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Deep Trade Agreements and FDI in Partial and General Equilibrium: A Structural Estimation Framework

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Abstract

This paper quantifies the relationships between deep trade agreements and foreign direct investment (FDI). The analysis relies on a structural framework that simultaneously enables (a) estimating the direct impact of deep trade agreements on FDI, (b) translating the partial deep trade agreement estimates into general equilibrium effects on FDI, and (c) obtaining partial deep trade agreement effects on trade and quantifying the impact of deep trade agreements on FDI through trade. The effects of deep trade agreements on both trade and FDI are sizeable, positive, and statistically significant. A counterfactual analysis suggests that together with direct and indirect channels deep trade agreements have contributed to a large but asymmetric increase in inward versus outward FDI.
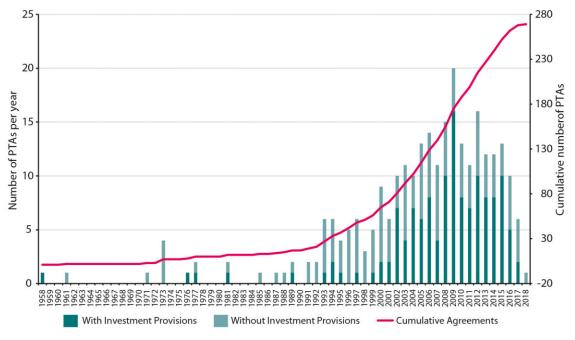
1. Introduction

Most modern preferential trade agreements (PTAs) include a variety of investment provisions. As pointed out by Crawford and Kotschwar (2020), "Following the entry into force of NAFTA and the GATS, trade negotiators increasingly began to incorporate into PTAs a broad set of investment provisions that liberalize, protect, and regulate investments" (p. 145). The increase, both in absolute and in relative terms, in the number of PTAs with investment provisions is depicted in fig. 1, which comes from Crawford and Kotschwar (2020).

Using the World Bank's Database on the Content of Regional Trade Agreements (DCRTA), cf. Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and Ruta (2020), we complement fig. 1 by
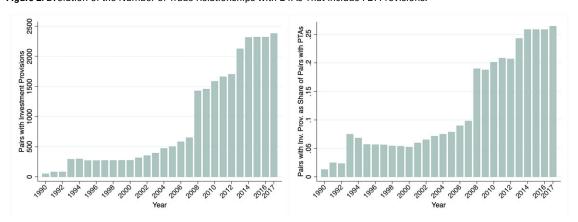
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Figure 1. Number of PTAs That Include Investment Provisions, 1958–2018

Source: The figure comes from Crawford and Kotschwar (2020). The original source is the WTO RTA database: http://rtais.wto.org, May 2018.
Note: This figure plots the number of PTAs with and without investment provisions.

Figure 2. Evolution of the Number of Trade Relationships with DTAs That Include FDI Provisions.

Source: The data used to construct the figure are from the World Bank's Database on the Content of Regional Trade Agreements, https://datatopics.worldbank.org/dta/about-the-project.html.
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Note: The left-hand panel of this figure plots the number of country pairs that have signed a trade agreement that includes investment provisions. The right-hand panel of the figure plots the same number but relative to all country pairs with PTAs.

plotting the number of country pairs that have signed a trade agreement that includes investment provisions in absolute terms (in the left-hand panel of fig. 2) and relative to all country pairs with PTAs (in the right-hand panel of fig. 2). This figure corroborates the evidence from fig. 1 by depicting a remarkable increase in the country pairs that have negotiated investment together with trade, especially since the early 1990s, as noted in the opening quote from Crawford and Kotschwar (2020).

Despite the increase in the number and importance of investment provisions in the negotiations and implementation of PTAs, there is relatively little and mixed evidence on the effectiveness of such provisions in promoting foreign direct investment (FDI). For example, the authoritative surveys of Eicher, Helfman, and Lenkoski (2012) and Blonigen and Piger (2014) on the determinants of FDI do not account for such provisions.[1] They do account for bilateral investment treaties (BITs) that have traditionally regulated foreign investments, but the empirical evidence of the effectiveness of BITs is mixed (see Lesher and Miroudot (2006) and Laget, Rocha, and Varela (2021) for examples). Nowadays, more and more trade agreements include investment provisions, which may partly explain the decline of the role of BITs. However, only very recently, some papers (e.g., Kox and Rojas-Romagosa 2020; Laget, Rocha, and Varela 2021) have studied the impact of deep trade agreements (DTAs) and various PTA provisions (disciplines) on FDI, offering mixed evidence of the effectiveness of investment provisions.[2]

Against this backdrop, we make three contributions to the existing literature on the links between deep trade liberalization and FDI. First, we contribute to the debate on whether deep trade agreements with investment provisions stimulate FDI by estimating the direct/partial equilibrium effects of DTAs and DTAs with investment and other provisions on FDI. While traditional trade agreements liberalize trade, DTAs cover additional policy areas, such as international flows of investment, international flows of labor, the protection of intellectual property rights, and the environment. Hence, the objective of the DTAs is to go beyond trade and to lead to deeper integration between the agreement members.

Besides capturing the movement of goods, services, capital, people, and ideas, DTAs also include enforcement provisions limiting the discretion of firms and governments in the importing and exporting country (see Mattoo, Rocha, and Ruta (2020) for an overview and discussion of typical areas of DTAs). Investment provisions are one important area of DTAs that go beyond trade. Crawford and Kotschwar (2020) distinguish five categories of investment provisions that are present in many trade agreements: (a) definitions and scope; (b) investment liberalization; (c) investment protection; (d) social and regulatory goals; and (e) institutional aspects and dispute settlement. For our DTA variable, we use the variable "pta_mapped" from Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and Ruta (2020), which is 1 whenever the depth variable is greater than 0, and 0 otherwise. The depth variable counts the number of provisions included in a PTA.

Second, we use our partial estimates to obtain novel general equilibrium (GE) estimates of the effects of DTAs on FDI. Third, within the same structural framework, we obtain estimates of the effects of DTAs on trade flows, and we translate those effects into general equilibrium effects of DTAs on FDI through trade liberalization.

Guided by the theoretical model of Anderson, Larch, and Yotov (2019),[3] we specify two estimating gravity equations—one for trade and one for FDI, which are (a) consistent with and representative of

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1   Other examples of studies on determinants of FDI, including studies on the impact of trade liberalization and deep trade agreements on FDI, include Baltagi, Egger, and Pfaffermayr (2008), Medvedev (2012), Osnago, Rocha, and Ruta (2019), and Di Ubaldo and Gasiorek (2022).

2   For example, Lesher and Miroudot (2006) obtain positive effects of investment provisions on FDI, while, more recently, Kox and Rojas-Romagosa (2020) and Laget, Rocha, and Varela (2021) do not find that investment provisions have a significant additional impact on FDI. Moreover, we are not aware of existing work that quantifies the full/general equilibrium impact of DTAs and their investment provisions on FDI.

3   The theoretical model of Anderson, Larch, and Yotov (2019) suits our objectives well because it (a) offers structural foundations for both our trade and FDI estimating gravity models and (b) enables us to translate our partial estimates of the effects of DTAs on trade and welfare into GE effects on FDI. We also acknowledge a potential caveat, which is that the theory of Anderson, Larch, and Yotov (2019) assumes non-rival technology FDI, while the data for our empirical analysis will include all/aggregate FDI flows. Our contributions in relation to Anderson, Larch, and Yotov (2019) are two-fold. First, from a methodological perspective, they *calibrate* the model in a cross-section while we build a panel data set to *estimate* some of the structural equations and empirically test the relationships of interest to us. Second, from a policy perspective, Anderson, Larch, and Yotov (2019) simulate a world without FDI, while we quantify the impact of

a large number studies that quantify the impact of various determinants on FDI (e.g., Eicher, Helfman, and Lenkoski 2012; Blonigen and Piger 2014; Kox and Rojas-Romagosa 2020; Laget, Rocha, and Varela 2021), and (b) capitalize on the latest developments in the trade gravity literature (e.g., Head and Mayer 2014; Yotov et al. 2016). Specifically, we rely on the Poisson pseudo-maximum-likelihood estimator to account for potential heteroskedasticity in the bilateral trade and FDI data and to take advantage of the information in the zero trade and FDI flows (cf. Santos Silva and Tenreyro 2006, 2011). In addition, we employ a rich set of fixed effects (including origin time, destination time, and directional country-pair fixed effects), which control for and absorb all possible country-specific and time-invariant bilateral determinants of trade and FDI.

We have potential concerns that our key variables of interest, PTAs and DTAs, are endogenous. There is a comparably large literature dealing with the potential endogeneity of trade policy variables in general and trade agreements to be specific.[4] As it is hard to come up with good instruments, one of the most followed suggestions in the literature by Baier and Bergstrand (2007) is to include country-pair fixed effects to control for all non-time-varying bilateral effects. We follow this literature to mitigate potential endogeneity concerns, acknowledging that some endogeneity concerns may still be left if time-varying country-pair factors that are not accounted for in our model are correlated with PTA and DTA.[5] In addition to PTAs and DTAs, we control other policy variables such as WTO membership, economic sanctions, and bilateral investment treaties.

To perform the empirical analysis we build a balanced panel data set for 89 countries covering more than 96 percent of world GDP and more than 94 percent of FDI throughout the sample period, 1990–2011. Our data set covers foreign direct investment, trade agreements, trade flows, gross domestic product (GDP), employment, physical capital, bilateral investment treaties, sanctions, and WTO membership. An important feature of the data set is that we capitalize on the richness of the Database on the Content of Regional Trade Agreements (DCRTA), cf. Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and Ruta (2020). Specifically, the DCRTA enables us to distinguish between several indicator and continuous PTA variables, including a standard dummy variable for PTAs, an indicator variable for DTAs, an indicator for DTAs that include investment provisions, and two continuous variables for the overall depth of DTAs and the depth of DTAs with investment provisions.

Three main findings stand out from our estimates of the effects of DTAs on trade. First, we find an average non-significant impact of PTAs on trade in our sample. However, second, we obtain positive and statistically significant estimates of the effects of deep trade agreements. Specifically, our estimates suggest that the DTAs in our sample have led to a 14.888 percent (std.err. 2.856) increase in bilateral trade among member countries. Finally, our estimates reveal that deeper trade agreements (as measured by the number of provisions) lead to larger increases in the trade flows among DTA members. Depending on the number of provisions that they include, the DTAs in our sample have led to trade increases between 0.784 percent (std.err. 0.300) and 32.472 percent (std.err. 14.194). Overall, our estimates of the DTA effects in trade are consistent with findings from recent studies that have utilized the database on the

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deep trade agreements on FDI. In policy work that is not intended for publication, Anderson, Larch, and Yotov (2016) rely on the framework of Anderson, Larch, and Yotov (2019) to quantify the effects of CETA.

4   See "Challenge 5: Endogeneity of trade policy" in Yotov et al. (2016), for example.

5   Note that any origin- and destination-specific determinants, such as institutions, are controlled for by the origin-time and destination-time fixed effects. Blanchard (2007) emphasized the role of endogeneity of tariffs for FDI at the firm level, and Blonigen, Oldenski, and Sly (2014), Blanchard and Matschke (2015), Kovak, Oldenski, and Sly (2021), as well as McCaig, Pavcnik, and Wong (2022), address the endogeneity of trade policy to FDI with firm-level data, for examples. Our setting is at the aggregate level, where these approaches to control for endogeneity cannot be followed.

Content of Regional Trade Agreements and reinforce the view that "depth" matters for the effectiveness of PTAs.[6]

Similar to our results for trade, the estimates of the effects of DTAs on FDI are also heterogeneous. Specifically, we do not obtain significant estimates of the effects of PTAs and DTAs on FDI. However, when we zoom in on the effects of DTAs that include investment provisions, we obtain a positive, sizable, and statistically significant estimate, which suggests that, on average, the PTAs with investment provisions in our sample have led to a 21.038 percent (std.err. 11.513) increase in FDI between their members. This result is consistent with earlier findings from Lesher and Miroudot (2006). We also obtain positive estimates of the effects on FDI of several other DTA provisions including labor-market regulations, export taxes, public procurement, and state-owned enterprises. This analysis reinforces and complements the findings of Laget, Rocha, and Varela (2021) who study the impact of different DTA provisions with firm-level data for the years 2003–2015. Finally, our estimates do not reveal a significant impact of the increase in the depth (number of provisions) on FDI. Our results suggest that an increase in the number/complexity of some investment provisions (e.g., related to transparency and to regulations) may decrease FDI.

We use the structural model in combination with our estimates of the partial effects of DTAs on trade and FDI to quantify the GE impact of DTAs on FDI. As discussed in more detail in A caveat with our GE analysis is that the underlying theory is based on the assumption of non-rival technology FDI, while our data include all/aggregate FDI flows.[7] We focus the analysis on inward usage of technology FDI per country and outward technology FDI stocks per country used abroad.

The main conclusions from this analysis are as follows. DTAs have had large and strongly asymmetric effects on FDI. The DTAs that were in force in 2011 have contributed to about 2 percent of inward FDI in the world and about 43 percent of outward FDI. The large average effect of outward FDI is driven by some large outward FDI countries (such as China and the United States), where, consistent with our theoretical model of non-rival capital, any change in the technology stock of these countries has a multiplying effect due to the usage in many other countries, resulting in a large boost in outward FDI stock, i.e., in the usage of a country's technology capital abroad. We view our result about the disproportionately large impact of outward FDI as novel and potentially important from a policy perspective, both for the negotiations of trade and investment agreements and for properly quantifying their implications.

Finally, we also find that changes in trade costs due to DTAs have led to additional boosts in FDI through the GE links between trade and FDI in our model. Specifically, through their impact on trade costs, the 2011 DTAs in our model have boosted inward FDI by an additional 1 percentage point and outward FDI by an additional 11 percentage points, i.e., effects that are about a quarter of the corresponding estimates due to FDI liberalization. By demonstrating that the impact of DTAs on FDI through trade is significant, we complement some recent work on the GE links between DTAs and trade, cf. Fontagné et al. (2023), and also, from a broader perspective, papers that have studied the GE links between trade liberalization and FDI, cf. Baltagi, Egger, and Pfaffermayr (2008), Tintelnot (2017), and Anderson, Larch, and Yotov (2019).

The rest of the paper is organized as follows. First, we presents the methodological foundations of our analysis, and the specifications of our estimating equations for bilateral trade flows and FDI. Next, we describe the main variables and the corresponding data sources that we use to construct them, followed

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6   We refer the reader to Fernandes, Rocha, and Ruta (2021), an eBook from the World Bank and CEPR, which is a collection of excellent papers that focus on various aspects of the determinants of DTAs and the DTA effects on trade and other economic outcomes.

7   While this gap, of course, has implications for the quantitative results, our conclusions about the disproportionately large impact on outward FDI will remain qualitatively the same if applied to better-suited data, such as, for example, patent data, which will hopefully be done in the future.

by a presentation and discussion our partial estimates and our GE results. At the end, we conclude and offer a supplementary online appendix that includes the derivations of the theoretical model, offers some additional estimation results and analysis of the effects of DTAs on trade and FDI, and includes additional counterfactual results and analysis.

2. Methods

To quantify the impact of deep trade agreements on FDI, we rely on the theoretical framework of Anderson, Larch, and Yotov (2019). While our current contribution is purely empirical, we find it helpful to summarize the model of Anderson, Larch, and Yotov (2019) for two reasons. First, it will motivate the two key estimating equations for trade and FDI, Second, we will use the model to perform counterfactual analysis.

2.1. Theoretical Foundations

Anderson, Larch, and Yotov (2019) derive the following steady-state structural system that describes the relationships between trade, domestic investment, and FDI:[8]

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma} \quad \text{for all } i \text{ and } j, \tag{1}$$

$$P_j^{1-\sigma} = \sum_{i=1}^{N} \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma} \frac{Y_i}{Y} \quad \text{for all } j, \tag{2}$$

$$\Pi_i^{1-\sigma} = \sum_{j=1}^{N} \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \frac{E_j}{Y} \quad \text{for all } i, \tag{3}$$

$$p_j = \frac{(Y_j / \sum_{j=1}^{N} Y_j)^{\frac{1}{1-\sigma}}}{\gamma_j \Pi_j} \quad \text{for all } j, \tag{4}$$

$$Y_j = p_j A_j (L_j^{1-\alpha_j} K_j^{\alpha_j})^{1-\phi} \left(\prod_{i=1}^{N} (\max\{1, \omega_{ij} M_i\})^{\eta_i} \right)^{\phi} \quad \text{for all } j, \tag{5}$$

$$E_j = Y_j + \phi \eta_j \sum_{i \in \mathbb{N}_{ji,t}} Y_i - \phi Y_j \sum_{i \in \mathbb{N}_{ij,t}} \eta_i \quad \text{for all } j, \tag{6}$$

$$K_j = \Psi_j \frac{Y_j}{P_j} \quad \text{for all } j, \tag{7}$$

$$\text{FDI}_{ij}^{\text{value}} = \Gamma_i \omega_{ij} \frac{E_i}{P_i} \frac{Y_j}{M_i} \quad \text{for all } i \text{ and } j. \tag{8}$$

Equations (1)–(4) may look familiar because they represent the structural gravity trade system of Anderson and van Wincoop (2003). Equation (1) is the standard structural gravity equation, which captures the fact that the exports from source i to destination j, X_{ij}, are proportional to the sizes of the two countries,

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8   We refer the reader to Anderson, Larch, and Yotov (2019) for the motivation behind some of the assumptions and details on all derivations. For the convenience of the reader, we enclose the online appendix from Anderson, Larch, and Yotov (2019) in the supplementary online appendix.

i.e., the exporter's output, Y_i, and the importer's expenditure, E_j, and inversely proportional to the trade costs between the two countries, including the direct bilateral trade frictions, t_{ij}, and the GE multilateral resistances. The multilateral resistance terms (MRTs, outward and inward, respectively), denoted by $\Pi_{i,t}^{1-\sigma}$ and $P_{j,t}^{1-\sigma}$, consistently aggregate bilateral trade costs and decompose their incidence on the producers and the consumers in each region.

Equations (5) and (6) define the value of production and the expenditure in country j, respectively. Specifically, equation (5) is the production value function. Here, $p_{j,t}$ denotes the factory-gate price of good (country) j at time t, $A_{j,t}$ is the local, country-specific technology, $L_{j,t}$ is country-specific (internationally immobile) labor, and all other variables are defined earlier. The last term, $\prod_{i=1}^{N}(\max\{1, \omega_{ij,t}M_{i,t}\})^{\eta_i}$, is the global technology stock in j, which may include non-rival technology capital, $M_{i,t}$, from all other countries[9] which is used in j subject to investment frictions ($1 \geq \omega_{ij,t} \geq 0$).[10] By assuming $\sum_{i=1}^{N} \eta_i = 1$, we impose constant returns to scale. Finally, the max-function implements the notion that there is some world knowledge of technology capital freely available to all countries and ensures that there is always some technology capital available for all countries. Equation (6) defines expenditure as the sum of total nominal output ($Y_{j,t}$) plus rents from foreign investments, $\phi\eta_j \sum_{i \in \mathbb{N}_{ji,t}} Y_{i,t}$, minus rents accruing to foreign investments, $\phi Y_{j,t} \sum_{i \in \mathbb{N}_{ij,t}} \eta_i$.

Equation (7) is the solution for physical capital, where Ψ_j is a composite model parameter. Intuitively, the direct relationship between K_j and Y_j reflects the fact that there will be more investment the higher the value of the marginal product of physical capital. The inverse relationship between K_j and P_j can be interpreted through the lens of the law of demand, i.e., if P_j is interpreted as the price of investment goods. Alternatively, if P_j is the price of consumption or technology goods, then the intuition for the inverse relationship is that there will be less investment when the opportunity cost of it (i.e., investment in consumption or technology goods) is higher.

Finally, equation (8) is the structural gravity equation for FDI, where FDI_{ij} is the value of the stock of FDI from origin i at destination j, Γ_i is a composite country-specific constant term, and all other variables are defined above. Intuitively, and similar to the gravity model of trade, (8) captures the direct relationship between FDI and the sizes of the source and the destination countries. The explanation for the inverse relationship between FDI and P_j is similar to the relationship between physical capital and P_j. The inverse relationship between FDI and M_i is a reflection of the law of diminishing marginal productivity, i.e., the larger the stock of technology capital in country i, the smaller the marginal productivity by an additional unit of investment in technology.[11]

For given parameters and variables that are exogenous in the model, we can use system (1)–(8) to simulate the impact of deep trade liberalization on trade and investment in the world. We capitalize on this in our counterfactual analysis.[12] Next, we rely on system (1)–(8) to specify the econometric models that will deliver our key estimates of the direct impact of DTAs on trade and FDI.

