Reassessing the Effects of Bilateral Tax Treaties on US FDI Activity

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Abstract

Despite substantial evidence that foreign direct investment (FDI) is influenced by taxation, the impact of bilateral tax treaties on FDI is surprisingly unclear. We provide a simple theoretical framework illustrating why the impact of tax treaties may be heterogeneous across the distribution of FDI, and thus why focusing on the average effect of tax treaties may be misleading. We then assess the empirical relevance of such heterogeneity by estimating the quantile treatment effects (QTEs) of tax treaties on US inbound and outbound FDI using panel data from 1980–1999. Our results are striking, and consistent with our expectations. We obtain *positive* effects of tax treaties at lower quantiles of the distribution of FDI, but *negative* effects in the upper quantiles. Moreover, while the negative effects are substantially larger in absolute terms relative to the positive effects, the two effects are roughly equivalent in percentage terms.

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1 Introduction

The impact of bilateral tax treaties on foreign direct investment (FDI) is surprisingly unclear. This ambiguity exists amid fairly pervasive empirical evidence that cross-country variation in taxation does influence the distribution of FDI activity (e.g., Chakrabarti 2001; Gresik 2001; Gordon and Hines 2002; De Mooij and Ederveen 2003; Mutti and Grubert 2004; Blonigen 2005), as well as the fact that tax treaties are costly to negotiate and implement, yet nonetheless cover much of today's bilateral FDI activity. Specifically, the number of tax treaties in force has increased from 100 in the 1960s to over 2,500 more recently (Egger et al. 2006). The US presently belongs to roughly 60 such treaties, covering approximately 78% of total US outbound FDI and 96% of total US inbound FDI, with over one-third being implemented since 1990 (Blonigen and Davies 2004). In light of these statistics, and the well known facts regarding the growing importance of FDI, understanding the effects, if any, of bilateral tax treaties on FDI activity is paramount.[1]

While the theoretical literature on bilateral tax treaties is more developed, empirical studies are relatively sparse. Blonigen and Davies (2004, 2005) find strong positive effects of 'old' tax treaties on FDI, but negative effects of 'new' tax treaties, using 1980–1999 US and 1983–1992 OECD data, respectively, particularly when modeling FDI in levels (as opposed to logs).[2] Ramondo (2005) uses data from over 150 countries from 1990–2002. While the raw data indicate that country-pairs with strictly positive FDI activity in both directions are much more likely to have a bilateral tax treaty in place (67% versus 4%) and have lower average corporate income tax rates (16.8% versus 34.1%), the presence of a treaty and the corporate tax rate have only minimal effects on the cost of FDI once other factors are accounted for (namely, distance). Egger et al. (2006) also obtain a significant negative effect of 'new' tax treaties on OECD outbound FDI from 1985–2000 using a difference-in-difference propensity score matching estimator. On the other hand, di Giovanni (2005) analyzes cross-border capital flows for mergers and acquisitions from 1990–1999 and finds positive effects of tax treaties. Similarly, Stein and Daude (2007) obtain a positive and statistically significant effect using data on OECD outbound FDI stocks from 1997–1999. Finally, Davies (2003a) finds no effect of revisions of existing bilateral tax treaties on FDI, and Hartman (1985) and Sinn (1993) find that the expansion of activities of multinational enterprises (MNEs) is essentially independent of withholding taxes. Davies (2004) provides an excellent review.[3]

The mixed, and perhaps counter-intuitive, empirical results could be an artifact of the empirical approach that overshadows nearly all of these previous studies: the focus on the *mean impact* of bilateral tax treaties. As is clear from the literature, there are three likely effects of tax treaties. First, tax treaties may remove barriers to FDI through reductions in withholding taxes and double taxation, as well as by clarifying tax definitions and providing methods for dispute resolution. For example, the introduction to the OECD's model tax treaty states that primary

[1] For instance, foreign affiliate sales (FAS) grew by 11% in the 1990s, roughly double the growth rate for exports and quadruple the growth rate for worldwide GDP (Markusen 2002). In 2001, total FAS represented nearly 60% of world GDP, with world exports representing only about 25% (Ramondo 2005).

[2] Results from log specifications with country fixed effects yield positive, but insignificant results (Blonigen and Davies 2004). Mutti and Grubert (2004) also advocate the use of log-linear models when analyzing FDI.

[3] A related literature assessing the impact of bilateral investment treaties (BITs) also fails to produce a consensus. For example, while Hallward-Driemeier (2003) fail to find a positive effect of such treaties on FDI, Egger and Pfaffermayr (2004) and Stein and Daude (2007) do.

goal of such treaties is "removing the obstacles that double taxation presents" to decrease its "harmful effects on the exchange of goods and services and movement of capital, technology, and persons" (OECD 1997, p. I-1). Similarly, the United Nation's draft manual for negotiating bilateral tax treaties states that the aim of such treaties is to "encourage economic growth by mitigating international double taxation and other barriers to cross-border trade and investment (p. 2).[4] Moreover, existing tax treaties always reduce withholding tax rates (Blonigen and Davies 2004). However, the second likely effect of tax treaties is the reduction of transfer pricing and other means of tax avoidance. In fact, the UN's draft manual continues by stating that a second objective is "to improve tax administration in the two Contracting States by reducing opportunities for international tax evasion" (p. 2). Radaelli (1997) and Gravelle (1988) assert that reducing tax evasion is the primary goal of US tax treaties. Finally, tax treaties may promote FDI by reducing uncertainty over the tax environment abroad. See Davies (2004) and Blonigen and Davies (2005) for further discussion.[5]

While these effects may push FDI in opposite directions, this does not imply that estimating the mean impact of tax treaties provides much useful insight if the magnitudes of the two competing effects are heterogeneous across countries. In terminology from the program evaluation literature, knowledge of the *average treatment effect* (ATE) or *average treatment effect on the treated* (ATT), while interesting, may not provide much guide to policymakers of the likely effects of *specific* bilateral tax treaties. The importance of this heterogeneity is brought to light in Blonigen and Davies (2004) who estimate treaty-specific effects for several bilateral tax treaties with the US, finding some positive, some negative, and some statistically insignificant effects. In this paper, we provide a more formal assessment of the potential heterogeneous effects of bilateral tax treaties. We also pay particular attention to the timing of the effect of such treaties.

To begin, we motivate our move beyond the focus on mean impacts through a simple theoretical model illustrating why the effects of a bilateral tax treaty on FDI activity may vary across country-pairs. In particular, under certain scenarios, the impact of a tax treaty on FDI activity is shown to be positive (negative) if FDI activity at the time of the treaty is high (low). To assess this empirically, we utilize data on US inbound and outbound FDI stocks, flows, and FAS over the period 1980–1999. The data are from Blonigen and Davies (2004), and thus enable us to compare our findings to the existing literature. Our empirical strategy entails estimating the distributions of FDI while adjusting for covariates using semi-nonparametric methods, and then examining the *quantile treatment effects* (QTEs).

Our results are striking, indicating important effects of tax treaties on the distribution of FDI that are consistent with our theoretical framework. Specifically, the impact of tax treaties is not homogeneous across quantiles, and we tend to find statistically insignificant, if not positive and statistically significant, effects of tax treaties at lower quantiles, but negative and statistically significant effects at upper quantiles. Moreover, also consonant with our simple theoretical set-up, the distributional results, particularly when FDI is measured in levels, are roughly sym-

[4] Available at http://unpan1.un.org/intradoc/groups/public/documents/un/unpan004467.pdf.

[5] An additional complication in theoretically assessing the effects of bilateral tax treaties is that while a reduction (increase) in the marginal effective tax rate abroad may increase (decrease) FDI activity, this direct effect may be partially or entirely offset by a corresponding reduction (expansion) in public infrastructure financed by tax revenues on MNEs. In fact, if the effect of public infrastructure on MNE costs is sufficiently strong, then a reduction (increase) in effective tax rates abroad may actually lead to a reduction (increase) in FDI activity (Egger et al. 2006).

metric across US inbound and outbound FDI. Finally, aside from issues of symmetry, the distributional results differ in other meaningful ways from the regression results, indicating substantial gains to moving away from parametric functional forms. The remainder of the paper is organized as follows. Section 2 provides a theoretical framework. Section 3 describes the empirical methodology. Section 4 discusses the data. Section 5 presents the results, while Section 6 concludes.

2 Theoretical Framework

To motivate our empirical methodology, consider the following simple unilateral framework, which builds on Blonigen and Davies (2005). An investor has an amount of capital K that may be invested either domestically (in the parent country) or abroad (in the host country). Let Z denote the amount of capital invested in the host country (i.e., the amount of FDI), $Z \leqslant K$. The rate of return in the parent country is given by $r = r(K - Z; x)$, where x represents a vector of attributes that shift the return to capital in the parent country and $r(\cdot)$ is decreasing in capital invested domestically. Similarly, $r^* = r(Z; x^*)$ is the rate of return in the host country, which is decreasing in Z. Efficiency requires the investor to allocate capital such that return at home and abroad are equal (assuming an interior solution). With taxes, however, the investor will equate the after-tax rates of return. Assuming an interior solution, this implies that Z is chosen such that $(1-t)r = (1-t^*)r^*$, where t and t^* are the marginal effective tax rates in the parent and host country, respectively. Thus, the optimal amount of FDI, Z, will depend on the marginal effective tax rates in both countries, as well attributes of the parent country, x, and the host country, x^*.

Prior to analyzing the impact of a bilateral tax treaty, one must assess how the tax rate is determined in each country absent such a treaty. One straightforward, but interesting, case is to suppose that the marginal effective tax rates are decreasing in the level of capital invested in each country. In other words, $t = t(K - Z; x)$ and $t^* = t(Z; x^*)$, where both functions are decreasing in their argument. This is consistent with the empirical evidence provided in Chisik and Davies (2004a), who report lower non-treaty (withholding) tax rates in net capital importers. Such an assumption is also consonant with recent theoretical and empirical evidence indicating that (aggregate) FDI activity affects the level of environmental regulations in a country due to the lobbying effort put forth by capital owners (Cole et al. 2006).[6] Consequently, one might expect the marginal effective tax rate to also decline with capital investment since taxation is likely more burdensome than environmental regulatory costs in most industries. Alternatively, if tax evasion increases with the level of capital investment due to greater administrative strain, then the effective tax rate will also be decreasing in the level of FDI.[7] In either case, holding all else constant (namely, x and x^*), $t \approx t^*$ if and only if $Z \approx K/2$. If, on the other hand, $Z < (>)K/2$, then $t < (>)t^*$.

[6] Specifically, the objective of the host government is not to maximize national income (as in, for example, Janeba (1995) and Davies (2003b)), but rather to maximize the weighted sum of political contributions and social welfare. In Cole et al. (2006), political contributions are offered by MNEs to the host government in return for a more favorable (lax) environmental policy.

[7] Other arguments for a declining effective tax rate exist at the firm-level. In a more complex model with multiple investors, the average marginal effective tax rate, conditional on aggregate captial investment, may be *increasing* in the number of investors (or, stated differently, *decreasing* in average investor size). For example, Grubert (2003) finds that the effective tax rate faced abroad by subsidiaries of US MNEs is declining in the size of the parent firm. Thus, a more realistic assumption may be that the average marginal effective tax rate is *declining* in aggregate capital flows *conditional* on the average investment size. In the analysis below, we augment the vectors of controls x and x^* to include a control for the average size of foreign affiliate.

To assess the impact of the parent and the host signing a tax treaty within this framework, one must model the impact of the treaty on the tax rate in each country. Maintaining simplicity, assume that the effect of the treaty is to coordinate the marginal effective tax rates in both countries at $\widetilde{t}$, where $\widetilde{t} = \alpha(x, x^*)t + [1 - \alpha(x, x^*)]t^*$ and $\alpha(\cdot)$ is the bargaining weight of the parent country, $\alpha \in [0, 1]$.[8,9] Thus, the treaty will have a non-negative (non-positive) effect on the marginal effective tax rate in the country with the initially lower (higher) tax rate, with the magnitude of the effects depending on the bargaining power of each country (which in turn depends on the attributes of both countries).

Although quite straightforward, this simple set-up is very insightful. In particular, the impact of signing a tax treaty on the level of FDI in this context is given by

$$\tau(x, x^*) = Z_1(x, x^*) - Z_0(x, x^*) \tag{1}$$

where Z_1 (Z_0) denotes the level of capital investment with (without) a tax treaty. The sign of (1) is ambiguous; however, we obtain

$$\tau(x, x^*) \begin{cases} < 0 & \text{if } t > t^* \\ \approx 0 & \text{if } t \approx t^* \\ > 0 & \text{if } t < t^* \end{cases} \tag{2}$$

In other words, the impact of the tax treaty on capital investment from the parent to the host country – holding country-level attributes x and x^* fixed – depends on in which country the marginal effective tax rate is higher *prior to* signing the treaty.[10] As a result, focusing on the ATE or ATT from signing a bilateral tax treaty masks the underlying heterogeneity of the effects. More specifically, we obtain two testable implications from this framework. First, τ is likely to be positive (negative) in situations where FDI activity is low (high), implying a particular pattern for the differential treaty effects across the distribution of FDI activity. Second, this setup does not predict any qualitatively different effects of a bilateral tax treaty on the *distribution* of inbound or outbound FDI. If the model is generalized to allow for bilateral FDI activity, then we obtain

$$\tau^{IN}(x, x^*) \begin{cases} < 0 & \text{if } t > t^* \\ \approx 0 & \text{if } t \approx t^* \\ > 0 & \text{if } t < t^* \end{cases} \tag{3}$$

where τ^{IN} is the impact of a treaty on inbound FDI *to the parent*, and we can view τ in (2) as τ^{OUT}, the impact of a treaty on outbound FDI *from the parent*. Thus, holding country-level attributes x and x^* fixed, we continue to

[8] In practice, effective tax rates are rarely coordinated under tax treaties, and withholding taxes are set below the non-treaty withholding tax rates in both contracting countries. However, effective tax rates may still rise. For instance, Egger et al. (2006), using OECD data, find evidence consistent with parent countries using bilateral tax treaties to reduce the attractiveness of low-tax countries to MNEs. We return to this below.

[9] Chisik and Davies (2004a) analyze the outcome of the bargaining process when a bilateral tax treaty is entered using data from the US and OECD countries in 1992. The authors find that greater asymmetry between countries in terms of the level of FDI activity leads to higher negotiated tax rates.

[10] If the marginal effective tax rates in both countries under the treaty is $\widetilde{t} < t, t^*$ (due to a movement away from distortionary taxation with a treaty) or $\widetilde{t} > t, t^*$ (due to a reduction in tax competition or excessive tax evasion with a treaty), then the preceding results are unaltered. For example, if $\widetilde{t} < t < t^*$, then the tax treaty entails a larger decline in the marginal effective tax rate in the host country. As a result, the impact of the tax treaty on host investment will remain positive when $t < t^*$ (i.e., $\tau(x, x^*) > 0$).

expect positive (negative) effects of a tax treaty in the lower (upper) tail of the distribution of FDI activity.[11]

3 Empirical Methodology

3.1 Potential Outcomes Framework

To contrast various estimators of τ^{IN} and τ^{OUT} in terms of what they estimate, and under what assumptions, we utilize the potential outcomes framework often adopted in the program evaluation literature. Let z_{1ijt} denote a measure of FDI activity involving countries i and j at time t if countries i and j *have* an effective tax treaty in place (denoted as $D_{ijt} = 1$), and z_{0ijt} denote the corresponding measure of FDI activity involving countries i and j at time t if countries i and j *do not have* an effective tax treaty in place (denoted as $D_{ijt} = 0$).[12] In this set-up, the effect of a tax treaty between contracting countries i and j on FDI activity at time t is given by $\tau_{ijt} \equiv z_{1ijt} - z_{0ijt}$. However, the *fundamental problem of causal inference* is that only one state of world (and, hence, potential outcome) is observed for a given pair of countries at a particular point in time (Holland 1986). Formally, one observes $z_{ijt} = D_{ijt}(z_{1ijt}) + (1 - D_{ijt})z_{0ijt}$.

