What Determines BITs?*

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Abstract

Similar to bilateral or regional preferential trade agreements (PTAs), bilateral investment treaties (BITs) have proliferated over the past 50 years. The purpose of this study is to provide the first systematic empirical analysis of the economic determinants of BITs and of the likelihood of BITs between pairs of countries using a qualitative choice model, and in a manner consistent with explaining PTAs. We develop the econometric specification for explaining the two based upon a general equilibrium model of world trade and foreign direct investment with three factors, two products, and trade and investment costs among multiple countries in the presence of national and multinational firms. The empirical model for BITs and PTAs is bivariate in nature and supports a set of hypotheses drawn from the general equilibrium model. Using the preferred empirical model for a sample of 12,880 country-pairs in year 2000, we predict correctly 88 percent of all pairs with a BIT and a PTA, 81 percent with a BIT but no PTA, and 84 percent with a PTA but no BIT.

Key words: Bilateral investment treaties; Foreign direct investment; Multinational firms; Free trade agreements; International trade

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1 Introduction

"The primary problem for researchers wishing to assess the impacts of policies to promote FDI is that policy adoption is endogenously determined." (Aisbett, 2009, p. 396)

"The literature on BITs is limited, making it difficult to truly understand the determinants for signing." (Tobin and Rose-Ackerman, 2005, p. 15)

One of the most notable economic events since World War II is the proliferation of preferential trade agreements (PTAs), including predominantly free trade agreements (FTAs) and some customs unions (CUs). However, the proliferation of bilateral investment treaties (BITs) has been significant as well. For instance, in 2010 the U.S. government had 40 BITs in force while it had only 17 PTAs in force. Figure 1 presents the numbers of BITs in existence in the world in every year from 1980-2007. Moreover, Table 1 indicates the numbers of country-pairs with BITs and with PTAs (including those with both) in year 2000 for 161 countries. Table 1 confirms for this sample 923 country-pairs with a BIT but no PTA, 1,478 pairs with a PTA but no BIT, and 556 pairs with both.[1]

Yet in contrast to the vast international trade literatures on the theoretical net benefits and costs of FTAs and CUs and on the empirically-estimated effects of FTAs and CUs on trade flows, the literature on BITs is not only considerably smaller but dominated by legal and political science scholars rather than economists, cf., Salacuse (1990), Vandevelde (1998, 2000), Tobin and Rose-Ackerman (2005), and Buthe and Milner (2009).[2] Consequently, none of these papers addresses factors explaining BITs' formations using formal theoretical economic models, and few provide econometric empirical analyses. Also, relative to the trade and PTA literature, there are few papers – some by economists and some by legal/political scholars – that have looked systematically and econometrically at the impact of BITs on foreign direct investment (FDI). Hallward-Driemier (2003), Tobin and Rose-Ackerman (2005), Gallagher and Birch (2006), and Aisbett (2009) find little economically and statistically significant effect of BITs on FDI flows. By contrast, Egger and Pfaffermayr (2004a), Salacuse and Sullivan (2005), Neumayer and Spess (2005), and Buthe and Milner (2009) find economically and statistically significant effects.[3] Furthermore, there is *no study* trying to systematically explain empirically the

[1]We note that, since 1990, many PTAs have introduced substantive investment provisions; such agreements are more accurately "preferential trade *and investment* agreements" (or PTIAs). However, the number of PTIAs still are fewer than 10 percent of the number of BITs (cf., Sauvant and Sachs, 2009) and this issue will be discussed later in a sensitivity analysis.

[2]An excellent edited volume of recent studies on the effect of BITs (and double taxation treaties) on foreign direct investment, including many of the papers noted in this paragraph, is Sauvant and Sachs (2009).

[3]Moreover, only one paper – Aisbett (2009) – provides a formal game-theoretic model of BITs formation based upon expropriation risk. We refer to this model later for motivating the inclusion of a measure of expropriation risk in our

economic determinants of BITs – much less one motivated by a formal general equilibrium model.[4] This paper addresses this shortcoming.

In this paper, we examine theoretically and econometrically the economic determinants of BITs – and in a manner consistent with understanding the economic determinants of PTAs. While BITs have been examined much less in the international economics literature, the motivation for such agreements for FDI is actually quite similar to that for PTAs for trade. While "Friendship, Commerce and Navigation" treaties surfaced as early as the 18th century, modern BITs were effectively created in the late 1950s in response to numerous expropriations of FDIs as well as the limitation of the General Agreement on Tariffs and Trade (GATT) to trade only; (West) Germany concluded the first modern (post-World War II) BIT with Pakistan in 1959. The first modern BITs were intended to reduce for home countries the relative cost of FDI outflows by reducing the risk of "expropriation" by host countries' governments. Hence, the likelihood of a BIT should be positively related to the degree of expropriation risk, other things equal. More recently, BITs have addressed FDI-related issues beyond expropriation risk to promote investment liberalization. UNCTAD (2007) notes that many of the existing BITs guarantee foreign investors fair-and-equitable, non-discriminatory, and "national" treatment. Consequently, more recently BITS have been spurred by host countries as "instruments" of investment liberalization to encourage capital exporting countries to provide FDI inflows to developing and developed capital importing countries, much as PTAs have proliferated as instruments of trade liberalization among and between developed and developing countries.

Since the fundamental purpose of a BIT is to encourage FDI flows between country-pairs by reducing the relative cost of FDI and that of a PTA is to encourage trade between country-pairs by reducing the relative cost of trade, economic determinants of BITs may well share many similarities to those of PTAs. Since there has been no previous formal theoretical nor econometric model of the determinants of BITs, our starting point is the new literature on the economic determinants of PTAs. This literature, surveyed in Freund and Ornelas (2009), starts with Baier and Bergstrand (2004), or BB, which developed a qualitative choice econometric model of the likelihood of a pair of countries having a PTA in a given year.[5] Motivated by a general equilibrium model of world trade

empirical analysis. However, the model does not address how factors such as economic size and similarity, trade and investment costs, relative factor endowments, and their interactions can help explain the likelihood of a BIT between a country-pair.

[4]The only empirical study close to ours is Swenson (2005), who provides an econometric analysis that explains the number of BITs across countries in terms of per capita incomes, expropriation risk, and pre-existing levels of FDI stocks. However, the study is not motivated by a formal economic model and does not address the economic determinants emphasized in our study.

[5]Recent extensions of the model include, for example, Egger and Larch (2008), Baldwin and Jaimovich (2010), Chen and Joshi (2010), who examined the role of "third-country PTAs" for explaining subsequent PTA formations and enlargements, and Bergstrand, Egger and Larch (2010), who examined the role of several economic variables for the "timing" of PTA formations and enlargements.

with two factors, two monopolistically-competitive markets with national exporting firms, and explicit intercontinental and intracontinental trade costs among multiple countries on multiple continents, the BB model suggests that country-pairs are more likely to have a PTA: (1) the closer together they are; (2) the more remote they are from other markets; (3) the larger their joint economic size; (4) the more similar their economic sizes; and (5) the larger the difference in the pairs' relative factor endowments (up to a point). BB showed that all these economic factors were economically and statistically significant (with expected signs) in explaining cross-sectional variation in country-pairs' probabilities of having PTAs with a pseudo-R^2 of 73 percent. Using a larger sample of 10,585 pairs in year 2000, Egger and Larch (2008) predicted correctly about 781 of the 1,263 pairs with PTAs (or 62 percent). Of course, their pseudo-R^2 was considerably lower at 27 percent (as expected) due to their much larger and less selective sample.

However, the economic determinants of BITs are not likely to be explained by the same econometric model, due to several considerations. First, BITs potentially influence FDI flows. Consequently, while economic size and similarity help to predict PTAs, they may not simultaneously predict BITs; as mentioned, most BITs are between developed and developing countries (and the latter tend also to be economically smaller than the former). Other factors – such as bilateral trade and investment costs and relative factor endowments – are likely to have differing effects on explaining BITs relative to PTAs. Since FDI is generated by multinational enterprises (MNEs), a theoretical framework should incorporate MNEs' behavior; consequently, a simple Helpman-Krugman-Heckscher-Ohlin general equilibrium model of trade as in BB is insufficient. An extension of the BB framework to include MNEs, FDI flows, and foreign affiliate sales (FAS), in the spirit of the "Knowledge-Capital" (KC) models of Markusen (2002) and Markusen and Maskus (2001, 2002), is a natural direction. Fortunately, Bergstrand and Egger (2007), or BE, extended the 2x2x2 KC model to three factors and three countries, and provide a ready framework to address the economic determinants of BITs and PTAs. BE is especially relevant because it is the first general equilibrium model to demonstrate that bilateral FDI *and* trade are maximized between countries with *identical* relative *and absolute* factor endowments, consistent with the large literature on gravity equations that explain very well both bilateral trade *and FDI* flows.[6] Thus, the first potential contribution of this paper is to use the theoretical framework in BE to generate new comparative statics to show (in the absence of any relative factor endowment differences) how: (1) economic size and size similarity of two countries influence their net utility gains (or losses) from a BIT and from a PTA; (2) bilateral investment and trade costs between

[6]Blonigen and Piger (2011), using a Bayesian moving average statistical technique, have recently shown that the most important factors for explaining FDI flows are basic gravity equation variables, parent-country and host-country real GDPs and bilateral distance.

two countries influence such gains; and (3) how interactions among these factors influence these gains. Note that, in general equilibrium, the net utility gains from BITs and PTAs are influenced by the behavior of multinational enterprises as well as national (exporting) firms. In the presence of MNEs and general equilibrium, the influences of these economic variables on the net utility gains from a PTA are not *necessarily* the same as those found in BB, where MNEs and FDI were absent.

Second, in reality relative factor endowments are not identical across countries, and such differences matter for economic determinants of BITs because many BITs (not to mention PTAs) are "North-South" in nature, that is, between countries with quite different relative factor endowments.[7] The second potential contribution of this paper is to show the relationship in the BE model between relative factor endowments between two countries and the net utility gains from BITs and from PTAs. With three factors – skilled labor, unskilled labor, and physical capital – the relationships are complex. However, using traditional Edgeworth boxes and recent developments in specifying properly the relationships between relative factor endowments and bilateral FAS flows in Braconier, Norback and Urban (2005), our theoretical relationships suggest easily specified empirical counterparts to capture some of the influences of relative factor endowments on the net utility gains from BITs and PTAs.[8] Moreover, we examine the interactive effects of relative factor endowments and investment costs on utility gains from such agreements.

Third, guided by the theoretical comparative statics, we specify a bivariate probit model of the probabilities of BITs and PTAs existing between country pairs in year 2000. We choose to estimate a bivariate probit model because the error terms may be correlated across probabilities, and this provides more efficient coefficient estimates. To anticipate some of the results, we find the following empirical conclusions. First, as much of trade is "intra-industry" and much of FDI is "horizontal," one would expect that the net utility gains from a BIT and from a PTA are positively related to economic size and similarity. Such results are confirmed here. Second, our theoretical model suggests that the initial level of expropriation risk should increase (decrease) the gains from a BIT (PTA) and higher natural investment costs, such as political instability, should decrease (increase) the gains from a BIT (PTA). Using measures of investment costs that should influence FDI and trade oppositely, we find evidence of these "substitution effects." Moreover, due to the non-linear probit model, we can estimate the sensitivity of the effects of investment costs on the probability of a BIT for a country-

[7]The KC model first introduced relative endowments of skilled and unskilled labor into a model with only HMNEs to illustrate the simultaneous presence of vertical and horizontal FAS, cf., Markusen, Venables, Eby-Konan, and Zhang (1996), Carr, Markusen, and Maskus (2001), Markusen and Maskus (2002), and Markusen (2002).

[8]Blonigen and Piger (2011) show that – beyond parent- and host-country real GDPs and bilateral distance – the most important variables explaining FDI flows are parent real GDP per capita, parent *physical capital per worker*, relative skilled-labor endowments, common official language, urban concentration of the host country, and remoteness of the host country from *ROW*.

pair to their economic size. Third, in the presence of three factors of production, the relationships between relative factor endowments and net utility gains of a pair of countries from a BIT or a PTA are complex, non-linear, and non-monotonic. However, we draw upon the geometric features of an Edgeworth box to introduce a measure of dissimilarity of factor shares that helps explain the importance of relative abundance of skilled labor for increasing the net utility gains from a BIT for a country-pair.[9] Alongside another (more standard) measure of deviations of capital-unskilled-labor ratios from the Edgeworth box diagonal, we show empirically how relative factor endowments affect the probabilities of a BIT and of a PTA, and estimate the sensitivity of the effects of investment costs to relative factor endowments. Finally, the bivariate empirical model has a relatively high explanatory power that holds up to an extensive sensitivity analysis, including extensions to "third-country-pair" effects and lagged effects. Moreover, the inclusion of different relative factor endowment variables for the BIT and PTA equations allows for potential identification in a (recursive) simultaneous equations system, which we explore. Using our sample of 12,880 country-pairs in year 2000, we predict correctly 88 percent of the 556 country-pairs with a BIT and a PTA, 81 percent of the 923 country-pairs with a BIT but no PTA, and 84 percent of the 1,478 country-pairs with a PTA but no BIT. The overall pseudo-R^2 of 28 percent for our bivariate probit model is comparable to the 27 percent pseudo-R^2 found in Egger and Larch (2008) for PTAs using a univariate probit model and a similar large sample. The results provide quantitative guidance as to the determinants of BITs and PTAs simultaneously (and also sequentially) and to addressing potentially the endogeneity bias inherent in many previous empirical analyses of the effects of BITs on FDI flows.

The remainder of the paper is as follows. In section 2, we summarize the theoretical BE model and the parameter values chosen for the numerical version of the general equilibrium model. In section 3, we discuss the general equilibrium comparative static results for the relationships between the net utility gains from a BIT and from a PTA with economic size and similarity, investment costs, and trade costs, assuming identical relative factor endowments across countries. In section 4, we relax the assumption of identical relative factor endowments and, using conventional Edgeworth boxes and their geometric properties, provide general equilibrium comparative statics to motivate two relative-factor-endowment variables for the empirical analysis. In section 5, we describe our econometric methodology and data set. Section 6 provides the results from the bivariate probit empirical analysis, including the robustness analysis, marginal response probability estimates, and predicted probabilities. Section 7 concludes.

[9] Also, our model allows us to see how the effects of investment costs on utility gains from a BIT are sensitive to levels of relative factor endowments.

2 Theoretical Framework: A Summary of the Bergstrand and Egger (2007) Knowledge-and-Physical-Capital Model

The model we use is the 3-country, 3-factor, 2-good Knowledge-and-Physical-Capital (KAPC) model in BE, an extension of the 2x2x2 Knowledge-Capital (KC) model in Markusen, Venables, Eby-Konan, and Zhang (1996), Carr, Markusen, and Maskus (2001), and Markusen (2002) to allow for a third factor (imperfectly mobile physical capital) and a third country (ROW). Since the theoretical model is identical to that in BE except for the introduction of a bilateral investment cost representing expropriation risk (g), we need not reproduce the model here. We summarize it briefly.[10]

The demand side of the KAPC model is analogous to that in the KC model. Consumers have Cobb-Douglas preferences between a differentiated good and a homogeneous (numeraire) good and constant-elasticity-of-substitution preferences among differentiated goods. Differentiated products can be produced under monopolistic competition by national exporting firms potentially located in all countries, horizontal multinational enterprises (HMNEs) with headquarters and a plant in the home country and plants potentially in either of the other two countries to serve markets directly through foreign affiliate sales (FAS), and vertical multinational enterprises (VMNEs) with headquarters in the home country and a plant abroad which can produce for the local market and/or export to the other two markets.[11] Differentiated goods are produced using physical capital, skilled labor, and unskilled labor under increasing returns to scale with skilled labor used to setup headquarters and physical capital used to setup plants. Trade costs – both natural factors and government tariffs – are of the iceberg type. Investment costs are implied by *ad valorem* cost-of-capital markups on foreign plant setups. The KAPC model is distinguished from the KC model in two ways. First, there is no factor in the KC model to represent the *tangible* assets of firms; physical capital has been omitted from the KC model even though Blonigen and Piger (2011) show that it is important empirically. In reality, of course, national firms and MNEs use both (rival) private capital – often measured by financial claims to tangible assets such as physical capital at home or aborad – as well as (non-rival) knowledge capital – often associated with skilled labor. Hence, the KAPC model has private physical capital, the services of which can be used at home or transferred abroad (via FDI, and not necessarily costlessly) either as a "greenfield" investment or an acquisition (though only home capital is used in *production* alongside home skilled and unskilled labor).[12] The second distinction of the KAPC model from the KC model is

[10]See Bergstrand and Egger (2007) or an online theoretical supplement for details (attached Appendixes A and B).

[11]See Alfaro and Charlton (2009) for firm-level evidence on the co-existence of HMNEs and VMNEs.

[12]Hence, in the KC model, skilled labor is immobile internationally, but the services of (non-rival) "knowledge capital" are (costlessly) mobile. In our model, this still holds, but additionally physical capital is immobile internationally, but the services of (rival) "financial capital" are internationally mobile for plant setups (with potential investment costs such as expropriation risk or political instability risk). Physical capital (K) in our model can just as easily be interpreted

a third country, ROW. The presence of ROW helps explain the observed complementarity of bilateral FAS and trade flows with respect to a country pair's economic size and similarity and that bilateral FDI and FAS tend empirically to be as well explained by gravity as are bilateral trade flows.

The complexity of the model (including the complementary-slackness conditions) introduces a high degree of nonlinearity, and the model cannot be solved analytically. As in BE, we provide numerical solutions to the model, requiring parameter choices. Utility and production function parameter values are identical to those in BE, as are the skilled labor costs to setup national firms' and MNEs' headquarters (MNE headquarter setups use 1 percent more skilled labor than national firms). Each home plant setup requires two units of capital, with foreign plants requiring an additional "natural" bilateral investment cost of 40 percent (representing, say, political instability, which a BIT cannot insure against) and a bilateral investment cost of 10 percent representing expropriation risk (which a BIT can insure against).[13] The *ad valorem* rate for natural international trade costs is 30 (45) percent for differentiated (homogeneous) products, following evidence in Bergstrand and Egger (2006), and *ad valorem* tariff rates are initially 20 percent (which are then removed by a PTA). The world endowment of physical capital is 500 units, of skilled labor is 200 units, and of unskilled labor is 2000 units; initially, country i has one-quarter of the world's endowment, country j has one quarter, and ROW has one-half.[14] In section 3. we assume no relative factor endowment differences (as in BE); in section 4, we allow relative factor endowment differences (as in the KC model).

