	0	1
FTA[c]	18747	0.217	0.348	0	1
Exchange Rate[c]	18747	65.839	225.884	1.14E-07	6265.78

Authors' calculations from BEA Annual Surveys of U.S. Direct Investment Abroad and various other data sources, described in Section 2. [a]Weighted average share of total sibling employment covered by a BTT with the US, using fixed affiliate employment shares. [b]Weighted average share of total sibling employment covered by a BTT with the affiliate's country, using fixed affiliate employment shares. [c]Parent-level versions of affiliate country controls are aggregated from the country to the parent firm level using a weighted average, using fixed affiliate employment shares as weights.

Table A4: Reduced Form Difference-in-Differences Analysis:
The Effect of BTTs on Parent Employment, Vertically Oriented Firms

Dependent variable: log parent employment: $\ln(s_{ft})$

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	All	High dif	Low dif	All	High dif	Low dif
BTT ($\mathbf{1}(t \geq \tilde{t}_f)$)	0.047*	0.048**	0.011	0.061**	0.061***	0.021
	(0.023)	(0.018)	(0.034)	(0.027)	(0.020)	(0.048)
$\ln(GDP_{us} + GDP_d)$				-1.992***	-3.029***	3.081
				(0.687)	(0.711)	(1.879)
$\ln((GDP_{us} - GDP_d)^2)$				-0.577***	-0.742***	0.191
				(0.156)	(0.157)	(0.308)
ln(Skill Difference)				0.107	0.125	-0.225*
				(0.084)	(0.105)	(0.129)
ln(Trade Costs)				0.040*	0.043**	-0.043
				(0.021)	(0.019)	(0.050)
FTA				-0.186*	-0.329***	0.420***
				(0.095)	(0.104)	(0.127)
Exchange Rate				-3.427e-4***	-3.827e-4***	-3.150e-4
				(0.920e-4)	(0.912e-4)	(3.865e-4)
BIT				0.786***	0.395	2.499**
				(0.231)	(0.290)	(1.042)
Parent FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
N:	18747	9223	9524	18747	9223	9524
R-sq	0.084	0.077	0.076	0.120	0.120	0.123

Notes: Documents the effect of newly-signed Bilateral Tax Treaties (BTTs) on parent employment in U.S. multinational enterprises. "High dif" and "Low dif" respectively refer to firms in high and low product differentiation industries, with differentiated-good input shares above or below 0.6. Standard errors clustered by both parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table A5: Foreign Affiliate-Level Analysis:
The Effect of BTTs on Offshore Employment, Vertically Oriented Firms

Dependent variable: log affiliate employment: $\ln(m_{at})$

	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	All	High dif	Low dif	All	High dif	Low dif
BTT	0.071	0.194***	0.016	0.056	0.177***	0.007
	(0.046)	(0.057)	(0.058)	(0.049)	(0.064)	(0.063)
$\ln(GDP_{us} + GDP_d)$				2.157***	3.586***	1.402
				(0.697)	(0.772)	(0.847)
$\ln(GDP_{us} - GDP_d)^2$				-0.050	0.080	-0.123
				(0.061)	(0.068)	(0.076)
ln(Skill Difference)				-0.011	-0.058	0.019
				(0.040)	(0.045)	(0.038)
ln(Trade Costs)				-0.009	-0.015	-0.006
				(0.008)	(0.010)	(0.010)
FTA				-0.043	-0.068	-0.031
				(0.045)	(0.092)	(0.030)
Exchange Rate				5.8e-6	-6.84e-5	1.91e-5
				(16.5e-6)	(3.73e-5)	(1.6e-5)
BIT				-0.069	-0.042	-0.079*
				(0.047)	(0.310)	(0.044)
Parent-Sibling BTTs				-0.004	-0.027	0.013
				(0.042)	(0.039)	(0.052)
Affiliate-Sibling BTTs				0.013	0.024***	0.003
				(0.009)	(0.009)	(0.011)
Affiliate FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
N	96276	37702	58574	96276	37702	58574
R-sq	0.0003	0.0017	0.0000	0.0062	0.0104	0.0053
F-Statistic	5.16	11.71	0.25	8.15	16.22	0.31

Notes: Documents the effect of newly-signed Bilateral Tax Treaties (BTTs) on foreign affiliate employment. “High dif” and “Low dif” respectively refer to firms in high and low differentiation industries, with differentiated-good input shares above or below 0.6. Standard errors clustered by both affiliate country and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table A6: U.S. Parent-Level Analysis:
The Effect of Offshore Employment on Domestic MNE Employment, Vertically Oriented Firms