To proceed, we begin by specifying a structural relationship for the potential outcomes. Define

$$\begin{aligned} z_{0ijt} &= \mu_0(x_{ijt}) + u_{0ijt} \\ z_{1ijt} &= \mu_1(x_{ijt}) + u_{1ijt} \end{aligned} \tag{4}$$

where $\mathrm{E}[z_d|x_{ijt}] = \mu_d(x_{ijt})$, $d = 0, 1$, and x_{ijt} is a vector of observable attributes of country pair ij (including an intercept).[13] u_d captures the impact of unobservable attributes on FDI when $D = d$, $d = 0, 1$.

[11] Note, symmetry here only applies to the impact of a tax treaty on the *distributions* of inbound and outbound FDI, not symmetry with respect to *specific country-pairs*. For example, assume that a firm based in the UK and active in the US faces non-treaty effective tax rates of $t_{UK} > t_{US}$; a firm based in the US and active in the UK faces the same inequality, $t_{UK} > t_{US}$. Given the assumption of non-treaty effective tax rates being decreasing in FDI, the higher (lower) non-treaty tax rate in the UK (US) implies that US inbound FDI from the UK is relatively high, whereas US outbound FDI to the UK is relatively low. As such, a bilateral tax treaty that coordinates the effective tax rate in both countries at $\widetilde{t} \in (t_{US}, t_{UK})$ will reduce (increase) US inbound (outbound) FDI activity, and this effect is confined to the upper (lower) tail of the distribution. Similarly, consider the impact of a treaty on FDI activity between the US and another country, say C, where $\widetilde{t}' \in (t_C, t_{US})$, $t_C < t_{US}$. US FDI activity in country C must be relatively high, whereas country C activity in the US must be relatively low. A bilateral tax treaty will thus reduce (increase) US outbound (inbound) FDI activity, and this effect is confined to the upper (lower) tail of the distribution. Thus, in both cases, the negative effect of the tax treaty is confined to the upper tail of either the US inbound or outbound distribution, whereas the positive effect occurs in the lower tail. This is the sense in which the *distributional* consequences of tax treaties are symmetric for US inbound and US outbound FDI.

[12] As discussed below in Section 4, FDI activity may either be measured in terms inbound FDI from country j to country i, or outbound FDI from country i to country j. In addition, following Blonigen and Davies (2004), we focus compare FDI activity with and without a tax treaty *in effect*, as opposed to a tax treaty being *signed* or *in force*.

[13] For simplicity, we simply refer to x as the vector of controls in the empirics. However, one should view x (in the empirics) as including controls for both x and x^* (from the theoretical model).

3.2 Regression Approach

Following Heckman et al. (1999), if one assumes that $\mu_d(x_{ijt}) = x_{ijt}\beta_d$, $d = 0, 1$, and $\beta_0 = \beta_1$ except for the intercept terms, then one obtains the following regression model

$$z_{ijt} = x_{ijt}\beta_0 + \tau D_{ijt} + [u_{0ijt} + D_{ijt}(u_{1ijt} - u_{0ijt})] \tag{5}$$

where τ is the constant treatment effect. OLS estimation of (5) yields a consistent estimate of τ if

(OLS.i) $\text{Cov}(D, u_0) = 0$, and

(OLS.ii) $\text{Cov}(D, u_1 - u_0) = 0$.

The former requires the presence of an effective tax treaty to be independent of unobservables that impact FDI without a tax treaty. The latter requires the presence of an effective tax treaty to be independent of unobserved, country–pair-specific gains from a tax treaty.

In contrast, a consistent estimate of τ may be obtained under an alternative sets of assumptions. First, given the presence of panel data, suppose we observe country-pairs in multiple time periods, where at least some country-pairs are observed both with and without an effective tax treaty during the sample period. Given the preceding functional form assumptions, the regression models for FDI in any two periods, t and $t-1$, are given by

$$\begin{aligned} z_{ijt} &= x_{ijt}\beta_0 + \tau D_{ijt} + [u_{0ijt} + D_{ijt}(u_{1ijt} - u_{0ijt})] \\ z_{ij,t-1} &= x_{ij,t-1}\beta_0 + \tau D_{ij,t-1} + [u_{0ij,t-1} + D_{ij,t-1}(u_{1ij,t-1} - u_{0ij,t-1})] \end{aligned} \tag{6}$$

First-differencing yields the following estimating equation

$$z_{ijt} - z_{ij,t-1} = \Delta z_{ijt} = \Delta x_{ijt}\beta_0 + \tau \Delta D_{ijt} + [\Delta u_{0ijt} + \Upsilon_{ijt}] \tag{7}$$

where $\Upsilon_{ijt} = D_{ijt}(u_{1ijt} - u_{0ijt}) - D_{ij,t-1}(u_{1ij,t-1} - u_{0ij,t-1})$. OLS estimation of (7) yields a consistent estimate of τ if

(PD.i) $\text{Cov}(\Delta D, \Delta u_0) = 0$, and

(PD.ii) $\text{Cov}(\Delta D, \Upsilon) = 0$.

Assumption (PD.i) differs from (OLS.i) in that the former requires only that *changes* in the presence of an effective tax treaty be uncorrelated with *changes* over time in unobservables impacting FDI without a tax treaty. Thus, as is well known in models with unobserved effects, identification is achieved even if the treatment is correlated with time-invariant unobservables that impact FDI when untreated. Assumption (PD.ii) is also weaker than (OLS.ii). To see this, note that we can re-write Υ_{ijt} as

$$\begin{aligned} \Upsilon_{ijt} &= D_{ijt}(u_{1ijt} - u_{0ijt}) - D_{ij,t-1}(u_{1ij,t-1} - u_{0ij,t-1}) \\ &= D_{ijt}(u_{1ijt} - u_{0ijt}) - D_{ijt}(u_{1ij,t-1} - u_{0ij,t-1}) + D_{ijt}(u_{1ij,t-1} - u_{0ij,t-1}) - D_{ij,t-1}(u_{1ij,t-1} - u_{0ij,t-1}) \\ &= D_{ijt}[(u_{1ijt} - u_{0ijt}) - (u_{1ij,t-1} - u_{0ij,t-1})] + \Delta D_{ijt}(u_{1ij,t-1} - u_{0ij,t-1}) \end{aligned} \tag{8}$$

As such, $\text{Cov}(\Delta D, \Upsilon)$ equals zero under a number of different scenarios, the most likely of which is if $\text{Cov}[D, \Delta(u_1 - u_0)]$, $\text{Cov}[D_{t-1}, \Delta(u_1 - u_0)]$, and $\text{Cov}(\Delta D, u_{1,t-1} - u_{0,t-1})$ each equals zero. In other words, whereas OLS requires the presence of an effective tax treaty to be independent of unobserved, country–pair-specific gains from a tax treaty, the panel data estimator requires (i) the presence of an effective tax treaty in a particular period to be independent of the lag and lead *change in* unobserved, country–pair-specific gains from a tax treaty, and (ii) the *change* in the presence of an effective tax treaty to be independent of the lagged unobserved, country–pair-specific gains from a tax treaty.

3.3 Distributional Approach

3.3.1 Quantile Treatment Effects

When the treatment effect is heterogeneous, the preceding regression-based approaches focus on specific summary measures of the treatment effect distribution. In light of recent advances in the program evaluation literature, additional information concerning the impact of effective tax treaties on FDI can be uncovered utilizing a distributional approach. To that end, we undertake several pairwise comparisons of the distributions of FDI, distinguished by the presence of an effective tax treaty, and analyze the *quantile treatment effects* (QTEs). To begin, let Z_0 and Z_1 denote two FDI variables to be compared; Z_0 (Z_1) represents potential FDI without (with) an effective tax treaty. $\{z_{0i}\}_{i=1}^{N_0}$ is a vector of N_0 observations of Z_0 (denoted by $D_i = 0$), where now i indexes a *country-pair-year* combination for notational convenience; $\{z_{1i}\}_{i=1}^{N_1}$ is an analogous vector of realizations of Z_1 (denoted by $D_i = 1$). Let $F_0(z) \equiv \Pr[Z_0 < z]$ represent the cumulative density function (CDF) of Z_0; define $F_1(z)$ similarly for Z_1. The p^{th} quantile of F_0 is given by the smallest value z_0^p such that $F_0(z_0^p) = p$; z_1^p is defined similarly for F_1.

Under this notation, the QTE for quantile p is given by $\Delta_p = z_1^p - z_0^p$, which is simply the horizontal difference between the CDFs at probability p, and should be interpreted as the effect of the treatment on the p^{th} quantile of the potential outcome distributions. Estimates, $\widehat{\Delta}_p$, are obtained using the sample analogues of $z_j^p \equiv \inf_z\{\Pr[Z_d \leq z] \geq p\}$, $d = 0, 1$ and $p = 0.01, ..., 0.99$, which requires first obtaining the empirical CDFs given by

$$\widehat{F}_{dN_d}(z) = \frac{1}{N_d}\sum_{i=1}^{N_d} \text{I}(Z_d \leq z), \qquad d = 0, 1 \tag{9}$$

where $\text{I}(\cdot)$ is the indicator function. The estimates, $\widehat{\Delta}_p$, are consistent if $Z_0, Z_1 \perp D$, and if the CDFs of potential outcomes are continuous and monotonically increasing (at the quantiles for which the QTE is estimated).

Prior to continuing, it is important to note that the QTEs do not correspond to quantiles of the *distribution of the treatment effect* unless the assumption of *rank preservation* holds (Heckman et al. 1997; Firpo 2007). Absent this assumption, whereby the ranking of individual country-pairs in the FDI distribution would remain unchanged across states of the world with and without a bilateral tax treaty, the QTEs simply reflect differences in the *quantiles* of the two marginal distributions. Nonetheless, if most of the variation in the potential outcome for observation i with a tax treaty, z_{1i}, is due to variation in the potential outcome absent a tax treaty, z_{0i}, then the assumption of rank preservation may approximately hold. In other words, if the treatment only results in marginal changes to the outcome that would have otherwise occurred absent the treatment, rank preservation may not be far off the mark.

Since dependence between the presence of an effective tax treaty and other determinants of FDI most certainly

invalidates the preceding identification assumption, we also estimate the QTEs under a weaker set of assumptions. Specifically, we obtain estimates of the QTEs *adjusting for covariates* using inverse propensity score weighting. Such estimates are consistent under the now familiar conditional independence (CIA) and common support (CS) assumptions, in addition to the previous requirement that the distributions of potential outcomes be continuous and monotonically increasing (at the quantiles for which the QTE is estimated). Formally, we require

(QTE.i) CIA: $Z_0, Z_1 \perp D|x$

(QTE.ii) CS: $p(x_i) \in (c, 1-c)$ for all i and for some $c > 0$

where $p(x_i)$ is the propensity score (i.e., the likelihood of observation i belonging to an effective tax treaty given a set of observed attributes, x_i). $\widehat{p}(x_i)$ is the estimated propensity score, obtained from a first-stage probit model.

To proceed, we follow Bitler et al. (2006) and estimate the empirical CDF for Z_j by

$$\widehat{F}_{dN_d}(z) = \frac{\sum_{i=1}^{N_d} \widehat{\omega}_i \, \mathrm{I}(Z_j \leq z)}{\sum_{i=1}^{N_d} \widehat{\omega}_i}, \qquad d = 0, 1 \tag{10}$$

where the weights, $\widehat{\omega}_i$, are given by

$$\widehat{\omega}_i = \frac{D_i}{\widehat{p}(x_i)} + \frac{1 - D_i}{1 - \widehat{p}(x_i)} \tag{11}$$

See also Firpo (2007). In the results below, we plot $\widehat{\Delta}_p$ obtained under each set of identifying assumptions, as well as 90% confidence intervals based on a simple bootstrap technique, similar to Bitler et al. (2006). When adjusting for covariates, the first-stage probit model and resulting weights are re-estimated during each bootstrap replication.

Note, in contrast to the standard implementation of regression-based approaches, the distributional approach does not require one to specify a functional form for the relationship between z_d, $d = 0, 1$, and x, nor does it require the assumption of normality or log normality. Given the failure of the regression models in Blonigen and Davies (2004) of both tests for normality (Shapiro and Wilk test) and mis-specification (Ramsey test), this is comforting.[14]

3.3.2 Test of Equality

In addition to examining the QTEs at select quantiles, we test the joint null $\mathrm{H}_o : \Delta_p = 0 \; \forall p \in (0, 1)$, or equivalently $\mathrm{H}_o : F_0 = F_1$, utilizing a two-sample Kolmogorov-Smirnov (KS) statistic (see, e.g., Abadie 2002; Bitler et al. 2006). The test is based on the following KS statistic:

$$d_{eq} = \sqrt{\frac{N_0 N_1}{N_0 + N_1}} \sup |F_1 - F_0| \tag{12}$$

Specifically, our procedure calls for computing

$$\widehat{d}_{eq} = \sqrt{\frac{N_0 N_1}{N_0 + N_1}} \max_k \{|\widehat{F}_1(z_k) - \widehat{F}_0(z_k)|\} \tag{13}$$

[14] If the failure of the Ramsey specification test in Blonigen and Davies (2004) is due to omitted variables, then such omitted variables will in all likelihood also invalidate the QTE estimates based on the CIA. However, if the failure is simply due to a mis-specified functional form, then the QTE estimates are likely to remain consistent, although we do have to choose a function form for the first-stage probit model.

where $\widehat{F}_d$, $d = 0, 1$, is obtained using either (9) or (10) and k indexes points in the joint support of Z_0 and Z_1.[15]

Inference for the test of equality of the distributions is conducted using the bootstrap procedure outlined in Abadie (2002). Specifically, we pool the two samples, resample (with replacement) from the combined sample, split the new sample into two samples, where the first N_0 represent Z_0 and the remainder represent Z_1, and compute the KS statistic. This process is repeated B times, and the p-value is given by

$$p - value = \frac{1}{B} \sum_{b=1}^{B} \mathrm{I}(\widehat{d}^{*}_{eq,b} > \widehat{d}_{eq}) \tag{14}$$

The null hypothesis – that the two distributions are identical – is rejected if the p-value is less than the desired significance level, say 0.10. In the analysis below, we report these p-values.

4 Data

The data come from Blonigen and Davies (2004); thus, we provide only limited details.[16] The data include information on US inbound FDI from 91 countries, as well as US outbound FDI to 44 countries, over the period 1980–1999. Thus, we analyze US inbound and outbound FDI separately, thereby allowing the effects of treaties to differ depending on the direction of investment, although the theoretical framework in Section 2 does not predict such heterogeneity. Three measures of FDI are utilized: (i) FDI stock, (ii) FDI flows, and (iii) FAS. In addition, we conduct the analysis using each measure in both levels and logs. As noted earlier, log specifications tend to preferred in the FDI literature given the skewness of the data, although this may not matter for the distributional approach. Nonetheless, it does provide some interesting insight into the pattern of regression results observed when using logs versus levels. The FDI data come from the US Bureau of Economic Analysis (BEA) website, and are converted into millions of real 1996 US dollars using the US chain-type price index for gross domestic investment calculated by the *Economic Report of the President*.

Information on US bilateral tax treaties is taken from the Worldwide Tax Treaties database at Tax.com (2002). As noted in the previous sections, each estimator relies on some assumption concerning conditional independence between the presence of an effective tax treaty and unobservable determinants of FDI activity. However, the US may negotiate tax treaties with countries on the basis of such unobservables (e.g., countries having historical ties to US, or countries for whom the gains from such a treaty are increasing over time). This non-random selection will bias the various estimators. To at least partially circumvent this issue, we follow Blonigen and Davies (2004) and assess the impact of 'new' treaties, where 'new' treaties are those negotiated after 1979. As shown in Blonigen and Davies (2004), the relative rank of a country in terms of the stock of US outbound FDI appears unrelated to the decision by the US to enter into a new tax treaty with that country.