3 Economic Determinants of BITs and PTAs

In this section, we focus on eight theoretical results (summarized in four hypotheses), assuming countries are identical in *relative* factor endowments. First, we address the relationship between economic (GDP) size and similarity for influencing the net utility gains from BITs and PTAs (four results). Second, we discuss the relationship between bilateral investment and trade costs for influencing such gains (four results). Finally, we discuss some interactive effects on these gains.

as financial equity claims on any tangible assets (other than knowledge). The key issue for our model is that there is another factor (K) that complements skilled labor (S) in production and that (rival) K is "used up" in the fixed costs of setting up a plant at home or abroad. One can also interpret physical capital as "putty" capital, with the fraction of home capital used in domestic production and the fraction that is used up in setting up plants at home and abroad as endogenously determined by the MNE's profit maximization decision.

[13] As noted in Salacuse and Sullivan (2005, pp. 86-87), "One of the primary functions of any BIT is to protect foreign investments against nationalization, expropriation, or other forms of interference with property rights by *host country governmental authorities*.... Many BITs also deal with losses to an investment due to armed conflict or internal disorder. However, they do *not normally establish a right to compensation*" (italics added).

[14] For more details, see our online theoretical supplement (attached Appendixes A and B).

3.1 Economic Size, Economic Similarity, and Welfare Gains from BITs and PTAs

We simulated the model under alternative scenarios of absolute factor endowments among three countries i, j, and ROW. The effect of a BIT was introduced by reducing the *ad valorem* FDI barrier representing expropriation risk between i and j (g_{ij}) from 10 percent to zero percent. Alternatively, the effect of a PTA was introduced between i and j by reducing the *ad valorem* tariff rate (b_{ij}) from 20 percent to zero percent. It is standard in the PTA literature to consider theoretically the introduction of a PTA by reducing the tariff rate. Since BITs have not been analyzed yet in the context of the KC or KAPC models, we follow BE which assumed that an FDI barrier increased by some proportion the cost of capital needed for the FDI. In the KAPC model in BE, this barrier was γ; we have simply augmented that model's FDI barriers to include an additional *ad valorem* barrier g, representing expropriation risk, which the BIT removes.[15]

Figures 2a and 2b present the results of the utility change for countries i and j from their forming alternatively a PTA and a BIT, respectively, depending upon their joint economic size (y-axis) and their similarity of economic size (x-axis). The z-axis represents the utility change for *both* i and j from their forming the agreement.[16] The y-axis is the sum of the GDPs of countries i and j. The lines on the y-axis are indexed from 1 to 1.7. The y-axis indexes country-pairs' GDPs from the smallest joint GDP (line 1) to the largest joint GDP (line 1.7).[17] The x-axis is indexed from 0.45 to 0.55. Each line represents i's share of both countries' GDPs, where the center line represents 50 percent, or identical GDP shares for i and j.

Hypothesis 1: The net utility gain from (and likelihood of) a PTA and of a BIT between i and j is a positive function of their joint economic sizes.

Consider Figure 2a first. When i and j have identical relative factor endowments, all bilateral trade is intra-industry exports of national enterprises (NEs). Consequently, when two countries are larger, there will be a larger volume of intra-industry trade of NEs (and associated larger number of varieties produced and consumed), since there are no VMNEs. The formation of a PTA will then reduce bilateral trade costs on a larger volume of trade for two larger countries, and consequently increase the utility gains more for both countries relative to two smaller countries, similar to that in

[15]The original motivation for BITs is the insurance for the capital exporter against expropriation "risk" in the capital importing country. "Risk," of course, raises the relative cost of capital for investing abroad. In the context of the model, our *ad valorem* factor g raises the cost of capital, $r_i(1 + \gamma_{ij} + g_{ij})$, of the capital exporting country in the host country. A BIT, by insuring the capital exporter against this risk, eliminates g; see our online theoretical supplement, equations (8b)-(8d). A recent paper by Moser and Rose (2011) provides event-study evidence on "excess returns to capital" created by announcements of PTAs; by analogy, such a methodology could also be applied to BITs.

[16]We assume the existence of transfers between the two countries' governments so that the relevant consideration is the sum of the two countries' representative consumers' utilities for the social planner.

[17]See Bergstrand and Egger (2007) on determination of relative GDP sizes; the dispersion is based upon empirical GDP data.

BB in the absence of MNEs. The novel aspect here is that – as established in BE – national firms can *coexist* with HMNEs when both countries are identical in absolute (and relative) factor endowments and trade costs. In the qualitative choice framework used later, this result suggests that the probability of a PTA between i and j increases with their economic size (for a given ROW GDP).

Figure 2b shows the relationship between the economic size of i and j and the utility gain from a BIT. When i and j have identical relative factor endowments as currently assumed, there are HMNEs in equilibrium, but no VMNEs, consistent with BE. All FDI (and FAS) is intra-industry. Consequently, when two countries are larger, there will be a larger volume of horizontal FDI. The formation of a BIT will then reduce bilateral investment costs on a larger volume of FDI for two larger countries (and associated larger number of varieties produced and consumed), and consequently increase the utility gains more for both countries relative to two smaller countries. This increases the probability of a BIT between i and j (for given ROW GDP).[18]

Hypothesis 2: The net utility gain from (and likelihood of) a BIT and of a PTA between i and j is a positive function of the similarity in their economic sizes.

The economic rationale is based upon similar intra-industry reasoning. Consider Figure 2a first. We know from BE that – for a given total economic size of i and j – bilateral trade (and the numbers of varieties traded) will be maximized when the two countries have identical absolute factor endowments. All trade will be intra-industry. Hence, the gains from a PTA are larger the more similar their GDPs, as in BB in the absence of MNEs.

A similar though not identical economic rationale holds for BITs, cf., Figure 2b. Intuitively, suppose i had all of the two countries' (i's and j's) GDP. Then there would be no reason for i to setup an affiliated plant in j, and consequently there would be no economic gain from forming a BIT. However, as shown in BE, the bilateral volume of FDI from i to j is not maximized when both countries have the same economic size. Yet, because of the symmetry of horizontal FDI flows from i to j and from j to i, the total number of HMNEs (and consequently varieties available) to consumers in i and j will be maximized when the two countries have identical absolute factor endowments. Consequently, the gains from a BIT will be maximized when the two countries have identical sizes. However, we note that because gross bilateral trade (FDI) flows are (are *not*) maximized at identical GDP sizes, the theoretical relationship between similarity and gains from a BIT is not as strong as that for a PTA. Consequently, we expect the estimated marginal effect (in our probit analysis) of economic similarity on the probability of a BIT to be *smaller* than that of a PTA.

[18]Note that the simultaneous gains in utility from a BIT and a PTA for two countries with identical absolute and relative factor endowments are not possible in the 2x2x2 KC model because intra-industry trade is zero, as shown in BE.

3.2 Investment Costs, Trade Costs, and Welfare Gains from BITs and PTAs

Figures 3a and 3b present the results of the utility change for two identical countries (i, j) from introducing alternatively a PTA between i and j and a BIT between i and j, respectively, at various values of natural trade (τ_{ij}) and natural investment (γ_{ij}) costs. First, we provide a brief explanation of the axes for these two figures. The "vertical" axis (or z-axis) represents the net utility gain (or, if negative, loss) for countries i and j from introducing either a PTA (cf., Figure 3a) or a BIT between i and j (cf., Figure 3b). The y-axis is labeled from 1 to 1.13 and represents the gross bilateral natural trade cost from i to j, τ_{ij}; τ=1 implies zero natural trade cost. The x-axis is labeled from 0.4 to 0.8 and represents a bilateral natural FDI investment cost, γ_{ij}, such as "political instability." A higher value of γ_{ij} represents a higher risk premium (added to the cost of capital) in *ad valorem* terms for an MNE with a headquarters in i to invest in j.[19] As above, the BIT between i and j, or BIT_{ij}, is captured by a reduction of the investment cost representing expropriation risk between i and j (g_{ij}) from 10 percent to zero.[20] The PTA between i and j, or PTA_{ij}, is captured by a reduction of the tariff rate between i and j (b_{ij}) from 20 percent to zero.

Hypothesis 3: The net utility gain from (and likelihood of) a PTA between i and j is a negative function of their natural bilateral trade costs and a positive function of their natural bilateral investment costs.

Consider first the negative relationship between the gains to countries i and j of PTA_{ij} and "natural" trade costs between i and j (τ_{ij}) established in BB, and shown here in Figure 3a. Common examples of "natural" bilateral trade costs (from the large trade gravity equation literature) are the absence of a common land border and absence of a common language. As shown in BB, a low value of natural trade costs (such as the presence of a common land border) between i and j – other things the same – implies a high value of bilateral trade. Consequently, a given reduction in the bilateral tariff rate between i and j will lead to a large increase in bilateral trade and a large gain in utility for i and j. Hence, larger natural bilateral trade costs reduce the net utility gains from and likelihood of PTA_{ij}.

Consider now the "cross-price" effect. A higher natural bilateral investment cost between i and j will tend to reduce bilateral FDI between i and j, but increase bilateral trade between i and j. Thus, a PTA between i and j will liberalize a larger volume of trade the higher are natural bilateral investment costs, leading to a larger net utility gain for i and j, and increasing the likelihood of PTA_{ij}, cf., Figure 3a. Hence, the likelihood of PTA_{ij} is higher the larger are natural bilateral investment costs (such as

[19] The selection of "political instability" as an important foreign direct investment cost is motivated partly by evidence of a strong empirical negative (positive) relationship between political instability and FDI (trade) flows established in Berden, Bergstrand, and van Etten (2011).

[20] The higher the level of expropriation risk, the larger the net utility gains from a BIT, other things constant.

political instability).[21]

Hypothesis 4: The net utility gain from (and likelihood of) a BIT between i and j is a negative function of their natural bilateral investment costs and a positive function of their natural bilateral trade costs.

Consider now the relationship between the gains for i and j from BIT_{ij} and natural bilateral investment costs (γ_{ij}), shown in Figure 3b. Using political instability again as a "natural" bilateral investment cost, a higher degree of political instability in host country j leads to a lower level of bilateral FDI from i to j. Since FDI is lower, the gains to FDI_{ij} from BIT_{ij} are lower. Hence, the net utility gains from and likelihood of BIT_{ij} are lower the higher the degree of political instability in j.

Consider now the "cross-price" effect. A higher natural bilateral trade cost between i and j will tend to reduce bilateral trade between i and j, but increase bilateral FDI between i to j. While for most country pairs, bilateral FDI flows in reality tend to be large when the countries' bilateral trade flows are large as in BE, FDI and trade are substitutes with respect to relative price effects. Thus, a BIT between i and j will liberalize a larger volume of FDI the higher are the countries' bilateral trade costs, leading to a larger net utility gain for i and j, and increasing the likelihood of BIT_{ij}, cf., Figure 3b. Hence, the net utility gains from and likelihood of BIT_{ij} are larger the higher are natural bilateral trade costs.

3.3 Interactions

The effects of natural investment costs (γ_{ij}) and the initial level of expropriation risk (g_{ij}) on the utility gains from a BIT (or PTA) are likely to be sensitive to country-pairs' economic characteristics, such as their GDP size, GDP similarity, or natural trade costs (τ_{ij}). Our theoretical model allows for such interactions. For instance, suppose a pair of countries ij are larger in absolute factor endowments than pair kl; pair ij will have more bilateral FDI (and FAS) than pair kl. Suppose pair ij also faces lower natural investment costs γ (or higher initial level of expropriation risk, g) than pair kl. Then a BIT between pair ij is likely to lead to larger utility gains than that between pair kl not just due to lower γ (or higher g) but that effect interacted with pair ij's larger economic size. This theoretical conclusion is confirmed using the numerical model (figure not shown).[22] We will evaluate this and other interactions later in the non-linear bivariate probit empirical analysis based upon estimated marginal effects.

[21] PTAs are assumed here to be trade agreements only, with no FDI provisions. We address this issue later in the empirical analysis.

[22] Due to page constraints, we can present here only some of the numerical simulations; others are available from the authors. Yet, later we show explicitly theoretical interaction effects between relative factor endowments, γ_{ij}, and g_{ij}.

4 Relative Factor Endowments and Determinants of BITS and PTAs

4.1 Relative Factor Endowments Hypotheses

As noted in the BITs literature, most BITs are between developed and developing countries, motivated initially (in the late 1950s) by the risk of expropriation. Consequently, relative factor endowment differences may well be influential in the likelihood of a BIT between a country-pair. We now allow relative factor endowments to vary between countries and consider the net utility gains (or losses) from either a BIT or a PTA. For tractability, we use the traditional Edgeworth box to illustrate our results. However, an Edgeworth box is designed to illustrate the impacts in a world with two countries and two factors. In our three-factor setting, we are taking a "slice" of an Edgeworth cube for the two countries. For instance, if we consider two factors, physical capital (K) and unskilled labor (U), there is a continuum of such slices for the various values of s_i – the share of i's and j's skilled labor (S) in country i. Let k_i (u_i) denote country i's share of i's and j's physical capital (unskilled labor) endowment. For illustration below, we will examine the relationship between the utility gains for i and j from BIT_{ij} with k_i and u_i at $s_i = 0.5$; similarly, we will examine the relationship between the utility gains for i and j from PTA_{ij} with k_i and u_i at $s_i = 0.5$.[23] Also, since we are operating in a three-country world, we are examining these relationships for a *given* endowment of factors K, S and U in the ROW. Of course, the Edgeworth box relationships are quantitatively sensitive to the economic size of and relative factor endowments in ROW.[24]

Hypothesis 5: The net utility gain from (and likelihood of) a BIT between i and j is increasing in the abundance of skilled labor relative to physical capital and unskilled labor in i or j.

Figure 4a presents the relationships between the utility gains for i and j from BIT_{ij} with k_i and u_i, at $s_i = 0.5$. Figure 4a suggests that the net utility gains for i and j from BIT_{ij} are maximized when either i or j has a very small amount of the two countries' K and U, given $s_i = 0.5$ (that is, i or j is very skilled labor abundant). Intuitively, the benefits of BIT_{ij} will be greater the larger the FDI/FAS created by the BIT. FAS will be larger with greater numbers of vertical MNEs (VMNEs) and horizontal MNEs (HMNEs). VMNEs and HMNEs will be prominent when skilled labor is abundant relative to physical capital and to unskilled labor, because such a country would have a comparative advantage in setting up headquarters (which are S intensive) and a comparative disadvantage in production at home (low K and U for plant setups and production). Hence, the benefits from a BIT between i and

[23]Empirically, for the data set used later the actual means of s_i, u_i, and k_i all range between 0.53 and 0.56, so using $s_i = 0.5$ is a feasible choice.

[24]In the simulations below, we assume for ROW that its endowments of K, S and U are exactly one-half of the world's endowments and that trade and investment costs in the benchmark equilibrium are the same between i and j as they are between either of these countries and the ROW.

j should be maximized when either i or j is abundant in S relative to K and U (note the utility gains are maximized near the two countries' origins, given $s_i = s_j = 0.5$).[25]

Hypothesis 6: The net utility gain from (and likelihood of) a PTA between i and j is decreasing in the difference of the two countries' ratios of physical capital to unskilled labor.

It is well established that a PTA between a pair of countries should increase trade between them. However, it *may not* be the case that the welfare of the country-pair is enhanced from this PTA – especially if the pair has large differences in physical capital-unskilled labor endowment ratios. Baier and Bergstrand (2004) showed in a world excluding MNEs that the welfare benefits from PTA_{ij} were positive in relative factor endowment differences, up to a point, based upon traditional comparative advantage interacted with trade costs.[26] While that study's empirical results supported that result, Egger and Larch (2008) found in a much larger sample that wider relative capital-unskilled labor ratios had a negative marginal effect on the likelihood of a PTA. The model here can help to explain this latter result.

Figure 4b illustrates the utility gain to i and j from PTA_{ij}. The prominent aspect of this figure is that the two countries' utility gains are decreasing in larger differences in their K/U ratios. Our model can explain this, drawing once again on changes in the activities of NEs, HMNEs, and VMNEs. Note initially that when i and j have identical shares of all three factors, pure intra-industry trade of NEs will be maximized, cf., Figure 4c (middle of the diagram). With a large amount of bilateral intra-industry trade, a PTA causes a large increase in trade between them, consistent with net utility gains at the center of Figure 4b. Moreover, the increase in the volume of trade due to a PTA is also very large if countries i and j have very *different* K/U ratios (cf., Figure 4c), consistent with a PTA benefiting traditional Heckscher-Ohlin trade, as in Baier and Bergstrand (2004).[27]

However, in our context with MNEs also, the utility gains on net from PTA_{ij} may in fact be a

[25]We can confirm using additional figures of the numbers of VMNEs and HMNEs headquartered in i and j that both countries benefit the most from a BIT when i or j is very skilled labor abundant. It is important to note that when k_i and u_i are small, k_j and u_j are large by construction (k_i= 1-k_j). Also, when k_i and u_i are small, they are small relative to s_i (since s_i=s_j=0.5 in Figure 4a), implying that i is relatively abundant in skilled labor, and consequently has a comparative advantage in setting up an MNE and benefitting from a BIT. Alternatively, when k_j and u_j are small, they are small relative to s_j, implying that j is relatively abundant in skilled labor, and consequently has a comparative advantage in setting up an MNE and benefitting from a BIT. Thus, the potential gains from a BIT are maximized when either i or j is abundant in skilled labor relative to physical capital and unskilled labor. Economically, consider initially the center of Figure 4a when $k_i = u_i = s_i = 0.5$. As k_i and u_i decrease (and we move toward the near origin), the relative abundance of skilled labor makes multi-plant HMNEs headquartered in i profitable (because HMNE headquarters (plants) setups require skilled labor (physical capital)), increasing the utility gain from BIT_{ij}. However, as k_i and u_i decrease further, multi-plant HMNEs based in i become less profitable (because of relative physical capital scarcity), but single-plant VMNEs based in i become profitable. Omitted figures, available in an online supplement, confirm this.

[26]Baier and Bergstrand (2004) showed a quadratic relationship, both theoretically and empirically.

[27]Hence, bilateral trade of NEs is very large when countries i and j are identical in absolute and relative factor endowments (i.e., intra-industry trade) *or* when the two countries have very different K/U ratios (i.e., inter-industry trade).

negative function of relative K/U ratios for i and j because of a large loss of HMNEs' varieties (and consequently utility) when K/U ratios of i and j are vastly different. The number of HMNEs are maximized when countries i and j are identical. With wider relative K/U ratios, there will be fewer HMNEs in i and j (and demand will be met more by NEs). The loss in volume of the relatively few varieties produced by HMNEs with PTA_{ij} – see Figure 4d – causes a greater loss of utility for i or j when K/U ratios are very large than the gain in utility for trading large volumes of the varieties goods produced by NEs, see Figure 4c.