Dependent variable: log parent employment: $\ln(s_{ft})$

	(1)	(2)	(3)	(4)	(5)	(6)
Specification:	OLS	OLS	IV	IV	IV	IV
Sample:					New Aff	Cont Aff
log affiliate employment:	0.384***	0.396***	0.094***	0.104***	0.028	0.137***
$\ln(M_{ft})$	(0.059)	(0.061)	(0.022)	(0.022)	(0.040)	(0.028)
$\ln(GDP_{us} + GDP_d)$		-0.809		-0.783	-3.280**	-0.208
		(0.789)		(0.785)	(1.603)	(0.908)
$\ln(GDP_{us} - GDP_d)^2$		0.072		0.073	-0.248	0.137
		(0.144)		(0.144)	(0.209)	(0.190)
ln(Skill Difference)		0.020		0.024	0.014	0.035
		(0.047)		(0.047)	(0.080)	(0.056)
ln(Trade Costs)		-0.007		-0.008	0.010	-0.015
		(0.016)		(0.016)	(0.042)	(0.016)
FTA		-0.105**		-0.103**	0.020	-0.111**
		(0.050)		(0.050)	(0.108)	(0.054)
Exchange Rate		-5.18e-5		-5.58e-5	-9.59e-5	-5.32e-5
		(5.3e-5)		(5.4e-5)	(17.24e-5)	(5.17e-5)
BIT		-0.228		-0.216	0.068	-0.283
		(0.209)		(0.206)	(0.449)	(0.236)
Parent FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	9223	9223	9223	9223	1699	7524
R-sq	0.1841	0.1924	0.1828	0.1919	0.3274	0.2232
First Stage F-Stat	-	-	465.24	459.42	86.11	439.66
Endog Test P-Val	-	-	0.0032	0.0028	0.0038	0.0029

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment of multinational firms in high differentiation industries. Columns (5) and (6) respectively restrict the sample to parent firms that did and did not open new affiliates in countries newly receiving a BTT. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Standard errors clustered by parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table A7: U.S. Industry-Level Analysis:
The Effect of Offshore Employment on U.S. Industry Employment, Vertically Oriented Firms

Dependent variable: log industry employment: $\ln(L_{it})$

	(1)	(2)	(3)	(4)
Specification:	OLS	OLS	IV	IV
industry log affiliate employment	0.095***	0.108***	0.023	0.024
($\ln M_{it}$)	(0.031)	(0.027)	(0.295)	(0.244)
$\ln(GDP_{us} + GDP_d)$		-5.694		-5.235
		(8.709)		(9.418)
$\ln(GDP_{us} - GDP_d)^2$		3.062		2.806
		(4.528)		(4.893)
ln(Skill Difference)		-0.964		-0.855
		(1.177)		(1.289)
ln(Trade Costs)		0.967***		0.982***
		(0.269)		(0.242)
FTA		-7.021***		-6.779***
		(1.330)		(1.906)
Exchange Rate		0.024		0.025
		(0.015)		(0.016)
BIT		-22.093*		-22.837
		(12.481)		(15.271)
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	395	395	395	395
R-sq	0.7231	0.7985	0.7213	0.7982
First Stage F-Stat	-	-	75.32	59.17
Endog Test P-Val	-	-	0.0018	0.0019

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment at the industry level for high differentiation industries. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Standard errors clustered by industry and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table A8: U.S. Metro Area Level Analysis:
The Effect of Offshore Employment on U.S. Regional Employment, Vertically Oriented Firms

Dependent variable: log regional employment: $\ln(L_{mt})$

	(1)	(2)	(3)	(4)
Specification:	OLS	OLS	IV	IV
regional log affiliate employment	0.136***	0.123***	0.081***	0.081***
$(\ln M_{mt})$	(0.047)	(0.046)	(0.028)	(0.027)
$\ln(GDP_{us} + GDP_d)$		0.893		0.531
		(2.177)		(1.054)
$\ln(GDP_{us} - GDP_d)^2$		-0.451		-0.268
		(1.090)		(0.528)
ln(Skill Difference)		0.228		0.104
		(0.193)		(0.096)
ln(Trade Costs)		-0.076		-0.041
		(0.154)		(0.076)
FTA		2.317***		1.131***
		(0.516)		(0.259)
Exchange Rate		-4.614e-4*		-2.311e-4*
		(2.587e-4)		(1.31e-4)
BIT		0.092		0.076
		(2.461)		(1.251)
Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
N	6080	6080	6080	6080
R-sq	0.7205	0.7262	0.7204	0.7259
First Stage F-Stat	-	-	325.70	358.04
Endog Test P-Val	-	-	0.0111	0.0148