The controls included in x follow the specification developed in Carr et al. (2001) and Markusen and Maskus (2001), combined with the skill adjustment applied in Blonigen et al. (2003). The specification is based on the knowledge-capital model of MNE activity. In the models analyzing both US inbound and outbound FDI activity, the vector of covariates includes the sum of real gross domestic products (GDPs), the GDP difference between the US and

[15] In the estimation, 500 equally spaced points are used.

[16] The data are found at http://www.uoregon.edu/~bruceb/. We are very grateful to the authors for making the data available.

foreign country squared, the (absolute value of the) skill difference between the US and foreign country, the distance between US and foreign country, a trade cost measure for home and host country, an investment barrier measure for the host country, the interaction between the skill difference and GDP difference, and the interaction between the host trade cost and the squared skill difference. In the regression models corresponding to (5), we also include a dummy variable for old treaty countries. Finally, to improve the likelihood of the various conditional independence assumptions holding, in some specifications we augment the covariate set to include interactions between a dummy variable for 'rich' countries and each of the aforementioned variables, as well as country dummies.[17] Table 1 displays summary statistics.

5 Results

5.1 Regression Results

5.1.1 Inbound FDI

Select results from the baseline regression models in (5) and (7) are shown in Table 2 for inbound FDI.[18] To begin, for each measure of FDI activity expressed in levels, we estimate four versions of (5) using pooled OLS (POLS) or random effects (RE), with or without interactions between the rich country indicator and the covariates. Next, we explicitly remove time invariant, country-level heterogeneity by estimating the first-differenced (FD) model in (7). Finally, we provide fixed effects (FE, or within group) estimates. Results are presented in Panels I–III.

We obtain a statistically and economically significant, negative impact of an effective tax treaty on all three measures of FDI in the POLS specifications without rich country interactions; negative, of more reasonable magnitude, and statistically significant estimates for FDI stocks and FAS with rich country interactions. However, when we switch from POLS to RE, we obtain positive and statistically insignificant tax treaty effects for each measure of FDI when we include rich country interactions; results omitting the rich country interactions remain negative, statistically significant, and quite large in magnitude. The FD estimates with rich country interactions switch signs relative to the RE estimates (now becoming negative), but remain statistically insignificant at conventional levels in all three cases; results omitting the rich country interactions remain negative, but are considerably smaller in magnitude and are only statistically significant in two of three cases (excluding FDI flows). Lastly, the FE estimates return to being negative, statistically significant, and implausibly large when omitting the rich country interactions, but positive and statistically significant for FDI stocks and flows when including such interactions.

Viewing the results, two observations stand out. First, as argued in Blonigen and Davies (2004), inclusion of the rich country interactions matters and thus the estimates including such interactions are preferable. Second, modeling assumptions matter even when rich country interactions are included. Specifically, while POLS yields negative and

[17] The set of rich countries includes EU countries, Austria, Australia, Canada, Finland, Hong Kong, Japan, New Zealand, Norway, Sweden, and Switzerland. The number of country dummies included in the QTE analysis varies by specification, as we can only include dummy variables for countries that are observed both with and without an effective treaty during the sample. Additional country dummies violate the common support assumption (QTE.ii) as they are perfect predictors in the first-stage probit used to obtain the inverse propensity score weights. In addition, rich country interactions are excluded from the QTE analysis as they also violate the common support assumption since no new tax treaty countries are considered 'rich'. We return to this point below.

[18] The full set of regression estimates are available in the Appendix (http://faculty.smu.edu/millimet/pdf/tt_appendix.pdf).

statistically significant results for two of the three FDI measures, the other models do not. Moreover, even among the models that remove time invariant, country-level heterogeneity, the results are sensitive to modeling choice as the FE estimator yields a *positive* and *statistically significant* of an effective tax treaty on FDI stocks and flows, whereas FD does not. The fact that the FD and FE estimates yield (seemingly) different estimates of new treaty effects is striking. Laporte and Windmeijer (2005) show that statistically different estimates of a binary treatment indicator can arise in FD and FE models if the treatment effect is not constant over time. Given the discussion earlier about the several possible dates that one could use to define the tax treaty variable (see footnote 12), combined with the fact that some of the effects of a tax treaty may precede the treaty (anticipatory effects) or operate with a lag (lagged effects), such model mis-specification seems likely in the current context.[19] To assess this, we perform the test of equality between the FD and FE estimates given in Laporte and Windmeijer (2005).[20] The results, shown in the row labelled *Specification Test*, indicate that we reject equality of the FD and FE estimates at the $p < 0.10$ level for all three (two of three) FDI measures when excluding (including) rich country interactions.

In light of these results, we estimate a more flexible model of treaty effects, given by

$$z_{ijt} = x_{ijt}\beta_0 + \tau_{-1}D^{-1}_{ijt} + \tau_0 D^0_{ijt} + \tau_1 D^1_{ijt} + \tau_2 D^2_{ijt} + \tau_{3+} D^{3+}_{ijt} + [u_{0ijt} + D_{ijt}(u_{1ijt} - u_{0ijt})] \tag{15}$$

where

$$D^s_{ijt} = \begin{cases} 1 & \text{if } ij \text{ have a tax treaty become effective in period } t-s \\ 0 & \text{otherwise} \end{cases}$$

To be clear, D^{-1}_{ijt} equals one in year t for country-pair ij if the countries will have a tax treaty *become effective* in the next period (zero otherwise); D^0_{ijt} equals one in the period when the tax treaty becomes effective (zero otherwise); D^1_{ijt} equals one in the period *immediately after* the tax treaty becomes effective (zero otherwise); D^2_{ijt} equals one in the period *two periods after* the tax treaty becomes effective (zero otherwise); and, D^{3+}_{ijt} equals one in any period *three periods or more after* the tax treaty becomes effective (zero otherwise). Thus, τ_{-1} captures any (short-run) anticipatory effects, τ_0 captures the instantaneous response, and τ_s, $s = 1, 2, 3+$, capture any lagged effects. The omitted category contains periods two or more years prior to a tax treaty becoming effective. As shown in Laporte and Windmeijer (2005), when the treatment effects are not constant over time, the FD and FE estimates of τ in (7) will diverge, as they do in Panels I–III in Table 2.

Results obtained by estimating (15) via FD and FE measuring FDI in levels are provided in Table 4 (Panel I). Concentrating on the models including rich country interactions, three findings emerge. First, the FD and FE estimates are much more closely aligned. Second, for both FDI stocks and flows, we find positive and statistically significant lagged effects of tax treaties, particularly in the FE models. In other words, the FDI-inducing impact of an effective tax treaty is not realized until a couple of years *after* the treaty becomes effective. This may suggest that the most important FDI-inducing component of bilateral tax treaties is the reduction in uncertainty in the foreign

[19] Egger et al. (2006) similarly undertake some exploratory analysis of possible anticipatory and lagged effects of bilateral tax treaties involving OECD countries. The authors find little evidence of either; anticipatory effects seem nonexistant in their data, and treatment effects appear constant over a five-year window following the implementation of a tax treaty.

[20] The test involves estimation of the model

$$\begin{pmatrix} z_{ijt} - z_{ij,t-1} \\ z_{ijt} - \overline{z}_{ij\cdot} \end{pmatrix} = \begin{pmatrix} D_{ijt} - D_{ij,t-1} \\ D_{ijt} - \overline{D}_{ij\cdot} \end{pmatrix} \tau + \begin{pmatrix} 0 \\ D_{ijt} - \overline{D}_{ij\cdot} \end{pmatrix} \phi + \begin{pmatrix} x_{ijt} - x_{ij,t-1} \\ x_{ijt} - \overline{x}_{ij\cdot} \end{pmatrix} \beta + \begin{pmatrix} 0 \\ x_{ijt} - \overline{x}_{ij\cdot} \end{pmatrix} \delta + u_{ijt}$$

by OLS and testing $\mathrm{H}_o : \phi = 0$ via a standard $t-$test using standard errors robust to heteroskedasticity and (serial) correlation.

tax environment, as such diminished uncertainty may be realized after a lag. It is also consonant with the gradualism argument in Chisik and Davies (2004b), where declines in tax rates may be gradual since tax treaties need to be self-enforcing. However, these effects are very modest in economic terms, representing roughly 0.03 – 0.04 standard deviations. Finally, consonant with the results in Table 2, we find no impact of an effective tax treaty on FAS. Thus, when focusing on average effects, we find some evidence of positive effects of a new tax treaty on the level of US inbound FDI stocks and flows, but not FAS, although the effects tend to be small and operate with a lag.

As noted previously, Blonigen and Davies (2004), Mutti and Grubert (2004), and others advocate the estimation of models of FDI activity in logs given the skewed nature of the data. Panels IV-VI show the corresponding results when we log all (non-binary) variables.[21] In the interest of brevity, we focus on the major findings. First, for FDI stocks and flows, we fail to find any statistically significant impact of an effective tax treaty in the RE, FD, and FE models, either with or without rich country interactions. Moreover, in all four cases, we *fail to reject* equality between the FD and FE estimates. Second, we find positive, statistically significant, and (unreasonably) large effects on FAS using the RE and FE estimators either with or without rich country interactions; negative, statistically significant, and (unreasonably) large effects using POLS. Finally, we reject equality of the FD and FE estimates for FAS either with or without rich country interactions. Turning to the more flexible model for FAS in Table 4 (Panel II), we find greater agreement between the FD and FE estimates. In particular, in the models including rich country interactions, we find positive and statistically significant effects of new tax treaties with a lag using both methods, with the magnitudes remaining quite large.

In sum, then, the regression analysis yields a positive, statistically significant, and relatively robust *average effect* of an effective bilateral tax treaty when one allows for a more flexible timing of the impact on US inbound FDI stocks and flows (in levels) and FAS (in logs) and includes rich country interactions. We will return to this discrepancy across the level and log specifications below, but first we examine the regression results for US outbound FDI.

5.1.2 Outbound FDI

The baseline US outbound FDI results are presented in Table 3; the results from the more flexible specifications based on (15) are shown in Table 5. To conserve space, we again focus on the major findings. First, when estimating the models in levels, we only obtain one statistically significant effect of a new tax treaty when using an estimation method other than POLS: FDI stocks when using RE without rich country interactions. For the remainder of the levels models, the estimated impact of an effective tax treaty is statistically insignificant, and we fail to reject equality between the FD and FE estimates at conventional levels in all cases. The point estimates in the FE models with rich country interactions are positive, however, for all three FDI measures. Second, when estimating the models in logs, we obtain a positive and statistically significant impact of an effective tax treaty on FAS using POLS and FD both with and without rich country interactions. For log FDI stocks and flows, all estimation methods yield a statistically insignificant coefficient on an effective tax treaty. Moreover, for all three FDI measures, we continue to fail to reject equality between the FD and FE estimates. Finally, the results of from the more flexible specifications with rich

[21] Note, Blonigen and Davies (2004) exclude the two interaction terms – between the skill difference and GDP difference and between the host trade cost and the squared skill difference – in their log specifications since the log of the interaction is collinear with the other variables entered in the model. However, rather than taking the log of the interactions, we include the interactions of the logs so that these variables remain in the model. The impact on the results is minor.

country interactions presented in Table 5 indicate a statistically insignificant impact of an effective tax treaty on all three FDI measures in levels (Panel I), as well as FAS in logs. However, the more flexible FE model indicates some *positive* and statistically significant (anticipatory and lagged) effects on log FDI stocks; the more flexible FD model indicates a *negative* and statistically significant effect on log FDI flows three or more years *after* a bilateral tax treaty becomes effective.

In sum, then, the regression analysis for US outbound FDI yields a much more muted impact of effective tax treaties relative to US inbound FDI. Specifically, there is no statistically meaningful evidence of a non-zero *average effect* of an effective tax treaty – even in the more flexible specifications – when analyzing FDI in levels. There is, however, some evidence of a positive and statistically significant *average effect* of an effective tax treaty on FDI stocks and FAS in the log models, the former (latter) occurring with a lag (instantaneously), and a negative lagged effect on log FDI flows. We now turn to the distributional analysis to assess heterogeneity in the effects of a tax treaty across the distribution, while paying attention to the timing issue. The distributional analysis will also help shed some light on the sensitivity of the regression results to the choice of FDI measure and the impact of analyzing FDI in levels versus logs.

5.2 Distributional Results

5.2.1 Baseline Specifications

Inbound FDI Results from the distributional analysis for US inbound FDI are given in Table 6; select QTE estimates are plotted in Figures 1 and 2. To begin, Panel I(A)–I(D) in Table 6 provides the p-values obtained using (14) to test for equality of the CDFs for four pairwise comparisons for each FDI measure expressed in levels. Recall, a p-value less than, say, 0.10 should be regarded as evidence of a statistically significant difference in the distributions being compared; in other words, bilateral tax treaties alter the distribution of FDI activity in a statistically meaningful way. The first three comparisons in Table 6 (Panels I(A)–I(C)) compare various CDFs with and without the treatment, when the treatment is defined as an effective bilateral tax treaty in place, where Panel I(A) compares the unconditional distributions and Panels I(B)–I(C) adjust for covariates using inverse propensity score weighting. Panel I(B) controls for the covariates included in Table 1, whereas Panel I(C) adds select country dummies (see footnote 17). Finally, Panel I(D) uses the covariate set from Panel I(C) but re-defines the treatment as an effective bilateral tax treaty being in place for two or more years. Since many of the statistically significant regression results did not appear until a bilateral tax treaty had been in effect for *at least* two years, this treatment may yield different estimated effects.

Figure 1 plots the QTEs corresponding to Panel I(A), the unconditional results, and Panels I(C) and I(D), the results adjusting for covariates including country dummies, using the two different treatment definitions. In the figure, the first column corresponds to the plots for FDI stocks, whereas the middle (third) column corresponds to the plots for FDI flows (FAS). Specifically, each graph plots the QTE, $\widehat{\Delta}_p$, on the vertical axis (as well the upper and lower bounds of the 90% confidence interval) against the quantile, q, on the horizontal axis. The magnitude may be interpreted as the impact of the treatment on quantile q of the potential outcome distributions.

In terms of the tests of equality, we reject equality of the unconditional CDFs for each of the three FDI measures

at the $p < 0.01$ confidence level. We similarly reject equality of the CDFs adjusted for covariates for all three FDI measures at the $p < 0.01$ confidence level regardless of the covariate set utilized or the definition of the treatment. Rejection of equality is a significant finding; it implies that an effective bilateral tax treaty does alter the distribution of US inbound FDI (in levels). To see how the distribution is affected, we examine Figure 1. Panel I in Figure 1 plots the QTEs for the unconditional CDFs. Consonant with the discussion in Blonigen and Davies (2004), there is significantly less US inbound FDI from new tax treaty partners at higher quantiles of the distribution regardless of the FDI measure utilized. In terms of magnitude, the impact on the 90^{th} quantile of the distribution of FDI stocks is roughly -35,000 (-$35 billion), or about 1.75 standard deviations. For FDI flows (FAS), the impact on the 90^{th} quantile of the distribution is roughly -5,000 (-10,000), which is roughly one (one-fifth) standard deviation.

When we adjust for the full set of covariates (including country dummies), we continue to obtain a negative and statistically significant effect of an effective tax treaty at higher quantiles for all three FDI measures (Panel II, columns 1–3). For FDI flows, however, we also obtain a (discernible) positive and statistically significant effect at extreme lower quantiles as well (Panel II, column 2). The pronounced, negative impact in the upper tail of the distributions for all three FDI measures, coupled with the insignificant, or even positive, impact in the lower tails, is consistent with the theoretical framework provided in Section 2, and highlights the importance of allowing for heterogeneous effects across the distribution. In terms of magnitudes, the impacts at, say, the 90^{th} quantile are similar to the unconditional results.