Moreover, VMNE activity cannot offset these welfare losses. There is little change in the volume of VMNE activity from PTA_{ij}.[28] Consequently, the large utility loss from the decline in production of the few HMNEs in i or j in the presence of large K/U ratio differences offsets the utility gains from trading more of NEs' outputs following a PTA, suggesting that the probability of a PTA between i and j – in the context of MNEs – may fall the greater the K/U endowment ratio differences between the two countries, as stated in **Hypothesis 6**.

4.2 Interactions

In anticipation of our empirical analysis later which examines – among other things – the *sensitivity* of some variables' effects on the probability of a BIT (or PTA) to countries' economic characteristics (i.e., interactions), we provide two more numerical theoretical results. For instance, the effect of relative skilled abundance in i (or j) on the gains from a BIT between i and j is sensitive to the level of natural bilateral investment costs (γ_{ij}). For instance, if natural investment costs are lower (say, γ_{ij}=0.35, rather than 0.40), FDI from i to j and j to i, and the gains from a BIT, will not only be larger, but are disproportionately larger for skilled labor abundant countries. Figure 5a confirms this by showing the relationship between k_i, u_i, and the gains from BIT_{ij}, at s_i=0.5, at a *lower* value of γ_{ij}=0.35 than in Figure 4a (where γ_{ij}=0.40). A comparison of Figure 5a with Figure 4a shows that the gains from BIT_{ij} increase disproportionately more when either i is very skilled labor abundant or j is (at either of the countries' origins). Economically, the benefits of BIT_{ij} should be larger, when there are lower natural investment costs, the more skilled labor abundant is i (or j) because i (or j) would headquarter more MNEs.

Similarly, the effect of relative skill abundance of i or j on the gains from BIT_{ij} should be larger the higher the initial level of expropriation risk (g_{ij}). If expropriation risk is higher, the gains from a BIT between i and j are higher, but should be disproportionately higher if i (or j) is relatively skilled abundant, since i (or j) would be headquartering more MNEs. Figure 5b confirms this, showing that

[28] Omitted figure for VMNE activity confirms this.

the gains from BIT_{ij} are disproportionately larger if one country is very skilled labor abundant when g_{ij} is 0.15 initially (examining at either origin), rather than 0.10 (see Figure 4a).

4.3 Measuring Influences of Relative Factor Endowments

Since the Edgeworth surfaces are handy, we address briefly the method for which we will capture empirically the influence of relative K/U ratios of i and j on the likelihood of PTA_{ij}, in the context of our theoretical model. First, as in Braconier, Norback, and Urban (2005), we want this measure of relative factor endowment differences to capture as precisely as possible the relationships between relative factor endowment shares as shown in the figures. Consequently, the absolute difference in the natural logs of k_i/u_i and k_j/u_j captures deviations of relative factor endowments from the NW-SE diagonal in Figure 4b (where i's origin is the SW corner); in the regressions later, we use specifically $KURatio_{ij} \equiv |ln(k_i/u_i) - ln(k_j/u_j)|$.

By contrast, measuring the difference in economic size *along* the SW-NE diagonal in Figure 4a (from i's origin to j's origin) has not been done traditionally in the international trade literature using factor-endowment shares. Typically, similarity in economic size is captured by variables such as $sh_i sh_j$, discussed in BE, where sh_i is the share of country i's GDP in the sum of countries' i's and j's GDPs. However, one cannot just use $sh_i sh_j$ to capture the difference in endowments of both K and U along the SW-NE diagonal in Figure 4a. The reason is that – when k_i and u_i are very small – s_i in Figure 4a is *still* 0.5; hence in an Edgeworth box, variation in k_i and u_i along the diagonal changes *relative* factor endowments as well. However, there is a way to capture variation along the SW-NE diagonal in Figure 4a (for a given s_i). Using the geometric properties of the Edgeworth box, variation in the diagonal is captured by a variable, $KUDiff_{ij}$:

$$KUDiff_{ij} \equiv \ln|(k_i^2 + u_i^2)^{1/2}\mu - (k_j^2 + u_j^2)^{1/2}\mu|, \tag{1}$$

where

$$\mu \equiv \frac{1}{(k_i^2 + u_i^2)^{1/2} + (k_j^2 + u_j^2)^{1/2}}$$

A rise in $KUDiff_{ij}$ reflects a wider difference in k_i *and* u_i relative to k_j *and* u_j, for given s_i. We expect $KUDiff_{ij}$ to be positively related to the probability of a BIT.

We provide no other hypotheses regarding the effects of relative factor endowments. Examination of the analogous comparative statics in $S - U$ space and in $K - S$ space yielded no clear empirically "testable" relationships between relative factor endowments and the utility gains or losses from a BIT or PTA.[29] Moreover, it will be important later for econometric purposes that BIT is likely related to $KUDiff_{ij}$ but not to $KURatio_{ij}$, and vice-versa for PTA. This satisfies the necessary *exclusion restriction* for estimating a simultaneous equation system in the robustness analysis later. Finally, in order to evaluate **Hypotheses 5** and **6** holding constant s_i and $s_j = (1 - s_i)$, we include the variable $Ssim_{ij}$ defined as:

$$Ssim_{ij} \equiv lns_i + ln(1 - s_i) \tag{2}$$

as a control variable.

5 Econometric Specification and Data Description

5.1 Econometric Specification

Similar to Baier and Bergstrand (2004), the econometric framework employed is a qualitative choice model. A qualitative choice model can be derived from an underlying latent variable model. In this paper, we consider a bivariate probit model because of possible correlation among the error terms. Let the underlying latent variable for BIT be denoted y_1^* and for PTA be denoted y_2^*. Let y_1^* (y_2^*) represent the difference in utility levels from having a BIT (PTA), where

$$y_{1ij}^* = \mathbf{x}_{1ij}\boldsymbol{\beta}_1 + e_{1ij} \tag{3}$$

$$y_{2ij}^* = \mathbf{x}_{2ij}\boldsymbol{\beta}_2 + e_{2ij}, \tag{4}$$

where $\mathbf{x}_{1ij}$ ($\mathbf{x}_{2ij}$) denotes a vector of explanatory variables (i.e., economic characteristics) of country-pair ij including a constant, $\boldsymbol{\beta}_1$ ($\boldsymbol{\beta}_2$) is a vector of parameters, and error terms e_{1ij} and e_{2ij} are assumed to be independent of $\mathbf{x}_{1ij}$ and $\mathbf{x}_{2ij}$, but possibly correlated with each other, and to have a bivariate normal distribution. In the context of the model formally, $y_{1ij}^* = \Delta U_{1i} + \Delta U_{1j}$ where ΔU_{1i} (ΔU_{1j}) denotes the change in utility for the representative consumer in i (j) from a BIT, and analogously for PTA. We are assuming implicitly the existence of transfers between the two countries' governments so that the relevant consideration is that the sum of the utility changes of the two countries' representative consumers needs to positive for their governments to form a BIT or PTA.

Since y_{1ij}^* and y_{2ij}^* are unobservable, we define an indicator variable BIT_{ij}, which assumes the value 1 if the two countries have a BIT and 0 otherwise, and an indicator variable PTA_{ij}, which

[29] See online supplement for these other figures.

assumes the value 1 if the two countries have a PTA and 0 otherwise, with the response probabilities:

$$Pr(BIT_{ij} = 1, PTA_{ij} = 1) = \Phi_B(\mathbf{x}_{1ij}\boldsymbol{\beta}_1, \mathbf{x}_{2ij}\boldsymbol{\beta}_2, \rho), \tag{5}$$

where $\Phi_B(\cdot)$ denotes the bivariate normal distribution and ρ captures the covariance between the vectors of disturbances $\mathbf{e}_1$ and $\mathbf{e}_2$, $Cov(\mathbf{e}_1, \mathbf{e}_2)$ (see Greene, 1997, ch. 19).[30] In this study, we are concerned with the determination of four probabilities, $Pr(BIT_{ij} = 1, PTA_{ij} = 1)$, $Pr(BIT_{ij} = 1, PTA_{ij} = 0)$, $Pr(BIT_{ij} = 0, PTA_{ij} = 1)$, and $Pr(BIT_{ij} = 0, PTA_{ij} = 0)$, depending on economic (and some political) fundamentals.

Notice that the model in (5) is nonlinear. Hence, none of the covariates included in $\mathbf{x}_{1ij}$ will display a linear effect on the response probabilities (see Greene, 1997). This feature means that there is no explicit need to include interactive terms or other nonlinear terms in the model *per se* (see Greene, 2010). Inclusion of interactive terms or powers of variables actually renders the interpretation of coefficients difficult (see Ai and Norton, 2003; Greene, 2010). However, we can and do calculate marginal response probabilities later to quantify interactive effects of variables.

5.2 Data Description

A general equilibrium model such as the one outlined earlier is mainly informative about long-run economic relationships. Therefore, as in BB we use cross-section data to infer the aforementioned hypotheses. These data capture the state of BITs and PTAs as of year 2000 and use explanatory variables which are averages of the five years prior to year 2000. With regard to the dependent and independent variables, we use data from the following sources.

First, information on BITs in force as of 2000 was collected from the United Nations Conference on Trade and Development (UNCTAD). We use this information to define a binary variable BIT_{ij}, which is unity if countries i and j had a BIT in force by the end of the year 2000 and zero otherwise. Second, we collected data on preferential trade agreements (customs unions, free trade areas, and other preferential trade agreements) from the World Trade Organization (WTO) and individual countries' sources. On the basis of that data, we defined an indicator variable PTA_{ij}, which is unity whenever two countries i and j had a preferential trade agreement in force (either under or outside of the auspices of the WTO) and zero otherwise. It is the case that some of the PTAs in our sample are actually preferential trade *and investment* agreements (PTIAs), such as the European Union (EU) and NAFTA. Since our dependent variable for BITs is actual bilateral investment treaties, investment

[30] In a sensitivity analysis later, we consider a 3SLS estimation of two linear probability models with endogenous explanatory variables as well as a (recursive) simultaneous equations probit model as possible alternatives to the bivariate probit model.

liberalizations covered under "trade" agreements are not included in our BITs dependent variable. For instance, for Germany and France – members of the European Union – PTA_{ij} is recorded as a 1 whereas BIT_{ij} is recorded as a 0. To use in a robustness check later, we also constructed an alternative measure of BIT_{ij} termed $AdjBIT_{ij}$. This alternative "adjusted" variable includes also any country-pairs with bilateral investment provisions "akin to a BIT" that are within any country-pairs' PTIAs. In this regard, we modified 108 "0's" to "1's" of the BIT variable to capture the influence of investment agreements in the EU and in NAFTA as representing BITs. We compare the empirical results using the alternative BITs variables later; essentially, the results are materially the same using the alternative variables.[31]

Third, data on a number of economic fundamentals such as real GDP in US dollars (GDP_i), labor force (L_i), and gross fixed capital formation at constant US dollars of 2000 (K_i) were taken from the World Bank's World Development Indicators (2005). These variables were used to construct the following determinants for our analysis: (i) a measure of bilateral economic size, $GDPSum_{ij} = \ln(GDP_i + GDP_j)$; (ii) a measure of similarity in bilateral economic size, $GDPSim_{ij} = \ln[sh_i(1 - sh_i)]$; and (iii) capital endowments of country i, K_i, and, in turn, the variable $k_i = K_i/(K_i + K_j)$.[32]

Fourth, data on skilled workers (S) come from a new database constructed by researchers at the World Population Program of the International Institute for Applied Systems Analysis (IIASA) which establishes panel data on attained education of the average workers in a comparable way for 120 countries (see Lutz, Crespo Cuaresma, and Sanderson, 2008). These data serve to distinguish between high-skilled workers (S) and low-skilled workers (U) in four education categories. We classify workers in education categories 3 and 4 (corresponding to upper secondary and tertiary education) as highly-skilled ones and workers with lower levels of attained education (categories 1 and 2) as unskilled workers. This obtains s_i and u_i as measures of i's share of skilled and unskilled workers, respectively, between i and j. Furthermore, we use s_i to construct $Ssim_{ij}$ to hold constant relative endowments of skilled workers between two countries i and j in some of the empirical specifications later (see above for theoretical rationale).

Fifth, we use data from CEPII on the distance between economic centers of countries ($Distance_{ij}$), a common land border indicator ($Adjacency_{ij}$), and a common language indicator ($Language_{ij}$). We

[31] Both BIT_{ij} and PTA_{ij} are constructed for each country-pair. If a country was part of a plurilateral agreement, this did not affect the variable's construction. Also, whether a country was a member of the WTO or not had no bearing on the determination of PTA_{ij} or BIT_{ij}.

[32] We calculate K_i by using the perpetual inventory method, following Leamer (1984). For this, we calculate an initial stock of capital for year 0 in each country i, $K_{i0} = \sum_{t=-5}^{-1} I_{it}$, where t is a time index. This provides an estimate of the initial capital stock for a chosen year 0 equivalent to the sum of gross fixed capital investments in the five years prior to that. We chose 1980 as the base year for all countries to make sure that the weight of measurement error of the initial capital stock is negligible by 2000. Then, we calculate the capital stock in year 1 as $K_{i1} = 0.87K_{i0} + I_{i1}$, where 0.87 is one minus the depreciation rate and I_{i1} are i's real gross investments in year 1, and so forth, until we obtain K_i as a measure of the capital stock in the year 2000.

use bilateral distance not only to measure $Distance_{ij}$ but also to construct a measure of remoteness ($REMOTE_{ij}$) of country-pair ij from the rest of the world. The latter is constructed as an average distance of i and j from all other countries, as in Baier and Bergstrand (2004) and Egger and Larch (2008). The variables $Adjacency_{ij}$ and $Language_{ij}$ are typically found in trade gravity equations, as measures of *inverse* bilateral trade costs, e.g., two adjacent countries have lower trade costs. Hence, we expect both of these to be negatively related to τ_{ij} (natural bilateral trade costs).

Sixth, we also need proxies for natural bilateral investment costs (γ_{ij}) – which cannot be removed by a BIT – and for the bilateral investment cost representing expropriation risk (g_{ij}). The literature on FDI determinants suggests that political instability in a host country is associated with lower FDI; we use this as a proxy for natural bilateral investment costs γ_{ij}. BERI publishes data on countries' political risk. We define $PolStab_{ij}$ such that a higher level measures greater political *stability* in the less stable of the two countries i and j; hence, like for our trade-cost variables, we are proxing for the *inverse* of γ_{ij}. BERI also provides data on expropriation risk. We define $IExpRisk_{ij}$ such that a higher level measures *less* expropriation risk in the riskier one of two countries i and j for investments between them. Hence, like above, we are proxing for the *inverse* of g_{ij}. Hence, our investment-cost variables $PolStab_{ij}$ and $IExpRisk_{ij}$ are negatively related to γ_{ij} and g_{ij}, respectively.[33]

Seventh, as addressed in Egger and Larch (2008), the probability of a country-pair having a PTA in year 2000 may be influenced by the degree of "PTA interdependence." That is, Baldwin's "domino effects" (Baldwin, 1993) may cause the existence of PTAs of i and j with "third countries" to influence the net welfare gains from and likelihood of the pair having a PTA; Egger and Larch (2008) demonstrated the significance of this interdependence. To address this, we also constructed for every country-pair a (ten-year-lagged) index of "third-country PTAs." We also constructed for each pair a similar index of "third-country BITs." Also, as addressed in BB and Egger and Larch (2008), the welfare gains from and probability of PTA_{ij} are larger the more "remote" pair ij is from the ROW (other third-country-pairs). We also constructed $REMOTE_{ij}$, as defined in BB, which is an index of how remote (using bilateral distances) pair ij is from other countries.

Table 2 presents summary statistics for all the variables used in this study.

[33]For a robustness analysis, we also construct and include two additional variables for political stability and inverse expropriation risk for the *more stable* and *less risky* of the two countries, respectively.

6 Empirical Results

6.1 Main Empirical Results

Table 3 presents the main empirical results based on seemingly unrelated bivariate probit models for BITs and PTAs. These models allow for correlation of BIT_{ij} and PTA_{ij} through two sources: (i) the observed determinants of such agreements as included in the specification of the latent process determining bivariate binary outcomes,[34] and (ii) unobserved characteristics as included in the disturbances. Table 3 has several columns presenting the results of including variables suggested by our discussion above incrementally, similar to the presentation in Baier and Bergstrand (2004) for only PTAs. We will refer below to "a" to denote a specification associated with BIT_{ij} and "b" refers to results associated with PTA_{ij}.

Specifications 1a and 1b are reported to examine the effects on the likelihood of a BIT and a PTA, respectively, of variables from section 3, in particular, measures of economic size, economic similarity, distance, and natural trade and investment costs. We consider first economic size and similarity. We find that the sum and similarity of the two countries' GDPs ($GDPSum_{ij}$ and $GDPSim_{ij}$) have positive and statistically significant impacts on the likelihood of a BIT and of a PTA, as our theoretical model suggested.[35] This is the first study to find and explain the positive association between the economic size and similarity of a pair of countries and the likelihood of their having a BIT. Other things the same, country-pairs that are economically larger and more similar in size tend to have more FDI so that these economies' welfare will tend to rise more from a BIT, increasing the likelihood of their forming one. Moreover, country-pairs that are economically larger and more similar in size tend to have more trade so that these economies' welfare will tend to rise more from a PTA, increasing the likelihood of their forming one. Hence, **Hypotheses 1** and **2** are confirmed.

We now turn to $Distance_{ij}$, $Adjacency_{ij}$ and $Language_{ij}$. As in Baier and Bergstrand (2004), $Distance_{ij}$ was included as a proxy for "natural" trade costs.[36] However, bilateral distance is well-known from the gravity-equation literature to have a negative, economically significant, and statistically significant impact both on bilateral trade flows *and* bilateral FDI flows. Consequently, one might argue that bilateral distance is not capturing "trade" costs *per se* but rather trade as well as other "information" costs.

However, although the marginal response probabilities will be provided later, there is some in-

[34]The latent processes underlying BIT_{ij} and PTA_{ij} could be interpreted as the net gains for country-pair ij from concluding one or the other type of agreement.

[35]We discuss the economic significance of these and other coefficients later in the section on marginal response probabilities.