Notes: Documents the effects of BTT-induced changes in foreign-affiliate employment on domestic employment at the region level. First-stage F-statistics are large for all IV specifications, though the relevant F-statistics for weak-instrument concerns appear in columns (2) and (5) of Table 4 (see text for discussion). In all IV specifications, the equality of OLS and IV is rejected. Standard errors clustered by parent firm and year are in parentheses. *,**, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

B Supplemental Theoretical and Econometric Results

B.1 Detailed Model of Double Taxation

In this section, we consider double taxation in the context of the U.S. corporate tax, demonstrating the conditions under which we can model double taxation as a proportional increase in the costs of foreign affiliate employment, τ_{cti} in equation (7) of the main text.

The U.S. taxes worldwide profits, but provides a credit for foreign tax liabilities in an effort to avoid double taxation. However, the U.S. offers only a limited credit, such that a multinational firm cannot claim a credit larger than the tax the U.S. would levy on foreign earnings (otherwise the U.S. tax authority would effectively subsidize foreign tax liabilities). The limited tax credit for foreign taxes paid can then subject the multinational firm to double taxation. To see how the incidence of double taxation arises with a limited foreign tax credit, here we derive the total taxes paid in each jurisdiction and the total tax liability of the multinational enterprise in the context of the Antràs and Helpman (2004) model outlined in Section 4.1.

As shown in the main text, the U.S. parent earns a share $\phi \equiv [\delta_c^{\alpha_i} + \beta(1-\delta_c^{\alpha_i})]$ of total revenue, while the foreign affiliate earns a share $1-\phi \equiv (1-\beta)(1-\delta_c^{\alpha_i})$. The domestic and foreign tax rates are t and t^*, where we assume $t > t^*$ reflecting the fact that the U.S. has one of the highest corporate tax rates in the world. Moreover, the foreign tax authority collects an additional withholding tax on royalties, interest, and dividends. We denote the foreign withholding rate by h^*.

Given this notation, the taxes paid to the foreign tax authority are the corporate tax on the income of the affiliate plus the withholding tax:

$$\underbrace{t^*[(1-\phi)r - w_c m]}_{\text{foreign corporate tax}} + \underbrace{h^*\phi r}_{\text{withholding tax}} . \tag{20}$$

The U.S. tax liability for the multinational enterprise is the tax on worldwide income less any credit for foreign taxes paid. The tax on worldwide income can be written as $t[\phi r - \omega s] + t[(1-\phi)r - w_c m]$ to reflect the domestic and foreign components of worldwide income. The firm is then eligible for a foreign tax credit designed to avoid double taxation, but this credit is limited so that it can not exceed the U.S. tax liability on foreign activities, $t[(1-\phi)r - w_c m]$. Thus, if this value is smaller than the foreign tax payments in (20), the foreign tax credit limit binds, and the firm faces double taxation. Combining terms, the U.S. tax liability, including the potentially limited foreign tax credit is

$$\underbrace{t[\phi r - \omega s] + t[(1-\phi)r - w_c m]}_{\text{U.S. worldwide corporate tax}} - \underbrace{\min\{t^*[(1-\phi)r - w_c m] + h^*\phi r,\ t[(1-\phi)r - w_c m]\}}_{\text{foreign tax credit}}, \tag{21}$$

Summing the foreign and domestic tax liabilities yields the total tax burden of the multinational firm.

$$t[\phi r - \omega s - w_c m] + \max\{0,\ t^*[(1-\phi)r - w_c m] + h^*\phi r - t[(1-\phi)r - w_c m]\} \tag{22}$$

The first term reflects the U.S. worldwide tax system, which in the absence of double taxation imposes the U.S. tax rate on global taxable income. The second term reflects the possibility of double taxation, which occurs only when the foreign tax credit limit binds, increasing the total tax liability above what the U.S. worldwide system would impose. This expression makes clear two important points. First, higher withholding tax rates, h^*, make it more likely that double taxation occurs, which explains why BTTs aim to reduce withholding rates as a mechanism for lowering double taxation. Second, The double taxation relief from a reduction in the withholding tax rate is increasing in $\phi \equiv [\delta_c^{\alpha_i} + \beta(1-\delta_c^{\alpha_i})]$. Since $\delta \in (0,1)$, ϕ is decreasing in α_i. Industries with lower values of α_i have smaller elasticities of substitution between varieties, i.e. they are more highly differentiated. Therefore, the model predicts larger effects of BTT-driven withholding rate reductions in industries with more highly differentiated products, as we confirm empirically.