When we define the treatment as an effective tax treaty in place for at least two years, the pattern and statistical significance of QTEs does not qualitatively change for any of the three FDI measures. We also continue to reject equality of the CDFs in all three cases at the $p < 0.01$ level (Table 6, Panel I(D)). Thus, once we move beyond the focus on average effects, we do not obtain a different picture of the impact of an effective bilateral tax treaty on inbound FDI in levels when we alter the timing in this straightforward manner. Moreover, the QTE results for the level of FDI stocks and flows is contrary to what one might expect based on the flexible regression results in Panel I in Table 5. In particular, recall we obtain a positive and statistically significant *average effect* on these FDI measures several periods after a tax treaty becomes effective. The QTE results suggest that the regression results may be an artifact of a mis-specified functional form, even with the relaxation of the assumption of a constant treatment effect over time.

The analogous results assessing the distributions of each FDI measure expressed in logs are provided in Panel II of Table 6 and Figure 2. In terms of the tests of equality, we continue to reject equality of the CDFs in every case at the $p < 0.01$ confidence level. Thus, there is statistically meaningful evidence that an effective bilateral tax treaty does alter the distribution of US inbound FDI. Turning to Figure 2, we observe a different pattern of results relative to the levels case in Figure 1. In terms of the unconditional QTEs for FDI stocks, we find *positive* and statistically significant QTEs over a small range below the median, and *negative* and statistically significant QTEs at the majority of quantiles above the 60^{th} quantile (Panel I, column 1). For FDI flows, the positive QTEs at roughly the median are statistically insignificant, whereas the negative QTEs are statistically significant above roughly the 65^{th} quantile (Panel I, column 2). Finally, for FAS, we obtain negative and statistically significant QTEs at all quantiles above roughly the 30^{th} quantile (Panel I, column 3).

Prior to assessing the results adjusted for covariates, two comments are in order. First, in terms of magnitude,

the impact on, say, the 40^{th} quantile of the distribution of FDI stocks is roughly two, representing an increase of over 600%. While this effect is large in terms of percentage change, the absolute change is not that large; the value at the 40^{th} quantile is roughly \$7 million, and a 600% increase corresponds to an increase of about \$42 million, which is small relative to the mean and standard deviation in the full sample. The impact on the 90^{th} quantile of the distribution of FDI stocks is roughly -2, representing a decline of over 85%. This effect is economically significant in both relative and absolute terms; the value at the 90^{th} quantile is over \$10 billion, and a 85% decrease corresponds to an decrease of roughly \$9 billion. Thus, for FDI stocks and flows, the positive effects at lower quantiles represent decidedly smaller absolute effects economically than the negative effects at higher quantiles.

Second, while the results for FDI stocks and flows using the log transformation appear to be more consistent with the theoretical framework relative to the corresponding level specifications (Figure 1), this is a bit deceiving. With the log transformation, we are able to better discern the positive impact of tax treaties in the lower quantiles *in the graphs* for these two measures. However, these positive effects exist in the level specifications as well, but the magnitude is dwarfed by the negative effects at higher quantiles, making the positive effects unnoticeable in the plots. Moreover, the fact that the positive and negative effects are roughly equal magnitude in percentage terms, but decidedly different magnitudes in absolute terms, explains why the *average effects* obtained via regression analysis are negative and quite substantial in levels specification, but close to zero in log specifications.

Adjusting for the full set of covariates (including country dummies), we continue to obtain a negative and statistically significant effect of an effective tax treaty on higher quantiles for all three FDI measures (Panel II, columns 1–3). However, we also obtain some positive QTEs for FDI stocks and flows. For FDI stocks, we obtain a positive impact of an effective tax treaty between roughly the $20^{th}$and 40^{th} quantiles, with a few statistically significant effects (Panel II, column 1). For FDI flows, we obtain a positive, but statistically insignificant, impact at roughly the median (Panel II, column 2). As in the level models, the negative impact in the upper tail of the distributions for all three FDI measures, in combination with the insignificant, or even positive, impact in the lower tails, is consistent with our theoretical framework provided.

Lastly, when we define the treatment as an effective tax treaty in place for at least two years, the pattern and statistical significant of QTEs does not qualitatively change for FAS (Figure 2, Panel III, column 3). As in the level results for FDI stocks and flows, the QTE results for log FAS is counter to the flexible regression results provided in Table 5 (Panel II). Recall, we obtain a positive and statistically significant *average effect* on log FAS two or more years after a tax treaty becomes effective. As in the level models, the QTE results suggest that the regression results may be based on a mis-specified functional form. For FDI stocks and flows, however, the pattern of positive QTEs at lower quantiles is accentuated when we re-define the treatment effect. Specifically, the QTEs are statistically significant over a wider range – between roughly the 20^{th} and 50^{th} quantiles – for FDI stocks; positive, but statistically insignificant over a wider range – between roughly the 40^{th} and 60^{th} quantiles – for FDI flows. We also continue to reject equality of the CDFs in all three cases at the $p < 0.01$ level (Table 6, Panel II(D)). Thus, in the log models, we are able to detect 'more' evidence consonant with our theoretical framework when we alter the potential timing of the tax treaty effects. Again, though, this has less to do with the choice of levels versus logs, and more to do with the scaling of the positive and negative effects in the graphs.

Outbound FDI Results from the distributional analysis for US outbound FDI are given in Table 7; select QTE estimates are plotted in Figures 3 and 4. As in the discussion of the regression results, we focus only on the most salient findings to conserve space. First, regardless of the measure of FDI, the use of the levels or logs specification, the control set utilized, or the definition of the treatment, we reject equality of the CDFs in every case at at least the $p < 0.01$ confidence level. Thus, there is robust evidence that an effective bilateral tax treaty also alters the distribution of US outbound FDI. Second, the pattern and statistical significance of the QTEs in the *levels specifications* is quite similar to the corresponding case for US inbound FDI. This result is interesting, given the prediction from our theoretical framework that the impact of a tax treaty on the *distributions* of inbound and outbound FDI should be symmetric. Third, the QTEs displayed in Figure 4 for the *log specifications* do differ considerably from Figure 2. In particular, whereas we found negative effects of new tax treaties on US inbound FAS at nearly all quantiles, we now find evidence consonant with our theoretical framework: positive and statistically significant impacts at extreme lower quantiles, and negative and statistically significant effects at all quantiles above roughly the 30^{th} quantile. However, the results for FDI stocks and flows are now negative and statistically significant at nearly all quantiles. Thus, symmetry does not extend to the log specification in our baseline distributional specification. Moreover, whereas US inbound FDI stocks and flows appear to respond to new tax treaties in a manner consonant with our expectations, while inbound FAS does not, the opposite is the case for US outbound FDI. This heterogeneity across FDI measures – to the extent that it is robust – highlights the need to pay particular attention to the choice of FDI measure in empirical studies. We will return to this below.

5.2.2 Alternative Specifications

Foreign Affiliate Size In light of the preceding discussions, we allow for two perturbations of our baseline distributional specifications. The first change is to incorporate the average size of foreign affiliate from each foreign country and its quadratic as additional covariates in the inbound models, and the average size of US affiliate in each foreign country and its quadratic as additional covariates in the outbound models. As discussed above (see footnote 7), prior evidence suggests that the non-treaty tax rate may be decreasing in the average size of foreign affiliates, holding constant the level of aggregate FDI activity. Thus, one might expect the pattern of positive (negative) QTEs at lower (higher) quantiles to be even more pronounced once we adjust for foreign affiliate size. However, there is an important caveat. Data on average foreign affiliate size is only available for a subset of the data, with the reduction in sample size being proportionately larger in the inbound analysis.[22] The results are not shown, but are available in Figures A1-A4 in the Appendix.[23]

For inbound and outbound FDI activity in levels, the results are qualitatively unchanged from those presented in Figures 1 and 3 regardless of the definition of the treatment as the effective date of a tax treaty or two years thereafter. There is essentially no impact for any of the three FDI measures up until roughly the 60^{th} (40^{th}) quantile for inbound (outbound) FDI, and the QTEs are negative and statistically and economically significant thereafter.

For inbound and outbound FDI activity in logs, many of the results change fairly dramatically from those shown in Figures 2 and 4 regardless of the definition of the treatment. In terms of the inbound results, the results for FAS

[22] In the inbound (outbound) analysss, the sample size is reduced to roughly 760 (645) total observations.

[23] The Appendix is available at http://faculty.smu.edu/millimet/pdf/tt_appendix.pdf.

remain unchanged, but the results for FDI stocks and flows now mimic the plot shown in Figure 2 for FAS (i.e., negative effects at nearly all quantiles). For outbound FDI, again the results for FAS remain unaltered, and again the results for FDI stocks, in particular, and flows, to some extent, now mimic the plot shown for FAS in Figure 4 (i.e., positive effects at some lower quantiles, and negative effects at higher quantiles). While these changes are interesting, additional analysis reveals that the changes in the log specifications are due to the change in *sample composition*, not the inclusion of average foreign affiliate size; estimation on the sub-sample for which average foreign affiliate size is available, but excluding these additional controls, yields virtually identical plots of the QTEs as displayed in Figures A2 and A4.

In sum, then, ignoring differences due to changes in sample composition, the qualitative results discussed in the previous sections appear robust to the inclusion of average foreign affiliate size in the conditioning set. However, the results are sensitive to sample composition, presumably because this alters the likelihood of the conditional independence assumption holding in the data. Thus, our second alteration of the baseline specification alters the sample along a different dimension, by excluding countries with 'old' tax treaties with the US from the control group.

'Old' Tax Treaty Countries Excluded As discussed previously (see footnote 17), rich country interactions (as well as a direct control for the presence of an 'old' tax treaty) are not permissible in the covariate set in the QTE analysis since their inclusion leads to a violation of the common support assumption; only control group observations are 'rich' or have an 'old' tax treaty with the US. This fact highlights the role played by the common support assumption, (QTE.ii), and the fact that regression analysis, by ignoring issues of common support, extrapolates effects from observations that may be 'too' different from the treatment group. To address this issue and make the treatment and control groups more similar (and thus improve the plausibility of the conditional independence assumption, (QTE.i)), we exclude countries with an 'old' tax treaty and re-perform the analysis.

Figures 5–8 plot the results, which differ in a number of salient ways from the baseline results. Panel I in Figures 5–8 defines the treatment based on the year a bilateral tax treaty becomes effective; Panel II defines the treatment based on an effective tax treaty being in place for at least two years. Panels E and F in Tables 6 and 7 display the p-values from the corresponding tests of equality.

In terms of the results for inbound FDI in levels and logs (Figures 5 and 6), there is little substantive change in either the pattern, statistical significance, or magnitude of the effects for FAS (regardless of the use of levels or logs and the definition of the treatment). However, there are several changes for FDI stocks and flows. For FDI stocks in levels and defining the treatment based on an effective treaty (Figure 5, Panel I), the most noticeable difference is the decline in magnitude of the negative effects at higher quantiles. For example, recall the QTE estimate at the 90^{th} quantile in Figure 1 (Panel II) is roughly -35,000; now it is about -1,000, which amounts to approximately one-twentieth of a standard deviation. For FDI flows in levels and defining the treatment based on an effective treaty (Figure 5, Panel I), there is a similarly sharp decline in magnitude at higher quantiles; from -5,000 at the 90^{th} quantile in Figure 1 (Panel II) to roughly -100 (one-fiftieth of a standard deviation). There is also a noticeable, positive effect of tax treaties in the extreme lower quantiles for FDI flows.

For FDI stocks and flows in logs and defining the treatment based on an effective treaty (Figure 6, Panel I), there is little change in magnitude (if anything, the magnitude appears to increase in the tails). However, the range over

which the QTEs are positive at lower quantiles expands, from the 20^{th} to the 40^{th} quantiles in Figure 2 (Panel II) for FDI stocks to now everywhere below the median; and, from only at the median in Figure 2 (Panel II) for FDI flows to now from the 40^{th} to the 65^{th} quantiles. As in the baseline analysis, we reject equality of the distributions for all three FDI measures at the $p < 0.01$ confidence level (Table 6, Panels I(E) and II(E)).

When we define the treatment as two or more years after a tax treaty becomes effective, the effect of a bilateral tax treaty becomes essentially statistically insignificant at all quantiles for both FDI stocks and flows in levels (Figure 5, Panel II). The fact that the statistically significant, negative effects at higher quantiles disappear when we re-define the treatment in this manner is consistent with the regression results in Table 4. Using the re-defined treatment and analyzing FDI stocks and flows in logs (Figure 6, Panel II), we find two additional changes. First, the range over which the point estimates of the QTEs are positive widens dramatically relative to Figure 2 (Panel III). Second, the negative and statistically significant effects at higher quantiles in Figure 2 disappear. Again, the finding of more positive (or, less negative) effects of tax treaties several periods after the treaty becomes effective is consistent with the prior regression results in Table 4. Lastly, we continue to reject equality of the distributions for all three FDI measures at the $p < 0.01$ confidence level (Table 6, Panels I(F) and II(F)).

In terms of the results for outbound FDI in levels and logs (Figures 7 and 8), only the results for FAS in logs are qualitatively unchanged (Figure 8). First, for FDI stocks and flows in levels and defining the treatment based on an effective treaty (Figure 7, Panel I), there continues to be a decline in magnitude of the negative effects at higher quantiles. Specifically, the QTE estimate at the 90^{th} quantile in Panel II of Figure 3 for FDI stocks (flows) is roughly -50,000 (-5,000), but declines to roughly -10,000 (-2,000), which amounts to approximately one-half (two-thirds) of a standard deviation. For FAS in levels and defining the treatment based on an effective treaty (Figure 7, Panel I), there is also a decline in magnitude of the negative effects at higher quantiles; the QTE estimate at the 90^{th} quantile declines from -125,000 in Figure 3 (Panel II) to roughly -20,000, which amounts to approximately one-third of a standard deviation. There is also a noticeable positive effect of tax treaties in the extreme lower quantiles for all three FDI measures, and we continue to reject equality of the distributions for all three FDI measures at the $p < 0.01$ confidence level (Table 7, Panel I(E)).

Second, while statistically insignificant, the point estimates of the QTEs for FDI flows in logs and defining the treatment based on an effective treaty (Figure 8, Panel I) now suggest a positive impact of tax treaties over a range of quantiles below the median. Finally, there is no statistically significant impact when we define the treatment as two or more years after a tax treaty becomes effective, measuring FDI in either in logs or levels for stocks and flows, although many of the point estimates are positive. Moreover, we *fail to reject* equality of the distributions for FDI flows in either logs or levels in this case at the $p < 0.10$ confidence level (Table 7, Panels I(F) and II(F)); we do, however, *reject* equality for FDI stocks in either levels or logs (Table 7, Panels I(F) and II(F)). In terms of FAS, there remains a negative and statistically significant effect at higher quantiles in the level specification with the treatment defined two years or more after a tax treaty becomes effective, but the magnitude falls considerably, from -125,000 to -25,000, which corresponds to less than one-half of a standard deviation; again, we continue to reject equality (Table 7, Panel I(F)).

5.3 Discussion

In light of the number of results presented, it is worth taking a step back to view the larger picture. In so doing, we reach several conclusions. First, regression estimates of bilateral tax treaty effects are quite fragile; statistical modeling assumptions matter, as well as assumptions concerning the timing of the effect. In our preferred regression specifications based on the more flexible Laporte and Windmeijer (2005) model with rich country interactions, we find some evidence of a positive, delayed response to tax treaties. Although contrary to Egger et al. (2006), the coefficients are of a reasonable magnitude, and the positive, lagged response is consistent with the gradualism argument in Chisik and Davies (2004b), where tax rates can only be reduced gradually under tax treaties due to the self-enforcing nature of such agreements. It is also consistent with the tax certainty role of tax treaties, where such certainty is only revealed over time, again perhaps due to lack of formal enforcement of such treaties. However, these positive, lagged effects are statistically significant only for US inbound FDI stocks and flows in levels, and inbound FAS and outbound stocks in logs.