[36]$Distance_{ij}$ is the natural logarithm of the country-pair's bilateral distance. Baier and Bergstrand (2004) used the variable $NATURAL_{ij}$, which was simply the log of the inverse of bilateral distance.

formation content in the relative coefficient estimates for $Distance_{ij}$ from Specifications 1a and 1b, consistent with gravity equations of FDI and trade. For instance, typically in gravity equations estimated using ordinary least squares (absolute values of) coefficient estimates on $Distance_{ij}$ are smaller for FDI flows relative to trade flows, cf., Berden, Bergstrand, and van Etten (2011), even though there are very few studies that estimate both trade and FDI gravity equations in the same study using a common specification.[37] This result is consistent with the following notion. FDI flows are motivated from two sources, with "trade costs" having opposite effects. Much vertical FDI is to set up plants abroad which serve as export platforms back to the home country; trade costs (as proxied by distance) should have a negative effect on this FDI. However, horizontal FDI sets up plants abroad to "jump-over" trade costs, so such costs should have a positive effect on this FDI. The smaller negative coefficient estimate for bilateral distance in gravity equations for FDI relative to trade flows is consistent with this behavior. Since BITs are intended to enhance FDI flows, the smaller negative coefficient estimate for $Distance_{ij}$ is consistent with this explanation.[38]

Specifications 1a and 1b reveal *opposite* coefficient signs between the BITs and PTA probits for $Adjacency_{ij}$ and $Language_{ij}$. These two variables are the most commonly used dummies in gravity equations of trade flows and typically have economically and statistically significant positive effects. It is interesting to find that these two variables have statistically significant *negative* coefficient estimates in the BITs equation but positive coefficient estimates in the PTA equation. These results are consistent with (the trade-cost portions of) **Hypotheses 3** and **4**. As Figure 3a suggests, the likelihood of a PTA should be greater between two countries the lower their trade costs, which implies a positive relationship between $Adjacency_{ij}$ and $Language_{ij}$ with $Pr(PTA_{ij} = 1)$. But lower trade costs discourage horizontal FDI, which suggests (as in Figure 3b) that the net utility change for a pair of countries from a BIT is a positive (negative) function of τ_{ij} ($Adjacency_{ij}$ and of $Language_{ij}$). Thus, the results are consistent with inferring that sharing a common land border and a common language reduce trade costs.

However, it would be useful to have a measure of natural investment costs in order to determine if the remaining (investment-cost) portions of **Hypotheses 3** and **4** are confirmed. Specifications 2a and 2b augment Specifications 1a and 1b to include a measure of natural investment costs (γ_{ij}). The measure employed here is the index $PolStab_{ij}$ described above, which is increasing in the perceived degree of political *stability* (of the less stable of the country-pair), and hence a measure of the *inverse* of γ_{ij}. In a recent study of several governance indicators and their relationships to FDI and trade

[37]For an exception, see Bergstrand and Egger (2010).

[38]See also Egger and Pfaffermayr (2004b) on this issue. These authors find opposite effects of distance, negative for trade and positive for FDI, consistent with our interpretation.

flows (cf., Berden, Bergstrand, and van Etten, 2011), the measure of political stability had a positive and statistically significant effect on FDI flows and an estimated zero effect on trade flows, suggesting a plausible (inverse) measure of natural investment costs; moreover, this variable had an economically and statistically significant effect on FDI relative to trade. Specification 2a reveals that greater political stability (in the less stable country), by lowering natural investment costs and enlarging FDI, leads country-pairs to be more likely to form a BIT. This confirms **Hypothesis 3**.[39] Moreover, $PolStab_{ij}$ has the opposite effect on the likelihood of a PTA. An increase in political stability reduces investment costs, which decreases the net utility gains from a bilateral PTA, consistent with Figure 3a and **Hypothesis 4**.

Figures 4a and 4b and **Hypotheses 5** and **6** suggest relationships between k_i and u_i with the welfare effects (and, hence, likelihoods) of BITs and PTAs. Figure 4a suggests a positive relationship between differences in k_i and u_i with k_j and u_j ($KUDiff_{ij}$) and the utility gains to i and j from a BIT, as a higher value of $KUDiff_{ij}$ is associated with a larger relative abundance of skilled labor in either i or j, which favors more MNEs and FDI. Figure 4b suggests a negative relationship between differences in k_i/u_i relative to k_j/u_j ($KURatio_{ij}$) and the utility gains to i and j from a PTA. Wider relative K/U ratios between i and j lead to more NEs trade, but a large decline in HMNEs activity, such that on net a PTA is welfare decreasing. Specifications 3a and 3b confirm the qualitative impacts of these two variables on their respective probabilities as consistent with these two hypotheses. Higher skilled labor abundance of either i or j ($KUDiff_{ij}$) leads to a higher probability of a BIT between them as expected. A wider K/U ratio between i and j ($KURatio_{ij}$) leads to a lower probability of a PTA between them as expected. Thus, all six hypotheses suggested by the numerical comparative statics discussed earlier are supported empirically.

Table 3 provides one more specification, Model 4. In the interest of brevity, we combine four issues in this last specification in Table 3.[40] First, we include the BERI measure of *inverse* expropriation risk (of the riskier country of the pair), $IExpRisk_{ij}$, which is negatively related to g_{ij}. As discussed above, higher bilateral expropriation risk (higher g_{ij}) should increase the gains from BIT_{ij}; hence, a higher value of $IExpRisk_{ij}$ should have a *negative* effect on the probability of BIT_{ij}. Specification 4 confirms this and the coefficient estimate is statistically significant. Second, the net welfare gains and probability of BIT_{ij} should not be influenced by economic characteristics of i and j alone; *third-country* effects matter also. BB showed that the net welfare gains from and probability of PTA_{ij} were influenced by the "remoteness" of pair ij from third-country pairs. For robustness, we included

[39] We also included, for robustness, political stability in the more stable of the country-pair. This variable was not statistically significant.

[40] This consolidation was recommended by a referee.

$REMOTE_{ij}$, defined earlier, to account for the influence of the distance of pair ij from the ROW. Specification 4 reveals that, as in BB and Egger and Larch (2008), $REMOTE_{ij}$ has a positive and statistically significant effect on the probability of PTA_{ij}. However, $REMOTE_{ij}$ has no statistically significant effect on the likelihood of BIT_{ij}. Third, Egger and Larch (2008) raised the issue of PTA "interdependence." The results may be sensitive to omitting the effect of "third-country" BITs and PTAs on the probability of BIT_{ij} and of PTA_{ij}. Following the methodology in Egger and Larch (2008), we constructed (ten-year-lagged) indexes of "third-country" BITs and PTAs. Specification 4 reveals that *interdependence* matters; both indexes had statistically significant effects on the probabilities of BIT_{ij} and of PTA_{ij}. Fourth, when we introduced the two relative-factor-endowment variables in Specification 3, we omitted (for methodological reasons discussed earlier) the index of similarity of GDPs of i and j. To show that the results are not materially different with or without $GDPSim_{ij}$, we included it in Model 4. While the coefficient estimates are significant, they are also identical; however, in Table 5 later we will show that the marginal effect of GDP similarity for BITs is smaller than that for PTAs, as expected.

6.2 Robustness Analysis

In this section, we discuss three sensitivity analyses pertaining to the robustness of the results just discussed for Model 4.

6.2.1 Robustness to Preferential Trade and Investment Agreements

As discussed under Data Description, some of the PTAs in our sample are actually preferential trade *and investment* agreements (PTIAs), such as the European Union (EU) and NAFTA. Since our dependent variable for BITs is actual bilateral investment treaties, investment liberalizations covered under "trade" agreements are not included in our BITs dependent variable. For instance, for Germany and France, PTA_{ij} is recorded as a 1 whereas BIT_{ij} is recorded as a 0. We approached this issue two alternative ways. Specifications 5a and 5b in Table 4 comprise the bivariate probit model where we include an "adjusted" variable for BIT. The new variable – $AdjBIT$ – includes also any bilateral investment agreements akin to BITs that are within country-pairs' PTIAs. We modified 108 "0's" to "1's" of the BIT variable to capture the influence of investment agreements in the EU and in NAFTA as representing BITs. A comparison of the results in Specifications 4a and 4b in Table 3 using BITs and PTAs with those in Specifications 5a and 5b in Table 4 using the adjusted-BITs variable and PTAs shows that the results are materially the same in the two sets of specifications.

Alternatively, we could simply remove all the PTIAs from our sample. However, we note that –

if anything – the inclusion of PTIAs in our sample of PTAs would tend to bias the results against us. For instance, the coefficient estimates for *Adjacency*, *Common Language*, *Political Stability*, and *Inverse Expropriation Risk* are expected to have opposite signs for PTAs and BITs. The inclusion of PTIAs in our PTA sample would tend to bias the coefficient estimates for these variables toward similar signs for PTAs and BITs. Nevertheless, we also re-ran Specifications 4a and 4b in Table 3 deleting the 108 observations associated with the EU members and NAFTA members, and the results do not change materially enough to be presented.

6.2.2 Robustness to Recursive Simultaneous Bivariate Probit Estimation

It is possible that the latent variable influencing the probability of a PTA for two countries also influences the latent variable influencing the probability of a BIT between the pair, or vice-versa. That is, the determination of the probabilities of PTA_{ij} and BIT_{ij} may be better represented by a *simultaneous equations* probit model. However, there is no econometric theoretical foundation for estimating a simultaneous equations probit model where *both* endogenous variables appear as explanatory variables (PTA affecting BIT in one equation and BIT affecting PTA in the other equation, cf., Wooldridge, 2002). However, there is econometric theory for estimating a *recursive* simultaneous equations model with one of the endogenous variables entering one of the equations, cf., Schmidt (1981) and Wooldridge (2002, pp. 477-478). Moreover, in order to evaluate which equation should have the endogenous explanatory variable, we turn for guidance to a three-stage least squares (3SLS) estimation of two linear probability models first.

First, we estimated the linear probability versions of Model 4 of BIT and PTA using 3SLS. The notable finding from the 3SLS estimation is that PTA does have a statistically significant effect on the existence of BIT (and the other coefficient estimates remain plausible), but the PTA equation has no statistically significant coefficient estimates, including that for BIT. Given there is only empirical evidence that PTA causes BIT using the 3SLS estimates, we estimated a recursive simultaneous probit equations model of BIT and PTA, where PTA was allowed to be an endogenous explanatory variable for the BIT equation. These estimates are reported in Specifications 6a and 6b of Table 4. The main finding is that PTA does have a statistically significant positive effect on the existence of BIT. However, *none* of the other coefficient estimates of the BIT equation are materially different from those in bivariate probit Specifications 4a and 4b in Table 3. The BIT equation is basically robust to including the endogenous explanatory variable PTA. Also, the PTA equation in Specification 6b is very similar to that in Specification 4b; the PTA equation is also robust and we find no evidence of (current) BITs affecting PTAs.

6.2.3 Robustness to Dynamic Effects

While the previous section explored the effects of *current* PTAs (BITs) on concurrent BITs (PTAs) using a recursive simultaneous equations approach, it is possible that PTAs (BITs) formed *earlier* – specifically, in 1990 – have caused *changes* in PTA (BIT) status from 1990 to 2000. We explored this possibility as well. Specifications 7a and 7b are the analogues to Specifications 4a and 4b, respectively, but include on the RHS ten-year-lagged values of PTAs (BITs) in the BITs (PTAs) equation. Moreover, the dependent variable is now the *change* in BIT (PTA) status from 1990 to 2000 in Specification 7a (7b). Qualitatively, the results in Specifications 7a and 7b are remarkably similar to those in Specifications 4a and 4b, despite the change in the dependent variables. Note, however, that ten-year-lagged levels of PTAs (BITs) had no statistically significant effect on the change in BIT (PTA) status in the subsequent decade.

6.3 Marginal Response Probabilities and Predictions

In this section, we report two sets of findings. We discuss the marginal response probabilities of one-standard-deviation changes in the right-hand-side variables as well as some interactive effects. Then, we summarize the percentages of correctly predicted bivariate observations on BIT and PTA, BIT but no PTA, PTA but no BIT, and no BIT or PTA from the model.

6.3.1 Marginal Response Probabilities

Probit coefficient estimates cannot reveal the quantitative (economic) effect of a change in any RHS variable on the probability of a BIT or PTA. Given the standard bivariate normal distribution, we can calculate the marginal response probabilities to unit- or one-standard-deviation changes in the RHS variables. For brevity, we report in Table 5 only the marginal response probabilities to one-standard-deviation changes in the RHS variables, although the other results are available on request. Since it is a bivariate probit model, we report both the unconditional and conditional response probabilities.

First, the variable that has the largest quantitative effect on either the probability of a BIT or a PTA is economic size. Moreover, a one-standard-deviation change in GDP size has a larger effect on the likelihood of a BIT than on that of a PTA. This result accords well with an empirical result in Bergstrand and Egger (2007) that FDI flows are more elastic with respect to changes in economic size than are trade flows.

Second, GDP similarity has an economically and statistically significant effect on BITs and PTAs, consistent with our theoretical findings. Moreover, the quantitative effect of a one-standard-deviation change in GDP similarity is larger for PTAs than for BITs, as our theoretical results predicted.

Third, distance has a larger (negative) impact on the likelihood of a PTA than on that for a BIT. This is consistent with the discussion earlier; the influence of distance on the likelihood of BITs is likely muted by the trade-cost-jumping role of horizontal FDI. Also, of *Adjacency* and *Language*, only *Adjacency* has a significant marginal response probability, and it is in the BITs equation. *Adjacency* has a clearer economic interpretation, as an inverse natural-trade-cost measure. Lower trade costs associated with adjacent economies increases trade, reduces horizontal FDI, and lowers the likelihood of a BIT.

Fourth, both measures of investment costs have economically and statistically significant marginal response probabilities in the expected direction for likelihood of BITs; more expropriation risk (higher g) increases $Pr(BIT_{ij} = 1)$ and more political instability (higher γ) decreases $Pr(BIT_{ij} = 1)$. A one-standard-deviation increase in the political stability index has a larger (in absolute terms) quantitative effect on the probability of a BIT than a one-standard-deviation increase in the inverse expropriation risk index.

Fifth, both relative factor endowment variables have economically and statistically significant marginal response effects on their respective probabilities. The negative effect on the probability of a PTA of a one-standard-deviation increase in relative K/U ratios is larger quantitatively (in absolute terms) than the positive effect on the probability of a BIT of a one-standard-deviation increase in the relative skilled-labor abundance of countries i and j. This actually accords well with Figures 4a and 4b, where the negative welfare effect from a PTA of widening K/U ratios was considerably larger (in absolute terms) than the positive welfare effect from a BIT of a widening of k_i and u_i relative to k_j and u_j (and consequently larger skilled-labor abundance of i or j).

Finally, we discuss the interactive effects suggested by theoretical Figures 5a and 5b. A comparison of Figure 5a with Figure 4a reveals a disproportionately greater effect of relative skill abundance on the net utility gains from a BIT when natural investment costs are lower (γ_{ij}=0.35 in Figure 5a, rather than 0.40 in Figure 4a), as the underlying level of FDI between i and j is larger. In our model, $PolStab_{ij}$ is the proxy for the inverse of γ_{ij}. The (unconditional) marginal response probability of a one-standard-deviation increase in $PolStab_{ij}$ is 3.2 percent. However, if $KUDiff_{ij}$ is one standard deviation higher, the $PolStab_{ij}$ marginal response probability is 5.4 percent, consistent with our theoretical conjecture of a negative interaction effect between γ_{ij} and $KUDiff_{ij}$ on the welfare gains from a BIT.

Moreover, a comparison of Figure 5b with Figure 4a reveals a disproportionately greater effect of relative skill abundance on the net utility gains from a BIT when the level of expropriation risk is higher (g_{ij}=0.15 in Figure 5b, rather than 0.10 in Figure 4a). In our model, $IExpRisk_{ij}$ is a measure of the inverse of g_{ij}. The (unconditional) marginal response probability of a one-standard-deviation *decrease* in $IExpRisk_{ij}$ is 1.3 percent. However, if $KUDiff_{ij}$ is one standard deviation higher, the response probability is 2.3 percent, consistent with our theoretical conjecture of a positive interaction effect between g_{ij} and $KUDiff_{ij}$ on the welfare gains from a BIT.

6.3.2 Explanatory Power and Predicted Probabilities

One of the interesting results from the original Baier and Bergstrand (2004) study was the high pseudo-R^2 value of 73 percent in their fullest specification of explaining the likelihood of PTAs. However, this study examined only 1,145 pairings of 54 countries. In a much larger and less selective cross-section using 146 countries and 10,585 country-pairs, Egger and Larch (2008) showed that the Baier-Bergstrand results held up, but the overall explanatory power, as captured by the pseudo-R^2, was unsurprisingly much smaller at 27 percent. In this study, we use an even larger data set than Egger-Larch, with 161 countries and 12,880 observations. Moreover, explaining the likelihood of PTAs *and* BITs *simultaneously* is a larger challenge. Hence, our pseudo-R^2 of 28 percent in our main specification, Model 4 in Table 3, is a strong result, in this context.

In the spirit of these papers, we also consider here the percent of correctly predicted, both for "true positives" and for "true negatives." However, in this bivariate model, we are calculating percent correctly predicted for each of the *four* outcomes: BIT and PTA, BIT but no PTA, PTA but no BIT, and no BIT or PTA. Baier and Bergstrand (2004) conducted this statistical summary for their cross-section analysis of year 1996 for PTAs and found that their model predicted correctly 243 of 286 PTAs, or 85 percent (using a cutoff probability of 0.5). They also predicted 1,114 of the 1,145 pairs without PTAs correctly, or 97 percent. However, this sample was quite small, and Egger and Larch conducted a similar analysis using their larger cross-section of 10,585 country-pairs. Also using a cutoff probability of 0.5 for year 2000, the percent PTAs correctly predicted was 62 percent and the percent of "No-PTAs" correctly predicted was 98 percent.

It is important to note, however, that a cutoff probability of 0.5 is not a very relevant one. The reason is that PTAs and BITs are still rare events. As Table 1 showed, of 12,880 country-pairs in year 2000 in our sample, only 556 country-pairs had a BIT and PTA, which implies an unconditional probability of only 4.3 percent. The unconditional probability of a BIT but no PTA is only 7.2 percent, and that of a PTA but no BIT is 11.5 percent. Hence, a cutoff probability of 50 percent for any of these events is too extreme. Cohen et. al. (2003) and Cameron and Trivedi (2005) suggest using *a priori* information about the proportion of (PTA and BIT) events and non-events in the sample for forming cutoff probabilities; hence, we use the unconditional probabilities. In the case of country-pairs with a BIT and PTA, we predict correctly 88.4 percent of the observations. In the case of pairs with a BIT but no PTA, we predict correctly 81.2 percent of the observations. In the case of pairs with a PTA but no BIT, we predict correctly 83.8 percent of the observations. Finally, in the case of pairs with no BIT or PTA, we predict correctly 56.5 percent of the observations.