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9   The modeling of FDI in the form of non-rival technology capital is in the spirit of Markusen (2002), McGrattan and Prescott (2009, 2010, 2014), and McGrattan and Waddle (2017). One interpretation of technology capital is akin to the notion of knowledge capital, and possible examples include patents, blue-prints, and management skills/practices.

10 When $\omega_{ij,t} = 0$, no foreign technology from country i can be used in country j at time t, and when $\omega_{ij,t} = 1$ usage of foreign technology is frictionless. With $\omega_{ij,t} > 0$ every unit of foreign technology from country i at time t has $\omega_{ij,t}$-times the use in country j.

11 A notable difference between the FDI gravity model (8) and the standard trade gravity model, as captured by (1), is that the FDI gravity equation does not include explicitly an outward multilateral resistance (OMR). The intuitive explanation for this is the non-rival nature of technology capital. Even though the OMR term is not present in our theoretical model, the use of origin-time fixed effects in our estimating equation will cover a wider class of models including such where the OMRs may be relevant.

12 In supplementary online appendix S2, we use equations (1)–(8) to decompose and describe the partial and GE channels through which DTAs impact FDI.

2.2. From Theory to Empirics

A key objective and contribution of this paper is to test for links between DTAs, trade, and FDI. Establishing such links, and obtaining estimates of the corresponding direct/partial effects of DTAs on trade and FDI, would also enable us to translate them into GE effects of trade liberalization on FDI through the structural links that we just described in the previous section. In this section, we rely on system (1)–(8) to specify our estimating equations for trade and FDI. Specifically, as noted earlier, equation (1) is the standard structural gravity equation from the trade literature, while (8) is our theoretical gravity equation for FDI. To estimate both equations, we will capitalize on the latest developments in the empirical trade literature.[13] We start with the estimating equation for bilateral trade flows:

$$X_{ij,t} = \exp\left[\psi_{i,t} + \phi_{j,t} + \mu_{ij} + \textbf{GRAV\_TRADE}_{ij,t}\alpha + \textbf{DTA\_TRADE}_{ij,t}\beta\right] + \epsilon_{ij,t} \quad \text{for all } i, j. \tag{9}$$

Here, $X_{ij,t}$ denotes nominal (cf. Baldwin and Taglioni 2006) exports from i to j at time t. Consistent with theory, $X_{ij,t}$ includes international and domestic trade flows (cf. Yotov 2022). Estimating equation (9) includes three sets of fixed effects. The terms $\psi_{i,t}$ and $\phi_{j,t}$ denote exporter-time and importer-time fixed effects, respectively, which will account for the country-size and the multilateral resistance terms (cf. Anderson and van Wincoop 2003) in equation (1), and also for any other observable or unobservable factors that affect trade flows on the exporter or on the importer side, including input-output links and other network and production relationships (possibly involving FDI), which may not even be captured by our theoretical model. The term μ_{ij} denotes a set of pair fixed effects, which will control for all time-invariant bilateral trade costs (cf. Egger and Nigai 2015) and will mitigate endogeneity concerns of the bilateral policy variables in our setting (cf. Baier and Bergstrand 2007), including DTAs. The pair fixed effects will also fully absorb the effects of all policies concluded before the beginning of our period of investigation. Our main results will be obtained with directional pair fixed effects, which allow for asymmetric time-invariant trade costs depending on the direction of trade flows, i.e., from i to j vs. from j to i.

The vector $\textbf{GRAV\_TRADE}_{ij,t}$ includes a set of time-varying bilateral control variables that control for WTO membership ($\text{WTO}_{ij,t}$), economic sanctions ($\text{SANCT}_{ij,t}$), and bilateral investment treaties ($\text{BIT}_{ij,t}$). Even though, by definition, BITs are not designed to promote trade, we include the BIT dummy in our trade model for three reasons. First, we do this for symmetry between our trade and FDI estimating equations. An alternative motivation could be based on some theories of substitutability, i.e., making trade easier could decrease FDI and vice versa. Finally, by promoting FDI, the BITs may stimulate intra-firm trade. Our data do not allow us to test these hypotheses directly. However, as will be seen shortly, in the results section, BITs have a strong impact on trade.

In addition, we also include a full set of time-varying border indicators ($\sum_t \text{BRDR}_{ij,t}$), which take the value 1 for international trade in a given year and 0 for domestic trade flows and, therefore, capture any common globalization trends (e.g., improvements in communication, transportation, and communication). Finally, the vector $\textbf{DTA\_TRADE}_{ij,t}$ includes the variables whose estimates would be of central interest to us. Specifically, we will differentiate between the effects of preferential trade agreements ($\text{PTA}_{ij,t}$), the effects of deep trade agreements ($\text{DTA}_{ij,t}$), and we will allow for the effects of DTAs to vary depending on their depth ($\text{DEPTH}_{ij,t}$), which will be measured by the number of provisions that they include. Specifically, we utilize the World Bank's database on deep trade agreements (DTA) (Hofmann, Osnago, and Ruta 2019; Mattoo, Rocha, and Ruta 2020), which provides information on the presence of any trade agreement between i and j at time t ($\text{PTA}_{ij,t}$) and on the number of provisions in each trade agreement. If the number of provisions in a trade agreement is greater than zero, then it is classified as a deep trade agreement ($\text{DTA}_{ij,t}$).

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13 Larch and Yotov (2024) survey the empirical gravity literature and synthesize the best practices for gravity estimations.

We estimate equation (9) with the Poisson pseudo-maximum-likelihood (PPML) estimator to account for the presence of heteroskedasticity in the trade data and to take advantage of the information contained in the zero trade flows; cf. Santos Silva and Tenreyro (2006, 2011). Despite the tradition in the trade literature to use interval data for gravity estimations, we follow the recent recommendations of Egger, Larch, and Yotov (2022) and employ all available data for consecutive years.[14] Finally, we cluster the standard errors by country pair.

Next, guided by equation (8), we specify our estimating gravity equation for FDI as follows:

$$\text{FDI}_{ij,t}^{\text{value}} = \exp\left[\psi_{i,t} + \phi_{j,t} + \mu_{ij} + \textbf{GRAV\_FDI}_{ij,t}\widetilde{\alpha} + \textbf{DTA\_FDI}_{ij,t}\widetilde{\beta}\right] + \tilde{\epsilon}_{ij,t} \quad \text{for all } i \neq j. \quad (10)$$

Here, $\text{FDI}_{ij,t}^{\text{value}}$ is the value of FDI stock from origin i to destination j at time t. Capitalizing on the developments in the bilateral trade and FDI literature, and for consistency with our estimating equation for trade flows, we specify our FDI econometric model to be as close as possible to our estimating equation for trade flows given in equation (9). Specifically, we use the same estimator (i.e., PPML), we include the same set of fixed effects (i.e., origin-time fixed effects ($\psi_{i,t}$), destination-time fixed effects ($\phi_{j,t}$), and directional pair fixed effects (μ_{ij})), and we employ the same set of time-varying policy covariates (i.e., indicators for WTO membership ($\text{WTO}_{ij,t}$), for bilateral investment treaties ($\text{BIT}_{ij,t}$), and for sanctions ($\text{SANCT}_{ij,t}$)). Finally, just as in our trade specification, we follow the recommendation of Egger, Larch, and Yotov (2022) to use consecutive-year data, and we use the same clustering (i.e., by country pair).

Even though, from an econometric perspective, we will use the same set of exporter-time and importer-time fixed effects as in our trade equation, the country-time fixed effects in the FDI model would proxy and account for different variables. Following the existing empirical FDI literature,[15] possible robust determinants of FDI in the country of origin include corporate tax rate, corruption, and bureaucratic red tape, while possible candidates at the destination include level of corruption, internal tensions, corporate tax rate, bureaucratic red tape, and quality of institutions.[16] Finally, the pair fixed effects in (10) will absorb and account for bilateral distance, common official language, and colonial relationships, which, similar to the trade literature, are among the most robust FDI determinants in Eicher, Helfman, and Lenkoski (2012) and Blonigen and Piger (2014). Using pair fixed effects also mitigates concerns regarding our inability to distinguish between horizontal and vertical FDI.

There are two differences between equations (9) and (10). First, we cannot include the set of time-varying border effects ($\sum_t \text{BRDR}_{ij,t}$) in equation (10) since we only use data on international transactions. This is why we use different notation for the vector of time-varying gravity covariates ($\textbf{GRAV\_FDI}_{ij,t}$). We also allow for potential differences in the estimated impact of the common policy covariates by denoting the vector of their estimates $\widetilde{\alpha}$. Second, and more importantly for our purposes, we use a

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14 Cheng and Wall (2005) note that "fixed-effects estimation is sometimes criticized when applied to data pooled over consecutive years on the grounds that dependent and independent variables cannot fully adjust in a single year's time" (footnote 8, p. 52). Trefler (2004) also criticizes trade estimations pooled over consecutive years. He uses three-year intervals. Baier and Bergstrand (2007) use five-year intervals. Olivero and Yotov (2012) provide empirical evidence that gravity estimates obtained with three-year and five-year lags are very similar. Most recently, Egger, Larch, and Yotov (2022) show that gravity models with three-way fixed effects deliver similar estimates of the common estimates of FTAs without throwing data away.

15 The two leading empirical FDI studies are Eicher, Helfman, and Lenkoski (2012) and Blonigen and Piger (2014). The objective of both studies is to identify a set of robust FDI determinants. Both papers utilize Bayesian model averaging and each of them comes up with a set of covariates that vary across the four dimensions that we propose to capture in our study.

16 Even though our theoretical model implies no impact of the outward multilateral resistances, our econometric specification would control for them, which is consistent with the use of aggregate FDI data, rather than data on non-rival technology capital as in our theory.

different set of variables to capture the impact of DTAs on FDI in the vector **DTA_FDI**$_{ij,t}$. Specifically, in addition to including indicators for PTAs (PTA$_{ij,t}$) and DTAs (DTA$_{ij,t}$), we add two more covariates. First, motivated by Osnago, Rocha, and Ruta (2019), Crawford and Kotschwar (2020), and Laget, Rocha, and Varela (2021), we include a separate indicator variable (INV$_{ij,t}$) that takes a value of 1 for agreements that include investment provisions. Second, we also account for depth of the investment treaties by using a count variable (INV_DEPTH$_{ij,t}$) for the number of investment provisions within the agreements with investment provisions, i.e., similar to the relationship between PTA$_{ij,t}$ and DEPTH$_{ij,t}$ on the trade side, INV_DEPTH$_{ij,t}$ is a continuous variable that is equal to 0 when INV$_{ij,t}$ is 0.[17]

Estimating equations (9) and (10) will deliver the estimates of the effects of DTAs on trade and investment that we will describe when we discuss our estimation results and use to obtain GE results. Before that, we describe our data.

3. Data and Sources

To perform the empirical analysis we build a balanced panel data set for 89 countries for the years 1990–2011, covering more than 96 percent of world GDP and more than 94 percent of FDI throughout the sample period.[18] Our data set includes the following variables: foreign direct investment, trade agreements, trade flows, gross domestic product (GDP), employment, physical capital, bilateral investment treaties, sanctions, and WTO membership. Next we describe, in turn, the sources to obtain these variables, as well as their construction.

- **FDI Data.** We use two sources to construct the FDI variable, (FDI$_{ij,t}$), which takes a central stage in our analysis. The main source for FDI data is the Bilateral FDI Statistics database of the United Nations Conference on Trade and Development (UNCTAD). These data can be accessed at https://unctad.org/topic/investment/investment-statistics-and-trends. UNCTAD's FDI data cover inflows, outflows, inward stock, and outward stock for 206 countries over the years 1990–2011. Data are collected from national sources and international organizations and to ensure maximum coverage the data are mirrored. The second source of FDI data is the International Direct Investment Statistics database, constructed and maintained by the Organization for Economic Co-operation and Development (OECD). OECD's data offer detailed statistics for inward and outward foreign direct investment flows and positions (stocks) of the OECD countries, including transactions between the OECD members and non-member countries. We use the OECD data to ensure consistency and maximum coverage. Finally, we note that, given our theory, we focus our analysis on FDI stocks (positions), which is also the FDI category for which most data are available.[19]

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17 The inclusion of trade agreement variables in our FDI gravity model is consistent with Eicher, Helfman, and Lenkoski (2012) and Blonigen and Piger (2014) who find that regional trade agreements are among the most important time-varying bilateral determinants of FDI flows. Interestingly, however, neither Eicher, Helfman, and Lenkoski (2012) nor Blonigen and Piger (2014) distinguish between the average effects of RTAs and the effects of RTAs covering FDI. As demonstrated by Crawford and Kotschwar (2020) and Laget, Rocha, and Varela (2021), FDI chapters and provisions are an important part of contemporary integration efforts. We will provide evidence that such provisions are indeed important determinants of FDI.

18 The list of countries and their respective alpha ISO3 codes appear in the first two columns of table 3.

19 The actual file we used is called "All_provisions_bilateral_Jan_2021.csv" and available for download at https://datacatalog.worldbank.org/search/dataset/0039575 under the label "Deep Trade Agreements database 2.0 (Vertical depth) – Bilateral observations – Updated January 2021." Anderson, Larch, and Yotov (2019) utilize the same sources to construct a cross-section FDI data set. For the estimation analysis in this paper, we also utilize the time variation in the FDI data. In the counterfactual experiments, we rely on the methods of Anderson, Larch, and Yotov (2019) to calibrate some parameters and vectors. See the counterfactual analysis for further details.

Before we continue, we note that, despite its relatively long period and large number of countries covered, our data set has some limitations. Specifically, we cannot distinguish between vertical and horizontal FDI and between FDI in different sectors or across firms. These caveats imply that our results may be masking some important heterogeneity across the dimensions not covered, and our findings should be interpreted accordingly.

- **Trade Agreements Data.** To account for the presence and depth of trade agreements, we use the World Bank's database on deep trade agreements (DTA); cf. Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and Ruta (2020) (https://datatopics.worldbank.org/dta/about-the-project.html).[20] Capitalizing on the rich dimensionality of the DTA database, we construct and utilize several variables for our analysis. The variable $PTA_{ij,t}$ is an indicator for the presence of any trade agreement between i and j at time t. The variable $DTA_{ij,t}$ is an indicator denoting the presence of a deep agreement between i and j at time t. The variable $DEPTH_{ij,t}$ is a count variable for the number of provisions in the corresponding DTA between i and j. The variable $INV_{ij,t}$ is an indicator that takes a value of 1 if the DTA between i and j includes investment provisions. Finally, $INV\_DEPTH_{ij,t}$ is a count variable for the number of investment provisions in the corresponding DTA between i and j. For further details on the general features of the DTA database, we refer the reader to Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and Ruta (2020). In addition, for analysis with a specific focus on investment provisions in the DTAs, we refer the reader to Crawford and Kotschwar (2020).

- **Production Data.** Data on GDP, employment, and capital stocks are from the Penn World Tables 8.0; cf. Feenstra, Inklaar, and Timmer (2013) (http://www.rug.nl/research/ggdc/data/pwt/). For data on GDP, we employ *output-side real GDP at current PPPs* ($CGDP^o$), which compares relative productive capacity across countries at a single point in time, as the initial level in our counterfactual experiments, and we use *real GDP using national-accounts growth rates* ($CGDP^{na}$) for our income-based cross-country growth regressions. We measure employment in effective units by multiplying the *number of persons engaged in the labor force* with the *Human Capital Index*, which is based on average years of schooling. Finally, capital stocks in the Penn World Tables 8.0 are constructed based on accumulating and depreciating past investments using the perpetual inventory method.

- **Trade Data.** Data on international trade flows come from the United Nations Statistical Division (UNSD) Commodity Trade Statistics Database (COMTRADE). We complement the international trade flows data with data on domestic trade flows from Anderson, Larch, and Yotov (2020), which we use for both the estimation and the counterfactual analysis. Anderson, Larch, and Yotov (2020) construct domestic trade flows at the aggregate level in two steps. First, they use the ratio between aggregate manufacturing in gross values and total exports of manufacturing goods to construct a multiplier at the country-time level. (Data on gross manufacturing production came from the United Nations IndStat database.) Then, they use this multiplier along with data on aggregate exports to project the values for domestic sales. The availability of data on domestic trade flows predetermined the time coverage of our estimating sample.

- **Other Data.** Finally, we employ the following additional covariates as control variables: We control for the presence of bilateral investment treaties with an indicator variable $BIT_{ij,t}$, which comes from the UNCTAD's data on international investment agreements (IIAs), which can be found at http://investmentpolicyhub.unctad.org/IIA. Data on sanctions come from the Global Sanctions Database (GSDB); cf. Felbermayr et al. (2020) and Kirilakha et al. (2021) (http://www.rug.nl/research/ggdc/data/pwt/). We use the GSDB to include an indicator variable ($SANCT_{ij,t}$) for the presence of sanctions in our estimations. Finally, data on WTO membership, captured by an indicator variable $WTO_{ij,t}$ in our analysis, come from the Dynamic Gravity Dataset (DGD) of the US International Trade Commission; cf. Gurevich and Herman (2018) (http://www.rug.nl/research/ggdc/data/pwt/).

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20 Specifically, we used the DTA 2. Database: Information by Trade agreements. Bilateral observations.

Table 1. Estimates of the Effects of DTAs on Trade

	(1) PTA	(2) CONT	(3) DTA	(4) INV	(5) PROV	(6) WTO-X	(7) WTO+
$\text{PTA}_{ij,t}$	0.089	0.050	−0.076	−0.133	−0.093	−0.094	−0.090
	(0.058)	(0.055)	(0.056)	(0.056)*	(0.051)+	(0.053)+	(0.050)+
$\text{DTA}_{ij,t}$	–	–	0.139	0.104	0.005	0.025	0.012
			(0.025)**	(0.026)**	(0.058)	(0.055)	(0.055)
$\text{INV}_{ij,t}$	–	–	–	0.137	–	–	–
				(0.052)**			
$\text{DEPTH}_{ij,t}$	–	–	–	–	0.001	–	–
					(0.000)**		
$\text{WTO-X}_{ij,t}$	–	–	–	–	–	0.001	–
						(0.001)*	
$\text{WTO+}_{ij,t}$	–	–	–	–	–	–	0.001
							(0.000)**
$\text{WTO}_{ij,t}$	–	0.413	0.423	0.429	0.436	0.435	0.434
		(0.041)**	(0.041)**	(0.040)**	(0.039)**	(0.039)**	(0.039)**
$\text{BIT}_{ij,t}$	–	0.172	0.160	0.166	0.165	0.164	0.166
		(0.031)**	(0.031)**	(0.031)**	(0.031)**	(0.030)**	(0.031)**
$\text{SANCT}_{ij,t}$	–	0.022	0.020	0.014	0.014	0.017	0.014
		(0.019)	(0.018)	(0.018)	(0.017)	(0.018)	(0.017)
N	161,425	161,425	161,425	161,425	161,425	161,425	161,425

Source: Own calculations.

Note: This table reports estimates of the effects of trade agreements on trade flows over the period 1990–2011. The dependent variable is nominal trade flows. The estimator is the Poisson pseudo-maximum-likelihood (PPML) estimator. All estimates are obtained with three-way fixed effects, including exporter-time, importer-time, and directional pair fixed effects. In addition, all specifications include a full set of time-varying border variables. The estimates of the border dummies and all fixed effects, including the constant, are omitted for brevity. The standard errors in all specifications are clustered by country pair. Columns (1) and (2) report the average preferential trade agreement (PTA) effect across all agreements in the sample without and with controls (controls are World Trade Organization (WTO) membership (WTO), bilateral investment treaties (BIT), and economic sanctions (SANCT)). Column (3) adds the effects of deep trade agreements (DTAs). Column (4) distinguishes DTAs with investment provisions (INV). In addition to PTAs and DTAs, column (5) introduces a continuous variable for DTA depth (DEPTH). Finally, the last two columns define depth by distinguishing between WTO-X/WTO+ provisions, respectively. $^+ p < 0.10, * p < .05, ** p < .01$.

4. Empirical Findings and Analysis

We first present our partial estimates of the impact of DTAs on trade and FDI. Then, we translate the partial estimates into corresponding GE effects and analyze the total impact of DTAs on FDI within our framework.