Second, regression estimates indicate some asymmetric impacts of effective tax treaties on US inbound and outbound FDI. As just stated, in our preferable regression specifications for US inbound FDI, we obtain positive average effects of an effective bilateral tax treaty on FDI stocks and flows (in levels) and FAS (in logs) several years after the tax treaty becomes effective. For US outbound FDI, we obtain some, less robust, evidence of positive average effects of an effective bilateral tax treaty on FDI stocks and FAS (in logs), the former occurring with a lag, and negative average effects of an effective bilateral tax treaty on FDI flows (in logs) several years after the tax treaty becomes effective.

Third, semi-nonparametric estimates based on QTEs indicate that bilateral tax treaties significantly (in a statistical sense, at least) impact the distribution of both US inbound and outbound FDI as we nearly always reject equality of the distributions. However, given the significance of the rich country interactions in the regression analysis, and the assumptions required for the QTEs to be consistent (i.e., the conditional independence assumption, (QTE.i), and the common support assumption, (QTE.ii)), our preferred distributional results come from the models excluding 'old' tax treaty countries. Here, the distributional analysis suggests substantial gains to allowing for heterogeneous effects of tax treaties in a systematic manner, as well as tax treaty effects of reasonable, if not small, magnitude. On the one hand, the *negative* impacts of effective tax treaties are concentrated at higher quantiles of the distribution when defining the treatment based on actual date a tax treaty becomes effective. On the other hand, we obtain 'weakly' *positive* impacts of effective tax treaties concentrated at lower quantiles; 'weakly' since the QTEs are not always statistically significant, although we obtain at least some positive *point estimates* for the QTEs at lower quantiles in all cases. This pattern of heterogeneous effects is consistent with our simple theoretical framework in which the impact of a bilateral tax treaty is inversely related to the level of FDI activity at the time the treaty becomes effective if the pre-treaty marginal effective tax rate is inversely related to the amount of pre-treaty FDI activity.

When we re-define the treatment as an effective tax treaty being in place for at least two years in our preferred specification, the pattern of positive (negative) point estimates at lower (higher) quantiles continues for FDI stocks and flows, but the effects are rarely statistically significant at individual quantiles. For FAS, we also find a similar pattern of positive and negative effects across the distribution, particularly for US outbound FAS in both levels and logs, and in this case the QTEs are statistically significant at both ends of the distribution. However, in all cases,

the magnitudes of the effects are either comparable or smaller relative to the corresponding case with the treatment defined based on the actual date a tax treaty becomes effective. This is contrary to the regression results, which suggested a stronger, lagged response in many instances, and may indicate that the functional form upon which the regression results are based is mis-specified. Mis-specification of the linear (or log-linear) functional form would also explain why Egger et al. (2006) fail to find any evidence of stronger effects over time, as they also do not rely on a linear functional form as they utilize a semi-nonparametric propensity score matching estimator to obtain average effects.

Fourth, there is evidence that distributional effects are symmetric with respect to direction of the capital investment in our preferred specification – excluding 'old' tax treaty countries – and measuring FDI in levels. This symmetry is consonant with our theoretical framework, but contrary to some of the regression results and, to a lesser extent, the distributional results in logs. Thus, there is certainly scope for future research to better address whether symmetry holds at the distributional level.

Fifth, while the decision to model FDI in levels versus logs is crucial in regression analyses, it is much less so in the distributional analysis. Assessing the distributions – in levels or logs – makes it clear that, in most cases, the effect of a new effective tax treaty is positive in lower quantiles, and negative in higher quantiles. In absolute terms in the level specifications, the negative effects at higher quantiles dwarfs the positive effects at lower quantiles, even when *excluding* 'old' tax treaty countries. Thus, the *average effect* estimated using regression analysis in levels tends to be negative and quite substantial. However, in absolute terms in the log specifications, the negative effects at higher quantiles and the positive effects at lower quantiles are of comparable magnitude, even when *including* 'old' tax treaty countries. As a result, the *average effect* estimated in logs tends to be close to zero. For example, our regression estimates presented here tend to be positive and statistically insignificant, whereas in Egger et al. (2006) they are negative and statistically significant, but of modest magnitude. The bottom line is that the relevance of the distinction between levels and logs appears to be primarily an artifact of the focus on the (conditional) mean effect of tax treaties.

Finally, the choice of FDI measure matters greatly in the regression analysis, particularly when combined with the decision between level and log specifications. The distributional analysis, while revealing some differences across the three measures, yields qualitatively similar results for all three measures when the treatment is defined based on when a tax treaty becomes effective. Different results do arise across the measures in our preferred specification – excluding 'old' tax treaty countries – when the treatment is defined based on an effective tax treaty being in place for at least two years. In particular, we fail to reject equality of the distributions for outbound FDI flows (in levels or logs), but do for inbound FDI flows (in levels or logs), as well as for the other two measures for both inbound and outbound. In addition, whereas the individual QTE estimates are rarely statistically significant for FDI stocks or flows (regardless of inbound or outbound, and in levels or logs), the majority of the QTE estimates for FAS are statistically significant (both positive QTEs at lower quantiles and negative quantiles at higher quantiles). Thus, while the short-run effect is qualitatively similar across FDI measures, the long-run effects appear specific to different FDI measures. Understanding the differences in the long-run across different types of FDI appears to be fruitful ground for future research.

6 Conclusion

Economists have been a bit puzzled by bilateral tax treaties because of the divergence of the empirical and theoretical results in the literature, the fragility of existing empirical estimates, as well as the extreme magnitudes obtained in some specifications. Whereas the theoretical literature suggests that such treaties can be FDI-inducing, the empirical (and legal) literature disputes these claims in practice. However, as suggested in Blonigen and Davies (2004) and Egger et al. (2006), not all tax treaties are created equally, and there is no reason to expect each treaty to have the identical impact. As such, focusing on the average effect may be misleading, and highly sensitive to sample composition. Moreover, restricting the timing of the effect to be instantaneous may also be problematic. To assess the role of these modeling choices in the current empirical literature, we re-examine the panel data set from Blonigen and Davies (2004) on US inbound and outbound FDI, which spans the period 1980–1999.

As discussed, there are important gains to taking a distributional approach to the empirical analysis of new bilateral tax treaties, in terms of both the depth of the picture painted and improved robustness of that picture. The bottom line is that tax treaties do alter the distribution of FDI activity, particularly in the short-run, with positive effects occurring at lower quantiles of the distribution and negative effects occurring at higher quantiles. Moreover, while the positive effects are much smaller in magnitude relative to the negative effects, they are on par in percentage terms. Finally, when making the control group more comparable to the treatment group, by excluding 'old' tax treaty countries, the effects at either low or high quantiles are of modest magnitude in absolute terms.

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Table 1. Summary Statistics

	Inbound			Outbound		
FDI	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
Stock	5,897.798	20,662.218	1470	11,100.921	22,311.850	871
Flow	983.490	5,050.522	1468	1,110.685	3,029.439	862
FAS	21,946.257	60,490.618	806	35,454.022	58,470.896	652
Controls						
Sum of GDPs	6,947.968	1,436.883	1556	7,142.787	1,515.579	881
GDP Difference Squared	42,413,787.434	17,311,073.759	1556	39,999,271.187	16,894,367.031	881
Skill Difference (Inbound)	5.837	2.609	1556	-4.992	2.412	881
Skill Difference (Outbound)				4.992	2.412	881
Skill Difference* GDP Difference	36,910.721	17,937.410	1556	30,289.531	15,328.371	881
Distance	4,988.012	2,391.464	1556	5,128.033	2,248.001	881
Investment Cost	29.236	2.561	1556	47.268	12.472	881
Trade Costs (Host)	80.709	4.888	1556	42.438	43.033	881
Trade Costs (Home)	33.869	44.927	1556	80.710	4.884	881
Trade Costs (Host)* Skill Difference Squared	3,322.917	2,503.452	1556	1,504.743	2,206.793	881

Notes: Data cover 1980-2000. Inbound refers to US inbound FDI from 91 countries; outbound refers to US outbound FDI to 44 countries. FDI variables are in millions of 1996 dollars. GDP variables in trillions of real dollars.

Table 2. Regression Estimates: Inbound FDI

	No Rich Country Interactions				Rich Country Interactions			
	Pooled OLS	**RE**	**FD**	**FE**	**Pooled OLS**	**RE**	**FD**	**FE**
I. FDI = Inbound Stock (Levels)								
New Treaty	-9,879.008***	-8,402.201***	-741.404***	-8,569.491**	-413.884***	164.034	104.868	397.283*
	(1,123.737)	(3,051.727)	(270.829)	(3,357.197)	(146.169)	(211.520)	(64.130)	(211.395)
N	1470	1470	1335	1470	1470	1470	1335	1470
Spec Test			p = 0.021				p = 0.078	
II. FDI = Inbound Flow (Levels)								
New Treaty	-1,626.135***	-1,508.543**	-177.784	-1,576.250**	11.715	43.087	-54.535	110.631*
	(293.048)	(590.087)	(120.586)	(728.756)	(40.999)	(53.558)	(88.063)	(57.698)
N	1468	1468	1326	1468	1468	1468	1326	1468
Spec Test			p = 0.057				p = 0.074	
III. FDI = Inbound FAS (Levels)								
New Treaty	-27,581.878***	-15,899.797**	-1,850.999**	-15,388.288**	-782.477***	307.142	-63.279	641.969
	(3,776.081)	(6,889.170)	(804.066)	(7,075.517)	(283.697)	(717.502)	(242.780)	(798.905)
N	806	806	686	806	806	806	686	806
Spec Test			p = 0.059				p = 0.430	
IV. FDI = Inbound Stock (Logs)								
New Treaty	-0.121	0.306	-0.085	0.299	-0.605**	0.281	-0.048	0.347
	(0.273)	(0.427)	(0.060)	(0.445)	(0.299)	(0.435)	(0.057)	(0.450)
N	1470	1470	1335	1470	1470	1470	1335	1470
Spec Test			p = 0.404				p = 0.393	
V. FDI = Inbound Flow (Logs)								
New Treaty	-0.236	0.255	-0.973	0.481	-0.27	0.416	-0.924	0.551
	(0.254)	(0.316)	(01.20)	(0.381)	(0.268)	(0.324)	(01.192)	(0.407)
N	1468	1468	1326	1468	1468	1468	1326	1468
Spec Test			p = 0.212				p = 0.199	
VI. FDI = Inbound FAS (Logs)								
New Treaty	-1.169***	1.250***	-0.008	1.353***	-1.542***	1.283***	-0.001	1.422***
	(0.316)	(0.399)	(0.164)	(0.422)	(0.333)	(0.413)	(0.167)	(0.452)
N	806	806	686	806	806	806	686	806
Spec Test			p = 0.003				p = 0.004	

Notes: FAS = foreign affiliate sales. Standard errors in parentheses are robust in pooled OLS models and clustered in random effects (RE), first-differenced (FD), and fixed effects (FE) models. Specification test is from Laporte and Windmeijer (2005) and tests equality between the coefficient on New Treaty in the FD and FE models. *, **, *** denotes statistical significant at the 10%, 5%, and 1% level, respectively. See text for further details, as well as list of covariates included.

Table 3. Regression Estimates: Outbound FDI

	No Rich Country Interactions				Rich Country Interactions			
	Pooled OLS	**RE**	**FD**	**FE**	**Pooled OLS**	**RE**	**FD**	**FE**
I. FDI = Outbound Stock (Levels)								
New Treaty	-7,798.073***	-5,585.681*	-381.71	-5,205.76	-1,794.917***	-166.38	-3.348	291.158
	(1,236.821)	(3,026.619)	(338.974)	(3,133.447)	(648.569)	(1,462.261)	(212.923)	(1,519.070)
N	871	871	820	871	871	871	820	871
Spec Test			p = 0.123				p = 0.858	
II. FDI = Outbound Flow (Levels)								
New Treaty	-844.018***	-748.083	-70.349	-664.012	-205.719*	-7.516	-40.227	76.157
	(183.239)	(487.060)	(185.637)	(503.507)	(106.355)	(270.804)	(189.943)	(301.767)
N	862	862	808	862	862	862	808	862
Spec Test			p = 0.252				p = 0.777	
III. FDI = Outbound FAS (Levels)								
New Treaty	-22,339.600***	-8,796.70	-928.791	-7,585.57	1,958.82	4,147.60	527.043	4,239.89
	(3,537.605)	(6,160.690)	(817.635)	(6,464.825)	(652.0)	(652.0)	(597.0)	(652.0)
N	652	652	597	652	652	652	597	652
Spec Test			p = 0.305				p = 0.377	
IV. FDI = Outbound Stock (Logs)								
New Treaty	-0.329	0.166	-0.006	0.194	-0.163	0.082	-0.005	0.116
	(0.237)	(0.278)	(0.128)	(0.255)	(0.260)	(0.350)	(0.124)	(0.352)
N	871	871	820	871	871	871	820	871
Spec Test			p = 0.536				p = 0.801	
V. FDI = Outbound Flow (Logs)								
New Treaty	-0.429	-0.436	-1.908	-0.378	-0.601	-0.648	-1.895	-0.717
	(0.359)	(0.592)	(01.552)	(0.704)	(0.376)	(0.596)	(01.509)	(0.784)
N	862	862	808	862	862	862	808	862
Spec Test			p = 0.381				p = 0.516	
VI. FDI = Outbound FAS (Logs)								
New Treaty	0.441*	0.525	0.120*	0.537	0.622**	0.446	0.089**	0.441
	(0.248)	(0.345)	(0.066)	(0.350)	(0.268)	(0.321)	(0.042)	(0.323)
N	652	652	597	652	652	652	597	652
Spec Test			p = 0.243				p = 0.281	

Notes: See Table 2.