7 Conclusions

The purpose of this study was to develop an econometric model that explains the "economic" determinants of BITs – at the same time as explaining PTAs. In the spirit of Baier and Bergstrand (2004), which explained PTAs in the context of a general equilibrium model of world trade with exporters, the model in this study is the first econometric model to explain BITs (along with PTAs) in the context of an explicit general equilibrium model of world production, consumption, trade, and FDI with national and multinational firms in multiple countries.

The main conclusions are that the potential welfare gains from and likelihood of a BIT (PTA) between a country-pair are higher: (1) the larger and more similar in GDP are the country-pair; (2) the closer in distance are the two countries; (3) if the two countries are not adjacent (are adjacent) and do not share (do share) a common language; (4) the higher (lower) the degrees of political stability and of expropriation risk of the pair; and (5) the relatively more skilled labor abundant (the wider the relative K/U ratio of) the pair. These factors have economically and statistically significant effects on the probability of a BIT (PTA).

While there exist choices of cutoff probabilities in determining the percent correctly predicted of the alternative outcomes, using the unconditional probabilities the preferred empirical model predicts correctly more than 80 percent of country-pairs with a BIT and PTA, with a BIT but no PTA, and with a PTA but no BIT. Consequently, the model provides a benchmark for incorporating other economic – and especially political science and legal variables – into understanding the determinants of BITs and PTAs.

References

Ai, D., and E.C. Norton (2003), Interaction Terms in Logit and Probit Models, *Economics Letters* **80**, 123-129.

Aisbett, Emma (2009), Bilateral Investment Treaties and Foreign Direct Investment: Correlation versus Causation, in Karl P. Sauvant and Lisa E. Sachs (eds.), *The Effect of Treaties on Foreign Direct Investment*, Oxford University Press, Oxford, UK.

Alfaro, Laura, and Andrew Charlton (2009), Intra-Industry Foreign Direct Investment, *American Economic Review*, **99** (5), December, 2096-2119.

Baier, Scott L., and Jeffrey H. Bergstrand (2004), Economic Determinants of Free Trade Agreements, *Journal of International Economics*, **64**, 29-63.

Baldwin, Richard E. (1993), A Domino Theory of Regionalism, National Bureau of Economic Research Working Paper No. 4465.

Baldwin, Richard E. and Dany Jaimovich (2010), Are free trade agreements contagious?, *unpublished manuscript*, Graduate Institute for International Studies, November.

Berden, Koen, Jeffrey H. Bergstrand, and Eva van Etten (2011), Globalization and Governance, working paper, University of Notre Dame.

Bergstrand, Jeffrey H., and Peter Egger (2006), Trade Costs and Intra-Industry Trade, *Review of World Economics*, **142** (3), October, 433-458.

Bergstrand, Jeffrey H., and Peter Egger (2007), A Knowledge-and-Physical-Capital Model of International Trade Flows, Foreign Direct Investment, and Multinational Enterprises, *Journal of International Economics*, **73**, 278-308.

Bergstrand, Jeffrey H., and Peter Egger (2010), A General Equilibrium Theory for Estimating Gravity Equations of Bilateral FDI, Final Goods Trade, and Intermediate Trade Flows, in Peter A.G. van Bergeijk and Steven Brakman (eds.), *The Gravity Model in International Trade.* Cambridge University Press, Cambridge, UK.

Bergstrand, Jeffrey H., and Peter Egger (2011), Shouldn't Physical Capital *Also* Matter for Multinational Enterprise Activity?, *unpublished manuscript*, University of Notre Dame.

Bergstrand, Jeffrey, Peter Egger, and Mario Larch (2010), Economic Determinants of the *Timing* if Preferential Trade Agreement Formations and Enlargements, *unpublished manuscript*, University of Notre Dame, September.

Blonigen, Bruce A., and Jeremy Piger (2011), Determinants of Foreign Direct Investment, National Bureau of Economic Research Working Paper No. 16704, January.

Braconier, Henrik, Pehr-Johan Norback, and Dieter Urban (2005), Reconciling the Evidence on the Knowledge-Capital Model, *Review of International Economics* **13** (4), 770-786.

Buthe, Tim, and Helen V. Milner (2009), Bilateral Investment Treaties and Foreign Direct Investment: A Political Analysis, in Karl P. Sauvant and Lisa E. Sachs (eds.), *The Effect of Treaties on Foreign Direct Investment: Bilateral Investment Treaties, Double Taxation Treaties, and Investment Flows*, Oxford University Press, Oxford, UK.

Cameron, A. Colin, and Pravin K. Trivedi (2005), *Microeconometrics: Methods and Applications*, Cambridge University Press, Cambridge, UK.

Carr, David, James R. Markusen, and Keith E. Maskus (2001), Estimating the Knowledge-Capital Model of the Multinational Enterprise, *American Economic Review*, **91** (3), June, 693-708.

Caves, Richard (1971), International Corporations: The Industrial Economics of Foreign Investment, *Economica* **38**, February, 1-27.

Chen, Maggie Xiaoyang, and Sumit Joshi (2010), Third-Country Effects on the Formation of Free Trade Agreements, *Journal of International Economics*, **82**, 238-248.

Cohen, Jacob, Patricia Cohen, Stephen G. West, and Leona S. Aiken (2003), *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences,* Third Edition, Lawrence Erlbaum Associates, Mahwah, NJ.

Egger, Peter, and Mario Larch (2008), Interdependent Preferential Trade Agreement Memberships: An Empirical Analysis, *Journal of International Economics* **76**, 384-399.

Egger, Peter, and Michael Pfaffermayr (2004a), The Impact of Bilateral Investment Treaties on Foreign Direct Investment, *Journal of Comparative Economics* **32**, 788-804.

Egger, Peter, and Michael Pfaffermayr (2004b), Distance, Trade, and FDI: A Hausman-Taylor SUR Approach, *Journal of Applied Econometrics* **19**, 227-246.

Frankel, Jeffrey A. (1997), *Regional Trading Blocs*, Institute for International Economics, Washington, DC.

Freund, Caroline, and Emanuel Ornelas (2009), Regional Trade Agreements, *unpublished manuscript*, London School of Economics.

Gallagher, Kevin P., and Melissa B.L. Birch (2006), Do Investment Agreements Attract Investment? Evidence from Latin America," *Journal of World Investment and Trade* **7** (6), 961-976.

Goldin, Claudia, and Lawrence F. Katz (1998), The Origin of Technology-Skill Complementarity, *Quarterly Journal of Economics* **113**(3), 693-732.

Greene, William H. (1997), *Econometric Analysis*, third edition, Prentice-Hall International, Inc., New York.

Greene, William H. (2010), Testing Hypotheses about Interaction Terms in Nonlinear Models, *Economics Letters* **107**(2), 291–296.

Griliches, Zvi (1969), Capital-skill Complementarity, *Review of Economics and Statistics* **51**(4), 465-468.

Hallward-Driemeier, Mary (2003), Do Bilateral Investment Treaties Attract FDI? Only a Bit and They Could Bite, World Bank Policy Research Paper WPS 3121.

Leamer, Edward E. (1984), *Sources of International Comparative Advantage: Theory and Evidence*, MIT Press, Cambridge, MA.

Lutz, Wolfgang , Jesus Crespo Cuaresma, and W. Sanderson (2008), The Demography of Educational Attainment and Economic Growth, *Science* **319**, 1047-1048.

Markusen, James R. (2002), *Multinational Firms and the Theory of International Trade*, MIT Press, Cambridge, Massachusetts.

Markusen, James R., and Keith E. Maskus (2001), Multinational Firms: Reconciling Theory and Evidence, in Magnus Blomstron and Linda Goldberg (eds.), *Topics in Empirical International Economics: A Festschrift in Honor of Robert E. Lipsey*, University of Chicago Press, Chicago, IL.

Markusen, James R., and Keith E. Maskus (2002), Discriminating Among Alternative Theories of the Multinational Enterprise, *Review of International Economics*, **10**, no. 4, 694-707.

Markusen, James R., Anthony J. Venables, Denise Eby-Konan, and Kevin H. Zhang (1996), A Unified Treatment of Horizontal Direct Investment, Vertical Direct Investment, and the Pattern of Trade in Goods and Services, National Bureau of Economic Research Working Paper No. 5696, August.

Moser, Christoph, and Andrew K. Rose (2011), Who Benefits from Regional Trade Agreements? The View from the Stock Market, National Bureau of Economic Research Working Paper No. 17415, September.

Neumayer, E., and L. Spess, (2005), Do Bilateral Investment Treaties Increase Foreign Direct Investment to Developing Countries?, *World Development*, **33**, no. 10, 1567-1585.

Salacuse, Jeswald W. (1990), BIT by BIT: The Growth of Bilateral Investment Treaties and Their Impact on Foreign Investment in Developing Countries," *HeinOnline*, **24**, 655-675.

Salacuse, Jeswald W., and Nicholas P. Sullivan (2005), Do BITs Really Work? An Evaluation of Bilateral Investment Treaties and Their Grand Bargain, *Harvard International Law Journal* **46**, no. 1.

Sauvant, Karl P., and Lisa E. Sachs (eds.) (2009), *The Effect of Treaties on Foreign Direct Investment*, Oxford University Press, New York, NY.

Schmidt, Peter (1981), Constraints on the Parameters in Simultaneous Tobit and Probit Models, in Charles Manski and Daniel McFadden (eds.), *Structural Analysis of Discrete Data and Econometric Application*, MIT Press, Cambridge, Massachusetts.

Slaughter, Matthew J. (2000), Production Transfer within Multinational Enterprises and American Wages, *Journal of International Economics* **50**(2), 449-472.

Swenson, Deborah (2005), Why Do Developing Countries Sign BITs?, *U.C. Davis Journal of International Law and Policy*, **131**.

Tobin, Jennifer, and Susan Rose-Ackerman (2005), Foreign Direct Investment and the Business Environment in Developing Countries: The Impact of Bilateral Investment Treaties, Yale Law School Center for Law, Economics, and Public Policy Research paper No. 293.

United Nations Conference on Trade and Development (2007), Bilateral Investment Treaties: 1995-2006, UNCTAD, New York, New York.

Vandevelde, Kenneth J. (1998), Investment Liberalization and Economic Development: The Role of Bilateral Investment Treaties, *Columbia Journal of Transnational Law*, **36**, 501-527.

Vandevelde, Kenneth J. (2000), The Economics of Bilateral Investment Treaties, *Harvard International Law Journal*, **41**, 469-502.

Wooldridge, Jeffrey M. (2002), *Econometric Analysis of Cross Section and Panel Data*, MIT Press, Cambridge, Massachusetts.