4.1. Estimation Results

Our estimates of the effects of DTAs on trade are presented in table 1. All estimates are obtained with the PPML estimator with three-way fixed effects, including exporter-time, importer-time, and directional country-pair fixed effects. In addition, all specifications use time-varying border dummy variables to control for the presence of common globalization trends.

The estimates in column (1) include a single indicator variable, $\text{PTA}_{ij,t}$, that reflects the presence of a trade agreement of any type (e.g., deep or shallow) between i and j at time t. We note that, while positive, the estimate on $\text{PTA}_{ij,t}$ is economically small and not statistically significant. A possible explanation for this result is that we impose a common effect for all trade agreements in our sample, regardless of their type and depth. We demonstrate that this is indeed the case in column (3) of table 1. Before that, however, we add additional policy covariates in column (2) and discuss their estimates.

In column (2) of table 1, we add indicator variables for WTO membership ($\text{WTO}_{ij,t}$), bilateral investment treaties ($\text{BIT}_{ij,t}$), and economic sanctions ($\text{SANCT}_{ij,t}$). First, we note that the estimate of the impact of WTO is positive, large, and statistically significant. This result is at odds with some of the existing literature, e.g., Rose (2004) and Esteve-Pérez, Gil-Pareja, and Llorca-Vivero (2020), who find that WTO membership did not promote international trade; however, our estimate on $\text{WTO}_{ij,t}$ confirms the findings of Larch et al. (2024) for positive WTO effects when domestic trade flows are used to estimate gravity equations. In robustness analysis, which appears in the supplementary online appendix, we confirm that when the model is estimated without domestic trade flows, the estimate of the effects of WTO is smaller and it is not statistically significant.

Second, we obtain a positive, sizable, and statistically significant estimate of the impact of bilateral investment treaties (BITs) on trade flows. A possible explanation for this result is multinational production. Third, we do not obtain a significant estimate of the impact of economic sanctions on trade. This result is consistent with estimates from Felbermayr et al. (2020), who argue that average estimates of the effects of sanctions may mask significant heterogeneity across the effects of sanctions by type. In addition, Kirilakha et al. (2021) demonstrate that the relative importance of trade sanctions has fallen significantly over time. In robustness analysis, we allowed for differential effects of different types of sanctions. This did not affect our main findings and conclusions.

In column (3) of table 1 we allow for heterogeneous effects between shallow and deep trade agreements. To this end, we capitalize on the data from World Bank's DCRTA (cf. Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and Ruta (2020)) to define $\text{DTA}_{ij,t}$ as an indicator that takes a value of 1 for deep trade agreements (i.e., we use the variable "pta_mapped" from the DCRTA database), and it is equal to 0 otherwise. Thus, by construction, the observations that take a value of 1 in the $\text{DTA}_{ij,t}$ variable are a subset of the observations that are equal to 1 in the $\text{PTA}_{ij,t}$ dummy from column (2). The main finding from column (3) of table 1 is encouraging and expected. Specifically, we obtain a positive and statistically significant estimate on $\text{DTA}_{ij,t}$, which suggests that, on average, the deep trade agreements in our sample have led to a 14.888 percent (std.err. 2.856) increase in bilateral trade among member countries relative to countries that only conclude a PTA.

Our positive and significant estimates of the impact of DTAs are consistent with and reinforce the general message from Fernandes, Rocha, and Ruta (2021) that DTAs have been effective in stimulating international trade. However, the DTA estimate that we obtain seems relatively small, which is consistent with a recent survey article (Larch and Yotov 2024), which traces the evolution of the estimates of trade agreements over the past sixty years. We investigate this puzzling finding further in the supplementary online appendix, where we show that using domestic trade flows and/or not accounting for common globalization effects leads to larger DTA estimates. We also show that the effects of the DTAs in the 1990s vs. 2000s are very similar and we obtain similarly small estimates with two alternative data sets. Finally, we show that the DTA estimates are very heterogeneous across disaggregated sectors.

In column (4) of table 1, we additionally split DTAs that contain investment provisions ($\text{INV}_{ij,t}$). We find that deep trade agreements with investment provisions have larger effects on bilateral trade flows relative to DTAs without investment provisions. This is in line with our findings for BITs before and shows that investment provisions may spur trade potentially due to the importance of trade between headquarters and affiliates of multinational firms.

In column (5) of table 1, we use the DTA database to construct a continuous variable ($\text{DEPTH}_{ij,t}$), which counts the number of provisions within each of the DTAs in our sample. The number of provisions across the DTAs in our sample varies between 12 and 432. The main result from column (5) is that, on average, the deeper the agreement, the more it would promote trade among its members. Specifically, we obtain a positive and statistically significant estimate on $\text{DEPTH}_{ij,t}$ (0.00065, std.err. 0.00024), which is consistent with the findings from Osnago, Rocha, and Ruta (2019). Our estimate suggests that depending on the number of provisions that they include, the DTAs in our sample have led to trade increases between

0.784 percent (std.err. 0.300) and 32.472 percent (std.err. 14.194). We capitalize on this variation in the counterfactual analysis, where we obtain corresponding GE effects on FDI.

We conclude the analysis of the impact of DTAs on trade by breaking our DEPTH$_{ij,t}$ variable into two count variables, WTO-X$_{ij,t}$ and WTO+$_{ij,t}$. The WTO-X$_{ij,t}$ commitments are commitments dealing with issues going beyond the current WTO mandate altogether, for example, commitments on labor standards, investments, or the environment. The WTO+$_{ij,t}$ commitments are commitments building on already agreed commitments at the multilateral level, for example, a further reduction in tariffs. The estimates for the two types of provisions, which appear in columns (6) and (7) of table 1, are very similar to each other. Thus, we do not find evidence for a differential impact of depth depending on whether the provisions are enforceable.

Our estimates of the effects of DTAs on FDI are presented in table 2. As discussed earlier, and similar to our trade specification, all estimates are obtained with the PPML estimator with three-way fixed effects, including origin-time, destination-time, and directional pair fixed effects. In addition, all specifications include indicator variables for WTO membership (WTO$_{ij,t}$), bilateral investment treaties (BIT$_{ij,t}$), and economic sanctions (SANCT$_{ij,t}$). Similar to our approach with trade flows, to highlight the importance of DTAs and their provisions for FDI, we develop the estimation analysis sequentially.

The estimates in column (1) of table 2 include a single indicator variable, PTA$_{ij,t}$, that reflects the presence of a trade agreement of any type (e.g., deep or shallow) between i and j at time t. The main result from column (1) is that none of the effects of the policy variables in our model, including the impact of trade agreements and BITs, are statistically significant. A possible explanation for this result is that some of the significant determinants of FDI are country-specific variables on the origin and/or the destination side (e.g., corporate tax rate, corruption, bureaucratic red tape, and quality of institutions). However, such determinants are fully absorbed by the origin-time and destination-time fixed effects. Moreover, it is also possible that several time-invariant characteristics (e.g., bilateral distance and common official language) are important for FDI (cf. Eicher, Helfman, and Lenkoski 2012; Blonigen and Piger 2014). However, similar to the country-specific variables, these effects are also absorbed in our econometric model (by the pair fixed effects). Our finding on the insignificant impact of BITs may seem particularly strange; however, this result is common in the related literature, e.g., Lesher and Miroudot (2006) and Laget, Rocha, and Varela (2021).

Next, in column (2) of table 2 we allow for heterogeneous effects between shallow and deep trade agreements by using the same DTA variable which we constructed for our trade regressions. Even though the estimate on DTA$_{ij,t}$ is positive, it is economically small and not statistically significant. Thus, unlike their significant impact on trade, our estimates suggest that DTAs per se do not promote FDI. One possible explanation for the insignificant estimates of the effects of PTAs and DTAs in our setting could be due to our inability to distinguish between horizontal and vertical FDI in our data. For example, it is plausible that PTAs could influence FDI due to increasing the incentive to undertake specifically vertical FDI, i.e., explore factor cost differences and disentangle (stages) of production and knowledge creation. If multinational firms rely heavily on global value chains (GVCs), one might expect that any agreement that lowers trade barriers would increase FDI by lowering the cost of shipping within GVCs. If horizontal FDI is seen as a substitute for exports, then one might expect PTAs to lower FDI, as they reduce the cost of trade and make it more appealing than FDI as a means of reaching consumers in the partner countries. Thus, it is indeed possible that the null effects of PTAs and DTAs on FDI are masking a positive effect for vertical FDI or GVCs that is offset by a negative effect for horizontal FDI.[21]

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21 We refer the reader to Markusen (2002) and Barba Navaretti et al. (2004) for informative monographs about multi-national firms discussing the differences between vertical and horizontal FDI. The test for horizontal vs. vertical FDI turned out to be difficult; see for example Carr, Markusen, and Maskus (2001) and Blonigen, Davies, and Head (2003). Therefore, the notion of "complex" FDI was introduced into the literature (see Yeaple (2003) and Grossman, Helpman, and Szeidl (2006) for examples) and support provided that "complex" FDI seems predominant (see Baltagi, Egger, and

Table 2. Estimates of the Effects of DTAs on FDI

Dependent var.: FDI value stock	(1) PTA	(2) DTA	(3) PROV	(4) MISS	(5) BIAS	(6) DEPTH	(7) TIME	(8) CNTRY	(9) ASYMM
$\text{PTA}_{ij,t}$	−0.053	−0.114	−0.160	−0.221	−0.154	−0.122	−0.169	−0.123	−0.111
	(0.063)	(0.092)	(0.093)[+]	(0.096)[*]	(0.106)	(0.092)	(0.094)[+]	(0.096)	(0.098)
$\text{DTA}_{ij,t}$	–	0.062	−0.034	−0.008	−0.046	−0.067	−0.025	−0.082	−0.086
		(0.070)	(0.076)	(0.077)	(0.085)	(0.075)	(0.076)	(0.080)	(0.082)
$\text{INV}_{ij,t}$	–	–	0.191	0.218	0.202	0.519	–	0.132	0.124
			(0.095)[*]	(0.099)[*]	(0.108)[+]	(0.242)[*]		(0.103)	(0.103)
$\text{INV\_DEPTH}_{ij,t}$	–	–	–	–	–	−0.012	–	–	–
						(0.008)			
$\text{INV\_1990}_{ij,t}$	–	–	–	–	–	–	0.114	–	–
							(0.108)		
$\text{INV\_2000}_{ij,t}$	–	–	–	–	–	–	0.199	–	–
							(0.097)[*]		
$\text{CHN}_{ij,t}$	–	–	–	–	–	–	–	−0.116	–
								(0.167)	
$\text{USA}_{ij,t}$	–	–	–	–	–	–	–	0.327	–
								(0.125)[**]	
$\text{USA\_OUT}_{ij,t}$	–	–	–	–	–	–	–	–	0.269
									(0.125)[*]
$\text{USA\_IN}_{ij,t}$	–	–	–	–	–	–	–	–	0.449
									(0.233)[+]
$\text{CHN\_OUT}_{ij,t}$	–	–	–	–	–	–	–	–	0.466
									(0.250)[+]
$\text{CHN\_IN}_{ij,t}$	–	–	–	–	–	–	–	–	−0.186
									(0.166)
$\text{SANCT}_{ij,t}$	0.002	0.003	0.007	0.008	0.003	0.007	0.008	0.014	0.011
	(0.037)	(0.037)	(0.037)	(0.038)	(0.042)	(0.037)	(0.037)	(0.037)	(0.037)
$\text{WTO}_{ij,t}$	0.373	0.379	0.380	0.252	0.391	0.373	0.382	0.360	0.393
	(0.330)	(0.327)	(0.334)	(0.291)	(0.391)	(0.337)	(0.333)	(0.340)	(0.338)
$\text{BIT}_{ij,t}$	−0.037	−0.040	−0.033	0.015	−0.030	−0.030	−0.032	−0.032	−0.034
	(0.066)	(0.066)	(0.065)	(0.068)	(0.071)	(0.065)	(0.064)	(0.064)	(0.064)
N	52,458	52,458	52,458	96328	52,458	52,458	52,458	52,458	52,458

Source: Own calculations.

Note: This table reports estimates of the effects of trade agreements on foreign direct investment (FDI) over the period 1990–2011. The dependent variable is the value of FDI stock. The estimator is the Poisson pseudo-maximum-likelihood (PPML) estimator. All estimates are obtained with three-way fixed effects, including origin-time, destination-time, and directional pair fixed effects. The estimates of all fixed effects, including the constant, are omitted for brevity. The standard errors in all specifications are clustered by country pair. Controls included in all columns are economic sanctions (SANCT), World Trade Organization (WTO) membership (WTO), and bilateral investment treaties (BIT).Column (1) reports the average preferential trade agreement (PTA) effect across all agreements in the sample.Column (2) adds the effects of deep trade agreements (DTAs). Column (3) isolates the DTAs with investment provisions (INV). Column (4) replaces the missing FDI values with zeros. Column (5) implements the bias correction procedure of Weidner and Zylkin (2021). In addition to PTAs, DTAs, and DTAs with investment provisions, column (6) introduces a continuous variable for investment depth (INV_DEPTH). Column (7) allows for heterogeneous effects of the DTAs in the 1990s vs. 2000s. Finally, column (8) isolates the impact of the DTAs with investment provisions for China and the United States, while column (9) also allows for directional effects of these agreements on outward vs. inward FDI. [+] $p < 0.10$, [*] $p < .05$, [**] $p < .01$.

Crawford and Kotschwar (2020) and Laget, Rocha, and Varela (2021) provide evidence on the heterogeneous impact of different types of provisions on FDI. Motivated by their analysis and by the fact that some DTAs include provisions that are specifically targeted at investment, in our next specification (in column (3) of table 2), we isolate the effects of DTAs that include investment provisions. We expect that investment provisions may exert a direct positive effect on FDI. To construct the new covariate, we again rely on the World Bank's DCRTA (cf. Hofmann, Osnago, and Ruta (2019) and Mattoo, Rocha, and

Pfaffermayr (2007) for example). Unfortunately, our data do not allow us to distinguish between horizontal and vertical FDI and to obtain estimates by sector.

Ruta (2020)), which includes 66 possible investment provisions. Based on this information, we construct a dummy variable, $INV_{ij,t}$, which takes a value of 1 if an agreement includes at least one investment provision, and it is equal to 0 otherwise. Thus, by construction, the observations that take a value of 1 in the $INV_{ij,t}$ indicator are a subset of the observations that are equal to 1 in the $DTA_{ij,t}$ dummy from column (2).

The main finding from column (3) is that we obtain a positive, sizable, and statistically significant estimate on $INV_{ij,t}$, which suggests that, on average, the PTAs with investment provisions in our sample have led to a 21.038 percent (std.err. 11.513) increase in FDI between their members. This result complements the findings from Laget, Rocha, and Varela (2021), who use firm-level data for the period 2003–2015 and obtain positive estimates of the effects of provisions related to "intellectual property rights" and "visa and asylum," which vary between 32 and 50 percent, but do not find significant effects of investment provisions on FDI.[22]

Given the insignificant estimates of all other policy variables in our specification, especially the BITs, and the general difficulty in the literature to identify policies that have significant effects on FDI (see Lesher and Miroudot (2006) and Laget, Rocha, and Varela (2021) for examples), we view our significant estimates of the impact of DTAs with investment provisions on FDI as an important result. Therefore, in the rest of the columns of table 2 we put this result to scrutiny by testing its robustness and exploring potential heterogeneity across several dimensions. We start by replacing the missing FDI values with zeros and by implementing the bias correction procedure of Weidner and Zylkin (2021), in columns (4) and (5), respectively. The new estimates on $INV_{ij,t}$ are very similar to our main result.

In column (6) of table 2 we use the DTA database to construct a continuous variable ($INV\_DEPTH_{ij,t}$), which counts the number of investment provisions within each of the DTAs in our sample. The number of investment provisions across the DTAs in our sample varies between 7 and 41. The estimates from column (4) do not reveal a significant impact of the increase in the depth (number of provisions) on FDI. In fact, and pushing inference to the limit, our estimates suggest that the impact of additional provisions is negative. A possible interpretation of this result is that more investment provisions make the agreements more difficult to comply with. Even though our estimate on $INV\_DEPTH_{ij,t}$ is insignificant, we use it in combination with the positive estimates on $INV_{ij,t}$ to construct a continuous FDI response to the impact of DTAs. The effects are all positive and vary between 3.04 percent (std.err. 14.87) and 54.57 percent (std.err. 29.42), depending on the number of investment provisions.[23]

Next we investigate the impact of DTAs with investment provisions over time. Specifically, in column (7) of table 2 we allow for heterogeneous effects in the 1990s vs. 2000s. Both estimates in column (7) are positive and sizable; however, only the estimate for the 2000s is statistically significant. A possible explanation for this result is that the investment provisions in the DTAs have become more effective over time. To obtain the estimates in fig. 3, we replace the single indicator for investment, $INV_{ij,t}$, with a series of leads and lags. The two main results from this figure are (a) that we do not find evidence for pre-trends; and (b) that it seems to take time for the effects of DTAs with investment provisions to materialize. While we find positive effects for all periods after entry into force of the DTA, the estimates only turn significant after 15 years. This may be the case because of the substantial uncertainty in our quantification reflected by the correspondingly large standard errors. It may also reflect the fact that, as compared to trade, investment relationships may take a longer time to shape.

22   In robustness analysis, we also investigate the impact of different broad types of provisions on FDI (e.g., export taxes vs. movement of capital vs. environmental laws) and different types of investment provisions on FDI (e.g., protection vs. liberalization vs. transparency). Since most of these estimates do not add new insights to the analysis, we have delegated them to the supplementary online appendix.

23   Specifically, to obtain these bounds, we used the expression $(\exp(\hat{\beta}_{INV_{ij,t}} + \hat{\beta}_{INV\_DEPTH_{ij,t}} \times N_{\min,\max}) - 1) \times 100$, where $\hat{\beta}_{INV_{ij,t}}$ and $\hat{\beta}_{INV\_DEPTH_{ij,t}}$ are the corresponding estimates from column (6) of table 2), and $N_{\min,\max}$ denotes the minimum (7) and the maximum (42) number of investment provisions in our sample.

Figure 3. Evolution of the Impact of DTAs with Investment Provisions on FDI

Source: Own calculations.

Note: This figure plots the evolution of the effects of deep trade agreements (DTAs) with investment provisions on foreign direct investment (FDI) by replicating the results from column (3) of table 2 after replacing the single dummy variable $INV_{ij,t}$ with a series of corresponding indicators before and after the agreement was signed. The designation '$t0$' denotes the year of entry into force of the DTA. See text for further details.

We conclude the analysis of the effects of DTAs on FDI by investigating their impact on two specific countries—China and the United States.[24] Three results stand out from column (8) of table 2. First, we see that the estimate for the United States is large, positive, and statistically significant, suggesting that the DTAs with investment provisions have been particularly effective for this country. Second, the estimate for China is not statistically significant, suggesting that China has not benefited from its DTAs with investment provisions. Finally, the estimate for the remaining agreements with investment provisions, $INV_{ij,t}$, is positive and sizable, but it is no longer statistically significant. In combination with the results for China and the United States, this suggests that the average estimate on $INV_{ij,t}$ from column (3) is masking significant heterogeneity across countries and points to the benefits of obtaining country-specific effects.

In our last experiment, we allow for the country-specific effects of DTAs with investment provisions for China and the United States to vary depending on the direction of FDI. Three main results stand out from column (9) of table 2. First, we see that both estimates for the United States are positive and statistically significant. However, second, we notice an asymmetry in the impact of DTAs with investment provisions on the inward vs. outward FDI of the United States, in favor of the former. This is consistent with the observation that the United States is the largest receiver of FDI in our sample. Third, and most remarkable, the results are completely the opposite for China, where we obtain a very large, positive, and statistically significant estimate for this country's outward FDI, but not statistically significant (and, in fact, negative) estimate for China's inward FDI. We are not aware of existing estimates of asymmetric effects of DTAs on FDI depending on the direction of FDI flows and we believe that the stark differences that we obtain for China's inward vs. outward FDI may have significant policy implications both for the negotiation and the implementation of DTAs with DFI provisions.

24 We selected the United States because it is the largest sender and receiver of FDI, while the focus on China is due to its leading position as an outward FDI country.

In sum, the analysis in this section demonstrated that while trade agreements do not necessarily promote trade and FDI on average, the impact of deep trade agreements on trade and the impact of deep trade agreements that include investment provisions on FDI is positive, statistically significant, and also heterogeneous over time and across countries too. We also offered evidence that deeper trade agreements (as measured by the number of provisions) lead to larger trade liberalization effects. However, we do not see evidence that increasing investment provisions in DTAs led to more FDI. Some of our results suggest that additional provisions and complexity may make DTAs less effective in promoting FDI. Next, we rely on the partial estimates from this section to obtain GE effects of DTAs on FDI.