Table 4. Regression Estimates: Inbound FDI

	FDI Stock				FDI Flow				Foreign Affiliate Sales			
	FD	**FE**	**FD**	**FE**	**FD**	**FE**	**FD**	**FE**	**FD**	**FE**	**FD**	**FE**
I. Levels												
$(\text{New Treaty})_{-1}$	-792.776**	-3,390.553**	119.244	150.615	-118.272	-697.575	207.093**	101.114	-1,659.765**	-1,889.331	392.881	468.737
	(345.011)	(1,602.914)	(97.306)	(174.131)	(129.734)	(442.708)	(84.192)	(68.785)	(724.899)	(2,551.893)	(452.051)	(643.487)
$(\text{New Treaty})_{0}$	-1,442.359**	-2,362.26	141.853	236.397	-324.234	-882.836*	140.997	44.560	-3,509.657**	-4,804.728	285.034	408.232
	(559.676)	(2,095.459)	(85.378)	(146.978)	(205.848)	(489.214)	(118.601)	(51.008)	(1,395.519)	(3,275.731)	(746.170)	(852.161)
$(\text{New Treaty})_{+1}$	-1,944.282**	-2,853.03	291.125*	468.995**	-269.959	-335.563	327.284*	135.512	-4,156.651**	-2,560.045	1,048.683	899.173
	(751.596)	(2,275.323)	(169.045)	(224.750)	(329.431)	(494.453)	(187.813)	(102.458)	(1,734.346)	(3,903.684)	(1,019.70)	(1,265.968)
$(\text{New Treaty})_{+2}$	-2,741.414***	-4,195.202	173.614	406.184**	-655.376	-929.017	198.173	-9.177	-6,410.244**	-7,375.583*	1,361.361	1,192.506
	(963.051)	(2,850.485)	(130.712)	(177.948)	(421.250)	(618.067)	(177.392)	(37.541)	(2,599.012)	(4,308.350)	(1,091.721)	(1,328.889)
$(\text{New Treaty})_{+3+}$	-3,380.269***	-10,601.061**	208.984	647.114**	-836.643	-2,100.313*	319.297*	146.212**	-8,010.765**	-22,414.127**	1,708.137	667.951
	(1,198.871)	(4,774.681)	(128.502)	(274.90)	(566.099)	(1,103.691)	(190.937)	(59.406)	(3,179.010)	(9,711.917)	(1,190.428)	(1,545.290)
Rich Interactions	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
N	908	1002	908	1002	898	990	898	990	402	462	402	462
II. Logs												
$(\text{New Treaty})_{-1}$	0.774	0.164	0.845	0.292	0.745	0.853	0.817	0.941	0.029	0.350	0.061	0.462*
	(0.558)	(0.699)	(0.567)	(0.649)	(0.843)	(0.988)	(0.853)	(0.984)	(0.104)	(0.218)	(0.116)	(0.236)
$(\text{New Treaty})_{0}$	0.661	0.173	0.785	0.334	-0.453	-0.147	-0.385	0.038	0.113	0.381	0.171	0.524
	(0.577)	(0.573)	(0.588)	(0.520)	(1.567)	(0.988)	(1.601)	(1.016)	(0.227)	(0.372)	(0.234)	(0.380)
$(\text{New Treaty})_{+1}$	-0.270	-0.072	-0.173	0.052	0.072	0.512	0.066	0.676	0.171	0.495	0.242	0.650*
	(0.628)	(0.755)	(0.623)	(0.770)	(1.550)	(0.895)	(1.631)	(0.931)	(0.246)	(0.348)	(0.269)	(0.376)
$(\text{New Treaty})_{+2}$	-0.331	-0.049	-0.261	0.094	-0.682	-0.153	-0.744	0.031	1.070*	1.250***	1.165**	1.415***
	(0.398)	(0.634)	(0.450)	(0.630)	(1.752)	(1.108)	(1.851)	(1.127)	(0.534)	(0.455)	(0.569)	(0.513)
$(\text{New Treaty})_{+3+}$	0.286	0.584	0.277	0.715	0.344	0.707	0.267	0.832	1.219**	1.619***	1.311**	1.852***
	(0.309)	(0.488)	(0.350)	(0.488)	(1.715)	(0.520)	(1.794)	(0.531)	(0.557)	(0.511)	(0.604)	(0.592)
Rich Interactions												
N	908	1002	908	1002	898	990	898	990	402	462	402	462

Notes: $(\text{New Treaty})_t$ is an indicator for t years prior to (after) a new tax treaty becoming effective if t is negative (positive). See Table 2 for further details.

Table 5. Regression Estimates: Outbound FDI

	FDI Stock				FDI Flow				Foreign Affiliate Sales			
	FD	**FE**	**FD**	**FE**	**FD**	**FE**	**FD**	**FE**	**FD**	**FE**	**FD**	**FE**
I. Levels												
$(\text{New Treaty})_{-1}$	-452.497	-1,584.768	30.011	159.576	-260.365	-323.995	-125.750	-104.477	40.166	-572.825	1,535.672	3,783.134
	(347.861)	(1,981.188)	(181.527)	(1,026.708)	(186.662)	(324.705)	(170.618)	(180.551)	(1,851.091)	(4,640.540)	(1,646.462)	(3,113.790)
$(\text{New Treaty})_{0}$	-954.353	-2,586.307	-1.681	164.011	-254.080	-420.701	-74.593	-54.814	-944.645	-640.356	2,420.225	5,354.599
	(705.039)	(2,527.082)	(396.670)	(1,332.280)	(199.556)	(446.427)	(177.323)	(292.249)	(2,749.457)	(5,892.914)	(2,117.716)	(3,943.343)
$(\text{New Treaty})_{+1}$	-1,417.585	-3,122.311	-28.086	95.479	-135.342	-374.473	151.251	24.757	-1,576.492	-1,169.706	3,650.820	7,198.811
	(969.428)	(2,941.577)	(514.950)	(1,579.331)	(303.492)	(622.719)	(247.90)	(450.961)	(3,852.599)	(8,136.705)	(2,961.939)	(5,731.671)
$(\text{New Treaty})_{+2}$	-1,794.608	-3,532.768	-115.002	452.418	-129.483	-427.650	181.931	127.756	-3,954.420	-2,557.494	2,045.257	6,257.995
	(1,186.178)	(3,160.344)	(594.669)	(1,639.714)	(317.158)	(565.538)	(239.425)	(318.958)	(3,617.902)	(7,481.116)	(2,474.179)	(5,346.933)
$(\text{New Treaty})_{+3+}$	-2,260.770*	-6,533.865	-484.834	727.494	-681.646*	-1,104.22	-407.356	-89.392	-4,869.929	-6,238.731	1,917.582	8,473.180
	(1,341.265)	(4,433.825)	(716.803)	(2,474.381)	(362.792)	(836.134)	(257.070)	(555.484)	(4,693.189)	(9,580.181)	(3,680.316)	(7,477.991)
Rich Interactions	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
N	621	670	621	670	601	652	601	652	403	449	403	449
II. Logs												
$(\text{New Treaty})_{-1}$	0.033	0.287**	0.048	0.394**	-0.187	0.165	-0.035	-0.085	-0.001	0.253	0.009	0.259
	(0.052)	(0.140)	(0.049)	(0.159)	(0.299)	(0.795)	(0.388)	(0.763)	(0.080)	(0.189)	(0.080)	(0.188)
$(\text{New Treaty})_{0}$	-0.071	0.165	-0.043	0.289	-1.027	-0.924	-0.962	-1.188	0.038	0.223	0.044	0.203
	(0.081)	(0.164)	(0.093)	(0.188)	(1.539)	(1.328)	(1.525)	(1.343)	(0.120)	(0.239)	(0.121)	(0.246)
$(\text{New Treaty})_{+1}$	-0.061	0.181	-0.028	0.298	0.024	0.029	0.332	-0.194	0.063	0.144	0.067	0.080
	(0.087)	(0.162)	(0.102)	(0.182)	(1.395)	(1.299)	(1.331)	(1.384)	(0.145)	(0.268)	(0.149)	(0.284)
$(\text{New Treaty})_{+2}$	-0.027	0.253	-0.003	0.378**	-0.051	0.568	-0.032	0.277	0.070	0.140	0.075	0.121
	(0.089)	(0.162)	(0.107)	(0.187)	(1.408)	(0.868)	(1.504)	(0.987)	(0.165)	(0.30)	(0.174)	(0.301)
$(\text{New Treaty})_{+3+}$	-0.094	0.048	-0.090	0.176	-3.129*	-1.458	-3.506*	-1.957	0.199	0.359	0.161	0.323
	(0.107)	(0.241)	(0.123)	(0.290)	(1.856)	(1.363)	(1.868)	(1.560)	(0.226)	(0.408)	(0.244)	(0.405)
Rich Interactions												
N	621	670	621	670	601	652	601	652	403	449	403	449

Notes: See Table 4.

Table 6. Tests of Equality for Inbound FDI

Z_0	Z_1	FDI Stock	FDI Flow	Foreign Affiliate Sales
I. FDI in Levels				
A. Unconditional				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
B. Adjusted for Covariates (No Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
C. Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
D. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
E. Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
F. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
II. FDI in Logs				
A. Unconditional				
No Treaty	Treaty	p = 0.000	p = 0.008	p = 0.000
B. Adjusted for Covariates (No Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
C. Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
D. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
E. Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
F. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000

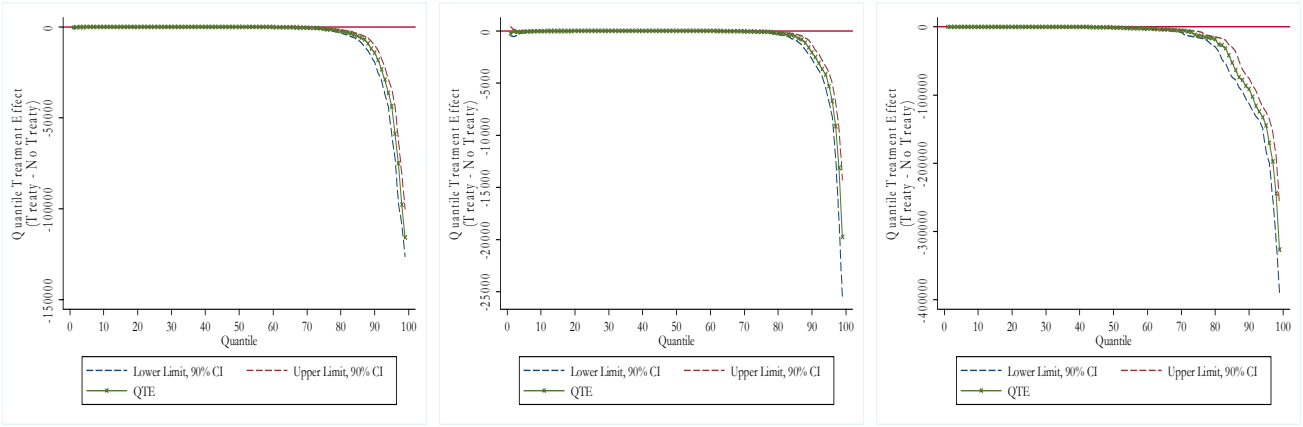
Notes: P-values based on 500 bootstrap repetitions. See text for further details, including the list of covariates used.

Table 7. Tests of Equality for Outbound FDI

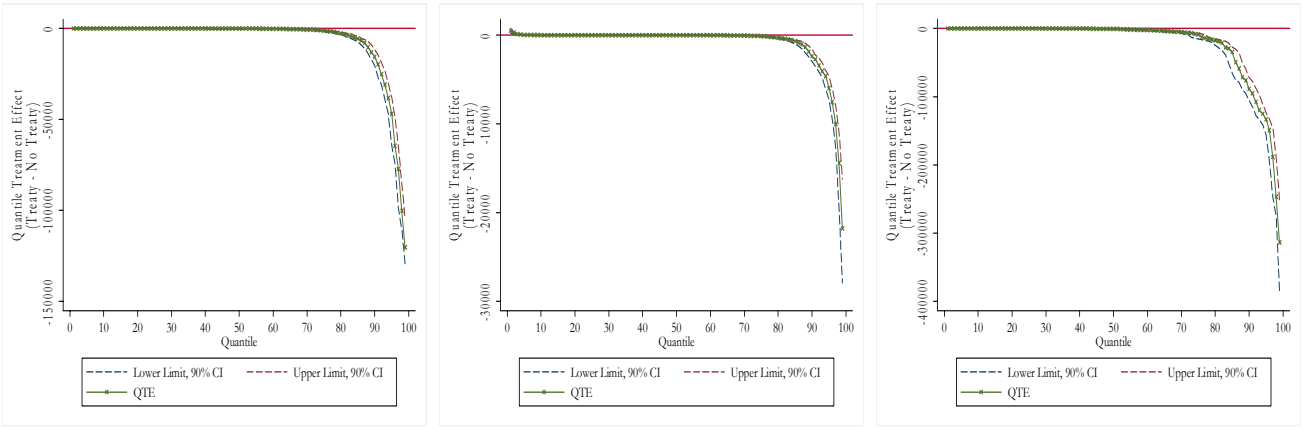
Z_0	Z_1	FDI Stock	FDI Flow	Foreign Affiliate Sales
I. FDI in Levels				
A. Unconditional				
No Treaty	Treaty	p = 0.000	p = 0.002	p = 0.000
B. Adjusted for Covariates (No Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
C. Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
D. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
E. Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
F. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.018	p = 0.278	p = 0.000
II. FDI in Logs				
A. Unconditional				
No Treaty	Treaty	p = 0.000	p = 0.004	p = 0.000
B. Adjusted for Covariates (No Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
C. Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
D. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
E. Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.000	p = 0.000	p = 0.000
F. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects, Excluding 'Old' Tax Treaty Countries)				
No Treaty	Treaty	p = 0.002	p = 0.262	p = 0.000

Notes: See Table 6.

Panel I. Unconditional Distributions



Panel II. Adjusted for Covariates (Country Effects)



Panel III. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)

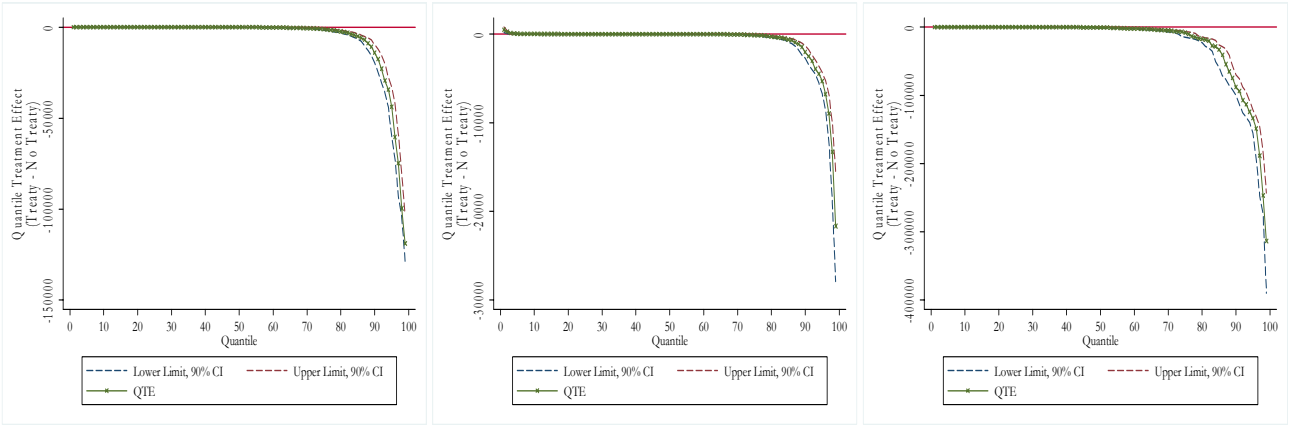
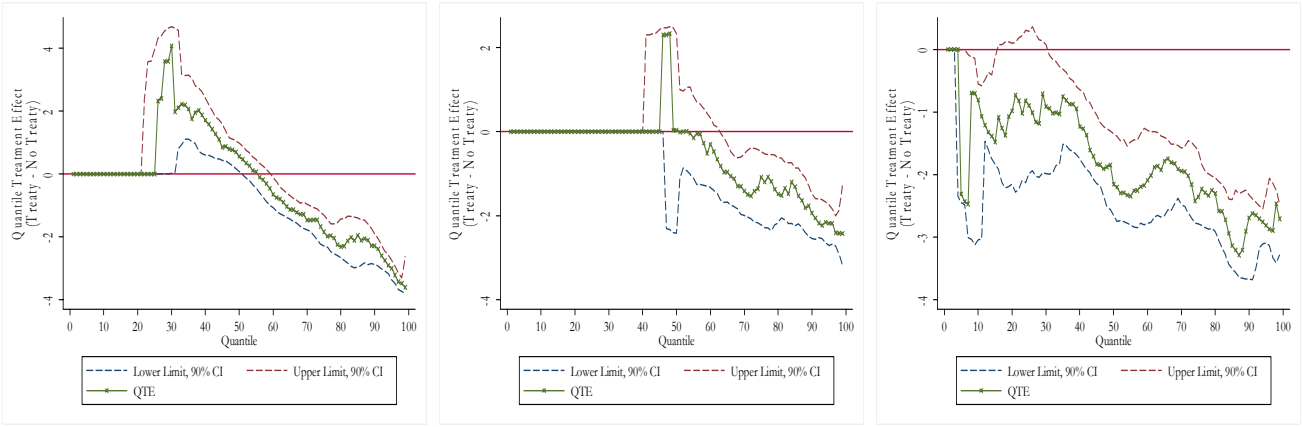


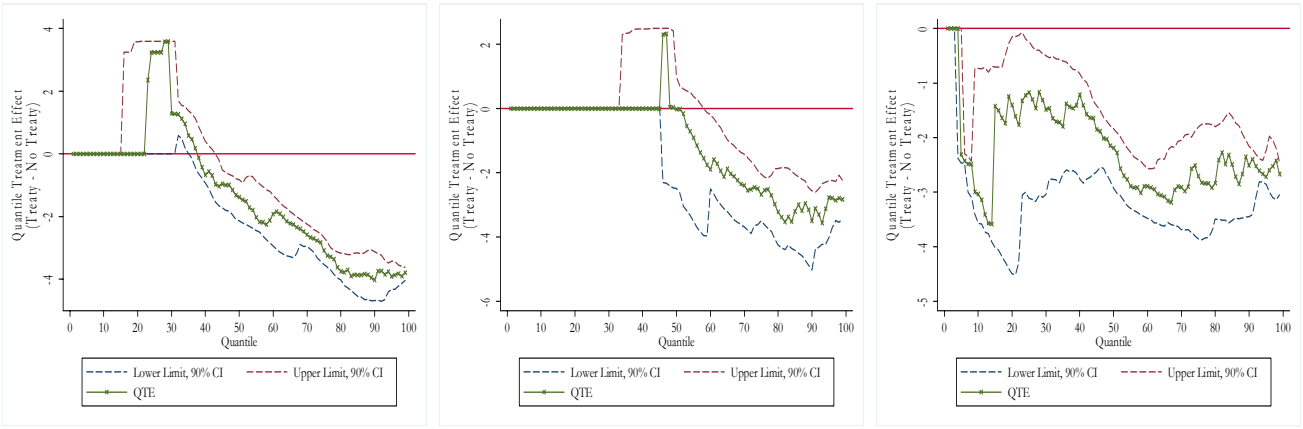
Figure 1. QTEs for Inbound FDI in Levels.