Figure 1
Number of BITs in the World by Year, 1980-2007

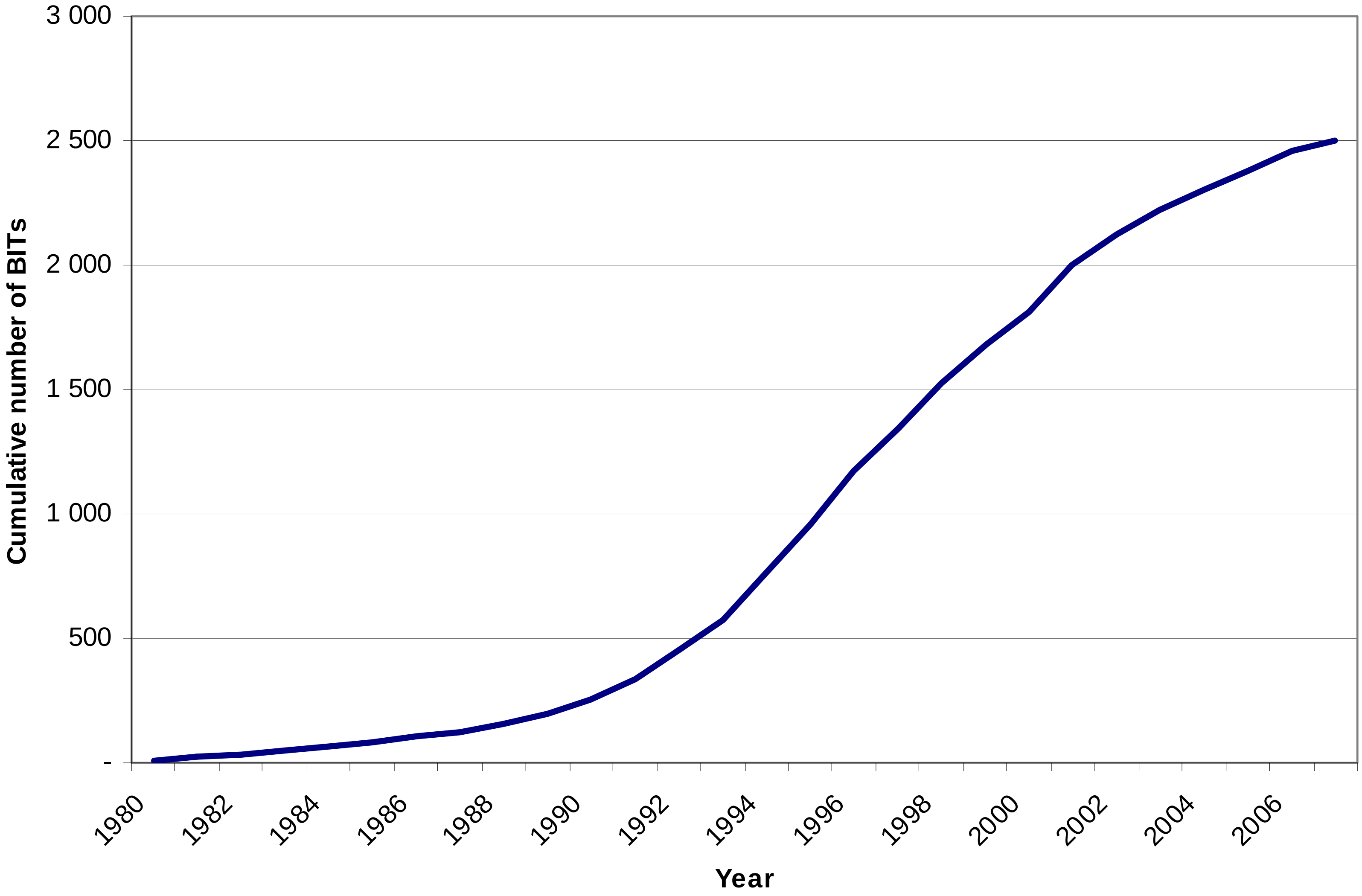

Figure 2a

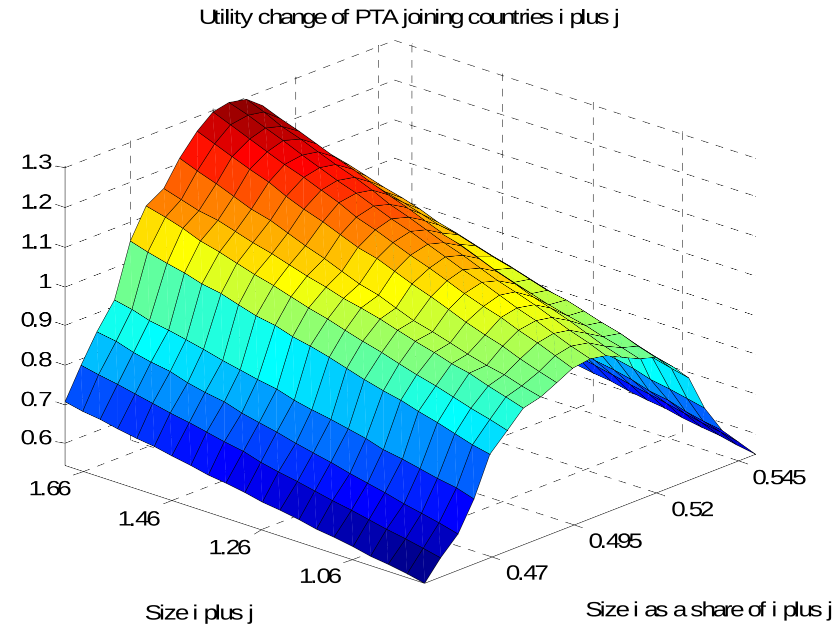

Figure 2b

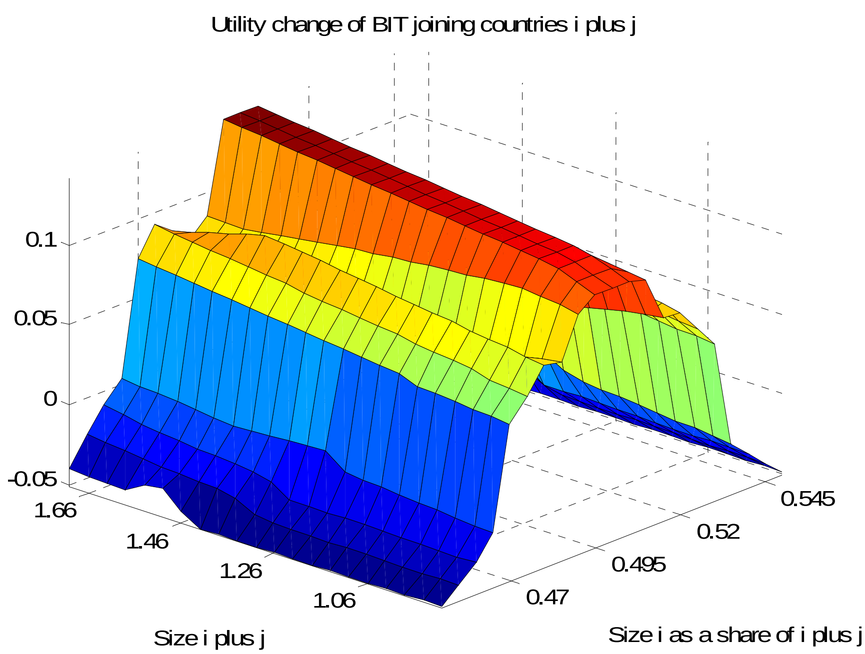

Figure 3a

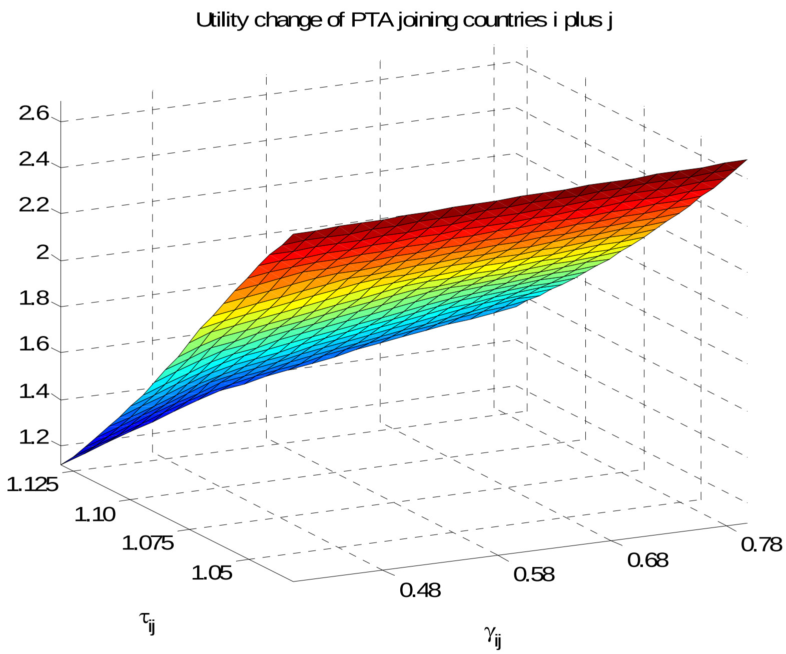

Figure 3b

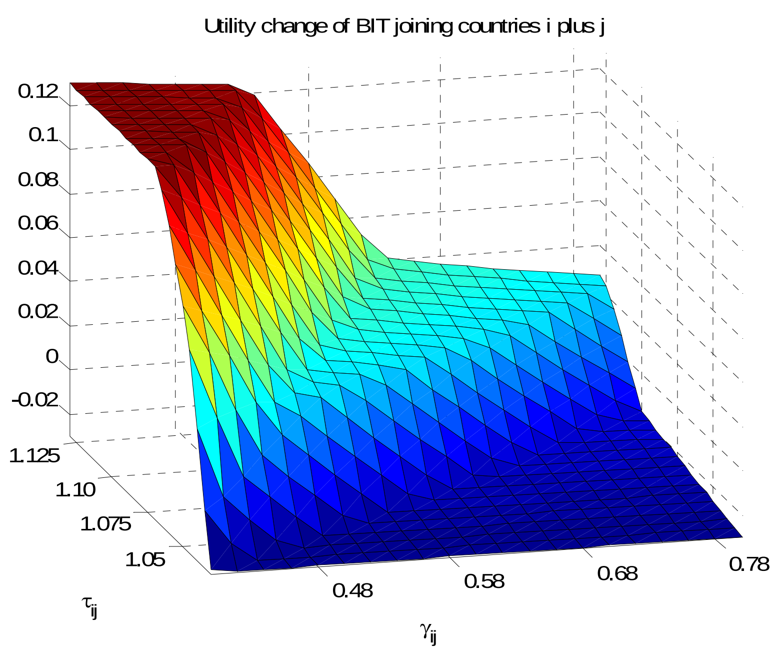

Figure 4a

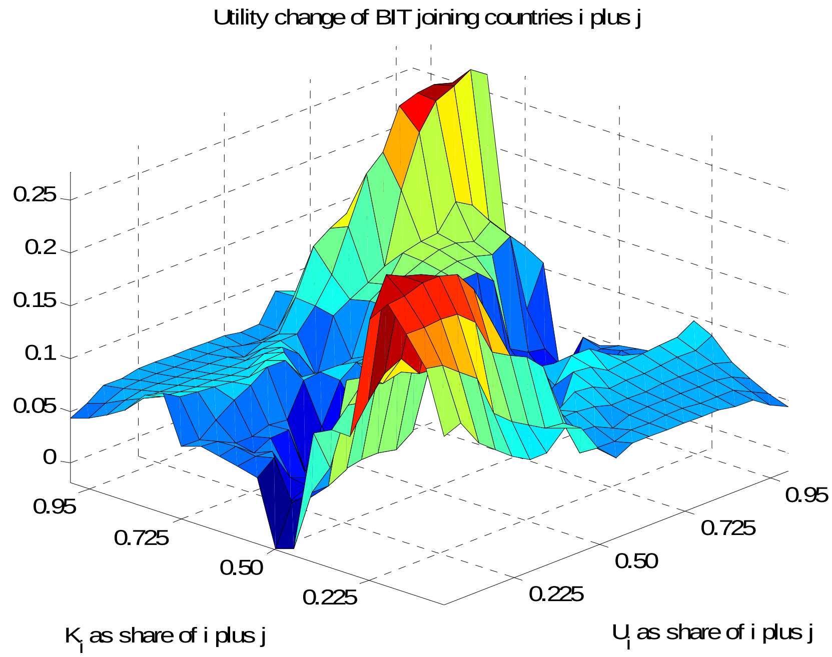

Figure 4b

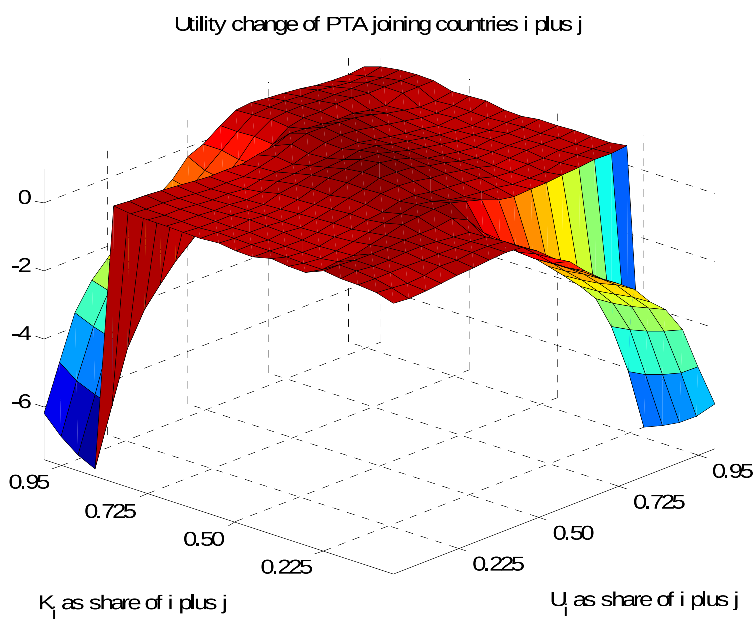

Figure 4c

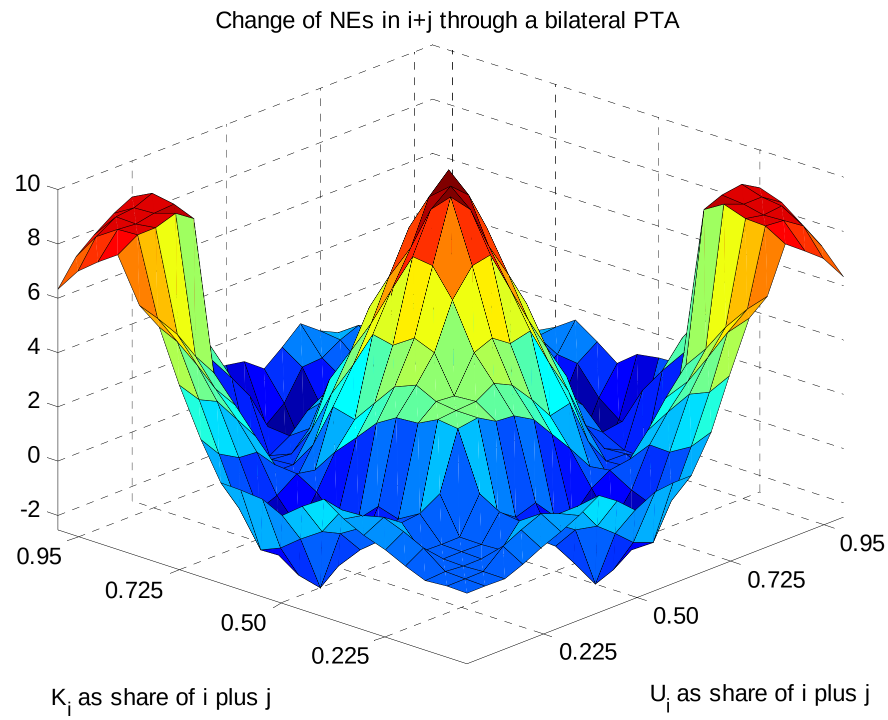

Figure 4d

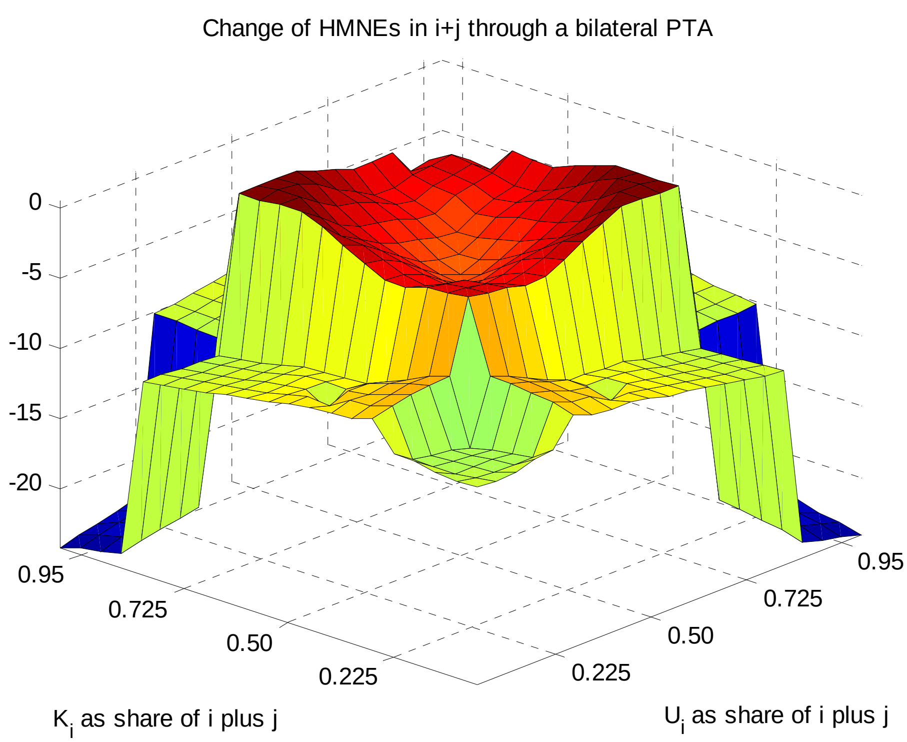

Figure 5a

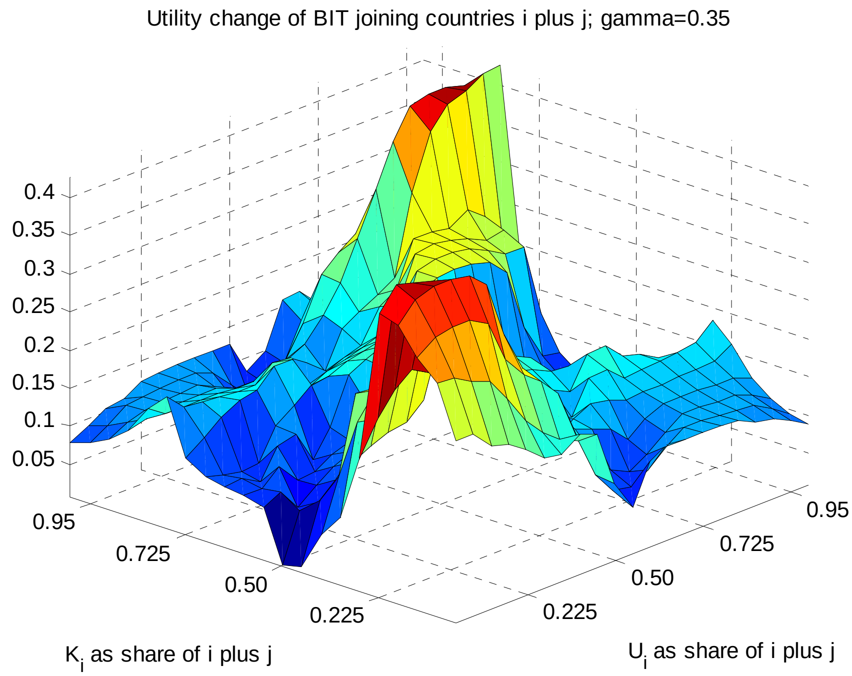

Figure 5b

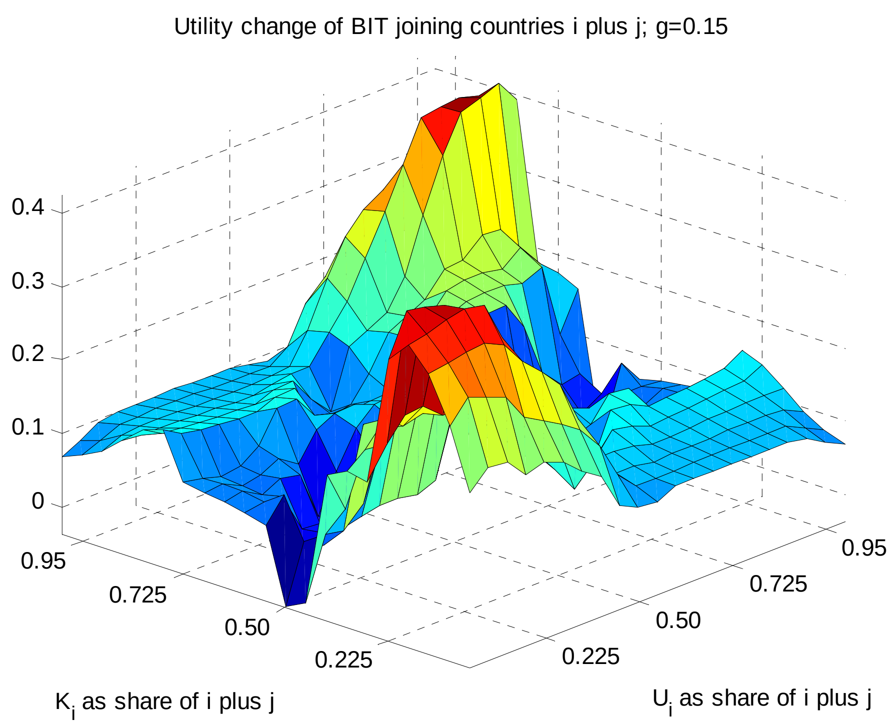

Table 1 - Bilateral Investment Treaties (BITs) and Preferential Trade Agreements (PTAs) Across 12,880 Country-Pairs in Year 2000

		PTAs		
		Yes (1)	No (0)	Sum
BITs	Yes (1)	556	923	1479
	No (0)	1478	9923	11401
	Sum	2034	10846	12880

Notes: There are 161 countries (12,880 pairs) in the sample.
Sources: WTO and UNCTAD.

Table 2 - Summary statistics for Bilateral Investment Treaties (BITs) and Preferential Trade Agreements (PTAs) and their Key Determinants

		Unconditional		At BIT=1		At PTA=1	
Variable	Acronym	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Dependent variables							
Bilateral Investment Treaty indicator	BIT_{ij}	0.115	0.319	1.000	0.000	0.273	0.446
Preferential Trade Agreement indicator	PTA_{ij}	0.158	0.365	0.376	0.485	1.000	0.000
Independent variables							
Log sum of i's and j's real GDP	$GDPSum_{ij}$	24.995	1.834	26.532	1.390	25.468	1.575
Log similarity of i's and j's real GDP	$GDPSim_{ij}$	-0.537	1.597	-0.793	1.790	-0.474	1.291
Log bilateral distance between i's and j's economic centers	$DIST_{ij}$	8.193	0.789	7.752	0.965	7.566	1.064
Adjacency indicator between i and j	ADJ_{ij}	0.021	0.142	0.045	0.207	0.084	0.277
Common official language indicator between i and j	$LANG_{ij}$	0.128	0.334	0.110	0.313	0.162	0.369
Political stability between i and j	$PolStab_{ij}$	72.875	11.764	80.010	9.473	73.907	11.673
Inverse expropriation risk between i and j	$IExpRisk_{ij}$	8.484	1.830	9.017	1.556	8.666	1.687
Log absolute difference in relative capital-unskilled labor ratios between i and j	$KURatio_{ij}$	2.349	1.713	2.010	1.536	1.615	1.231
Log absolute difference in capital and unskilled labor shares between i and j	$KUDiff_{ij}$	-2.727	2.388	-2.466	2.155	-2.431	2.027
Log similarity of i's and j's skilled labor endowment shares	$Ssim_{ij}$	-2.406	1.156	-2.390	1.149	-2.153	0.858
Log distance of i and j to the rest of the world	$REMOTE_{ij}$	8.436	0.153	8.385	0.163	8.403	0.180
BITs of i and j other than with each other (third-country BITs)		7.688	15.018	21.644	21.395	12.267	17.151
PTAs of i and j other than with each other (third-country PTAs)		31.961	29.764	37.927	29.091	48.572	32.577

Table 3 - The Determinants of Bilateral Investment Treaties (BITs) and Preferential Trade Agreements (PTAs) in Seemingly Unrelated Bivariate Probit Models: Main Results

		Model 1		Model 2		Model 3		Model 4	
Determinants	Acronym	BITs	PTAs	BITs	PTAs	BITs	PTAs	BITs	PTAs
Log sum of i's and j's real GDPs	$GDPSum_{ij}$	0.374 ***	0.147 ***	0.327 ***	0.160 ***	0.353 ***	0.203 ***	0.286 ***	0.129 ***
		(0.010)	(0.007)	(0.011)	(0.008)	(0.012)	(0.010)	(0.014)	(0.012)
Log similarity of i's and j's real GDPs	$GDPSim_{ij}$	0.035 ***	0.058 ***	0.029 ***	0.060 ***			0.124 ***	0.124 ***
		(0.008)	(0.007)	(0.008)	(0.007)			(0.012)	(0.0126)
Log bilateral distance between i's and j's economic centers	$DIST_{ij}$	-0.529 ***	-0.617 ***	-0.509 ***	-0.614 ***	-0.475 ***	-0.542 ***	-0.472 ***	-0.775 ***
		(0.022)	(0.020)	(0.022)	(0.021)	(0.023)	(0.021)	(0.030)	(0.028)
Adjacency indicator between i and j	ADJ_{ij}	-0.341 ***	0.398 ***	-0.242 **	0.342 ***	-0.233 *	0.280 ***	-0.429 ***	0.008
		(0.116)	(0.099)	(0.123)	(0.100)	(0.126)	(0.101)	(0.14)	(0.116)
Common official language indicator between i and j	$LANG_{ij}$	-0.091 *	0.087 **	-0.087	0.048	-0.064	0.091 **	0.081	-0.042
		(0.053)	(0.041)	(0.054)	(0.042)	(0.056)	(0.046)	(0.060)	(0.053)
Political stability between i and j	$PolStab_{ij}$	-	-	0.017 ***	-0.005 ***	0.015 ***	-0.007 ***	0.018 ***	-0.001
		-	-	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Inverse expropriation risk between i and j	$IExpRisk_{ij}$							-0.051 ***	0.007
								(0.013)	(0.012)
Log absolute difference in capital and unskilled labor shares between i and j	$KUDiff_{ij}$	-	-	-	-	0.029 ***	-	0.029 ***	
		-	-	-	-	(0.009)	-	(0.009)	
Log absolute difference in relative capital-unskilled labor ratios between i and j	$KURatio_{ij}$	-	-	-	-	-	-0.166 ***		-0.151 ***
		-	-	-	-	-	(0.010)		(0.012)
Log similarity of i's and j's skilled labor endowment shares	$Ssim_{ij}$	-	-	-	-	0.169 ***	0.226 ***	0.117 ***	0.154 ***
		-	-	-	-	(0.021)	(0.017)	(0.020)	(0.018)
Log distance of i and j to the rest of the world	$REMOTE_{ij}$							-0.109	0.759 ***
								(0.142)	(0.130)
BITs of i and j other than with each other (third-country BITs)								0.024 ***	0.0099 ***
								(0.001)	(0.001)
PTAs of i and j other than with each other (third-country PTAs)								0.004 ***	0.0168 ***
								(0.001)	(0.001)
Constant		-6.436 ***	0.296	-6.679 ***	0.334	-7.018 ***	-0.333	-4.717 ***	-4.352 ***
		(0.272)	(0.233)	(0.286)	(0.236)	(0.299)	(0.253)	(1.112)	(1.015)
Observations		12880		12561		11325		11325	
Countries		161		159		151		151	
Correlation between disturbances in BITs and RTA processes		0.219		0.222		0.161		0.099	
Standard error of correlation coefficient above		0.023		0.024		0.025		0.025	
Log-likelihood of model		-8123.94		-7972.69		-7434.08		-6676.72	
Log-likelihood of constant-only model		-9968.14		-9968.14		-9312.86		-9312.86	
McFadden pseudo-R^2		0.185		0.200		0.202		0.283	

Notes: Standard errors in parentheses are robust to heteroskedasticity of unknown form. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively, using 2-tailed tests.