4.2. Counterfactual Analysis

This section translates the partial equilibrium estimates from tables 1 and 2 into GE effects of DTAs on FDI. To this end, we rely on our structural trade and investment system . At the onset of this section, we point to a potential caveat with our GE analysis. Specifically, as noted earlier, the underlying theory is based on the assumption of non-rival technology FDI, while our data includes all/aggregate FDI flows. This gap, of course, has implications for the quantitative results. Therefore, the specific indexes we obtain and report in this section should be interpreted accordingly and with caution. Nevertheless, we believe that the main conclusions and policy implications we will draw in this section, e.g., about a disproportionately large impact on outward FDI, will remain qualitatively the same if applied to appropriate data on technology FDI.

We start the analysis by describing the steps we took to make system (1)–(8) operational for our purposes. For the counterfactual analysis, we use as a baseline the latest available year in our data set, which is 2011, determined by the availability of capital stock data. To perform the counterfactual analysis, we need to set values for the parameters. Some parameters are borrowed from the literature: (a) the elasticity of substitution is set equal to $\sigma = 6$,[25] (b) the consumer discount factor is set equal to $\beta = 0.98$ (Yao et al. 2012), and (c) the country-specific capital shares of production α_j and the country-specific adjustment costs of capital δ_j are calculated using the Penn World Tables and reported in columns (3) and (4) of table 3, respectively.

We calibrate other parameters to match the observed data. The share of technology capital of a country to all destinations as a share from total world technology capital (η_i) is calculated using FDI_{ij}^{value}:

$$\eta_i = \frac{\sum_j \text{FDI}_{ij}^{value}}{\sum_i \sum_j \text{FDI}_{ij}^{value}}.$$

The variable ϕ_j is calculated using the relationship between inward FDI ($\text{FDI}_j^{in} = \sum_i \text{FDI}_{ij}^{value}$) and physical capital in the production function, along with FDI and physical capital data and data on the capital shares:

$$\phi_j = \frac{\alpha_j \times (\text{FDI}_j^{in}/K_j)}{1 + \alpha_j (\text{FDI}_j^{in}/K_j)}.$$

The exact values for η and ϕ are given in columns (5) and (6) of table 3.

For the baseline, we calibrate bilateral trade frictions to the power of $1 - \sigma$, i.e., trade openness $t_{ij}^{1-\sigma}$, using data on trade flows, income, and expenditure and solving equations (2) and (3) for given trade costs

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25 The value of 6 for σ is about the mean value reported in Head and Mayer (2014, table 3.5) based on 744 significant estimates from 32 papers, where the reported values correspond to $1 - \sigma$. The median value is lower and suggested to be around 4. Fontagné, Guimbard, and Orefice (2022) use product-level (HS6) trade data and bilateral tariff variation to estimate trade elasticities. The average value for σ after excluding products with a positive tariff elasticity and setting insignificant estimates to zero is 6.3 (the reported values again correspond to $1 - \sigma$). The median trade elasticity reported is 4.5 and 5.4 at 1 percent and 5 percent significance levels, respectively. We, therefore, perform a sensitivity check of our analysis with a value of 4 instead of 6. Results are reported in table S4.2 in the supplementary online appendix.

Table 3. Total General Equilibrium (GE) Effects on Inward and Outward FDI—Dummy DTA Variable

						FDI lib.		FDI and trade lib.	
ISO3 (1)	Country (2)	α (3)	δ (4)	η (5)	ϕ (6)	Inw. FDI (7)	Outw. FDI (8)	Inw. FDI (9)	Outw. FDI (10)
AGO	Angola	0.47	0.0528	0.00078	0.056	0.08	0.00	0.52	0.00
ARG	Argentina	0.57	0.0394	0.00792	0.024	0.74	0.34	1.58	1.30
AUS	Australia	0.44	0.0375	0.01375	0.052	4.43	2.87	5.32	3.22
AUT	Austria	0.43	0.0442	0.00521	0.058	0.64	0.34	1.45	1.48
AZE	Azerbaijan	0.79	0.0725	0.00058	0.041	0.16	0.00	0.98	0.01
BEL	Belgium	0.38	0.0452	0.00677	0.235	0.65	0.65	1.51	1.07
BGD	Bangladesh	0.47	0.0407	0.00322	0.003	0.16	0.01	0.95	0.16
BGR	Bulgaria	0.51	0.0565	0.00093	0.091	0.60	0.06	1.41	0.21
BLR	Belarus	0.48	0.0506	0.00152	0.031	0.14	0.00	0.88	0.09
BRA	Brazil	0.44	0.0475	0.02653	0.042	0.39	1.14	1.25	1.89
CAN	Canada	0.39	0.0371	0.01658	0.057	3.95	2.09	4.77	4.90
CHE	Switzerland	0.35	0.0568	0.00683	0.190	2.23	1.26	3.04	1.87
CHL	Chile	0.55	0.0427	0.00305	0.057	11.28	1.61	12.13	2.11
CHN	China	0.46	0.0530	0.18395	0.009	0.93	40.70	1.76	56.99
COL	Colombia	0.39	0.0411	0.00536	0.008	0.99	0.33	1.64	0.55
CYP	Cyprus	0.48	0.0357	0.00117	0.186	0.53	0.04	1.15	0.15
CZE	Czech Republic	0.49	0.0416	0.00359	0.063	0.65	0.09	1.47	0.29
DEU	Germany	0.39	0.0389	0.04024	0.031	0.64	3.41	1.47	8.56
DNK	Denmark	0.37	0.0431	0.00320	0.054	0.65	0.27	1.50	0.82
DOM	Dominican Republic	0.34	0.0307	0.00097	0.009	6.46	0.04	7.02	0.10
ECU	Ecuador	0.55	0.0466	0.00160	0.007	0.09	0.00	0.59	0.05
EGY	Egypt, Arab Rep.	0.62	0.0597	0.00351	0.029	0.11	0.01	0.69	0.45
ESP	Spain	0.39	0.0375	0.02146	0.047	0.62	1.38	1.40	3.39
EST	Estonia	0.42	0.0461	0.00030	0.086	0.15	0.01	0.95	0.03
ETH	Ethiopia	0.47	0.0494	0.00073	0.002	0.07	0.00	0.42	0.03
FIN	Finland	0.39	0.0412	0.00323	0.049	0.64	0.21	1.43	0.58
FRA	France	0.37	0.0382	0.03254	0.036	0.65	2.16	1.53	6.05
GBR	United Kingdom	0.39	0.0379	0.02665	0.083	0.64	2.32	1.48	5.45
GHA	Ghana	0.47	0.0553	0.00057	0.018	0.08	0.01	0.55	0.02
GRC	Greece	0.47	0.0335	0.00396	0.014	0.57	0.11	1.29	0.46
GTM	Guatemala	0.58	0.0454	0.00037	0.030	3.54	0.01	3.99	0.03
HKG	Hong Kong SAR, China	0.48	0.0435	0.00687	0.228	0.13	0.05	0.81	0.51
HRV	Croatia	0.34	0.0436	0.00106	0.039	0.16	0.04	0.86	0.05
HUN	Hungary	0.41	0.0436	0.00229	0.065	0.60	0.10	1.42	0.48
IDN	Indonesia	0.54	0.0370	0.01334	0.019	6.77	1.38	7.50	2.70
IND	India	0.50	0.0558	0.04216	0.007	2.77	7.52	3.63	11.21
IRL	Ireland	0.52	0.0496	0.00238	0.292	0.62	0.19	1.41	0.61
IRN	Iran, Islamic Rep.	0.74	0.0588	0.01147	0.001	0.07	0.03	0.44	0.49
IRQ	Iraq	0.70	0.0558	0.00099	0.004	0.07	0.00	0.40	0.02
ISR	Israel	0.45	0.0448	0.00242	0.026	0.13	0.01	0.78	0.27
ITA	Italy	0.46	0.0380	0.03135	0.021	0.67	2.71	1.56	6.00
JPN	Japan	0.39	0.0466	0.07416	0.004	2.25	16.76	3.07	22.59
KAZ	Kazakhstan	0.58	0.0400	0.00270	0.065	0.14	0.01	0.93	0.08
KEN	Kenya	0.57	0.0519	0.00049	0.017	0.12	0.00	0.76	0.01
KOR	Korea, Rep.	0.50	0.0501	0.02197	0.012	6.40	14.81	7.31	16.87
KWT	Kuwait	0.75	0.0557	0.00204	0.008	0.07	0.00	0.44	0.01
LBN	Lebanon	0.56	0.0413	0.00134	0.002	0.07	0.02	0.55	0.20
LKA	Sri Lanka	0.31	0.0446	0.00119	0.001	0.08	0.01	0.51	0.15
LTU	Lithuania	0.53	0.0418	0.00050	0.058	0.57	0.01	1.41	0.04
LUX	Luxembourg	0.46	0.0463	0.00649	0.634	0.62	0.64	1.35	1.13
LVA	Latvia	0.45	0.0336	0.00037	0.051	0.53	0.00	1.15	0.02

Table 3. Continued

						FDI lib.		FDI and trade lib.	
ISO3	Country	α	δ	η	φ	Inw. FDI	Outw. FDI	Inw. FDI	Outw. FDI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MAR	Morocco	0.51	0.0521	0.00176	0.045	3.52	0.05	4.17	0.31
MEX	Mexico	0.61	0.0362	0.01590	0.050	5.56	2.31	6.47	6.87
MKD	North Macedonia	0.47	0.0406	0.00026	0.031	4.12	0.07	4.77	0.09
MLT	Malta	0.46	0.0529	0.00015	0.219	0.58	0.01	1.17	0.03
MYS	Malaysia	0.47	0.0596	0.00587	0.034	6.78	0.78	7.54	1.53
NGA	Nigeria	0.50	0.0581	0.00178	0.050	0.14	0.00	0.80	0.03
NLD	Netherlands	0.41	0.0401	0.01680	0.109	0.67	1.17	1.56	4.47
NOR	Norway	0.48	0.0399	0.00348	0.094	0.97	0.45	1.83	0.77
NZL	New Zealand	0.43	0.0408	0.00124	0.081	4.76	0.19	5.55	0.23
OMN	Oman	0.70	0.0602	0.00110	0.029	3.50	0.03	4.05	0.04
PAK	Pakistan	0.47	0.0551	0.00468	0.007	3.82	0.09	4.43	0.44
PER	Peru	0.69	0.0395	0.00364	0.016	8.43	0.27	9.26	0.57
PHL	Philippines	0.64	0.0488	0.00485	0.012	6.81	0.50	7.59	1.44
POL	Poland	0.44	0.0491	0.00746	0.046	0.65	0.34	1.52	1.19
PRT	Portugal	0.39	0.0351	0.00382	0.043	0.55	0.17	1.31	0.73
QAT	Qatar	0.81	0.0960	0.00235	0.034	0.10	0.00	0.63	0.02
ROM	Romania, Socialist Republic of	0.53	0.0518	0.00298	0.049	0.12	0.01	0.83	− 0.02
RUS	Russian Federation	0.26	0.0402	0.03052	0.011	0.16	0.19	0.98	0.90
SAU	Saudi Arabia	0.72	0.0530	0.00976	0.009	0.12	0.02	0.76	0.10
SDN	Sudan	0.41	0.0664	0.00035	0.008	0.04	0.00	0.23	0.00
SER	Serbia	0.42	0.0402	0.00103	0.035	0.15	0.00	0.91	0.00
SGP	Singapore	0.56	0.0533	0.00494	0.182	10.67	2.23	11.49	3.65
SVK	Slovak Republic	0.46	0.0520	0.00125	0.073	0.59	0.01	1.43	0.07
SVN	Slovenia	0.33	0.0439	0.00086	0.023	0.57	0.04	1.33	0.08
SWE	Sweden	0.45	0.0453	0.00408	0.182	0.62	0.30	1.34	1.01
SYR	Syrian Arab Republic	0.47	0.0552	0.00122	0.003	0.07	0.00	0.46	0.08
THA	Thailand	0.61	0.0655	0.00946	0.035	6.81	1.03	7.62	2.57
TKM	Turkmenistan	0.47	0.0430	0.00115	0.001	0.04	0.00	0.29	0.07
TUN	Tunisia	0.50	0.0474	0.00108	0.005	0.09	0.01	0.58	0.19
TUR	Türkiye	0.56	0.0554	0.00729	0.037	0.15	0.03	0.92	0.64
TZA	Tanzania, United Republic of	0.57	0.0435	0.00055	0.032	0.12	0.00	0.76	0.03
UKR	Ukraine	0.44	0.0308	0.00631	0.013	0.10	0.01	0.71	0.25
USA	United States	0.40	0.0475	0.17546	0.023	1.33	42.50	2.21	53.75
UZB	Uzbekistan	0.47	0.0327	0.00099	0.003	0.08	0.00	0.48	0.04
VEN	Venezuela, RB	0.63	0.0389	0.00366	0.020	0.82	0.16	1.61	0.23
VNM	Vietnam	0.47	0.0455	0.00507	0.010	6.77	0.07	7.43	0.32
ZAF	South Africa	0.46	0.0506	0.00419	0.066	0.16	0.01	0.95	0.12
ZWE	Zimbabwe	0.44	0.0371	0.00004	0.083	0.08	0.00	0.51	0.00
World						1.80	42.50	2.63	53.75
Lib-countries						1.94	42.50	2.64	53.75
ROW						0.35	0.01	0.86	0.00

Source: Own calculations.

Note: This table reports results from our calibration and counterfactual analysis. Column (1) gives the ISO3 country codes, and column (2) the country names. The country-specific capital shares of production α_j are reported in column (3), while in column (4) we give the values of the country-specific adjustment costs of capital δ. The values for the η's, i.e., the share of technology capital of a country to all destinations, are given in column (5). Column (6) gives the values for the production share of foreign direct investment (FDI) (ϕ). Columns (7) and (8) report the percentage changes in inward and outward FDI, respectively, based on our estimate of 0.191 from column (3) of table 2 for our change in the bilateral FDI frictions between all countries that have signed a deep trade agreement (DTA) with investment provisions, while in columns (9) and (10) in addition to the change in FDI frictions, DTAs also change trade frictions based on our estimate of 0.139 from column (2) of table 1.

and calculating a new matrix $t_{ij}^{1-\sigma}$ using equation (1) until convergence, where we normalize all internal trade costs and trade costs for one exporter to 1. Given trade costs, we can calculate the inward and outward multilateral resistance indexes using equations (2) and (3), respectively, where we set the inward MRT for Angola to 1.

The variable M_j is calibrated using data on income, FDI, and constructed MRTs and the following theory-consistent equation for technology capital:

$$M_j = \frac{\beta \eta_j}{1 - \beta + \beta \delta_{j,M}} \left(\left(1 - \phi_j \sum_{\substack{i \neq j \\ \mathrm{FDI}_{ij} > 1}} \eta_i \right) \frac{\phi_j Y_j}{P_j} + \sum_{\substack{i \neq j \\ \mathrm{FDI}_{ji} > 1}} \frac{\eta_i \phi_i^2 Y_i}{P_j} \right).$$

With this, we can construct FDI openness (ω_{ij}) using the following equation for FDI flows in values:[26]

$$\mathrm{FDI}_{ij}^{\mathrm{value}} = \omega_{ij} \frac{\beta \eta_i^2}{1 - \beta + \beta \delta_{i,M}} \left(\left(1 - \phi_i \sum_{\substack{k \neq i \\ \mathrm{FDI}_{ki} > 1}} \eta_k \right) \frac{\phi_i Y_i}{P_i} + \sum_{\substack{k \neq i \\ \mathrm{FDI}_{ik} > 1}} \frac{\eta_i \phi_k^2 Y_k}{P_i} \right) \frac{\phi_j Y_j}{M_i}.$$

The variable A_j/γ_j, the preference-adjusted technology, is calibrated using equations (4) and (5). As the values of domestic income and expenditure calculated from the trade data do not perfectly match up, we define $\psi_j \equiv E_j / (Y_j + \eta_j \sum_{i \in \mathbb{N}_{ji,t}} \phi_i Y_i - \phi_j Y_j \sum_{i \in \mathbb{N}_{ij,t}} \eta_i)$ as an exogenous country-specific parameter that accounts for these trade imbalances. In the spirit of Dekle, Eaton, and Kortum (2007, 2008), we first eliminate all exogenous trade imbalances and take the equilibrium without trade imbalances as baseline.[27]

To highlight the alternative channels through which DTAs affect FDI, and also to capitalize on the full set of our partial estimates, we perform two sets of experiments. First, we rely on our estimates of the dummy variables for DTAs and DTAs with investment provisions from column (3) of table 1 and column (3) of table 2, respectively. Then, we also obtain corresponding effects based on the estimates of the continuous depth variables from column (5) of table 1 and column (6) of table 2. We perform each of the two experiments in two steps. First, we change the vector of FDI frictions. Then, in addition, we change the vector of trade costs. As the DTAs are already in place, we perform an ex-post evaluation, i.e., we assume that in the baseline the agreement is in place and simulate the effect without DTAs as counterfactual. We then report the change from the baseline to the counterfactual, i.e., baseline value minus counterfactual value relative to the counterfactual value.

Given the main purpose of our analysis, and to keep the presentation of our results manageable, we focus the discussion of our counterfactual results on the percentage changes (between the baseline and the counterfactual scenarios) in the stocks of FDI per country. Specifically, we construct and report percentage changes in inward and outward FDI stocks, i.e., the percentage changes in technology capital used in total at home and technology capital from one country used abroad:

$$\% \Delta \mathrm{FDI}^{\mathrm{in}} = (\mathrm{FDI}_j^{\mathrm{in},b} - \mathrm{FDI}_j^{\mathrm{in},c}) / \mathrm{FDI}_j^{\mathrm{in},c} \times 100,$$

$$\% \Delta \mathrm{FDI}^{\mathrm{out}} = (\mathrm{FDI}_j^{\mathrm{out},b} - \mathrm{FDI}_j^{\mathrm{out},c}) / \mathrm{FDI}_j^{\mathrm{out},c} \times 100,$$

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26   The values of ω_{ij} are restricted to be between 0 and 1. Hence, we normalize each row by the maximum element. Further, all zero FDI flows are leading to zero ω_{ij}'s by construction. To avoid this, we set $\omega_{ij} M_i = 1.00001$ for those observations.

27   Note that we do not directly calibrate the capital-to-GDP ratio, as it is determined by equation (7) when the parameters are calibrated. We, therefore, compared the obtained capital-to-GDP ratio in our model with the capital-to-GDP ratio from our underlying data from WIOD for the 89 countries used. It turns out that the order of magnitudes aligns very well. While the capital-to-GDP ratio for the 89 countries in our data is on average about 3 (with a minimum of 0.05 and a maximum of 5.8), our calibrated model leads to a capital-to-GDP ratio of 2.9 on average (minimum 0.2 and maximum 10.7). We are satisfied with this fit and think that for our comparative-static counterfactual analysis, this properly enough reflects the underlying relationships in the data.

where the superscript b denotes baseline values with DTAs in place, and the superscript c the counterfactual situation without DTAs in place, and, consistent with our theory, inward FDI and outward FDI stocks per country can be calculated as follows:

$$\text{FDI}_j^{\text{in}} = \prod_{i=1}^{N} (\max\{1, \omega_{ij} M_i\})^{\eta_i}, \tag{11}$$

$$\text{FDI}_i^{\text{out}} = \prod_{j=1}^{N} (\max\{1, \omega_{ij} M_i\})^{\eta_i}. \tag{12}$$

Note that the inward FDI stock can be seen as the global technology stock applied locally, whereas the outward FDI stock is the usage of a country's technology capital abroad. The variable η determines the usage of FDI abroad of one country, i.e., outward FDI stocks per country will change a lot if this share is large (i.e., η is large), even if the change in technology capital M_i is comparably small. This is due to the non-rival nature of FDI. This is not the case for inward FDI per country, where the η's always sum to 1, and therefore changes in inward FDI are a weighted average of changes in the $\omega_{ij} M_i$. In other words, the non-rival nature of FDI in our theory implies that any investment into technology FDI increases the stock of FDI available to all countries. The bilateral nature, i.e., that the outward FDI of one country is inward FDI for another country, does not hold up with this notion of FDI. Rather, as soon as an investment in non-rival FDI is undertaken, it can be used by every country in the world subject to friction. We believe that this knowledge flow is important and captured by the investment provisions.