We now consider the implications of this tax structure for the multinational parents' and affiliates' employment choices. We assume that any foreign tax credit goes to the affiliate for their foreign tax payments. Generally, we require only that any burden of double taxation to the parent is uncorrelated with the change in withholding rates following a new BTT. In this case, the parent's problem is

$$\max_s \phi r - \omega s - t[\phi r - \omega s]. \tag{23}$$

Note that the withholding tax rate h^* does not enter the parent's problem in (23), explicitly demonstrating that the effects of BTTs in reducing withholding rates are excluded from parent hiring decisions. Solving the parent's problem and reintroducing subscripts yields the following first order condition.

$$\begin{aligned}\ln s_t(f) = \\ &\underbrace{\ln \eta_i + \frac{\ln \alpha_i - \ln \omega - \ln(1-t) + \alpha_i[\ln \theta(f) - (1-\eta_i)\ln(1-\eta_i)] + \ln(\phi_{ci}(1-t))}{1-\alpha_i\eta_i}}_{\psi_{fci}} \\ &\qquad \underbrace{-\frac{\alpha_i - \mu}{1-\alpha_i\eta_i}\ln X_{ti}}_{\vartheta_{ti}} + \frac{\alpha_i(1-\eta_i)}{1-\alpha_i\eta_i}\ln m_{ct}(f) \ . \end{aligned} \tag{24}$$

We can collect the terms in the first line on the right side of the equal sign in an affiliate-level fixed effect, ψ_{fci}, and the first term on the second line into an industry-time fixed effect, ϑ_{ti}. This expression corresponds to (8) in the main text.

The affiliate pays the foreign tax and faces partial reimbursement when the foreign tax credit limit is reached. Specifically, the affiliate's problem is

$$\begin{aligned}\max_m (1-\phi)r - w_c m - t^*[(1-\phi)r - w_c m] - h^*\phi r \\ + \min\{t^*[(1-\phi)r - w_c m] + h^*\phi r,\ t[(1-\phi)r - w_c m]\}.\end{aligned} \tag{25}$$

When the foreign tax credit does not bind, the affiliate is fully reimbursed for its tax payments and the withholding tax rate drops out of the problem. In this case, a change in the withholding tax resulting from a BTT would have no effect on firm incentives, and we would not observe the various empirical effects that we document. If instead double taxation is present because the foreign tax credit does bind for some firms, changes in withholding tax rates do affect the affiliate's problem. In this case (25) reduces to.

$$\max_m (1-\phi)r - w_c m + (t-t^*)[(1-\phi)r - w_c m] - h^*\phi r. \tag{26}$$

Solving the affiliate's problem and reintroducing subscripts yields the following first order condition.

$$\ln m_{ct}(f) = \underbrace{-\frac{\alpha_i - \mu}{1-\alpha_i(1-\eta_i)} \ln X_{ti}}_{\zeta_{ti}} \\ + \underbrace{\ln(1-\eta_i) + \frac{\alpha_i[\ln\theta(f) - \eta_i \ln \eta_i] + \ln \alpha_i - \ln w_c - \ln(1+t-t_c^*)}{1-\alpha_i(1-\eta_i)}}_{\nu_{fci}} \\ + \frac{\alpha_i \eta_i}{1-\alpha_i(1-\eta_i)} \ln s_t(f) + \frac{1}{1-\alpha_i(1-\eta_i)} \ln\left[(1+t-t_c^*)(1-\phi_{ci}) - h^* \phi\right]. \quad (27)$$

Again, we can group terms into an affiliate fixed effect, ν_{fci}, and an industry-time fixed effect, ζ_{ti}. Affiliate employment relates to parent employment, fixed effects, and the final term that depends upon withholding rates, h^*. Note that the last term in equation (27) corresponds precisely to the last term in (9) in the main text, so that a reduction in h^* corresponds to a reduction in τ_{cti}. BTTs lower withholding rates in an effort to resolve double taxation, which is equivalent to a decline in τ_{cti}, as modeled in the main text. Thus, the simplified notation in the main text is equivalent to this more detailed model of how BTTs lower effective tax rates for firms experiencing double taxation.