Table 4 - The Determinants of Bilateral Investment Treaties (BITs) and Preferential Trade Agreements (PTAs): Sensitivity Analyses

		Model 5 (Bivariate Probit)		Model 6 (Recursive)		Model 7 (Dynamic)	
Determinants	Acronym	AdjBITs	PTAs	BITs	PTAs	ΔBITs	ΔPTAs
Log sum of i's and j's real GDPs	$GDPSum_{ij}$	0.333 ***	0.129 ***	0.279 ***	0.129 ***	0.301 ***	0.154 ***
		(0.014)	(0.012)	(0.014)	(0.012)	(0.012)	(0.012)
Log similarity of i's and j's real GDPs	$GDPSim_{ij}$	0.148 ***	0.124 ***	0.117 ***	0.123 ***	0.186 ***	0.061 ***
		(0.012)	(0.013)	(0.012)	(0.013)	(0.018)	(0.015)
Log bilateral distance between i's and j's economic centers	$DIST_{ij}$	-0.611 ***	-0.776 ***	-0.420 ***	-0.774 ***	-0.342 ***	-0.332 ***
		(0.030)	(0.028)	(0.038)	(0.028)	(0.041)	(0.029)
Adjacency indicator between i and j	ADJ_{ij}	-0.376 ***	0.007	-0.436 ***	0.017	-0.171	0.030
		(0.133)	(0.116)	(0.140)	(0.118)	(0.168)	(0.112)
Common official language indicator between i and j	$LANG_{ij}$	0.067	-0.041	0.086	-0.043	-0.107	0.444 ***
		(0.062)	(0.053)	(0.060)	(0.053)	(0.097)	(0.054)
Political stability between i and j	$PolStab_{ij}$	0.023 ***	-0.001	0.019 ***	-0.001	0.022 ***	-0.018 ***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)
Inverse expropriation risk between i and j	$IExpRisk_{ij}$	-0.047 ***	0.007	-0.052 ***	0.007	-0.002	-0.008
		(0.014)	(0.012)	(0.013)	(0.012)	(0.021)	(0.014)
Log absolute difference in capital and unskilled labor shares between	$KUDiff_{ij}$	0.035 ***		0.027 ***		0.061 ***	
		(0.010)		(0.010)		(0.016)	
Log absolute difference in relative capital-unskilled labor ratios betwe	$KURatio_{ij}$		-0.148 ***		-0.153 ***		-0.088 ***
			(0.012)		(0.012)		(0.013)
Log similarity of i's and j's skilled labor endowment shares	$Ssim_{ij}$	0.137 ***	0.154 ***	0.107 ***	0.154 ***	0.343 ***	0.165 ***
		(0.021)	(0.018)	(0.021)	(0.018)	(0.037)	(0.022)
Log distance of i and j to the rest of the world	$REMOTE_{ij}$	-0.130	0.766 ***	-0.183	0.750 ***	0.202	0.268 *
		(0.145)	(0.130)	(0.146)	(0.131)	(0.215)	(0.151)
BITs of i and j other than with each other (third-country BITs)		0.027 ***	0.010 ***	0.024 ***	0.010 ***	0.042 ***	0.006 *
		(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.003)
PTAs of i and j other than with each other (third-country PTAs)		0.005 ***	0.017 ***	0.003 ***	0.017 ***	0.006 ***	0.002 **
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
PTA between i and j				0.218 *		-0.171	
				(0.116)		(0.124)	
BIT between i and j							-0.249
							(0.230)
Constant		-4.961 ***	-4.395 ***	-4.409 ***	-4.288 ***	-9.499 ***	-3.164 ***
		(1.150)	(1.014)	(1.123)	(1.018)	(1.718)	(1.194)
Observations		11325		11325		11325	
Countries		151		151		151	
Correlation between disturbances in BITs and RTA processes		0.164		-0.021		-0.243	
Standard error of correlation coefficient above		0.027		0.060		0.050	
Log-likelihood of model		-6516.54		-6675.77		-3526.99	
Log-likelihood of constant-only model		-9312.86		-9312.86		-4391.58	
McFadden pseudo-R^2 (in Model 7); R2 (in Models 8 and 9)		0.300		0.283		0.197	

Notes: Standard errors in parentheses are robust to heteroskedasticity of unknown form. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively, using 2-tailed tests. In Model 6a, PTA on the RHS is current year (2000); in Models 7a and 7b, PTA and BIT on the RHS are lagged values (from 1990).

Table 5 - Impact of One-Standard-Deviation Change in the Determinants of BITs and PTAs on Marginal and Conditional Response Probabilities
(parameters are based on Model 4 in Table 3)

		Uncond. responses		Conditional responses	
Determinants	Acronym	BITs	PTAs	BITs|PTA=1	PTAs|BIT=1
Log sum of i's and j's real GDPs	$GDPSum_{ij}$	0.076 ***	0.042 ***	0.073 ***	0.030 ***
		(0.004)	(0.004)	(0.004)	(0.003)
Log similarity of i's and j's real GDPs	$GDPSim_{ij}$	0.029 ***	0.035 ***	0.025 ***	0.042 ***
		(0.003)	(0.004)	(0.003)	(0.005)
Log bilateral distance between i's and j's economic centers	$DIST_{ij}$	-0.054 ***	-0.108 ***	-0.074 ***	-0.145 ***
		(0.003)	(0.004)	(0.005)	(0.006)
Adjacency indicator between i and j	ADJ_{ij}	-0.009 ***	0.000	-0.020 ***	0.002
		(0.003)	(0.003)	(0.007)	(0.005)
Common official language indicator between i and j	$LANG_{ij}$	0.004	-0.002	0.005	-0.003
		(0.003)	(0.003)	(0.004)	(0.003)
Political stability between i and j	$PolStab_{ij}$	0.032 ***	-0.003	0.037 ***	-0.005
		(0.004)	(0.005)	(0.005)	(0.004)
Inverse expropriation risk between i and j	$IExpRisk_{ij}$	-0.013 ***	0.002	-0.014 ***	0.004
		(0.004)	(0.004)	(0.004)	(0.004)
Log absolute difference in capital and unskilled labor shares between i and j	$KUDiff_{ij}$	0.007 ***		0.006 ***	
		(0.002)		(0.002)	
Log absolute difference in relative capital-unskilled labor ratios between i and j	$KURatio_{ij}$		-0.063 ***		-0.066
			(0.005)		(0.006)
Log similarity of i's and j's skilled labor endowment shares	$Ssim_{ij}$	0.020 ***	0.031 ***	0.015 ***	0.034 ***
		(0.003)	(0.004)	(0.003)	(0.004)
Log distance of i and j to the rest of the world	$REMOTE_{ij}$	-0.002	0.021 ***	-0.005	0.026 ***
		(0.003)	(0.004)	(0.004)	(0.004)
BITs of i and j other than with each other (third-country BITs)		0.009 ***	0.044 ***	0.008 ***	0.072 ***
		(0.001)	(0.001)	(0.002)	(0.003)
PTAs of i and j other than with each other (third-country PTAs)		0.105 ***	0.052 ***	0.129 ***	0.047 ***
		(0.005)	(0.006)	(0.007)	(0.007)
Political stability between i and j (at 1 std.dev. higher $GDPSum_{ij}$)	$PolStab_{ij}$	0.047 ***		0.052 ***	
		(0.006)		(0.006)	
Political stability between i and j (at 1 std.dev. higher $KUDiff_{ij}$)	$PolStab_{ij}$	0.054 ***		0.059 ***	
		(0.010)		(0.010)	
Inverse expropriation risk between i and j (at 1 std.dev. higher $GDPSum_{ij}$)	$IExpRisk_{ij}$	-0.020 ***		-0.020 ***	
		(0.005)		(0.005)	
Inverse expropriation risk between i and j (at 1 std.dev. higher $KUDiff_{ij}$)	$IExpRisk_{ij}$	-0.023 ***		-0.023 ***	
		(0.007)		(0.007)	

Notes: Standard errors in parentheses. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively, using 2-tailed tests.

Appendix A: The Bergstrand and Egger (2007) Theoretical Model
[NOT INTENDED FOR PUBLICATION]

A.1. Consumers

Consumers are assumed to have a Cobb-Douglas utility function between final differentiated goods (X) and homogeneous goods (Y). Consumers' tastes for final differentiated products (e.g., manufactures) are assumed to be of the Dixit-Stiglitz constant elasticity of substitution (CES) type, as typical in trade. We let V_i denote the utility of the representative consumer in country i. Let η be the Cobb-Douglas parameter reflecting the relative importance of manufactures in utility and ε be the parameter determining the constant elasticity of substitution, σ, among these manufactured products ($\sigma \equiv 1-\varepsilon$, $\varepsilon < 0$). Manufactures can be produced by three different firm types: national firms (n), horizontal multinational firms (h), and vertical multinational firms (v). In equilibrium, some of these firms may not exist (depending upon absolute and relative factor endowments and parameter values). These will be reflected in three sets of components in the first of two RHS bracketed terms in equation (1) below:

$$V_i = \left[\begin{array}{l} \sum_{j=1}^{3} n_j \left(\frac{x_{ji}^n}{t_{Xji}} \right)^{\frac{\varepsilon}{\varepsilon-1}} + \left(\sum_{j=1}^{3} h_{3,j} (x_{ii}^{h_3})^{\frac{\varepsilon}{\varepsilon-1}} + \sum_{j\neq i} h_{2,ij} (x_{ii}^{h_2})^{\frac{\varepsilon}{\varepsilon-1}} + \sum_{j\neq i} h_{2,ji} (x_{ii}^{h_2})^{\frac{\varepsilon}{\varepsilon-1}} \right) \\ + \sum_{m\neq j} \sum_{j=1}^{3} v_{mj} \left(\frac{x_{ji}^v}{t_{Xji}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \end{array} \right]^{\frac{\varepsilon-1}{\varepsilon}\eta} \left[\sum_{j=1}^{3} Y_{ji} \right]^{1-\eta} \tag{1}$$

The first component reflects *national* (non-MNE) firms that can produce final differentiated goods for the home market or export to foreign markets from a single plant in the country with its headquarters, where x_{ji}^n denotes the (endogenous) output of country j's representative national firm in industry X sold to country i, n_j is the (endogenous) number of these national firms in j, and t_{Xji} is the gross trade cost of exporting X from j to i.

The second set of components reflects *horizontal* multinational firms that may have plants in either two or three countries to be "proximate" to markets to avoid trade costs; HMNEs cannot export goods. Every HMNE has a plant in its headquarters country. Let x_{ii} denote the output of a horizontal multinational firm producing in i and selling in i, $h_{3,j}$ denote the (endogenous) number of multinationals that produce in all three countries and are headquartered in j (j = 1, 2,3), $h_{2.ij}$ denote the number of two-country multinationals headquartered in i with a plant also in j, and $h_{2,ji}$ denote the number of two-country multinationals headquartered in j with a plant also in i. Hence, x_{ii}^{h3} is output produced in country i (and consumed in i) of the representative three-country HMNE headquartered in country j and x_{ii}^{h2} is the output produced in country i (and consumed in i) of the representative two-country multinational firm either headquartered in i with a plant also in j or headquartered in j with a plant also in i. Note that h_2 plants arise when market size in one of the three countries is inadequate to warrant a local plant, and is more efficiently served (given trade and investment costs) by its own national firms and imports from foreign firms; this is one feature that extends the model in Bergstrand and Egger (2007), but is inconsequential in the calibration.

The third component reflects *vertical* multinational firms. VMNEs have headquarters in one country and a plant in one of the other countries, just not in the headquarters country. The primary motivation for a vertical MNE is "cost differences"; different relative factor intensities and relative factor abundances motivate separating headquarters from production into different countries. Let v_{mj} denote the number of vertical multinational firms with headquarters in m, a plant in j, and output can be sold to any country (including m). Let x_{ji}^v denote the output of the representative VMNE with production in j and consumption in i. In Bergstrand and Egger (2007), in equilibrium VMNEs did not surface; they will here due to differences in relative factor endowments.

In the second bracketed RHS term, let Y_{ji} denote the output of the homogenous (e.g., agriculture) good produced in country j under constant returns to scale using unskilled labor and consumed in i.

We let t_{Xji} (t_{Yji}) denote the gross trade cost for shipping final differentiated (homogeneous) good X (Y) from j to i.[1] Let $t_{Xji} = 1$ for $i = j$, and analogously for t_{Yji}. It will be useful to define:

$$t_{Xji} = (1+b_{Xji})(1+\tau_{Xji})$$
$$t_{Yji} = (1+b_{Yji})(1+\tau_{Yji})$$

where τ denotes a "natural" trade cost of physical shipment (cif/fob - 1) of the "iceberg" type, while b represents a "policy" trade cost (i.e., tariff rate) which generates potential revenue. For instance, b_{Xji} denotes the tariff rate (e.g., 0.05=5 percent) on imports from j to i in differentiated final good X.

The budget constraint of the representative consumer in country i is assumed to be:

$$\sum_{j=i}^{3} n_j p_{Xj}^{n} x_{ji}^{n} + \sum_{j=i}^{3} h_{3,j} p_{Xi}^{h_3} x_{ii}^{h_3} + \sum_{j\neq i} h_{2,ij} p_{Xi}^{h_2} x_{ii}^{h_2} + \sum_{j\neq i} h_{2,ji} p_{Xi}^{h_2} x_{ii}^{h_2} + \sum_{m\neq j}\sum_{j\neq i} v_{mj} p_{Xj}^{v} x_{ji}^{v} + \sum_{j=i}^{3} p_{Yj} Y_{ji}$$

$$= r_i K_i + w_{Si} S_i + w_{Ui} U_i + \sum_{j\neq i} n_j b_{Xji} p_{Xj}^{n} x_{ji}^{n} + \sum_{k\neq j}\sum_{j\neq i} v_{kj} b_{Xji} p_{Xj}^{v} x_{ji}^{v} + \sum_{j\neq i} b_{Yji} p_{Yj} Y_{ji} \tag{2}$$

where p_{Xi}^{h3} (p_{Xi}^{h2}) denotes the price charged by the representative 3-country (2-country) HMNE with a plant in i. Let p_{Xj}^{n}, p_{Xj}^{v}, and p_{Yj} denote the prices charged by producers in j for goods X (national firms and VMNEs, respectively) and Y, respectively. In the second line of equation (2), the first three RHS terms denote factor income; the last three RHS terms denote tariff revenue redistributed lump-sum by the government in i back to the representative consumer. Let r_i denote the rental rate for capital in i, K_i is the capital stock in i (which can be used at home or transferred abroad at a cost in units of capital of γ), w_{Si} (w_{Ui}) is the wage rate for skilled (unskilled) workers in i, and S_i (U_i) is the stock of internationally-immobile skilled (unskilled) workers in i.

Maximizing (1) subject to (2) yields the domestic demand functions:

$$x_{ii}^{\ell} \geq \left(p_{Xi}^{\ell}\right)^{\varepsilon-1} P_{Xi}^{-\varepsilon} \eta E_i; \quad \ell = \left\{n, h_3, h_2, v\right\} \tag{3}$$

where E_i is the income (and expenditure) of the representative consumer in country i from eq. (2), and

$$P_{Xi} = \left[\sum_{j=1}^{3} n_j \left(t_{Xji} p_{Xj}^{n}\right)^{\varepsilon} + \sum_{j=1}^{3} h_{3,j}\left(p_{Xi}^{h_3}\right)^{\varepsilon} + \sum_{j\neq i} h_{2,ij}\left(p_{Xi}^{h_2}\right)^{\varepsilon} + \sum_{j\neq i} h_{2,ji}\left(p_{Xi}^{h_2}\right)^{\varepsilon} + \sum_{m\neq j}\sum_{j=1}^{3} v_{mj}\left(t_{Xji} p_{Xj}^{v}\right)^{\varepsilon}\right]^{\frac{1}{\varepsilon}} \tag{4}$$

is the corresponding CES price index. Following the literature, we assume that all firms producing in the same country face the same technology and marginal costs and we assume complementary-slackness conditions (cf., Markusen, 2002). Hence, the mill (or ex-manufacturer) prices of all varieties in a specific

[1] For modeling convenience, we define Y_{ji} net of trade costs; trade costs t_{Yji} surface explicitly in the factor-endowment constraints.

country are equal in equilibrium. Then, the relationship between differentiated final goods produced in j and at home is:

$$\frac{x_{ji}}{x_{ii}} = \left(\frac{p_{Xj}}{p_{Xi}}\right)^{\varepsilon-1} t_{Xji}^{\varepsilon}(1+b_{Xji})^{-1} \tag{5}$$

Hence, from now on we can omit superscripts for both prices and quantities of differentiated products for the ease of presentation. It follows that homogeneous goods demand is:

$$\sum_{j=1}^{3} Y_{ji} \geq \frac{1-\eta}{p_{Yi}} E_i \tag{6}$$

where Y_{ji} denotes output of the agriculture good of county j demanded in country i.