To use a concrete example, consider a DTA with investment provisions signed between the United States and the European Union (EU). Because this DTA reduces the cost of FDI between the United States and EU countries, US firms invest more in technology capital, which cannot only be used in the United States, but also in all EU countries and other FDI destinations of the US firms. This leads to a greater increase in outward relative to inward FDI globally. Hence, an increase in technology FDI from the United States (i.e., an increase in the outward FDI of the United States), leads to an increase of inward FDI not only for one country but for all countries, even though to a different degree, depending on the FDI frictions (see equations (11) and (12)) and the share of technology capital of a country (as a share from total world technology capital). Whenever a country has a large share of FDI in the world, as is the case for China and the United States, any change in FDI frictions will have a comparably large effect on many FDI-receiving countries. The implication is that reducing frictions for countries that have large FDI outward flows, will lead to strong increases in inward FDI.[28]

Our findings are reported in table 3, where the first column lists the ISO3 country codes for the countries in our sample, the second column the country names, and columns (7)–(10) report the results from the scenario based on the estimates of the dummy DTA variables.[29]

The results in columns (7) and (8) of table 3 are obtained in response to a change in the bilateral FDI frictions between all countries that have signed a DTA with investment provisions that are based on our estimate of 0.191 (std.err. 0.095) from column (3) of table 2. There are several things noteworthy. First, both inward and outward FDI increase for most of the countries. For the countries that have signed a DTA, the effect for inward FDI is on average an about 2 percent increase, while it amounts to 42 percent for outward FDI. The large values for outward FDI are driven by the importance of China and the United States as the largest outward FDI countries. Their technology capital as a share of total world technology capital (i.e., their η's) is about 18 percent (see table 3). Hence, their stocks are used substantially in many countries of the world (the exact usage at the bilateral level also depends on the FDI frictions ω). Even

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28   Note that we do not allow for changes in the share of technology capital of a country, i.e., the η is fixed.

29   Results based on the estimates of the continuous depth variables are reported in table S4.1.

though China and the United States only increased their technology capital stock (M) by about 0.16 percent and 0.12 percent, respectively, the effect on their outward FDI stocks is large due to the huge share of their FDI in world FDI and the non-rival nature, allowing the technology capital to be used in all countries in the world simultaneously.

On the inward FDI side, we see the largest increases for Chile, Singapore, Peru, Thailand, the Philippines, Malaysia, Indonesia, Vietnam, the Dominican Republic, and the Republic of Korea. These are all countries that have many DTAs and also rely substantially on inward FDI. On the other end of the spectrum are countries that are hardly affected, either on the inward or on the export side, such as Sudan, Turkmenistan, the Islamic Republic of Iran, and Iraq. Those countries do not have many (or any) DTAs in place and are also relatively closed regarding FDI. Overall, we see a wide heterogeneity among countries. This is even more extreme for outward FDI, where the importance of the large outward FDI investors is very dominant.

The estimates in columns (9) and (10) of table 3 are obtained when, in addition to the change in bilateral FDI frictions, we also change the vector of bilateral trade frictions based on our estimate from column (2) of table 1. Relative to the scenario where only the bilateral FDI frictions are changed (i.e., the results presented in columns (7) and (8) of table 3), we see qualitatively a very similar picture and quantitatively an increase in both, inward and outward FDI. Specifically, on average, trade liberalization has contributed to a 0.8 percentage points (or about 46 percent) increase in inward FDI and about 11 percentage points (or about 26 percent) in outward FDI. These estimates reveal that trade liberalization via DTAs is an important channel to stimulate FDI, thus complementing the results from Anderson, Larch, and Yotov (2019), who show that FDI liberalization is important for trade.

table S4.1 in the supplementary online appendix reports estimates that are obtained based on the estimates of the continuous depth variables . Te estimates in columns (2) and (3) rely on the estimates from column (4) of table 2. Allowing for continuous depth leads to qualitatively and quantitatively similar results, with heterogeneous changes across countries. The estimates in columns (4) and (5) of table S4.1 are obtained when, in addition to the change in bilateral FDI frictions, we also change the vector of bilateral trade frictions based on our estimate from column (3) of table 1. Similar to the changes based on the estimates with the dummy variables, the additional allowance for changes in bilateral trade frictions leads to larger effects for inward and outward FDI.

Table S4.2 in the supplementary online appendix reports estimates obtained based on the estimates of the dummy variables but using a value of 4 instead of 6 for σ. The estimates in columns (2) and (3) rely on the estimates from column (3) of table 2. Decreasing σ from 6 to 4 hardly changes the effects on inward and outward FDI if DTAs only lower FDI frictions. The estimates in columns (4) and (5) of table S4.2 are obtained when, in addition to the change in bilateral FDI frictions, we also change the vector of bilateral trade frictions based on our estimate from column (3) of table 1. In this case, we see an increase of about 0.5 percentage points of inward FDI and about 7 percentage points of outward FDI when σ is decreased from 6 to 4. A lower σ implies a lower substitutability of varieties. Hence, lowering trade costs leads to a larger change in trade flows when σ is lower. This reduces prices more and leads to a larger increase in inward and outward FDI.

Given the huge importance of China and the United States as investors in technology FDI and their corresponding large role in outward FDI, in table S4.3 in the supplementary online appendix we report estimates that are obtained based on the estimates of the dummy variables, but excluding China and the United States. All other assumptions are the same as for the results in table 3. In table S4.3 we report, after the country codes and country names, the values of the parameters α, δ, η, and ϕ. The estimates in columns (7) and (8) rely on the estimates from column (3) of table 2. Excluding China and the United States from the data set leads to slightly larger average inward FDI effects for liberalizing countries and lower effects for non-liberalizing countries if DTAs only lower FDI frictions. Outward FDI is on average substantially smaller for the liberalizing countries, but more countries play a larger role now, like Japan, Korea, India,

France, and Germany. This reflects the dominance of China and the United States for outward FDI. The estimates in columns (9) and (10) of table S4.3 are obtained when, in addition to the change in bilateral FDI frictions, we also change the vector of bilateral trade frictions based on our estimate from column (3) of table 1. As in the results before, lowering trade frictions alongside FDI frictions increases the effects on inward and outward FDI, highlighting again that trade and technology FDI are complementry, as discussed above.

To sum up, according to our analysis, the DTAs in force in 2011 contributed to about 3 percent of inward FDI in the world and about 50 percent of outward FDI. The latter is heavily driven by the fact that some countries have large stocks of FDI used in many countries in the world, multiplying the effect of any change in outward FDI of those countries due to changes in frictions.

5. Conclusion

The objective of this paper was to study the links between deep trade liberalization in the form of DTAs and FDI. To this end, we identified and decomposed three channels through which DTAs impact FDI. First, we obtained significant direct/partial equilibrium effects of DTAs and their investment provisions on FDI from a theory-motivated FDI gravity model. Second, we translated the partial estimates of the DTA effects on FDI into GE effects. This analysis highlighted the importance of the GE links between DTAs and FDI and uncovered significant asymmetries in the response of inward vs. outward FDI in our model. Finally, we performed a counterfactual analysis of the impact of deep trade liberalization on FDI, which revealed that, through their impact on trade, DTAs promote FDI additionally.

While, as discussed earlier, our counterfactual analysis is subject to criticism on the mismatch between the data used and the underlying theory, we believe that our conclusions about the disproportionately large impact on outward FDI would remain qualitatively the same if applied to appropriate data on technology FDI. We view this finding as novel and potentially important from a policy perspective, both for the negotiations of trade and investment agreements and for properly quantifying their implications. Moreover, we see significant potential in developing and utilizing data sets on global technology transfers that would generate more precise partial estimates and more informative GE analysis of the links between trade liberalization and FDI and lead to clearer policy recommendations. In addition to the theory on the intensive margin that we utilize here, we expect significant payoffs from developing theories that would capture the links between trade liberalization and the extensive margins (both domestic and international) of technology capital and its diffusion in the global economy.

Data Availability Statement

The data underlying this article and the codes to reproduce the results are available under the following link https://www.dropbox.com/scl/fo/rurwez2lzvqewqay9h3gs/AGO7T2k6gNzusg2XAFbsi-Q?rlkey=m84nzkmmb3od0nsgz3hcp3tcp&st=70vo8ab8&dl=0.

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Supplementary Online Appendix

Deep Trade Agreements and FDI in Partial and General Equilibrium: A Structural Estimation Framework

Mario Larch and **Yoto V. Yotov**

This supplementary online appendix consists of four sections. For the convenience of the reader, appendix S1 is a replication of the online appendix from Anderson, Larch, and Yotov (2019). It includes all derivations leading to the structural system of trade and investment used in this paper along with some further derivations that may aid intuition and the discussion of our results. Appendix S3 offers some additional estimation results and analysis of the effects of deep trade agreements (DTAs) on trade and foreign direct investment (FDI). Finally, Appendix S4 includes additional counterfactual results and analysis.

S1. Derivation of System of Equations (1)–(8)

This appendix gives derivation details for our system of equations (1)– (8).

First, let us restate our production function as given in equation (5), also allowing ϕ to vary by country:

$$Y_{j,t} = p_{j,t} A_{j,t} \left(L_{j,t}^{1-\alpha_j} K_{j,t}^{\alpha_j} \right)^{1-\phi_j} \left(\prod_{i=1}^{N} (\max\{1, \omega_{ij,t} M_{i,t}\})^{\eta_i} \right)^{\phi_j}, \tag{S1.1}$$

for $\alpha_j, \phi_j, \eta_i \in (0, 1)$. Note that we can write $\max\{1, \omega_{ij,t} M_{i,t}\} = (1 + \omega_{ij,t} M_{i,t} + |1 - \omega_{ij,t} M_{i,t}|)/2 = (1 + \omega_{ij,t} M_{i,t} + ((1 - \omega_{ij,t} M_{i,t})^2)^{1/2})/2$.[30] The derivative of $\max\{1, \omega_{ij,t} M_{i,t}\}$ with respect to $M_{i,t}$ is given by

$$\frac{\partial (\max\{1, \omega_{ij,t} M_{i,t}\})}{\partial M_{i,t}} = \left(\omega_{ij,t} - \frac{(1 - \omega_{ij,t} M_{i,t})}{((1 - \omega_{ij,t} M_{i,t})^2)^{1/2}} \omega_{ij,t} \right)/2$$
$$= \left(1 - \frac{(1 - \omega_{ij,t} M_{i,t})}{|1 - \omega_{ij,t} M_{i,t}|} \right) \frac{\omega_{ij,t}}{2}.$$

Using this definition of nominal output, the value marginal product of technology capital at home is given by

$$\frac{\partial Y_{j,t}}{\partial M_{j,t}} = \frac{\phi_j \eta_j Y_{j,t}}{\max\{1, \omega_{jj,t} M_{j,t}\}} \left(1 - \frac{(1 - \omega_{jj,t} M_{j,t})}{|1 - \omega_{jj,t} M_{j,t}|} \right) \frac{\omega_{jj,t}}{2},$$

and the value marginal product of $M_{j,t}$ abroad by

$$\frac{\partial Y_{i,t}}{\partial M_{j,t}} = \frac{\eta_j \phi_i Y_{i,t}}{\max\{1, \omega_{ji,t} M_{j,t}\}} \left(1 - \frac{(1 - \omega_{ji,t} M_{j,t})}{|1 - \omega_{ji,t} M_{j,t}|} \right) \frac{\omega_{ji,t}}{2}.$$

Note that an alternative way of writing these two conditions is

$$\frac{\partial Y_{j,t}}{\partial M_{j,t}} = \begin{cases} \frac{\eta_j \phi_j Y_{j,t}}{M_{j,t}} & \text{if } \omega_{jj,t} M_{j,t} > 1, \\ 0 & \text{if } \omega_{jj,t} M_{j,t} \le 1, \end{cases}$$

$$\frac{\partial Y_{i,t}}{\partial M_{j,t}} = \begin{cases} \frac{\eta_j \phi_i Y_{i,t}}{M_{j,t}} & \text{if } \omega_{ji,t} M_{j,t} > 1, \\ 0 & \text{if } \omega_{ji,t} M_{j,t} \le 1. \end{cases}$$

With these new expressions for the value marginal products, disposable income can be written as

$$E_{j,t} = Y_{j,t} + \eta_j M_{j,t} \sum_{i \ne j} \frac{\phi_i Y_{i,t}}{\max\{1, \omega_{ji,t} M_{j,t}\}} \left(1 - \frac{(1 - \omega_{ji,t} M_{j,t})}{|1 - \omega_{ji,t} M_{j,t}|} \right) \frac{\omega_{ji,t}}{2}$$

$$- \phi_j Y_{j,t} \sum_{i \ne j} \frac{\eta_i M_{i,t}}{\max\{1, \omega_{ij,t} M_{i,t}\}} \left(1 - \frac{(1 - \omega_{ij,t} M_{i,t})}{|1 - \omega_{ij,t} M_{i,t}|} \right) \frac{\omega_{ij,t}}{2},$$

which describes expenditure as the sum of total nominal output ($Y_{j,t}$) plus rents from foreign investments ($\sum_{i \ne j} M_{j,t} \times \frac{\partial Y_{i,t}}{\partial M_{j,t}}$), minus rents accruing to foreign investments ($\sum_{i \ne j} M_{i,t} \times \frac{\partial Y_{j,t}}{\partial M_{i,t}}$), which are part

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30 See for example https://math.stackexchange.com/questions/429622/show-that-the-max-x-y-fracxyx-y2.

of nominal output. Rewriting a bit further, we end up with

$$E_{j,t} = Y_{j,t} + \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t}M_{j,t}>1}} \phi_i Y_{i,t} - \phi_j Y_{j,t} \sum_{\substack{i \neq j \\ \omega_{ij,t}M_{i,t}>1}} \eta_i. \tag{S1.2}$$

In the next subsection, we first derive the solution of the dynamic problem. Afterward, we state the steady state of the system. At the end, we derive our FDI gravity system.

S1.1. Solving the "Upper Level"

This section details the Lagrangian problem and the corresponding first-order conditions for the "upper level" optimization problem leading to the structural dynamic system of trade, growth, and FDI.

We assume a log-intertemporal utility function,

$$U_{j,t} = \sum_{t=0}^{\infty} \beta^t \ln(C_{j,t}),$$

and combine the budget constraint $E_{j,t} = P_{j,t}C_{j,t} + P_{j,t}\Omega_{j,t} + P_{j,t}\chi_{j,t}$ with the expenditure function given by equation (S1.2):

$$P_{j,t}C_{j,t} + P_{j,t}\Omega_{j,t} + P_{j,t}\chi_{j,t} = Y_{j,t} + \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t}M_{j,t}>1}} \phi_i Y_{i,t} - \phi_j Y_{j,t} \sum_{\substack{i \neq j \\ \omega_{ij,t}M_{i,t}>1}} \eta_i$$

$$= \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t}M_{i,t}>1}} \eta_i\right) Y_{j,t} + \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t}M_{j,t}>1}} \phi_i Y_{i,t}.$$

Further, we replace $Y_{j,t}$ with the production function as formulated in equation (), leading to

$$P_{j,t}C_{j,t} + P_{j,t}\Omega_{j,t} + P_{j,t}\chi_{j,t} = \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t}M_{i,t}>1}} \eta_i\right) p_{j,t}A_{j,t}(L_{j,t}^{1-\alpha_j}K_{j,t}^{\alpha_j})^{1-\phi_j}\left(\prod_{i=1}^{N}(\max\{1, \omega_{ij,t}M_{i,t}\})^{\eta_i}\right)^{\phi_j}$$

$$+ \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t}M_{j,t}>1}} \phi_i p_{i,t}A_{i,t}(L_{i,t}^{1-\alpha_i}K_{i,t}^{\alpha_i})^{1-\phi_i}\left(\prod_{k=1}^{N}(\max\{1, \omega_{ki,t}M_{k,t}\})^{\eta_k}\right)^{\phi_i}.$$

To end up with only one constraint, we also replace $\Omega_{j,t}$ and $\chi_{j,t}$ by using

$$\Omega_{j,t} = K_{j,t+1} - (1-\delta_{j,K})K_{j,t},$$

$$\chi_{j,t} = M_{j,t+1} - (1-\delta_{j,M})M_{j,t},$$

leading to the following budget constraint:

$$P_{j,t}C_{j,t} + P_{j,t}(K_{j,t+1} - (1-\delta_{j,K})K_{j,t}) + P_{j,t}(M_{j,t+1} - (1-\delta_{j,M})M_{j,t})$$

$$= \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t}M_{i,t}>1}} \eta_i\right) p_{j,t}A_{j,t}(L_{j,t}^{1-\alpha_j}K_{j,t}^{\alpha_j})^{1-\phi_j}\left(\prod_{i=1}^{N}(\max\{1, \omega_{ij,t}M_{i,t}\})^{\eta_i}\right)^{\phi_j}$$

$$+ \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t}M_{j,t}>1}} \phi_i p_{i,t}A_{i,t}(L_{i,t}^{1-\alpha_i}K_{i,t}^{\alpha_i})^{1-\phi_i}\left(\prod_{k=1}^{N}(\max\{1, \omega_{ki,t}M_{k,t}\})^{\eta_k}\right)^{\phi_i}.$$

The corresponding expression for the Lagrangian is

$$\mathcal{L}_j = \sum_{t=0}^{\infty} \beta^t \Bigg[\ln(C_{j,t}) + \lambda_{j,t} \Bigg(\Bigg(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t} M_{i,t} > 1}} \eta_i \Bigg) p_{j,t} A_{j,t} (L_{j,t}^{1-\alpha_j} K_{j,t}^{\alpha_j})^{1-\phi_j} \Bigg(\prod_{i=1}^{N} (\max\{1, \omega_{ij,t} M_{i,t}\})^{\eta_i} \Bigg)^{\phi_j}$$

$$+ \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t} M_{j,t} > 1}} \phi_i p_{i,t} A_{i,t} (L_{i,t}^{1-\alpha_i} K_{i,t}^{\alpha_i})^{1-\phi_i} \Bigg(\prod_{k=1}^{N} (\max\{1, \omega_{ki,t} M_{k,t}\})^{\eta_k} \Bigg)^{\phi_i}$$

$$- P_{j,t} C_{j,t} - P_{j,t} (K_{j,t+1} - (1-\delta_{j,K}) K_{j,t}) - P_{j,t} (M_{j,t+1} - (1-\delta_{j,M}) M_{j,t}) \Bigg) \Bigg].$$

Take derivatives with respect to $C_{j,t}$, $K_{j,t+1}$, $M_{j,t+1}$, and $\lambda_{j,t}$ to obtain the following set of first-order conditions:

$$\frac{\partial \mathcal{L}_j}{\partial C_{j,t}} = \frac{\beta^t}{C_{j,t}} - \beta^t \lambda_{j,t} P_{j,t} \overset{!}{=} 0 \quad \text{for all } j \text{ and } t,$$

$$\frac{\partial \mathcal{L}_j}{\partial K_{j,t+1}} = \beta^{t+1} \lambda_{j,t+1} \Bigg(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i \Bigg)(1-\phi_j) \alpha_j \frac{Y_{j,t+1}}{K_{j,t+1}} - \beta^t \lambda_{j,t} P_{j,t}$$

$$+ \beta^{t+1} \lambda_{j,t+1} P_{j,t+1} (1-\delta_{j,K}) \overset{!}{=} 0 \quad \text{for all } j \text{ and } t,$$

$$\frac{\partial \mathcal{L}_j}{\partial M_{j,t+1}} = \beta^{t+1} \lambda_{j,t+1} \Bigg(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i \Bigg) \frac{\eta_j \phi_j Y_{j,t+1}}{\max\{1, \omega_{jj,t+1} M_{j,t+1}\}} \left(1 - \frac{(1 - \omega_{jj,t+1} M_{j,t+1})}{|1 - \omega_{jj,t+1} M_{j,t+1}|} \right) \frac{\omega_{jj,t+1}}{2}$$

$$+ \beta^{t+1} \lambda_{j,t+1} \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t+1} M_{j,t+1} > 1}} \frac{\eta_j \phi_i^2 Y_{i,t+1}}{\max\{1, \omega_{ji,t+1} M_{j,t+1}\}} \left(1 - \frac{(1 - \omega_{ji,t+1} M_{i,t+1})}{|1 - \omega_{ji,t+1} M_{j,t+1}|} \right) \frac{\omega_{ji,t+1}}{2}$$

$$- \beta^t \lambda_{j,t} P_{j,t} + \beta^{t+1} \lambda_{j,t+1} P_{j,t+1} (1-\delta_{j,M}) \overset{!}{=} 0 \quad \text{for all } j \text{ and } t,$$

$$\frac{\partial \mathcal{L}_j}{\partial \lambda_{j,t}} = \Bigg(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t} M_{i,t} > 1}} \eta_i \Bigg) p_{j,t} A_{j,t} (L_{j,t}^{1-\alpha_j} K_{j,t}^{\alpha_j})^{1-\phi_j} \Bigg(\prod_{i=1}^{N} (\max\{1, \omega_{ij,t} M_{i,t}\})^{\eta_i} \Bigg)^{\phi_j}$$

$$+ \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t} M_{j,t} > 1}} \phi_i p_{i,t} A_{i,t} (L_{i,t}^{1-\alpha_i} K_{i,t}^{\alpha_i})^{1-\phi_i} \Bigg(\prod_{k=1}^{N} (\max\{1, \omega_{ki,t} M_{k,t}\})^{\eta_k} \Bigg)^{\phi_i} - P_{j,t} C_{j,t} - P_{j,t} (K_{j,t+1} - (1-\delta_{j,K}) K_{j,t})$$

$$- P_{j,t} (M_{j,t+1} - (1-\delta_{j,M}) M_{j,t})$$

$$\overset{!}{=} 0 \quad \text{for all } j \text{ and } t. \tag{S1.3}$$

Use the first-order condition for consumption to express $\lambda_{j,t}$ as

$$\lambda_{j,t} = \frac{1}{C_{j,t} P_{j,t}}. \tag{S1.4}$$

Replace this in the first-order condition for physical capital:

$$\frac{\partial \mathcal{L}_j}{\partial K_{j,t+1}} = \beta^{t+1} \frac{1}{C_{j,t+1} P_{j,t+1}} \Bigg(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i \Bigg)(1-\phi_j) \alpha_j \frac{Y_{j,t+1}}{K_{j,t+1}} - \beta^t \frac{P_{j,t}}{C_{j,t} P_{j,t}}$$

$$+ \beta^{t+1} \frac{P_{j,t+1}}{C_{j,t+1} P_{j,t+1}} (1-\delta_{j,K}) \overset{!}{=} 0 \quad \text{for all } j \text{ and } t.$$