B.2 Model with CES Production

In Section 4 we consider a model with a Cobb-Douglas production function, following Antràs and Helpman (2004). In this section we derive the relationship between foreign affiliate employment and domestic parent employment using a CES production production function. In this more general setting, the effect of affiliate employment on parent employment may be positive or negative, depending upon the relative size of scale and substitution effects.

We suppress subscripts to simplify notation. The CES production function is given by

$$x = \theta(\eta s^{\rho} + (1-\eta)m^{\rho})^{\frac{1}{\rho}}. \tag{28}$$

where $\sigma = \frac{1}{1-\rho}$ indicates the elasticity of substitution between domestic and foreign labor.

The parent's problem is $\max_s A_s r - \omega s$, where $r = X^{\mu-\alpha}x^{\alpha}$, and $A_s \equiv \delta^{\alpha} + \beta(1-\delta^{\alpha})$. Let $B_s \equiv A_s X^{\mu-\alpha}\alpha\eta\theta^{\rho}$, so that the parent's first-order condition can be written

$$B_s x^{\alpha-\rho} s^{\rho-1} = \omega. \tag{29}$$

The affiliate's problem is $\max_m A_m r - w_c m$, where $A_m \equiv (1-\beta)(1-\delta^{\alpha})$.
Let $B_m \equiv A_m X^{\mu-\alpha}\alpha(1-\eta)\theta^{\rho}$, so the affiliate's first-order condition can be written

$$B_m x^{\alpha-\rho} m^{\rho-1} = w_c. \tag{30}$$

Combining the first-order conditions, we can solve for parent hiring s as a function of parameters, which yields

$$s = B_s^{\frac{1}{1-\alpha}} \omega^{\frac{-1}{1-\alpha}} \theta^{\frac{\alpha-\rho}{1-\alpha}} \left(\eta + (1-\eta)\left(\frac{\omega B_m}{w_c B_s}\right)^{\sigma-1}\right)^{\frac{\alpha-\rho}{\rho(1-\alpha)}} \tag{31}$$

Our goal is to determine the effect of a change in the cost of foreign hiring w_c on s (note that the effect of a change in w_c is isomorphic to a change in the τ in the main body of the text). Thus, we want to obtain

$$\frac{d\ln s}{d\ln w_c} = \frac{d\ln s}{dw_c} w_c. \tag{32}$$

We first calculate

$$\frac{d\ln s}{dw_c} = \frac{\alpha-\rho}{\rho(1-\alpha)} \cdot \frac{1}{\eta + (1-\eta)\left(\frac{\omega B_m}{w_c B_s}\right)^{\sigma-1}} \cdot (1-\eta)\left(\frac{\omega B_m}{B_s}\right)^{\sigma-1}(1-\sigma)w_c^{-\sigma}. \tag{33}$$

Then, simplifying and using $\frac{1-\sigma}{\rho} = -\sigma$ and the expression in (32) we have

$$\frac{d\ln s}{d\ln w_c} = \underbrace{(\rho-\alpha)}_{\text{determines sign}} \cdot \underbrace{\frac{(1-\eta)\sigma}{1-\alpha}}_{>0} \cdot \underbrace{\frac{w_c^{\sigma-1}}{\eta + (1-\eta)\left(\frac{\omega B_m}{w_c B_s}\right)^{\sigma-1}}}_{>0} \tag{34}$$

The sign of (34) is determined by the sign of $\rho - \alpha$ and may generally be positive or negative.

The parameter-dependent relationship between foreign affiliate hiring and parent employment is intuitive. The substitution effect between s and m contributes a positive component to (34), since a decrease in w_c drives a decrease in the demand for s, holding output fixed. As ρ approaches 1, the inputs become stronger substitutes, so this substitution effect grows in magnitude. The scale effect contributes a negative component to (34), since a decrease in w_c drives a decrease in output price, an increase in output quantity, and an increase in s. The demand elasticity is $\frac{1}{1-\alpha}$, so as α gets larger, demand becomes more elastic, and the scale effect gets larger. The balance between ρ and α corresponds to the balance between substitution and scale effects determining the overall sign of the effect. Under the Cobb-Douglas restriction $\rho = 0$, so $\rho - \alpha < 0$ and a decrease in offshore costs increases domestic employment. Our empirical results confirm that scale effect dominates on average in our sample, and additional offshore hiring by U.S. multinational firms leads to greater employment at domestic parent firms.