A.2. Differentiated Goods Producers

We assume that manufactures can be produced in all three countries, using skilled labor, unskilled labor, and physical capital. Each country is assumed to be endowed with exogenous amounts of internationally immobile skilled labor and unskilled labor. Each country is assumed to be endowed with an exogenous amount of physical capital; however, the "services" of physical capital can be transferred endogenously (but with potential costs) across countries (in the form of financial claims) by MNEs to maximize their profits, thus making endogenous the determination of bilateral FDI flows. Differentiated goods producers operate in monopolistically competitive markets, similar to Markusen (2002, Ch. 6). Two assumptions used for our theoretical results that follow are the existence of a third factor – physical capital – *and* that any headquarters setup (fixed cost) requires the services of home skilled labor – to represent R&D – and any plant setup requires the services of home country's physical capital – to represent the resources needed for a domestic or foreign direct investment.[2]

Assume the production of differentiated good X is given by a nested Cobb-Douglas-CES technology where F_{Xi} denotes production of these goods for both the domestic and foreign markets; we assume MNEs and NEs have access to the same technology. Let K_{Xi}, S_{Xi}, and U_{Xi} denote the quantities used of physical capital, skilled labor, and unskilled labor, respectively, in country i to produce X:

$$F_{Xi} = B(K_{Xi}^{\chi} + S_{Xi}^{\chi})^{\frac{\alpha}{\chi}} U_{Xi}^{1-\alpha} \tag{7}$$

The specific form of the production function is motivated by two literatures. First, the Cobb-Douglas function provides a standard, tractable, and empirically relevant method of combining capital and labor; α denotes the share of "capital" in production. Second, early work by Griliches (1969) indicates that physical capital and human capital tend to be complements, rather than substitutes, in production; recent evidence for this in the domestic (U.S.) literature is Goldin and Katz (1998) and in the MNE literature is found in Slaughter (2000). We nest a CES production function within the Cobb-Douglas function to allow for the potential complementarity of physical and human capital in production; χ determines the

[2]Note it is not necessary that plants (firms) require only the services of physical (human) capital to setup plants (firms); what is necessary is that setups of plants (firms) are *relatively* more physical (human) capital intensive, which we conjecture is true empirically. Also, the model is robust to assuming instead that plants (firms) require the services of human (physical) capital for setups. The key is that the services of two factors are used in setups, and that the two setups have different relative factor intensities, cf., Bergstrand and Egger (2007).

degree of complementarity or substitutability.

NEs and MNEs differ in fixed costs. Each NE incurs only one firm (or headquarters) setup and one plant setup; each MNE incurs one firm setup (the cost of which is assumed larger than that of an NE, as in Markusen, 2002) and a plant setup for its home market and for each foreign market it enters endogenously. A horizontal MNE has headquarters at home and plants in two or three markets to serve them; it has no exports. A vertical MNE has headquarters at home and one plant abroad, which can export to any market. Maximizing profits subject to the above technology yields a set of conditional factor demands reported later.

A.3. Homogeneous Goods Producers

We assume homogeneous good (Y) is produced under constant returns to scale in perfectly competitive markets using only unskilled labor; assume the technology $Y_i = U_i$ (i = 1,2,3). In the presence of positive trade costs, we assume country 1 is the numeraire; hence, $p_{Y1} = w_{U1} = 1$.

A.4. Profit Functions, Pricing Equations, and the Definition of FDI

All firms are assumed to maximize profits given the technologies and the demand relationships suggested above. The profit functions are:

$$\begin{aligned}
\pi_{ni} &= (p_{Xi} - c_{Xi})\sum_{j=1}^{3} x_{ij} - a_{Sni} w_{Si} - a_{Kni} r_i \\
\pi_{h3,i} &= \sum_{j=1}^{3} (p_{Xj} - c_{Xj}) x_{jj} - a_{Sh3i} w_{Si} - a_{Kh3i}[3 + \sum_{j \neq i} (\gamma_{ij} + g_{ij})] r_i \\
\pi_{h2,ij} &= (p_{Xi} - c_{Xi}) x_{ii} + (p_{Xj} - c_{Xj}) x_{jj} - a_{Sh2i} w_{Si} - a_{Kh2i}[2 + \gamma_{ij} + g_{ij}] r_i \\
\pi_{v,ij} &= (p_{Xj} - c_{Xj})\sum_{m=1}^{3} x_{jm} - a_{Svi} w_{Si} - a_{Kvi}[1 + \gamma_{ij} + g_{ij}] r_i
\end{aligned} \tag{8a-8d}$$

Eq. (8a) is the profit function for each national final goods enterprise (NE) in i. Let c_{Xi} denote marginal production costs of differentiated final good X in country i and the latter two RHS terms represent, respectively, fixed human and physical capital costs for the NE producer. Eq. (8b) is the profit function for each HMNE in country i with three operations. The last two terms in (8b) represent fixed costs of each 3-country HMNE. As with national firms, the HMNE incurs a single fixed cost of home skilled labor to setup a firm. However, each 3-country HMNE incurs a fixed cost of home physical capital for each plant. Moreover, each foreign investment incurs a potential "natural" investment cost γ (say, political instability) as well as an investment cost g, representing expropriation risk. Consequently, in the context of our model, the flow (and stock) of FDI of country i's representative three-country HMNEs in j (if profitable) would be $a_{Kh3i} r_i (1+\gamma_{ij}+g_{ij})$; in our model, international capital "mobility" is defined as the (exclusive) services of country i's physical capital being used abroad (say, in j) in the form of a flow of financial claims, but the factor rewards are earned in i.[3] Eq. (8c) is the profit function for each HMNE in country i with two operations (one at home and one abroad in j); FDI from i to j is defined analogously, $a_{Kh2i} r_i (1+\gamma_{ij}+g_{ij})$. Finally, eq. (8d) is the profit function for a vertical MNE with a headquarters in i and a

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[3]Note that, while physical capital can be "utilized" in different countries, the "ownership" of any country's endowment of such capital is immobile, cf., Jones (1967) and footnote 12. In the typical 2x2x2 model, headquarters use home skilled labor exclusively for setups; home (foreign) plants use home (foreign) skilled labor for setups (cf., Markusen, 2002, p. 80). With only immobile skilled and unskilled labor, these models naturally preclude home physical capital being utilized to set up foreign plants.

plant in j; FDI from i to j is analogously $a_{Kvi}r_i\ (1+\gamma_{ij}+g_{ij})$.

A key element of our model is that – in each country – the numbers of NEs (type n), three-country HMNEs (type h_3), two-country HMNEs (type h_2), and vertical MNEs (type v) are *endogenous* to the model. Two conditions characterize models in this class. First, profit maximization ensures markup pricing equations:

$$p_{Xi} \leq \frac{c_{Xi}(\varepsilon - 1)}{\varepsilon} \tag{9}$$

Second, free entry and exit ensures:

$$\begin{aligned}
&a_{Sni}w_{Si} + a_{Kni}r_i \geq \frac{c_{Xi}(-1)}{\varepsilon}\sum_{j=1}^{3} x_{ij} \\
&a_{Sh3i}w_{Si} + a_{Kh3i}[3 + \sum_{i\neq j}(\gamma_{ij} + g_{ij})]r_i \geq \sum_{j=1}^{3}\frac{c_{Xj}(-1)}{\varepsilon}x_{jj} \\
&a_{Sh2i}w_{Si} + a_{Kh2i}[2 + \gamma_{ij} + g_{ij}]r_i \geq \frac{c_{Xi}(-1)}{\varepsilon}x_{ii} + \frac{c_{Xj}(-1)}{\varepsilon}x_{jj} \\
&a_{Svi}w_{Si} + a_{Kvi}[1 + \gamma_{ij} + g_{ij}]r_i \geq \frac{c_{Xj}(-1)}{\varepsilon}\sum_{m=1}^{3} x_{jm}
\end{aligned} \qquad \text{(10a)-(10d)}$$

A.5. Factor-Endowment and Current-Account-Balance Constraints

We assume that, in equilibrium, all factors are fully employed and that every country maintains multilateral (though not bilateral) current account balance; endogenous bilateral current account imbalances allow for endogenous bilateral FDI of financial claims (to physical capital). Following the established literature, this is a static model. The formal factor-endowment and multilateral current-account-balance constraints are provided below. The conditional factor demands for final goods production are given by:

$$\begin{aligned}
K^*_{Xi} &= F_{Xi}\underbrace{\frac{1}{B}\left(\frac{w_{Ui}}{r_i}\frac{\alpha}{1-\alpha}\right)^{1-\alpha} T_{1i}^{\frac{\alpha(\chi-1)-\chi}{\chi}}}_{a_{KXi}} \\
S^*_{Xi} &= F_{Xi}\underbrace{\frac{1}{B}\left(\frac{w_{Ui}}{w_{Si}}\frac{\alpha}{1-\alpha}\right)^{1-\alpha} T_{2i}^{\frac{\alpha(\chi-1)-\chi}{\chi}}}_{a_{SXi}} \\
U^*_{Xi} &= F_{Xi}\underbrace{\frac{1}{B}\left(\frac{r_i}{w_{Ui}}\frac{1-\alpha}{\alpha}\right)^{\alpha} (T_{1i}^{-\chi} + T_{2i}^{-\chi})^{\frac{-\alpha}{\chi}}}_{a_{UXi}}
\end{aligned} \tag{11}$$

where B is a constant and we introduce definitions:

$$T_{1i} = 1 + \left(\frac{r_i}{w_{Si}} \right)^{\frac{\chi}{1-\chi}} ; \; T_{2i} = 1 + \left(\frac{w_{Si}}{r_i} \right)^{\frac{\chi}{1-\chi}} \tag{12}$$

We assume that, in equilibrium, all factors are fully employed for each country i (i=1,2,3), so that:

$$K_i \geq a_{KXi} \left[n_i \sum_{j=1}^{3} x_{ij} + x_{ii} \left(\sum_{j=1}^{3} h_{3,j} + \sum_{j \neq i} h_{2,ji} + \sum_{j \neq i} h_{2,ij} \right) + \sum_{j \neq i} v_{ji} \left(\sum_{j=1}^{3} x_{ij} \right) \right] +$$

$$a_{Kni} n_i + a_{Kmi} \left\{ \left[3 + \sum_{j \neq i} (\gamma_{ij} + g_{ij}) \right] h_{3,i} + [2 + \gamma_{ij} + g_{ij}] h_{2,ij} + [1 + \gamma_{ij} + g_{ij}] v_{ij} \right\}$$

$$S_i \geq a_{SXi} \left[n_i \sum_{j=1}^{3} x_{ij} + x_{ii} \left(\sum_{j=1}^{3} h_{3,j} + \sum_{j \neq i} h_{2,ji} + \sum_{j \neq i} h_{2,ij} \right) + \sum_{j \neq i} v_{ji} \left(\sum_{j=1}^{3} x_{ij} \right) \right] +$$

$$a_{Sni} n_i + a_{Smi} (h_{3,i} + \sum_{j \neq i} \left(h_{2,ij} + v_{ij} \right))$$

$$U_i \geq a_{UXi} \left[n_i \sum_{j=1}^{3} x_{ij} + x_{ii} \left(\sum_{j=1}^{3} h_{3,j} + \sum_{j \neq i} h_{2,ji} + \sum_{j \neq i} h_{2,ij} \right) + \sum_{j \neq i} v_{ji} \left(\sum_{j=1}^{3} x_{ij} \right) \right] + a_{UYi} \sum_{j=1}^{3} t_{Yij} Y_{ij} \tag{13}$$

Multilateral current account balance for each country i (i=1,2,3; $i \neq j \neq m$) requires the following to hold:

$$(n_i + v_{ji} + v_{mi}) p_{Xi} (x_{ij} + x_{ik}) + p_{Yj} Y_{ij} + p_{Ym} Y_{im}$$

$$+ \frac{1}{1-\varepsilon} ([h_{2,ij} + h_{3,i}] p_{Xj} x_{jj} + [h_{2,im} + h_{3,i}] p_{Xm} x_{mm})$$

$$+ \frac{1}{1-\varepsilon} (v_{ij} p_{Xj} [x_{jj} + x_{ji} + x_{jm}] + v_{im} p_{Xm} [x_{mm} + x_{mi} + x_{mj}])$$

$$=$$

$$(n_j + v_{ij} + v_{mj}) p_{Xj} x_{ji} + (n_m + v_{im} + v_{jm}) p_{Xm} x_{mi} + p_{Yi} (Y_{ji} + Y_{mi})$$

$$+ \frac{1}{1-\varepsilon} (h_{2,ji} + h_{3,j} + h_{2,mi} + h_{3,m}) p_{Xi} x_{ii}$$

$$+ \frac{1}{1-\varepsilon} (v_{ji} + v_{mi}) p_{Xi} (x_{ii} + x_{ij} + x_{im}) \tag{14}$$

The first line in equation (14) represents the exports of goods of country *i*. The second and third lines represent income earned on capital invested by country *i* in horizontal and vertical affiliates, respectively, in country's *j* and *m* (*m* denoting the *ROW* for country *i)*. The fourth line represents country *i*'s imports of goods from *j* and *m*. The fifth and sixth lines represent *i*'s repatriation of income on capital of countries' *j* and *m* invested in country *i* in horizontal and vertical affiliates, respectively.

Appendix B: Calibration of Model

[NOT INTENDED FOR PUBLICATION]

The complexity of the model (including the complementary-slackness conditions) introduces a high degree of nonlinearity, and it cannot be solved analytically. Consequently, as in Markusen (2002) we provide numerical solutions to the model. With three countries, we have several potential types of asymmetries, e.g., large vs. small GDPs, developed vs. developing economies. We focus initially on bilateral flows between three identical economies (in absolute and relative factor endowments). We then introduce absolute and relative factor endowment asymmetries. We use *GAMS* for our numerical analysis. The calibration of the model is very similar to that in Bergstrand and Egger (2007).

B.1. Values of (Exogenous) Factor Endowment, Trade Cost, and Investment Cost Variables

We assume a world endowment of capital (*K*) of 500 units, skilled labor (*S*) of 200 units, and unskilled labor (*U*) of 2000 units. Initially, countries *i* and *j* together have half of the world's endowments of each factor, and *i*'s and *j*'s factor endowments are identical. In the remaining summary of parameter choices, we note that we have tried to base selections upon empirical observations (as much as data availability allowed) or upon widely-known regression estimates of elasticities.

"Trade costs" include both the costs of shipping and distributing goods, as well as trade policies. Initially, we set the former costs for good *X* and good *Y* at (*ad valorem* equivalents of) 30 percent and 45 percent, respectively (for τ). This reflects recent estimates that homogeneous goods' transport costs are higher than those of differentiated goods, cf., Bergstrand and Egger (2006). Both values exceed estimated (c.i.f.-f.o.b.)/f.o.b. factors in that paper of 15 and 20 percent, respectively. However, values used are in the range of levels discussed in Anderson and van Wincoop (2004) on trade costs. For simplicity, we set tariff rates initially at *ad valorem* equivalents of 20 percent (for *b*).

In reality, of course, informational costs and policy barriers to FDI exist between countries. However, *ad valorem* empirical measures of such FDI cost are not available. We assumed initially a "tax-rate" equivalent (for γ) of 40 percent for FDI and a value for *g* of 10 percent.

B.2. Utility and Technology Parameter Values

Consider first the utility function (see Appendix A equation (1) for details). The only two parameters are the Cobb-Douglas share of income spent on differentiated products from various producers (η) and the CES parameter (ε) influencing the elasticity of substitution between differentiated products ($\sigma \equiv 1-\varepsilon$). Initially, we use 0.71 for the value of η, based upon an estimated share of manufactures trade in overall world trade averaged between 1990 and 2000 using 5-digit SITC data from the UNs' COMTRADE data set, which is a plausible estimate. The initial value of ε is set at -5, implying an elasticity of substitution of 6 among differentiated final goods, consistent with a wide range of recent empirical studies estimating the elasticity between 2 and 10, cf., Feenstra (1994).

Consider next the production function for differentiated goods (see Appendix A equation (7) for details). Labor's share of differentiated goods gross output is assumed to be 0.8; the Cobb-Douglas formulation implies the elasticity of substitution between capital and labor is unity. Griliches (1969) proposed – in a three-factor world with unskilled labor, skilled labor, and physical capital – that skills were more complementary with physical capital than with unskilled labor in production. Griliches found convincing econometric evidence that physical capital and skilled labor were relatively more complementary in production than physical capital and unskilled labor. Most evidence to date suggests that human and physical capital are relatively complementary in production, cf., Goldin and Katz (1998). In the only empirical study of MNE behavior considering this issue, Slaughter (2000) finds statistically significant evidence in favor of capital-skill complementarity. Initially, we assume $\chi = -0.25$, implying a technical rate (elasticity) of substitution of 0.8 [$=1/(1-\chi)$] and complementarity between physical and human capital.

As in the 2x2x2 KC model in CMM (2001), a firm (or headquarters) setup uses only skilled labor. For national final goods producers, we assume a headquarters setup requires one unit of skilled labor per unit of output ($a_{Sn,1}=a_{Sn,2}=a_{Sn,3}=1$). As in the knowledge-capital model, we assume "jointness" for MNEs; that is, services of knowledge-based assets are joint inputs into multiple plants. Markusen suggests that the *ratio* of fixed headquarters setup requirements for a horizontal or vertical MNE relative to a domestic firm ranges from 1 to 2 (for a 2-country model). We assume initially a headquarters cost for MNEs of 1.01 ($a_{Sh,1}=a_{Sh,2}=a_{Sh,3}=a_{Sv,1}=a_{Sv,2}=a_{Sv,3}=1.01$) ; hence, we assume the additional firm setup cost of an MNE over a national firm is quite small. We assume that every plant (national or MNE) requires two units of home physical capital ($a_K=2$); however, MNEs setting up plants abroad face additional natural investment cost (γ), for which we assumed a value of 0.40 (40 percent), and an investment cost (g) of 0.1 (10 percent), representing expropriation risk.

Theoretical relationships are qualitatively similar for a wide range of alternative values of the parameters (results of which are available on request).