Simplify and rearrange to obtain

$$\beta\left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i\right) \alpha_j (1 - \phi_j) \frac{Y_{j,t+1}}{K_{j,t+1}} - \frac{C_{j,t+1} P_{j,t+1}}{C_{j,t}} = -\beta(1 - \delta_{j,K}) P_{j,t+1} \quad \text{for all } j \text{ and } t. \tag{S1.5}$$

Now replace λ_j with the expression from the first-order condition for consumption given in equation (S1.4) in the first-order condition for technology capital given in equation (S1.3):

$$\frac{\partial \mathcal{L}_j}{\partial M_{j,t+1}} = \beta^{t+1} \frac{1}{C_{j,t+1} P_{j,t+1}} \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i\right) \times \frac{\eta_j \phi_j Y_{j,t+1}}{\max\{1, \omega_{jj,t+1} M_{j,t+1}\}} \left(1 - \frac{(1 - \omega_{jj,t+1} M_{j,t+1})}{|1 - \omega_{jj,t+1} M_{j,t+1}|}\right) \frac{\omega_{jj,t+1}}{2}$$

$$+ \beta^{t+1} \frac{1}{C_{j,t+1} P_{j,t+1}} \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t+1} M_{i,t+1} > 1}} \frac{\eta_j \phi_i^2 Y_{i,t+1}}{\max\{1, \omega_{ji,t+1} M_{i,t+1}\}} \left(1 - \frac{(1 - \omega_{ji,t+1} M_{i,t+1})}{|1 - \omega_{ji,t+1} M_{i,t+1}|}\right) \frac{\omega_{ji,t+1}}{2} - \beta^t \frac{1}{C_{j,t}}$$

$$+ \frac{\beta^{t+1}}{C_{j,t+1}} (1 - \delta_{j,M}) \overset{!}{=} 0 \quad \text{for all } j \text{ and } t.$$

Simplify and rearrange to obtain

$$\beta\left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i\right) \frac{\eta_j \phi_j Y_{j,t+1}}{\max\{1, \omega_{jj,t+1} M_{j,t+1}\}} \left(1 - \frac{(1 - \omega_{jj,t+1} M_{j,t+1})}{|1 - \omega_{jj,t+1} M_{j,t+1}|}\right) \frac{\omega_{jj,t+1}}{2}$$

$$+ \beta \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t+1} M_{i,t+1} > 1}} \frac{\eta_j \phi_i^2 Y_{i,t+1}}{\max\{1, \omega_{ji,t+1} M_{i,t+1}\}} \left(1 - \frac{(1 - \omega_{ji,t+1} M_{i,t+1})}{|1 - \omega_{ji,t+1} M_{i,t+1}|}\right) \frac{\omega_{ji,t+1}}{2}$$

$$- \frac{C_{j,t+1} P_{j,t+1}}{C_{j,t}} = \beta(1 - \delta_{j,M}) P_{j,t+1} \quad \text{for all } j \text{ and } t. \tag{S1.6}$$

Assuming that for sure $\omega_{jj,t+1} M_{j,t+1} > 1$, i.e., technology stock at home is positive and frictions small (i.e., $\omega_{jj,t+1}$ sufficiently large), we may simplify as follows:

$$\beta\left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i\right) \frac{\eta_j \phi_j Y_{j,t+1}}{M_{j,t+1}} + \beta \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t+1} M_{i,t+1} > 1}} \frac{\eta_j \phi_i^2 Y_{i,t+1}}{M_{j,t+1}} - \frac{C_{j,t+1} P_{j,t+1}}{C_{j,t}} = -\beta(1 - \delta_{j,M}) P_{j,t+1} \quad \text{for all } j \text{ and } t.$$

Combining the production function given by equation (S1.1), the budget constraint given by $E_{j,t} = P_{j,t} C_{j,t} + P_{j,t} \Omega_{j,t} + P_{j,t} \chi_{j,t}$, the expression for $E_{j,t}$ given in equation (S1.2), the expressions for $p_{j,t}$ for each t from equation (4), and the equations for the trade MRTs $P_{j,t}$ and $\Pi_{j,t}$ given by equations (2) and (3), respectively, with the two first-order conditions for $K_{j,t+1}$ and $M_{j,t+1}$ as given by equations (S1.5) and (S1.6), respectively, we end up with the following system:

$$Y_{j,t} = p_{j,t} A_{j,t} (L_{j,t}^{1-\alpha_j} K_{j,t}^{\alpha_j})^{1-\phi_j} \left(\prod_{i=1}^{N} (\max\{1, \omega_{ij,t} M_{i,t}\})^{\eta_i}\right)^{\phi_j} \quad \text{for all } j \text{ and } t, \tag{S1.7}$$

$$E_{j,t} = P_{j,t} C_{j,t} + P_{j,t}(K_{j,t+1} - (1 - \delta_{j,K}) K_{j,t}) + P_{j,t}(M_{j,t+1} - (1 - \delta_{j,M}) M_{j,t}) \quad \text{for all } j \text{ and } t, \tag{S1.8}$$

$$E_{j,t} = Y_{j,t} + \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t} M_{j,t} > 1}} \phi_i Y_{i,t} - \phi_j Y_{j,t} \sum_{\substack{i \neq j \\ \omega_{ij,t} M_{i,t} > 1}} \eta_i \quad \text{for all } j \text{ and } t, \tag{S1.9}$$

$$p_{j,t} = \frac{(Y_{j,t}/Y_t)^{\frac{1}{1-\sigma}}}{\gamma_j \Pi_{j,t}} \quad \text{for all } j \text{ and } t, \tag{S1.10}$$

$$Y_t = \sum_{j=1}^{N} Y_{j,t} \quad \text{for all } t, \tag{S1.11}$$

$$P_{j,t}^{1-\sigma} = \sum_{i=1}^{N} \left(\frac{t_{ij,t}}{\Pi_{i,t}}\right)^{1-\sigma} \frac{Y_{i,t}}{Y_t} \quad \text{for all } j \text{ and } t, \tag{S1.12}$$

$$\Pi_{i,t}^{1-\sigma} = \sum_{j=1}^{N} \left(\frac{t_{ij,t}}{P_{j,t}}\right)^{1-\sigma} \frac{E_{j,t}}{Y_t} \quad \text{for all } i \text{ and } t, \tag{S1.13}$$

$$\beta \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{i,t+1} > 1}} \eta_i\right) \alpha_j (1 - \phi_j) \frac{Y_{j,t+1}}{K_{j,t+1}} - \frac{C_{j,t+1} P_{j,t+1}}{C_{j,t}} = \beta(\delta_{j,K} - 1) P_{j,t+1} \quad \text{for all } j \text{ and } t. \tag{S1.14}$$

$$\beta \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij,t+1} M_{j,t+1} > 1}} \eta_i\right) \frac{\eta_j \phi_j Y_{j,t+1}}{M_{j,t+1}} + \beta \eta_j \sum_{\substack{i \neq j \\ \omega_{ji,t+1} M_{j,t+1} > 1}} \frac{\eta_j \phi_i^2 Y_{i,t+1}}{M_{j,t+1}} - \frac{C_{j,t+1} P_{j,t+1}}{C_{j,t}}$$
$$= \beta(\delta_{j,M} - 1) P_{j,t+1} \quad \text{for all } j \text{ and } t. \tag{S1.15}$$

This is a system of $(8 \times N + 1) \times T$ equations in the $(8 \times N + 1) \times T$ unknowns $C_{j,t}, K_{j,t}, M_{j,t}, Y_{j,t}, Y_t,$ $p_{j,t}, P_{j,t}, \Pi_{j,t}, E_{j,t}$ and given parameters and exogenous variables $A_{j,t}, \omega_{ij,t}, L_{j,t}, \alpha_j, \beta, \phi_j, \eta_j, \gamma_j, \sigma, t_{ij,t},$ $\delta_{j,K}$, and $\delta_{j,M}$.

S1.2. Derivation of the Steady State
In steady state, values for $t + 1$ and t have to be equal. Hence, we can express physical and technology capital as

$$K_j = \frac{\Omega_j}{\delta_{j,K}}, \quad M_j = \frac{\chi_j}{\delta_{j,M}}.$$

Further, we can drop the time index for all variables. Let us first drop time indices in the first-order condition for physical capital as given in equation (S1.14):

$$\beta \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij} M_i > 1}} \eta_i\right) \alpha_j (1 - \phi_j) \frac{Y_j}{K_j} - \frac{C_j P_j}{C_j} = \beta(\delta_{j,K} - 1) P_j \quad \text{for all } j$$

$$\Rightarrow \beta \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij} M_i > 1}} \eta_i\right) \alpha_j (1 - \phi_j) \frac{Y_j}{P_j K_j} - 1 = \beta(\delta_{j,K} - 1) \quad \text{for all } j$$

$$\Rightarrow \beta \left(1 - \phi_j \sum_{\substack{i \neq j \\ \omega_{ij} M_i > 1}} \eta_i\right) \frac{\alpha_j (1 - \phi_j)}{(1 - \beta + \beta \delta_{j,K})} \frac{Y_j}{P_j} = K_j \quad \text{for all } j.$$

Let us next drop time indices in the first-order condition for technology capital as given in equation (S1.15):

$$\beta\left(1-\phi_j\sum_{\substack{i\neq j\\ \omega_{ij}M_i>1}}\eta_i\right)\frac{\eta_j\phi_j Y_j}{M_j}+\beta\eta_j\sum_{\substack{i\neq j\\ \omega_{ji}M_j>1}}\frac{\eta_j\phi_i^2 Y_i}{M_j}-\frac{C_j P_j}{C_j}=\beta(\delta_{j,M}-1)P_j\quad\text{for all }j$$

$$\Rightarrow\beta\left(1-\phi_j\sum_{\substack{i\neq j\\ \omega_{ij}M_i>1}}\eta_i\right)\frac{\eta_j\phi_j Y_j}{P_j M_j}+\beta\eta_j\sum_{\substack{i\neq j\\ \omega_{ji}M_j>1}}\frac{\eta_j\phi_i^2 Y_i}{P_j M_j}-1=\beta(\delta_{j,M}-1)\quad\text{for all }j$$

$$\Rightarrow\frac{\beta\eta_j}{1-\beta+\beta\delta_{j,M}}\left(\left(1-\phi_j\sum_{\substack{i\neq j\\ \omega_{ij}M_i>1}}\eta_i\right)\frac{\phi_j Y_j}{P_j}+\sum_{\substack{i\neq j\\ \omega_{ji}M_j>1}}\frac{\eta_j\phi_i^2 Y_i}{P_j}\right)=M_j\quad\text{for all }j.$$

Hence, the equation system given by equations (S1.7)–(S1.15) simplifies to

$$Y_j=p_j A_j(L_j^{1-\alpha_j}K_j^{\alpha_j})^{1-\phi_j}\left(\prod_{i=1}^{N}(\max\{1,\omega_{ij}M_i\})^{\eta_i}\right)^{\phi_j}\quad\text{for all }j,$$

$$E_j=P_j C_j+P_j\delta_{j,K}K_j+P_j\delta_{j,M}M_j\quad\text{for all }j,$$

$$E_j=Y_j+\eta_j\sum_{\substack{i\neq j\\ \omega_{ji}M_j>1}}\phi_i Y_i-\phi_j Y_j\sum_{\substack{i\neq j\\ \omega_{ij}M_i>1}}\eta_i\quad\text{for all }j,$$

$$p_j=\frac{(Y_j/Y)^{\frac{1}{1-\sigma}}}{\gamma_j\Pi_j}\quad\text{for all }j,$$

$$Y=\sum_{j=1}^{N}Y_j,$$

$$P_j^{1-\sigma}=\sum_{i=1}^{N}\left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma}\frac{Y_i}{Y}\quad\text{for all }j,\tag{S1.16}$$

$$\Pi_i^{1-\sigma}=\sum_{j=1}^{N}\left(\frac{t_{ij}}{P_j}\right)^{1-\sigma}\frac{E_j}{Y}\quad\text{for all }i,\tag{S1.17}$$

$$K_j=\beta\left(1-\phi_j\sum_{\substack{i\neq j\\ \omega_{ij}M_i>1}}\eta_i\right)\frac{\alpha_j(1-\phi_j)}{(1-\beta+\beta\delta_{j,K})}\frac{Y_j}{P_j}\quad\text{for all }j,$$

$$M_j=\frac{\beta\eta_j}{1-\beta+\beta\delta_{j,M}}\left(\left(1-\phi_j\sum_{\substack{i\neq j\\ \omega_{ij}M_i>1}}\eta_i\right)\frac{\phi_j Y_j}{P_j}+\sum_{\substack{i\neq j\\ \omega_{ji}M_j>1}}\frac{\eta_j\phi_i^2 Y_i}{P_j}\right)\quad\text{for all }j.\tag{S1.18}$$

Note that trade flows in steady state are then given by $X_{ij}=\frac{Y_i E_j}{Y}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma}$.

S1.3. Derivation of the FDI Gravity Equation

The steady-state system above yields a convenient gravity representation of FDI that is remarkably similar to the familiar trade gravity system. To obtain it, recall the (steady-state) definition of bilateral FDI stock:

$$\text{FDI}_{ij}\equiv\omega_{ij}M_i.\tag{S1.19}$$

Replacing M_i by the expression given in equation (S1.18), we can write

$$\text{FDI}_{ij} \equiv \omega_{ij} \frac{\beta \eta_i}{1 - \beta + \beta \delta_{i,M}} \left(\left(1 - \phi_i \sum_{\substack{k \neq i \\ \omega_{ki} M_k > 1}} \eta_k \right) \frac{\phi_i Y_i}{P_i} + \sum_{\substack{k \neq i \\ \omega_{ik} M_i > 1}} \frac{\eta_i \phi_k^2 Y_k}{P_i} \right). \tag{S1.20}$$

Equation (S1.20) describes physical FDI stocks. To translate (S1.20) into a stock value FDI equation needed for estimation with data on FDI stock *values*, define the value of FDI from country i to country j as the product of the FDI stock times its value marginal product:

$$\text{FDI}_{ij}^{\text{value}} \equiv \text{FDI}_{ij} \times \frac{\partial Y_j}{\partial M_i}$$

$$= \omega_{ij} \frac{\beta \eta_i^2}{1 - \beta + \beta \delta_{i,M}} \left(\left(1 - \phi_i \sum_{\substack{k \neq i \\ \omega_{ki} M_k > 1}} \eta_k \right) \frac{\phi_i Y_i}{P_i} + \sum_{\substack{k \neq i \\ \omega_{ik} M_i > 1}} \frac{\eta_i \phi_k^2 Y_k}{P_i} \right) \frac{\phi_j Y_j}{M_i}.$$

Assuming a common production share of FDI across countries,

$$E_i = Y_i + \eta_i \phi \sum_{\substack{j \neq i \\ \omega_{ij} M_i > 1}} Y_j - \phi Y_i \sum_{\substack{j \neq i \\ \omega_{ji} M_j > 1}} \eta_j,$$

and using the steady-state solution for technology capital M_i from equation (S1.18), we can write

$$M_i = \frac{\beta \phi \eta_i}{1 - \beta + \beta \delta_{i,M}} \frac{E_i}{P_i}.$$

Substitute for M_i in equation (S1.19) to obtain

$$\text{FDI}_{ij} = \omega_{ij} \frac{\beta \phi \eta_i}{1 - \beta + \beta \delta_{i,M}} \frac{E_i}{P_i}. \tag{S1.21}$$

Translating (S1.21) into a stock value FDI equation needed for estimation we again multiply by the value marginal product:

$$\text{FDI}_{ij}^{\text{value}} \equiv \text{FDI}_{ij} \times \frac{\partial Y_j}{\partial M_i} = \omega_{ij} \frac{\beta \phi \eta_i}{1 - \beta + \beta \delta_{i,M}} \frac{E_i}{P_i} \phi \eta_i \frac{Y_j}{M_i}$$

$$= \frac{\beta \phi^2 \eta_i^2}{1 - \beta + \beta \delta_{i,M}} \omega_{ij} \frac{E_i}{P_i} \frac{Y_j}{M_i}. \tag{S1.22}$$

Combine equation (S1.22) with the definitions of the multilateral resistance terms P_j and Π_j given by equations (S1.16) and (S1.17), respectively, to obtain the following FDI gravity system:

$$\text{FDI}_{ij}^{\text{value}} = \frac{\beta \phi^2 \eta_i^2}{1 - \beta + \beta \delta_{i,M}} \omega_{ij} \frac{E_i}{P_i} \frac{Y_j}{M_i},$$

$$P_i = \left[\sum_{j=1}^{N} \left(\frac{t_{ji}}{\Pi_j} \right)^{1-\sigma} \frac{Y_j}{Y} \right]^{\frac{1}{1-\sigma}},$$

$$\Pi_j = \left[\sum_{i=1}^{N} \left(\frac{t_{ji}}{P_i} \right)^{1-\sigma} \frac{E_i}{Y} \right]^{\frac{1}{1-\sigma}}.$$

S2. On the Links between DTAs and FDI: A Discussion

This section describes and decomposes the channels through which DTAs affect FDI. To this end, and consistent with the estimation results that we presented in the main text, as a comparative static shock to system (1)–(8) we consider the formation of a DTA with investment provisions, which is successful in liberalizing both trade and FDI. For clarity and ease of exposition, we consider a specific example—

the EU–Canada Comprehensive Economic and Trade Agreement (CETA).[31] Moreover, consistent with the counterfactual analysis that we perform in Section 4, we discuss the effects of trade liberalization and investment liberalization sequentially, starting with the effects of investment liberalization, which is captured by an increase of ω_{ij} in our model. A decrease in FDI barriers will have a direct effect and several indirect (GE) effects on FDI in system (1)–(8):

- *Direct DTAs impact on FDI.* The direct effect of lower bilateral investment costs between the EU and Canada is captured by equation (8), and it would lead to an immediate increase in FDI between the liberalizing partners. In the empirical analysis below, we can identify the direct impact of DTAs on FDI from our estimating FDI gravity model. Then, we will use our partial estimates of these direct effects to simulate the indirect/GE effects, which we describe next.

- *First-order GE effect of DTAs on FDI.* The removal of FDI barriers (i.e., an increase of ω_{ij}) between Canada and the EU will lead to higher income, through (5), and higher expenditure, through (6), in the two regions. In turn, via equation (8), the changes in the sizes of the liberalizing partners will lead to more FDI between them and also, ceteris paribus, between each of them and all other countries in the world. These GE size effects are similar to the familiar size effects from the trade gravity literature.