B.3 Smearing

In Section 4.2.2, we discuss the need to aggregate affiliate-level predicted values from the first-stage regression in (13) up to the parent-firm level. Because this aggregation involves nonlinear transformations, we must account for the sampling distribution of the affiliate-level predictions, using a procedure known as "smearing."

The affiliate-level first-stage regression in (13) yields predicted values for log affiliate employment, $\widehat{\ln m_{at}}$. Our objective is to generate an unbiased estimate of log total affiliate employment at the parent firm level, $\widehat{\ln M_{ft}}$, where $M_{ft} \equiv \sum_{a \in f} m_{at}$. Rewriting this aggregation definition to incorporate logs,

$$\ln M_{ft} = \ln \left(\sum_{a \in f} \exp \left(\ln m_{at} \right) \right). \tag{35}$$

This expression makes clear that there are three steps in constructing an estimate of $\ln M_{ft}$ from the constituent $\widehat{\ln m_{at}}$.

First, we generate unbiased estimates of $m_{at} = \exp(\ln m_{at})$. Assume that the errors in (13) are i.i.d. and normally distributed, $\epsilon_{at} \sim N(0, \sigma^2)$, and refer to the regressors and coefficients on the right side of (13) as $\boldsymbol{X}_a \boldsymbol{\beta}$. Then m_{at} is lognormally distributed with location parameter $\boldsymbol{X}_a \boldsymbol{\beta}$ and variance parameter σ^2. Thus, $E[m_{at}] = \exp\left(\boldsymbol{X}_a \boldsymbol{\beta} + \frac{\sigma^2}{2} \right)$, which we can estimate as $\hat{m}_{at} = \exp\left(\boldsymbol{X}_a \hat{\boldsymbol{\beta}} + \frac{\hat{\sigma}^2}{2} \right)$. Similarly, we can use the variance of the lognormal distribution to estimate $v\hat{a}r(\hat{m}_{at}) = (\exp(\hat{\sigma}^2) - 1) \cdot \exp(2\boldsymbol{X}_a \boldsymbol{\beta} + \hat{\sigma}^2)$.

Second, we must sum across sibling affiliates to estimate $M_{ft} \equiv \sum_{a \in f} m_{at}$. Since the summation operator is linear, we can construct

$$\widehat{M_{ft}} = \sum_{a \in f} \hat{m}_{at} = \sum_{a \in f} \exp \left(\boldsymbol{X}_a \hat{\boldsymbol{\beta}} + \frac{\hat{\sigma}^2}{2} \right). \tag{36}$$

Assuming zero covariance between errors for sibling affiliates, the variance estimate for $\widehat{M_{ft}}$ is

$$v\hat{a}r \left(\widehat{M_{ft}} \right) = \sum_{a \in f} v\hat{a}r(\hat{m}_{at}) = \sum_{a \in f} \left[(\exp(\hat{\sigma}^2) - 1) \cdot \exp(2\boldsymbol{X}_a \boldsymbol{\beta} + \hat{\sigma}^2) \right]. \tag{37}$$

Finally, we need to estimate the log of total affiliate employment at the parent level, $\widehat{\ln M_{ft}}$. Note that the sum of lognormal random variables is well approximated by a lognormal distribution (Mehta et al. 2007). Thus, we simply implement the reverse of the lognormal transformation from the first step. Therefore, our estimate of parent-level log total affiliate employment is

$$\widehat{\ln M_{ft}} = \ln \mu - \frac{1}{2} \ln \left(\frac{s^2}{\mu^2} + 1 \right), \tag{38}$$

$$\text{where } \mu = \widehat{M_{ft}} = \sum_{a \in p} \exp \left(\boldsymbol{X}_a \hat{\boldsymbol{\beta}} + \frac{\hat{\sigma}^2}{2} \right)$$

$$\text{and } s^2 = v\hat{a}r\left(\widehat{M_{ft}}\right) = \sum_{a \in p} \left[(\exp(\hat{\sigma}^2) - 1) \cdot \exp(2\boldsymbol{X}_a \boldsymbol{\beta} + \hat{\sigma}^2) \right].$$

Our parent-level estimates of predicted total affiliate employment are constructed following (38). Because the final step of this process involves an approximation, we implemented alternatives including a naive plug-in estimate and a nonparametric smearing procedure following Duan (1983), finding very similar results.