Notes: Plots in first column use FDI stocks; second column use FDI flows; plots in third column use foreign affiliate sales. The treatment in Panels I and II is defined as one if an effective bilateral tax treaty exists, zero otherwise. The treatment in Panel III is defined as one if an effective bilateral tax treaty has existed for at least two years, zero otherwise. Covariates adjusted for using inverse propensity score weighting. Confidence intervals (CIs) obtained via 500 bootstrap repetitions. See text for further details, including the list of covariates used.

Panel I. Unconditional Distributions



Panel II. Adjusted for Covariates (Country Effects)



Panel III. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)

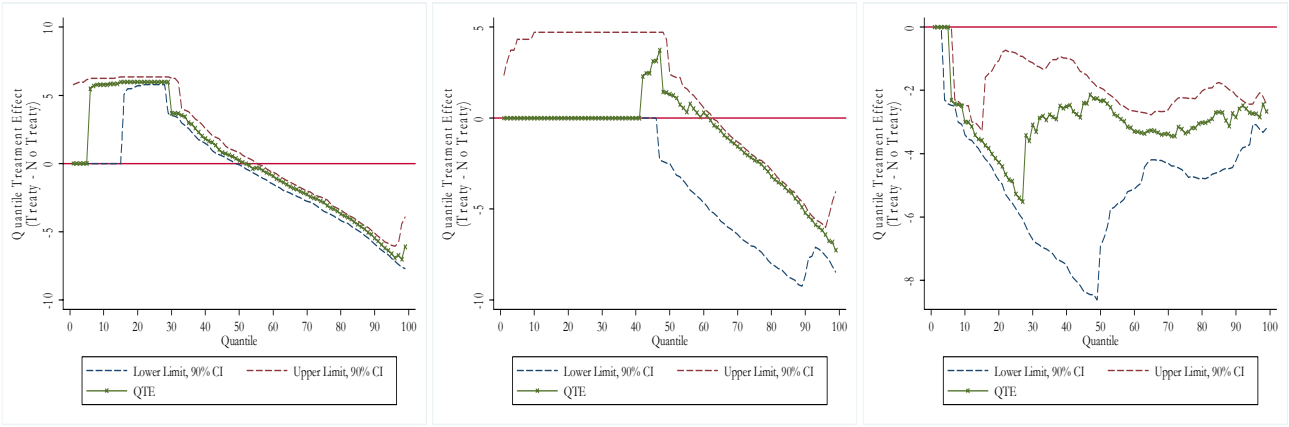
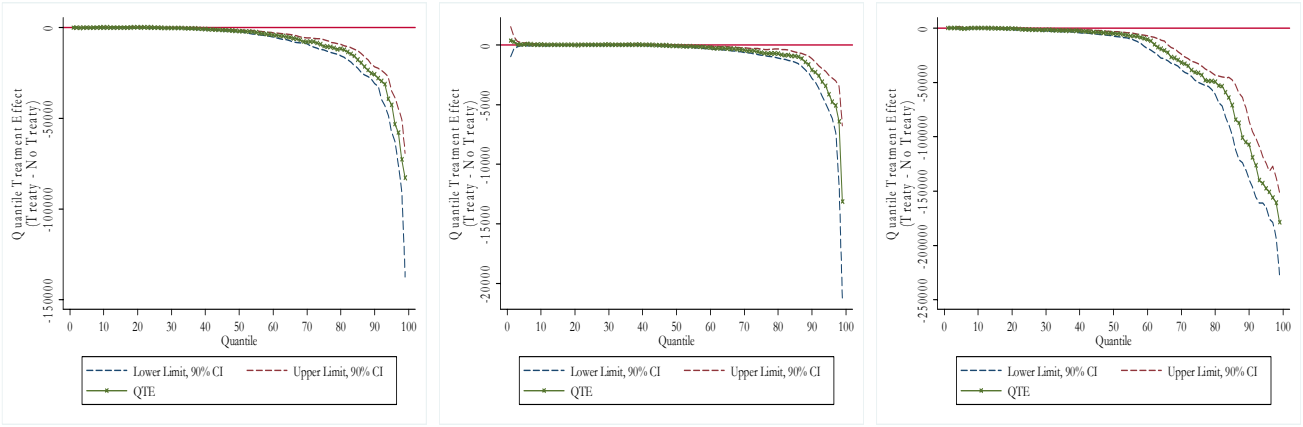
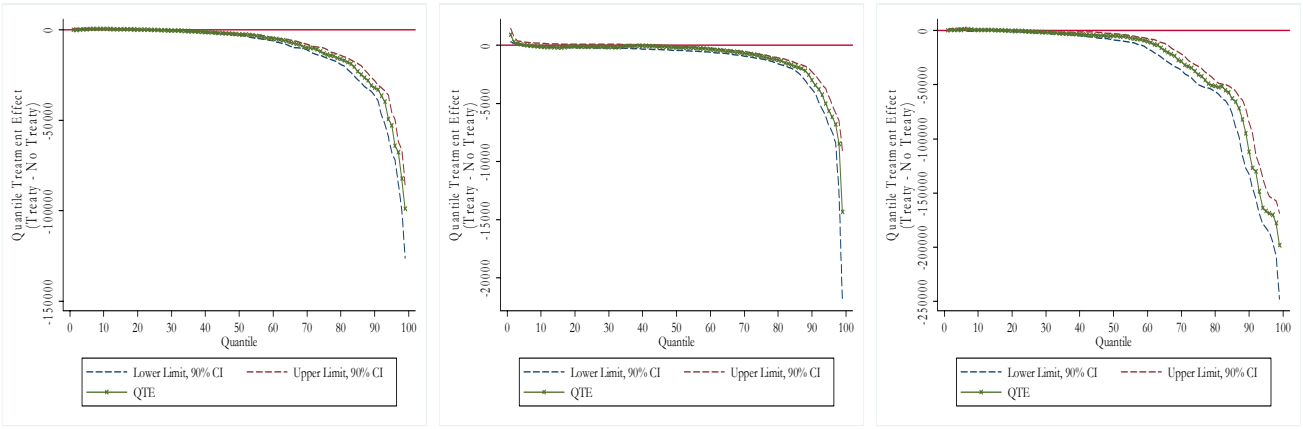


Figure 2. QTEs for Inbound FDI in Logs.
Notes: See Figure 1.

Panel I. Unconditional Distributions



Panel II. Adjusted for Covariates (Country Effects)



Panel III. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)

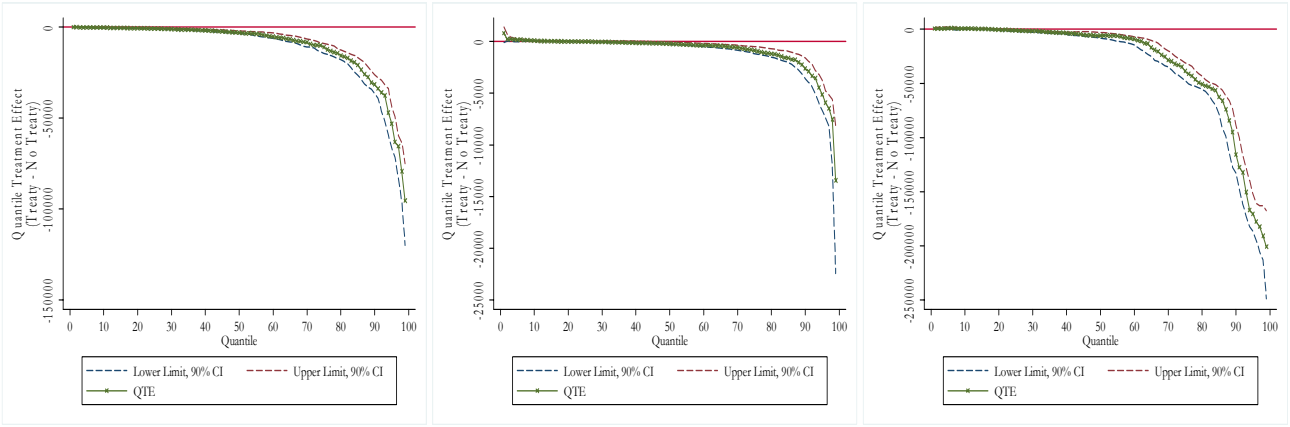
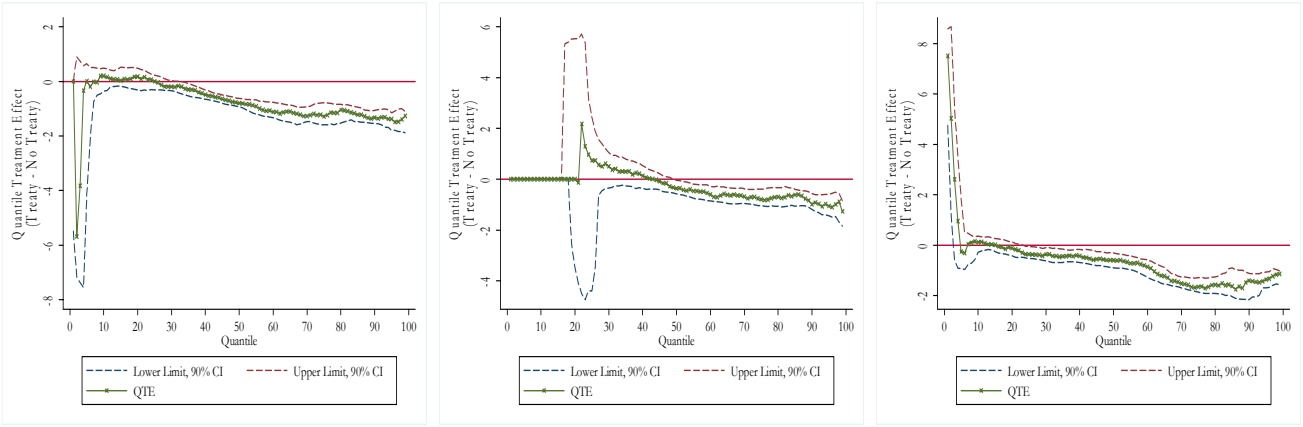
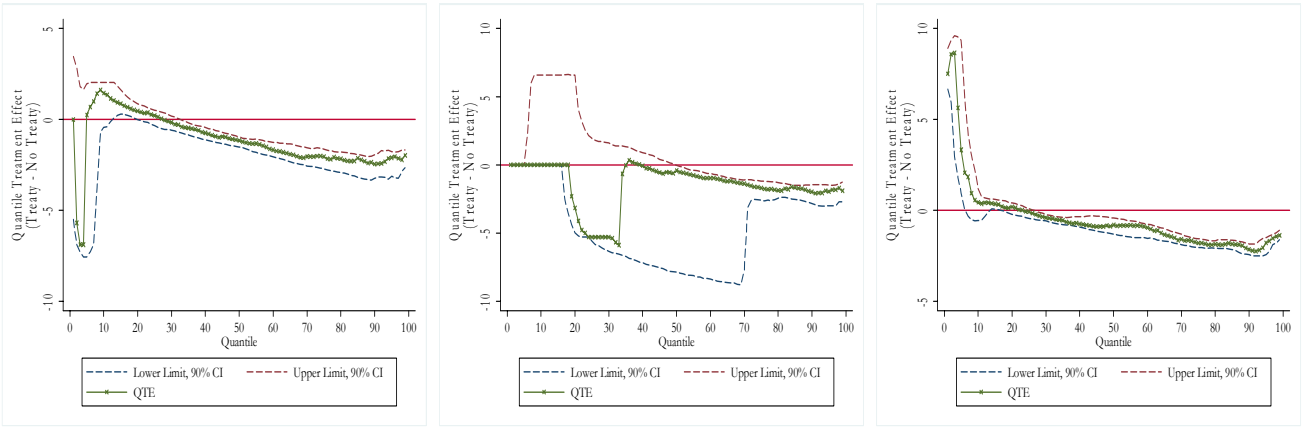


Figure 3. QTEs for Outbound FDI in Levels.
Notes: See Figure 1.