- *Second-order GE effect of DTAs on FDI.* The changes in the sizes of the two regions will lead to changes in the multilateral resistances through system (2)–(3). This relationship is inverse, which means that the multilateral resistances will fall. A lower inward multilateral resistance will stimulate investment via (8). As discussed earlier, the intuition for this result is that the IMR can be interpreted as the price of investment or the opportunity cost of investment.

- *Third-order GE effects of DTAs on FDI.* Finally, we label the effects of changes in FDI barriers through variables not explicitly included in equation (8) as "third-order GE effect of DTAs on FDI." System (1)–(8) captures at least two such effects. The first one is via the outward multilateral resistance. As noted earlier, the OMR does not appear explicitly in (8). Nevertheless, it is linked to the other endogenous variables in our model via the MR system (2)–(3). The second one is via physical capital accumulation, which, as captured by equation (7), would respond to the changes in size and the IMR and, in turn, will stimulate a further increase in size.

Next, we turn to the effects of DTAs on FDI through trade liberalization, e.g., a reduction in the bilateral trade costs (t_{ij}) between Canada and the EU countries in our model. Naturally, all such effects would be indirect, and, similar to the analysis of FDI liberalization, we discuss three GE channels through which trade liberalization could impact FDI:

- *First-order GE effect of DTAs on FDI.* A fall in the trade barriers between Canada and the EU will lead to lower inward multilateral resistance, via the direct relationship between bilateral trade frictions and the IMR as captured by equation (2). A lower inward multilateral resistance will stimulate investment via equation (8). As explained by Anderson, Larch, and Yotov (2019), in their framework, on the net, non-rival FDI is complementary to exports. This is different from frameworks where the trade-off between trade and FDI is based on the proximity-concentration trade-off (see Brainard 1993, 1997; Markusen 1995; Antràs and Yeaple 2014).

- *Second-order GE effect of DTAs on FDI.* Triggered by trade liberalization the outward multilateral resistances for Canada and the EU will decrease (via (2)–(3)). In turn, this will lead to higher factory-gate prices (via (4)) and larger sizes (via (5) and (6)) in Canada and the EU. As discussed earlier, larger sizes would stimulate FDI (via (8)).

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31 CETA is appropriate for our purposes as it is a deep trade agreement that "features some of the strongest commitments ever included in an EU trade agreement" to promote both trade and investment between the two partners https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/canada/eu-canada-agreement_en.

• *Third-order GE effects of DTAs on FDI.* Finally, similar to the impact of FDI liberalization, a fall in trade barriers will trigger "third-order GE effect of DTAs on FDI," which are channeled via the OMR, through system (2)–(3), and via physical capital accumulation, as captured by equation (7).

To summarize, this section demonstrated how our structural system captures and decomposes a series of channels through which DTAs may affect FDI in member and non-member countries. We capitalize on this analysis in the main text, where we simulate the GE effects of DTAs based on our partial estimates of the effects of DTAs on trade and investment, which we also obtain in the main text based on the econometric models that we specify next.

S3. Additional Estimation Analysis

This section includes results and a discussion of some econometric specifications, which complement our main findings and test their robustness. Table S3.1 offers additional results for the impact of DTAs on trade. To ease comparison, the estimates in column (1) reproduce our main findings. The results in column (2) of table S3.1 are obtained from our main specification but without domestic trade flows. The new DTA estimate is smaller and it is not statistically significant. This result is consistent with the findings of Dai, Yotov, and Zylkin (2014), Bergstrand, Larch, and Yotov (2015), and, most recently, Larch and Yotov (2024), and the intuition for it is that the addition of domestic trade flows allows us to capture trade diversion effects from domestic toward international trade flows.[32]

The results in column (3) of table S3.1 are obtained from our main specification but without explicitly accounting for common globalization effects. Specifically, we omit the time-varying dummy variables for international borders. Consistent with the arguments from Bergstrand, Larch, and Yotov (2015), we see that once common globalization effects are not explicitly accounted for, the estimate on DTAs is significantly larger—almost two times larger. The intuition is that the DTA estimates from column (3) are now also capturing common globalization trends. Thus, our findings support the conclusion from Bergstrand, Larch, and Yotov (2015) that failing to control common globalization may bias the estimates of trade agreements in gravity regressions.

The results in column (4) of table S3.1 are obtained from our main specification but without explicitly controlling for the impact of the WTO. The DTA estimate is not statistically different from our main result. However, it is a bit smaller. The interpretation of this result is that the effects of the WTO and DTAs are complementary to each other, rather than being substitutes. Pushing inference to the limit, a possible interpretation of the smaller DTA estimate in column (4) is that WTO membership benefits DTA trade liberalization.

In addition to not controlling for the impact of WTO, we also do not control for sanction effects in column (5) of table S3.1. Compared to column (4), we see hardly any change of the estimated effect of preferential trade agreements (PTAs), deep trade agreements (DTAs), and bilateral investment agreements (BITs). Hence, in our sample and for our time period, sanctions do not seem to affect the impacts of trade and investment policies.

In column (6) of table S3.1, we allow for heterogeneous effects of the impact of DTAs on trade in the 1990s and in the 2000s. We find that the two estimates are very similar to each other. Combined with the fact that DTAs have become deeper over time, this result seems a bit counterintuitive, i.e., because deeper agreements should have led to larger trade effects. We have several explanations. First, many of the "natural" trade agreements were concluded in the 1980s and 1990s. Thus, some of the largest gains

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32 We also note that the effects of the WTO disappear in column (2). This result is consistent with the findings from Larch et al. (2024).

Table S3.1. Estimates of the Effects of DTAs on Trade

	(1) PTA	(2) DOM	(3) GLOB	(4) WTO	(5) WTO/SANCT	(6) TIME	(7) DATA
$PTA_{ij,t}$	−0.076	−0.076	−0.099	−0.005	−0.004	−0.075	−0.094
	(0.056)	(0.047)	(0.063)	(0.057)	(0.057)	(0.056)	(0.045)*
$DTA_{ij,t}$	0.139	0.023	0.251	0.103	0.102	–	0.164
	(0.025)**	(0.026)	(0.030)**	(0.027)**	(0.027)**		(0.028)**
$DTA\_1990s_{ij,t}$	–	–	–	–	–	0.143	–
						(0.026)**	
$DTA\_2000s_{ij,t}$	–	–	–	–	–	0.136	–
						(0.028)**	
$WTO_{ij,t}$	0.423	0.120	0.519	–	–	0.421	0.374
	(0.041)**	(0.116)	(0.043)**			(0.042)**	(0.047)**
$BIT_{ij,t}$	0.160	0.057	0.227	0.216	0.218	0.159	0.166
	(0.031)**	(0.027)*	(0.033)**	(0.041)**	(0.040)**	(0.031)**	(0.031)**
$SANCT_{ij,t}$	0.020	0.038	0.069	−0.010	–	0.020	−0.069
	(0.018)	(0.019)*	(0.017)**	(0.021)		(0.018)	(0.020)**
N	161,425	159,808	161,425	161,425	161,425	161,425	148,263

Source: Own calculations.

Note: This table reports robustness estimates of the effects of trade agreements on trade. The dependent variable is nominal trade flows. The estimator is the Poisson pseudo-maximum-likelihood (PPML) estimator. All estimates are obtained with three-way fixed effects, including exporter-time, importer-time, and directional pair fixed effects. In addition, all specifications, except for column (3), include a full set of time-varying border variables. The estimates of the border dummies and all fixed effects, including the constant, are omitted for brevity. The standard errors in all specifications are clustered by country pair. Column (1) replicates our main estimates, where the main variables of interest are the effects of the average preferential trade agreements (PTA) and deep trade agreements (DTA), and World Trade Organization (WTO) membership (WTO), bilateral investment treaties (BIT), and economic sanctions (SANCT) are further controls. Column (2) does not include domestic trade flows. Column (3) does not include the time-varying border variables. Column (4) does not control for (WTO) effects. Column (5) does not control for WTO and sanction effects. Column (6) allows for heterogeneous effects of the impact of DTAs on trade in the 1990s and the 2000s. Finally, column (7) uses the structural gravity data set of the WTO. $^+ p < 0.10, ^* p < .05, ^{**} p < .01$.

from trade agreements have already been realized.[33] Second, the period 2000–2010 was marked by two deep recessions. Finally, combined with our previous findings about the effects of globalization, we believe that the DTAs have been effective in promoting trade, and without the additional efforts and provisions, our estimate of the DTA effects for the 2000s would have been significantly smaller.

Next, we experiment with two alternative data sets.[34] The motivation for these analyses is two-fold. First, we want to test whether the small DTA estimates that we obtain are confirmed with different data. Second, the two alternative data sets that we employ use different procedures to construct domestic trade. The estimates in column (6) are obtained with the structural gravity data set of the World Trade Organization (WTO), which covers international and domestic trade for total manufacturing.[35] The DTA estimate from column (6) is not statistically different from (and only slightly larger than) our main results.

Finally, the results in fig. S3.1 are obtained with the International Trade and Production Database for Estimations (ITPD-E) of the US International Trade Commission (USITC).[36] Similar to our main data set, ITPD-E includes international and domestic trade flows. However, an additional advantage of the ITPD-E database is that it offers disaggregated data for 170 industries. We are not aware of the existence of DTA estimates with domestic trade flows at such disaggregated level, and we draw two conclusions based on

33 We remind the reader that the pair fixed effects in our econometric model fully absorb the impact of DTAs that entered into force before 1990.
34 We are grateful for helpful referee suggestions that pushed us in this direction.
35 These data are constructed by Larch et al. (2024), and we refer the reader to https://www.wto.org/english/res_e/reser_e/structural_gravity_e.htm for further details.
36 This data set is constructed by Borchert et al. (2021), Borchert et al. (2022), and we refer the reader to https://www.usitc.gov/data/gravity/itpde.htm for further details.

Figure S3.1. Industry-Level DTA Effects on Trade, ITPD-E

Source: Own calculations.

Note: This figure reports disaggregated estimates (together with the corresponding 95 percent confidence limits) of the effects of deep trade agreements (DTAs) on trade, which are obtained for each of the 170 industries in the ITPD-E database. The estimates are ordered in terms of magnitude and, for clarity, we have eliminated the bottom 5 percent and the top 5 percent of the estimates. The dependent variable is always nominal trade flows. The estimator is the Poisson pseudo-maximum-likelihood (PPML) estimator, and all estimates are obtained with three-year interval data and three-way fixed effects, including exporter-time, importer-time, and directional pair fixed effects. In addition, all specifications include a full set of time-varying border variables. The standard errors in all specifications are clustered by country pair..

the results in fig. S3.1. First, we confirm that, on average, the estimates of the effects of DTAs on trade are relatively small. Second, we see that they are quite heterogeneous across the ITPD-E industries. Exploring the drivers of the heterogeneous DTA estimates is beyond the scope of this paper. However, we believe that a deeper analysis may generate important policy implications.

In our second set of robustness experiments, we explore further the heterogeneity of the effects of DTAs on FDI by capitalizing on the richness of the DCRTA data set to shed light on the links between DTA provisions and FDI.[37] First, we complement the analysis of Laget, Rocha, and Varela (2021), who study the impact of several alternative PTA disciplines/provisions on FDI, by investigating the effects of all provision types from DCRTA on aggregate FDI. To this end, we rely on the dummy-variable specification from column (3) of table 2 by sequentially replacing the dummy variable for DTAs with investment provisions ($INV_{ij,t}$) with corresponding indicator variables for each of the other 17 types of provisions from DCRTA. For brevity, in table S3.2 we just summarize our main findings concerning the DTA provisions.

The following results stand out from our analysis. First, due to (near) perfect collinearity with the DTAs dummy, we could not identify the effects of agreements with provisions covering "antidumping duties," "countervailing duties," and "competition policy." Our indicator for agreements including "competition policy" provisions is perfectly collinear with the DTA dummy, while the correlations between the indicators for agreements with provisions covering "antidumping duties" and "countervailing duties" and the

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37 We are very grateful to Nadia Rocha and Vanessa Alviarez for suggesting we investigate the effects of additional provisions and alternative measures of the depth of DTAs.

Table S3.2. Alternative DTA Provisions and FDI

(1) Provision description	(2) Estimate	(3) Standard error
Investment	0.191	0.095
Labor market regulations	0.220	0.087
Public procurement	0.385	0.115
State-owned enterprises	0.292	0.114
Movement of capital	0.135	0.103
Export taxes	0.173	0.115
Environmental laws	− 0.165	0.199
Intellectual property rights	− 0.107	0.083
Visa and asylum	0.120	0.099
Rules of origin	0.085	0.127
Services	0.048	0.089
Technical barriers to trade	0.066	0.097
Subsidies	− 0.231	0.195
Sanitary and phytosanitary	− 0.019	0.091
Trade facilitation and customs	− 0.168	0.138
Anti-dumping duties	.	.
Competition policy	.	.
Countervailing duties	.	.

Source: Own calculations.

Note: This table reports estimates of the effects of a series of deep trade agreement (DTA) provisions on foreign direct investment (FDI) over the period 1990–2011. Each row corresponds to a separate econometric model based on the specification from column (3) of table 2 after replacing the dummy variable for DTAs with investment provisions ($INV_{ij,t}$) with corresponding indicator variables for each of the other 17 types of provisions from World Bank's Database on the Content of Regional Trade Agreements (DCRTA). The dependent variable is the value of FDI stock. The estimator is the Poisson pseudo-maximum-likelihood (PPML) estimator. All estimates are obtained with three-year interval data and three-way fixed effects, including origin-time, destination-time, directional pair fixed effects, and all other control variables from column (3) of table 2. The estimates of all fixed effects and controls are omitted for brevity. The standard errors in all specifications are clustered by country pair.

DTA dummy were larger than 0.99. This is why these three types of provisions appear in the bottom panel of table S3.2 without corresponding estimates.

Second, we obtain positive and statistically significant estimates for three additional provisions, which, together with our estimate for investment provisions, are reported in the top panel of table S3.2. Consistent with the result from Laget, Rocha, and Varela (2021) for FDI in service-related activities, we find that "labor-market regulations" promote overall FDI. We also obtain large, positive, and statistically significant estimates of the effects of agreements with provisions that cover "public procurement" and "state-owned enterprises." A possible explanation for this result is that such provisions ensure transparency and protection from the host state. We are not aware of existing estimates that link "public procurement" and "state-owned enterprises" to FDI and, given the size and significance of our estimates, we view this as an interesting and important channel that deserves a more detailed analysis and investigation.

Finally, we do not find evidence that other provisions, some of which are potentially closely related to capital and technology movement, have had a significant impact on FDI. Specifically, our estimates of the effects of provisions related to "intellectual property rights" and "movement of capital" are not statistically significant. Consistent with Laget, Rocha, and Varela (2021), our estimate of the effects of "movement of capital" is sizable and positive, but it is not statistically significant in our case. Also similar to Laget, Rocha, and Varela (2021), we obtain a negative estimate of the effects of provisions related to "environmental laws," but, again, our estimate is not statistically significant. A possible explanation for the lack of significance is that the correlation between the indicators for DTAs and agreements with

Table S3.3. Investment Provision Types & FDI

Provision description	Estimate (1)	Standard error (2)
Protection	0.191	0.095
Liberalization	0.191	0.095
Transparency	0.151	0.096
Regulation	0.185	0.095
Dispute settlement	0.193	0.095
Scope and definitions	0.191	0.095

Source: Own calculations.

Note: This table reports estimates of the effects of a series of deep trade agreement (DTA) investment provisions on foreign direct investment (FDI) over the period 1990–2011. Each row in each panel corresponds to a separate econometric model. The results are based on the specification from column (3) of table 2 after replacing the dummy variable for DTAs with investment provisions ($INV_{ij,t}$) with corresponding indicator variables for each of the six types of investment provisions from World Bank's Database on the Content of Regional Trade Agreements (DCRTA). The dependent variable is always the value of FDI stock. The estimator is the Poisson pseudo-maximum-likelihood (PPML) estimator All estimates are obtained with three-year interval data and three-way fixed effects, including origin-time, destination-time, directional pair fixed effects, and all other control variables from column (3) of table 2. The estimates of all fixed effects and controls are omitted for brevity. The standard errors in all specifications are clustered by country pair.

environmental provisions is large, i.e., 0.724. Overall, the estimates in table S3.2 indicate that, on average, only a few types of DTA provisions affected FDI directly.

In our next experiment, we zoom in on the effects of alternative sets of provisions within the broad category of "investment" provisions. Specifically, the DCRTA distinguishes between six types of investment provisions, which are listed in the first column of table S3.3. As before, we focus on the dummy-variable specification, as in column (3) of table 2, by sequentially replacing the dummy variable for DTAs with investment provisions ($INV_{ij,t}$) with corresponding indicator variables for each of the six types of investment provisions from DCRTA. Our results appear in table S3.3, and we see that they are all positive and significant. In fact, some of the new estimates are identical to our estimate for the overall impact of DTAs with investment provisions. The simple, mechanical explanation for this result is that some of the subcategories of investment provisions (e.g., for "protection" and "liberalization") appear in all DTAs that cover investment. Thus, the indicator variables for such provisions are perfectly collinear with our main dummy variable ($INV_{ij,t}$) from column (3) of table 2. We do, however, obtain estimates for some provision types (e.g., covering "transparency") that are not perfectly collinear with $INV_{ij,t}$. The "transparency" estimate is a bit smaller but still sizable, positive, and statistically significant.

S4. Additional Counterfactual Results

This section includes additional counterfactual results and analysis. Specifically, table S4.1 reports estimates that are obtained based on the estimates of the continuous depth variables from the main text. Allowing for continuous depth leads to qualitatively and quantitatively similar results. Similar to the changes based on the estimates with the dummy variables, the additional allowance for changes in bilateral trade frictions leads to larger effects for inward and outward FDI.

Table S4.2 reproduces the findings from our main table 3 but uses a value of 4 instead of 6 for the elasticity of substitution σ. Decreasing σ from 6 to 4 hardly changes the effects on inward and outward FDI if DTAs only lower FDI frictions. When trade frictions are also reduced, inward FDI increases by about 0.5 percentage points and outward FDI by about 7 percentage points. These increases are due to the complementary of trade and technology FDI in our framework.

Table S4.1. Total General Equilibrium (GE) Effects on Inward and Outward FDI—Continuous DTA Variable

ISO3 (1)	FDI lib.		FDI and trade lib.	
	Inw FDI (2)	Outw. FDI (3)	Inw. FDI (4)	Outw. FDI (5)
AGO	0.09	0.00	0.47	0.00
ARG	1.00	0.48	1.77	1.06
AUS	3.83	2.05	4.64	2.47
AUT	1.05	0.62	1.79	1.50
AZE	0.17	0.00	0.92	0.01
BEL	1.06	1.09	1.84	1.45
BGD	0.17	0.01	0.90	0.06
BGR	0.96	0.11	1.68	0.23
BLR	0.16	0.00	0.81	0.04
BRA	0.49	1.59	1.28	2.01
CAN	5.05	2.11	5.83	6.71
CHE	2.03	1.63	2.77	1.96
CHL	14.64	2.51	15.45	3.05
CHN	0.48	24.60	1.25	35.54
COL	1.04	0.42	1.65	0.59
CYP	0.88	0.07	1.43	0.17
CZE	1.05	0.17	1.81	0.34
DEU	1.05	5.76	1.81	9.92
DNK	1.05	0.45	1.83	0.91
DOM	6.58	0.05	7.13	0.13
ECU	0.10	0.00	0.57	0.02
EGY	0.12	0.01	0.62	0.22
ESP	1.03	2.25	1.75	3.87
EST	0.17	0.02	0.89	0.03
ETH	0.08	0.00	0.39	0.03
FIN	1.04	0.38	1.78	0.68
FRA	1.05	3.90	1.85	7.06
GBR	1.04	3.92	1.81	6.51
GHA	0.10	0.01	0.50	0.01
GRC	0.92	0.19	1.57	0.48
GTM	3.05	0.01	3.47	0.04
HKG	0.15	0.04	0.76	0.27
HRV	0.20	0.10	0.83	0.10
HUN	0.95	0.19	1.71	0.49
IDN	3.92	0.84	4.56	1.98
IND	1.91	4.93	2.69	7.54
IRL	1.03	0.35	1.76	0.68
IRN	0.08	0.04	0.38	0.29
IRQ	0.08	0.00	0.38	0.00
ISR	0.14	0.01	0.76	0.18
ITA	1.08	4.53	1.89	7.19
JPN	1.98	15.41	2.74	20.77
KAZ	0.16	0.01	0.88	0.05
KEN	0.14	0.00	0.71	0.01
KOR	8.69	19.87	9.53	21.64
KWT	0.08	0.00	0.41	0.00
LBN	0.09	0.03	0.50	0.16
LKA	0.09	0.02	0.46	0.10
LTU	0.92	0.02	1.68	0.05

Table S4.1. Continued

ISO3 (1)	FDI lib.		FDI and trade lib.	
	Inw FDI (2)	Outw. FDI (3)	Inw. FDI (4)	Outw. FDI (5)
LUX	1.02	1.13	1.67	1.55
LVA	0.87	0.00	1.43	0.02
MAR	3.22	0.04	3.77	0.20
MEX	6.76	2.78	7.59	9.23
MKD	7.93	0.13	8.52	0.14
MLT	0.99	0.01	1.52	0.03
MYS	3.60	0.45	4.26	1.11
NGA	0.15	0.00	0.75	0.01
NLD	1.08	2.11	1.89	4.80
NOR	1.13	0.67	1.91	1.04
NZL	2.45	0.10	3.17	0.15
OMN	3.19	0.03	3.66	0.04
PAK	5.76	0.09	6.30	0.34
PER	8.04	0.24	8.80	0.59
PHL	3.58	0.29	4.27	1.15
POL	1.06	0.62	1.85	1.32
PRT	0.91	0.31	1.61	0.76
QAT	0.11	0.01	0.57	0.01
ROM	0.14	0.01	0.77	− 0.01
RUS	0.17	0.21	0.92	0.74
SAU	0.13	0.03	0.71	0.07
SDN	0.04	0.00	0.19	0.00
SER	0.16	0.00	0.83	0.00
SGP	7.16	1.52	7.88	3.06
SVK	0.94	0.01	1.71	0.07
SVN	0.92	0.07	1.59	0.10
SWE	1.02	0.54	1.67	1.14
SYR	0.08	0.00	0.42	0.03
THA	3.65	0.65	4.35	2.13
TKM	0.05	0.01	0.24	0.05
TUN	0.10	0.01	0.53	0.13
TUR	0.16	0.04	0.84	0.41
TZA	0.14	0.00	0.72	0.01
UKR	0.12	0.02	0.63	0.14
USA	1.47	41.08	2.27	54.92
UZB	0.09	0.00	0.44	0.01
VEN	1.10	0.22	1.84	0.27
VNM	3.92	0.05	4.48	0.28
ZAF	0.17	0.01	0.87	0.10
ZWE	0.09	0.00	0.47	0.00
World	1.83	41.08	2.59	54.92
Lib countries	1.97	41.08	2.60	54.92
ROW	0.46	0.01	0.79	0.00

Source: Own calculations.

Note: This table reports alternative results from our counterfactual analysis. Column (1) gives the ISO3 country codes. Columns (2) and (3) report the percentage changes in inward and outward foreing direct investment (FDI), respectively, based on our estimates of the continuous depth variables from column (6) of table 2 for the bilateral FDI frictions between all countries that have signed a deep trade agreement (DTA) with investment provisions. Columns (4) and (5) report results where in addition to the change in FDI frictions, DTAs also change trade frictions based on our estimates from column (3) of table 1.

Table S4.2. Total General Equilibrium (GE) Effects on Inward and Outward FDI—Dummy DTA Variable, $\sigma = 4$

ISO3 (1)	FDI lib.		FDI and trade lib.	
	Inw. FDI (2)	Outw. FDI (3)	Inw. FDI (4)	Outw. FDI (5)
AGO	0.07	0.00	0.77	0.01
ARG	0.74	0.35	2.08	1.90
AUS	4.42	2.87	5.84	3.44
AUT	0.63	0.34	1.93	2.20
AZE	0.15	0.00	1.46	0.02
BEL	0.64	0.65	2.02	1.34
BGD	0.15	0.01	1.41	0.26
BGR	0.59	0.06	1.87	0.30
BLR	0.13	0.00	1.31	0.15
BRA	0.38	1.13	1.76	2.35
CAN	3.94	2.07	5.26	6.63
CHE	2.23	1.25	3.51	2.27
CHL	11.27	1.60	12.63	2.42
CHN	0.92	40.40	2.25	65.88
COL	0.99	0.33	2.03	0.67
CYP	0.53	0.04	1.51	0.23
CZE	0.64	0.09	1.96	0.43
DEU	0.64	3.40	1.96	12.00
DNK	0.64	0.27	2.01	1.18
DOM	6.46	0.15	7.35	0.24
ECU	0.08	0.00	0.89	0.09
EGY	0.10	0.01	1.05	0.74
ESP	0.61	1.38	1.87	4.70
EST	0.14	0.01	1.42	0.04
ETH	0.07	0.00	0.62	0.05
FIN	0.63	0.21	1.89	0.82
FRA	0.64	2.15	2.05	8.63
GBR	0.63	2.32	1.98	7.56
GHA	0.08	0.01	0.83	0.03
GRC	0.56	0.11	1.72	0.68
GTM	3.54	0.01	4.26	0.05
HKG	0.13	0.05	1.21	0.85
HRV	0.15	0.04	1.28	0.05
HUN	0.59	0.10	1.91	0.72
IDN	6.76	1.39	7.93	3.56
IND	2.76	7.46	4.14	13.30
IRL	0.62	0.19	1.88	0.86
IRN	0.06	0.03	0.65	0.75
IRQ	0.06	0.00	0.59	0.04
ISR	0.12	0.01	1.17	0.44
ITA	0.67	2.69	2.09	8.11
JPN	2.25	16.62	3.55	25.45
KAZ	0.13	0.01	1.40	0.13
KEN	0.11	0.00	1.13	0.01
KOR	6.39	14.79	7.84	18.13
KWT	0.07	0.00	0.65	0.02
LBN	0.07	0.02	0.83	0.32
LKA	0.08	0.01	0.75	0.22
LTU	0.57	0.01	1.90	0.06

Table S4.2. Continued

ISO3	FDI lib.		FDI and trade lib.	
	Inw. FDI	Outw. FDI	Inw. FDI	Outw. FDI
(1)	(2)	(3)	(4)	(5)
LUX	0.61	0.63	1.78	1.45
LVA	0.52	0.00	1.52	0.04
MAR	3.52	0.04	4.55	0.49
MEX	5.55	2.27	7.01	9.61
MKD	4.12	0.07	5.15	0.10
MLT	0.58	0.01	1.52	0.05
MYS	6.77	0.79	7.98	2.01
NGA	0.14	0.00	1.19	0.04
NLD	0.67	1.16	2.09	6.56
NOR	0.97	0.45	2.33	0.98
NZL	4.75	0.19	6.02	0.26
OMN	3.50	0.03	4.38	0.05
PAK	3.81	0.08	4.79	0.63
PER	8.43	0.27	9.74	0.76
PHL	6.80	0.50	8.06	2.03
POL	0.64	0.34	2.03	1.74
PRT	0.55	0.17	1.76	1.10
QAT	0.10	0.01	0.94	0.03
ROM	0.12	0.01	1.24	− 0.02
RUS	0.15	0.16	1.48	1.22
SAU	0.11	0.02	1.14	0.15
SDN	0.04	0.00	0.33	0.01
SER	0.14	0.00	1.36	0.00
SGP	10.66	2.13	11.97	4.41
SVK	0.58	0.01	1.93	0.11
SVN	0.56	0.04	1.77	0.10
SWE	0.61	0.30	1.76	1.47
SYR	0.07	0.00	0.67	0.13
THA	6.80	1.02	8.09	3.53
TKM	0.04	0.00	0.42	0.10
TUN	0.08	0.01	0.88	0.30
TUR	0.14	0.03	1.37	1.04
TZA	0.11	0.00	1.14	0.06
UKR	0.10	0.01	1.07	0.40
USA	1.31	42.32	2.72	60.85
UZB	0.07	0.00	0.71	0.06
VEN	0.81	0.16	2.07	0.28
VNM	6.76	0.07	7.82	0.48
ZAF	0.15	0.01	1.43	0.20
ZWE	0.07	0.00	0.77	0.00
World	1.80	42.32	3.13	60.85
Lib countries	1.95	42.32	3.14	60.85
ROW	0.36	0.01	1.29	0.00

Source: Own calculations.

Note: This table reports alternative results from our counterfactual analysis. Column (1) gives the ISO3 country codes. Columns (2) and (3) report the percentage changes in inward and outward foreign direct investemnt (FDI), respectively, based on our estimate of 0.191 from column (3) of table 2 for the bilateral FDI frictions between all countries that have signed a deep trade agreement (DTA) with investment provisions, while in columns (4) and (5), in addition to the change in FDI frictions, DTAs also change trade frictions based on our estimate of 0.139 from column (2) of table 1. In contrast to table 3, where σ is set to 6, results in this table are based on a σ value of 4.

Table S4.3 reports estimates that are obtained when we exclude China and the United States from our data set. Note that this also changed the values for η and ϕ. We therefore also report the parameters, as we do in our main table 3. Excluding China and the United States from the data set leads to slightly larger average inward FDI effects for liberalizing countries and lower effects for non-liberalizing countries if DTAs only lower FDI frictions. Outward FDI is on average substantially smaller for the liberalizing countries, but more countries play a larger role now. These results reflect the dominance of China and the United States for outward FDI. As in the results before, lowering trade frictions alongside FDI frictions substantially increases the effects on inward and outward FDI.

Table S4.3. Total General Equilibrium (GE) Effects on Inward and Outward FDI—Dummy DTA Variable, without China and the United States

						FDI lib.		FDI and trade lib.	
ISO3	Country	α	δ	η	ϕ	Inw. FDI	Outw. FDI	Inw. FDI	Outw. FDI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
AGO	Angola	0.47	0.0528	0.00124	0.043	0.05	0.00	0.43	0.01
ARG	Argentina	0.57	0.0394	0.01261	0.020	1.09	0.55	2.07	2.16
AUS	Australia	0.44	0.0375	0.02148	0.036	1.48	3.56	2.49	4.07
AUT	Austria	0.43	0.0442	0.00825	0.051	0.92	0.56	1.86	2.41
AZE	Azerbaijan	0.79	0.0725	0.00092	0.038	0.16	0.00	1.11	0.02
BEL	Belgium	0.38	0.0452	0.01027	0.229	0.94	1.06	1.95	1.72
BGD	Bangladesh	0.47	0.0407	0.00513	0.003	0.16	0.01	1.05	0.22
BGR	Bulgaria	0.51	0.0565	0.00149	0.089	0.86	0.11	1.83	0.34
BLR	Belarus	0.48	0.0506	0.00242	0.031	0.14	0.01	1.00	0.15
BRA	Brazil	0.44	0.0475	0.04224	0.035	0.52	1.91	1.53	3.42
CAN	Canada	0.39	0.0371	0.02503	0.026	0.74	2.25	1.65	3.76
CHE	Switzerland	0.35	0.0568	0.00950	0.169	3.42	1.93	4.36	2.79
CHL	Chile	0.55	0.0427	0.00486	0.045	11.95	2.39	12.91	2.93
COL	Colombia	0.39	0.0411	0.00854	0.007	1.44	0.56	2.10	1.10
CYP	Cyprus	0.48	0.0357	0.00185	0.168	0.76	0.07	1.40	0.25
CZE	Czech Republic	0.49	0.0416	0.00571	0.061	0.93	0.16	1.88	0.49
DEU	Germany	0.39	0.0389	0.06262	0.028	0.93	5.48	1.89	14.24
DNK	Denmark	0.37	0.0431	0.00504	0.049	0.93	0.44	1.93	1.33
DOM	Dominican Republic	0.34	0.0307	0.00154	0.007	4.52	0.04	4.97	0.06
ECU	Ecuador	0.55	0.0466	0.00255	0.006	0.06	0.00	0.50	0.09
EGY	Egypt, Arab Rep.	0.62	0.0597	0.00559	0.018	0.09	0.03	0.72	0.76
ESP	Spain	0.39	0.0375	0.03388	0.043	0.90	2.29	1.81	5.70
EST	Estonia	0.42	0.0461	0.00047	0.085	0.15	0.02	1.07	0.04
ETH	Ethiopia	0.47	0.0494	0.00116	0.001	0.04	0.01	0.28	0.09
FIN	Finland	0.39	0.0412	0.00511	0.049	0.91	0.34	1.81	0.95
FRA	France	0.37	0.0382	0.05049	0.032	0.93	3.48	1.97	10.02
GBR	United Kingdom	0.39	0.0379	0.03946	0.060	0.92	3.51	1.90	8.49
GHA	Ghana	0.47	0.0553	0.00091	0.006	0.06	0.02	0.49	0.05
GRC	Greece	0.47	0.0335	0.00630	0.013	0.81	0.20	1.65	0.84
GTM	Guatemala	0.58	0.0454	0.00059	0.023	0.18	0.00	0.70	0.01
HKG	Hong Kong SAR, China	0.48	0.0435	0.00748	0.084	0.13	0.03	0.88	0.08
HRV	Croatia	0.34	0.0436	0.00169	0.038	0.17	0.07	0.98	0.08
HUN	Hungary	0.41	0.0436	0.00353	0.063	0.85	0.19	1.80	0.78
IDN	Indonesia	0.54	0.0370	0.02124	0.016	4.81	1.61	5.61	3.51
IND	India	0.50	0.0558	0.06715	0.005	4.28	12.50	5.30	19.58
IRL	Ireland	0.52	0.0496	0.00364	0.273	0.91	0.33	1.81	1.03
IRN	Iran, Islamic Rep.	0.74	0.0588	0.01828	0.001	0.07	0.06	0.52	0.82

Table S4.3. Continued

ISO3 (1)	Country (2)	α (3)	δ (4)	η (5)	φ (6)	FDI lib. Inw. FDI (7)	FDI lib. Outw. FDI (8)	FDI and trade lib. Inw. FDI (9)	FDI and trade lib. Outw. FDI (10)
IRQ	Iraq	0.70	0.0558	0.00157	0.001	0.03	0.01	0.23	0.06
ISR	Israel	0.45	0.0448	0.00380	0.012	0.10	0.04	0.76	0.41
ITA	Italy	0.46	0.0380	0.04979	0.021	0.97	4.46	2.02	10.21
JPN	Japan	0.39	0.0466	0.11587	0.003	3.46	28.10	4.40	42.42
KAZ	Kazakhstan	0.58	0.0400	0.00430	0.054	0.15	0.01	1.06	0.13
KEN	Kenya	0.57	0.0519	0.00078	0.015	0.12	0.00	0.84	0.01
KOR	Korea, Rep.	0.50	0.0501	0.03456	0.009	10.03	24.41	11.12	27.50
KWT	Kuwait	0.75	0.0557	0.00325	0.008	0.03	0.00	0.29	0.02
LBN	Lebanon	0.56	0.0413	0.00214	0.002	0.05	0.04	0.49	0.40
LKA	Sri Lanka	0.31	0.0446	0.00189	0.001	0.06	0.03	0.42	0.27
LTU	Lithuania	0.53	0.0418	0.00080	0.057	0.82	0.02	1.80	0.07
LUX	Luxembourg	0.46	0.0463	0.00921	0.627	0.90	1.06	1.75	1.83
LVA	Latvia	0.45	0.0336	0.00059	0.050	0.75	0.00	1.38	0.04
MAR	Morocco	0.51	0.0521	0.00280	0.043	0.11	0.02	0.85	0.42
MEX	Mexico	0.61	0.0362	0.02526	0.023	3.16	2.43	4.20	5.96
MKD	North Macedonia	0.47	0.0406	0.00042	0.031	6.37	0.11	7.06	0.13
MLT	Malta	0.46	0.0529	0.00024	0.219	0.85	0.01	1.43	0.05
MYS	Malaysia	0.47	0.0596	0.00931	0.029	4.82	0.93	5.67	1.90
NGA	Nigeria	0.50	0.0581	0.00283	0.040	0.15	0.00	0.88	0.04
NLD	Netherlands	0.41	0.0401	0.02524	0.093	0.97	1.82	2.02	6.99
NOR	Norway	0.48	0.0399	0.00544	0.084	1.42	0.73	2.42	1.24
NZL	New Zealand	0.43	0.0408	0.00196	0.070	1.71	0.18	2.57	0.24
OMN	Oman	0.70	0.0602	0.00175	0.025	0.08	0.00	0.61	0.01
PAK	Pakistan	0.47	0.0551	0.00745	0.006	0.29	0.13	0.93	0.76
PER	Peru	0.69	0.0395	0.00580	0.014	1.82	0.16	2.70	0.42
PHL	Philippines	0.64	0.0488	0.00771	0.008	4.86	0.50	5.75	1.78
POL	Poland	0.44	0.0491	0.01184	0.044	0.94	0.56	1.96	1.95
PRT	Portugal	0.39	0.0351	0.00608	0.042	0.80	0.29	1.68	1.21
QAT	Qatar	0.81	0.0960	0.00374	0.023	0.08	0.00	0.60	0.02
ROM	Romania, Socialist Republic of	0.53	0.0518	0.00475	0.047	0.13	0.02	0.95	0.00
RUS	Russian Federation	0.26	0.0402	0.04860	0.010	0.16	0.37	1.13	1.87
SAU	Saudi Arabia	0.72	0.0530	0.01555	0.007	0.12	0.05	0.84	0.32
SDN	Sudan	0.41	0.0664	0.00056	0.001	0.02	0.00	0.13	0.01
SER	Serbia	0.42	0.0402	0.00164	0.035	0.15	0.00	1.05	0.00
SGP	Singapore	0.56	0.0533	0.00742	0.154	5.17	1.98	6.06	3.61
SVK	Slovak Republic	0.46	0.0520	0.00199	0.072	0.83	0.02	1.82	0.12
SVN	Slovenia	0.33	0.0439	0.00137	0.023	0.82	0.06	1.72	0.13
SWE	Sweden	0.45	0.0453	0.00621	0.172	0.90	0.49	1.73	1.60
SYR	Syrian Arab Republic	0.47	0.0552	0.00194	0.003	0.05	0.00	0.34	0.12
THA	Thailand	0.61	0.0655	0.01505	0.031	4.87	1.03	5.79	3.04
TKM	Turkmenistan	0.47	0.0430	0.00184	0.000	0.03	0.01	0.23	0.16
TUN	Tunisia	0.50	0.0474	0.00172	0.005	0.07	0.02	0.54	0.32
TUR	Türkiye	0.56	0.0554	0.01162	0.034	0.15	0.06	1.06	1.09
TZA	Tanzania, United Republic of	0.57	0.0435	0.00088	0.032	0.12	0.00	0.83	0.05
UKR	Ukraine	0.44	0.0308	0.01005	0.013	0.09	0.04	0.76	0.47
UZB	Uzbekistan	0.47	0.0327	0.00158	0.003	0.05	0.00	0.38	0.06
VEN	Venezuela, RB	0.63	0.0389	0.00581	0.015	1.21	0.26	2.13	0.41
VNM	Vietnam	0.47	0.0455	0.00808	0.010	4.80	0.23	5.54	0.53

Table S4.3. Continued

ISO3 (1)	Country (2)	α (3)	δ (4)	η (5)	φ (6)	FDI lib.		FDI and trade lib.	
						Inw. FDI (7)	Outw. FDI (8)	Inw. FDI (9)	Outw. FDI (10)
ZAF	South Africa	0.46	0.0506	0.00658	0.060	0.16	0.02	1.11	0.21
ZWE	Zimbabwe	0.44	0.0371	0.00006	0.059	0.05	0.00	0.43	0.00
World						1.87	5.48	2.85	14.24
Lib countries						2.01	5.48	2.87	14.24
ROW						0.15	0.01	0.99	0.00

Source: Own calculations.

Note: This table reports alternative results from our calibration and counterfactual analysis where we exclude China and the United States from our sample. Column (1) gives the ISO3 country codes, and column (2) the country names. The country-specific capital shares of production α_j are reported in column (3), while in column (4) we give the values of the country-specific adjustment costs of capital δ. The values for the η's, i.e., the share of technology capital of a country to all destinations, are given in column (5). Column (6) gives the values for the production share of foreign direct investment (FDI) (ϕ). Columns (7) and (8) report the percentage changes in inward and outward FDI, respectively, based on our estimate of 0.191 from column (3) of table 2 for our change in the bilateral FDI frictions between all countries that have signed a deep trade agreement (DTA) with investment provisions, while in columns (9) and (10) in addition to the change in FDI frictions, DTAs also change trade frictions based on our estimate of 0.139 from column (2) of table 1.