Panel I. Unconditional Distributions



Panel II. Adjusted for Covariates (Country Effects)



Panel III. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates (Country Effects)

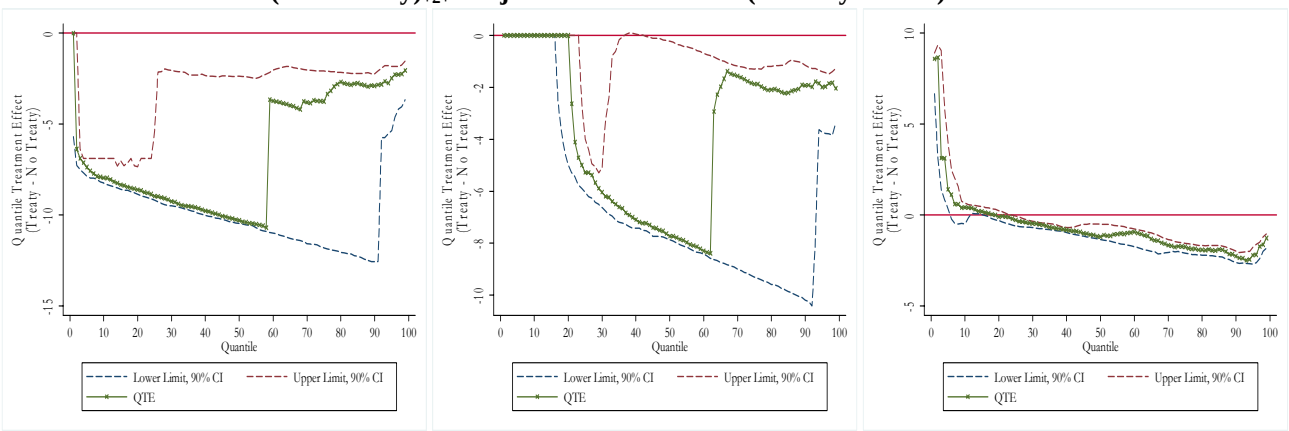
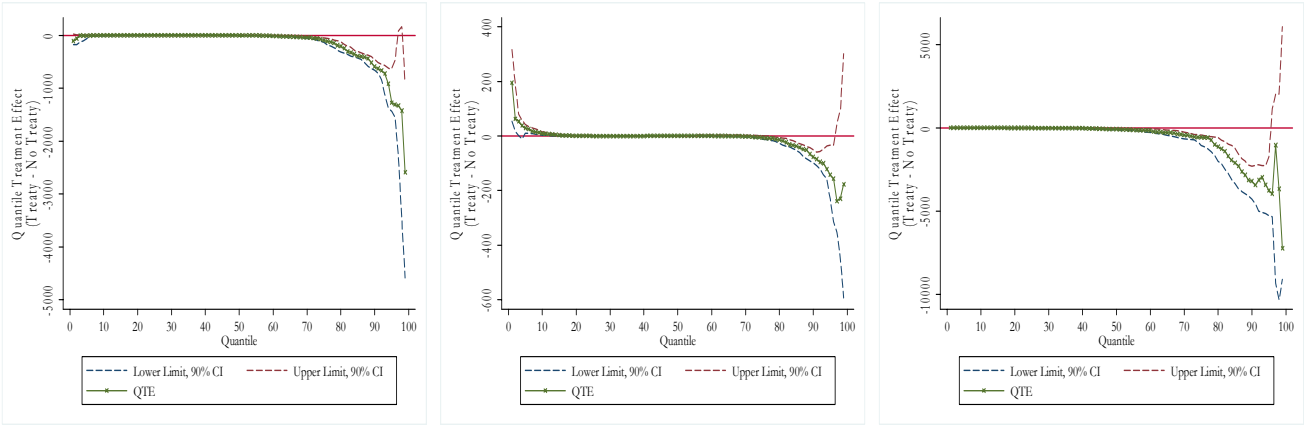


Figure 4. QTEs for Outbound FDI in Logs.
Notes: See Figure 1.

Panel I. Adjusted for Covariates



Panel II. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates

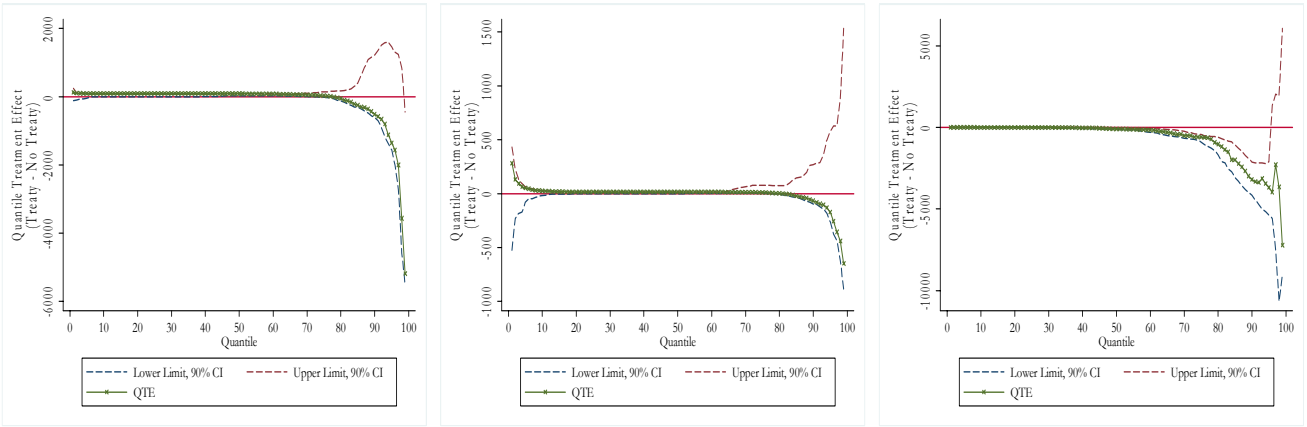
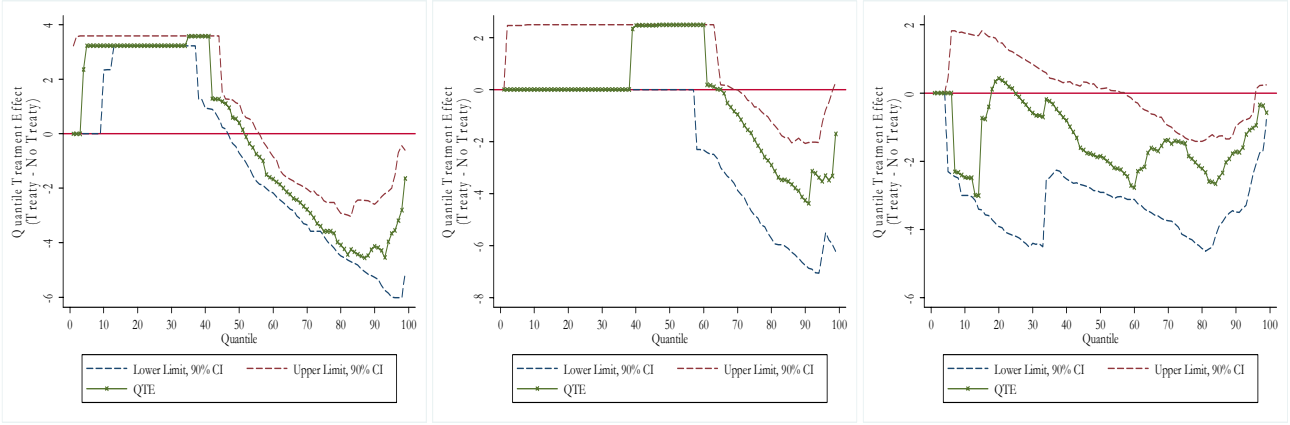


Figure 5. QTEs for Inbound FDI in Levels: Old Tax Treaty Countries Excluded.
Notes: See Figure 1.

Panel I. Adjusted for Covariates



Panel II. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates

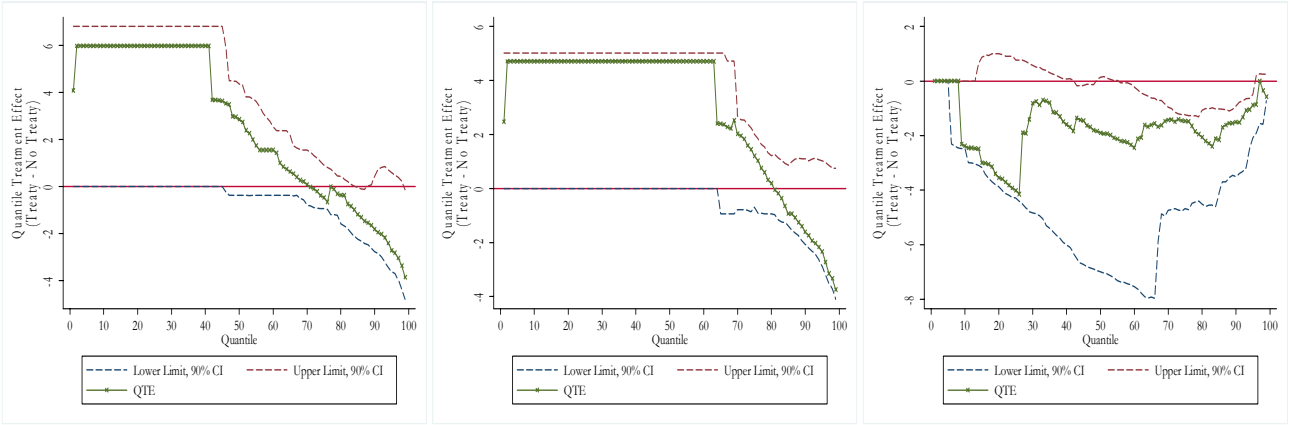
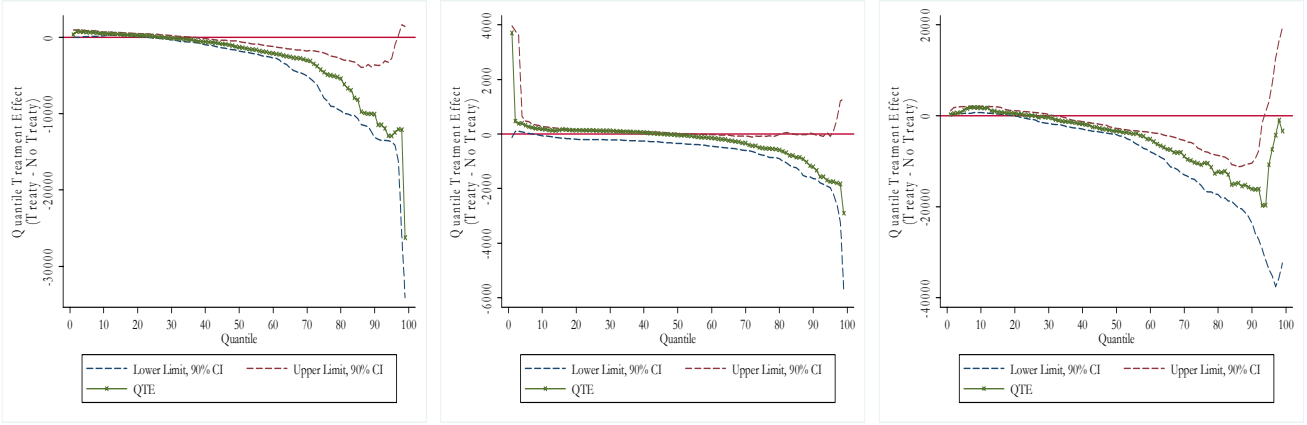


Figure 6. QTEs for Inbound FDI in Logs: Old Tax Treaty Countries Excluded.
Notes: See Figure 1.

Panel I. Adjusted for Covariates



Panel II. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates

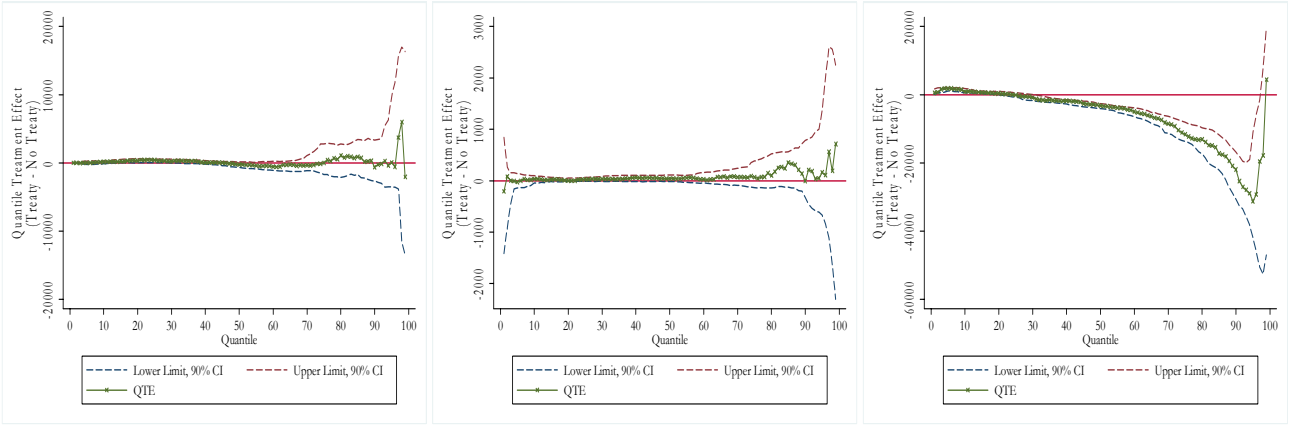
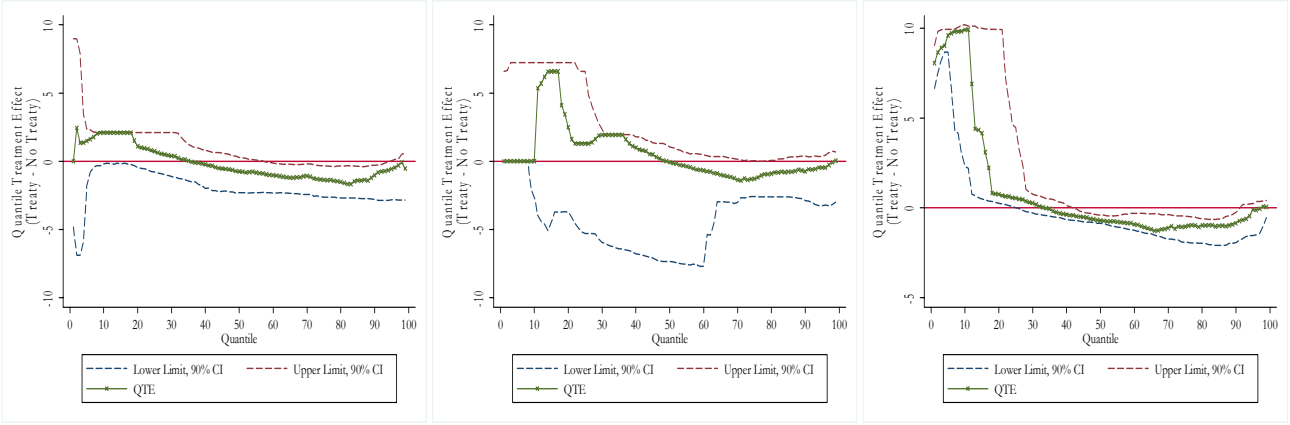


Figure 7. QTEs for Outbound FDI in Levels: Old Tax Treaty Countries Excluded.
Notes: See Figure 1.

Panel I. Adjusted for Covariates



Panel II. Treatment = (New Treaty)$_{+2+}$: Adjusted for Covariates

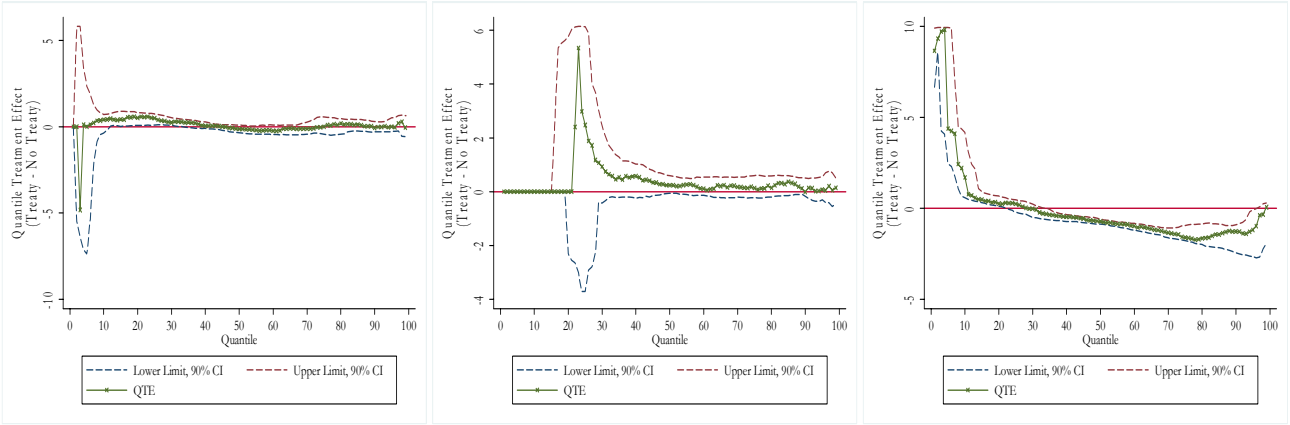


Figure 8. QTEs for Outbound FDI in Logs: Old Tax Treaty Countries Excluded.
Notes: See Figure 1.