A THEORETICAL SUPPLEMENT (Not Intended for Publication)

Since the focus of our study is identifying empirical determinants of the timing of PTA events, we choose a minimal general equilibrium model to motivate the eleven observable economic variables for our empirical specifications. Importantly, our purpose here is simply to motivate *economic* factors that "shift" the hazard rate ($\lambda_{ij}(t)$) in any year t. Consequently, a static (one-period) model is sufficient. Similar to Baier and Bergstrand (2004), we use a simple one-sector Krugman general equilibrium model. However, under a simple assumption that there are costs increasing in the number of agreements bargained (e.g., negotiation "congestion" costs which are quadratic in the number of partners one deals with per period), to every PTA formation that ensures one PTA formation at a time, our model generates endogenously the determination of the sequencing (not timing *per se*) of PTA events, implying which PTA events occur before others.[26]

A.1 Theoretical Model

A.1.1 Consumers

The model consists of N countries and one sector. Each country j hosts a single representative consumer who derives utility from the consumption of goods. Utility is characterized by a taste for variety which is captured formally by Dixit and Stiglitz (1977) preferences with a constant elasticity of substitution (CES). Let $c_{ij}(k)$ be the consumption in country j of the differentiated good produced by firm k in country i. Let σ denote the elasticity of substitution between varieties of goods (assuming $\sigma > 1$). Finally, n_i refers to the number of varieties produced (and firms) in country i. The utility function U_j is given by:

$$U_j = \left[\sum_{i=1}^{N} \int_{n_i} c_{ij}(k)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}}. \tag{7}$$

We include Samuelson iceberg-type trade costs that are allowed to be asymmetric among all country pairs. We assume that $1 + a_{ij}$ units of a good have to be shipped from county i to ensure that one unit arrives in country j (assuming $a_{ii} = 0$); in the section discussing calibration of the model for simulations, we will discuss our novel trade-cost structure in detail.[27] Furthermore, we assume *ad valorem* import tariff rates on goods and services, where t_{ij} denotes the tariff rate levied by country j on goods imported from i (assuming $t_{ii} = 0$).

We assume one factor of production, labor (L). Each laborer in each country also represents one household.

[26] A static model cannot say anything about "time" *per se*, of course. However, under the simple assumption of one PTA event at a time (e.g., assuming that the U.S. International Trade Commission or Congress can only deal with one or a few PTAs at a time), our static model can deliver endogenously the sequencing of events. If certain events occur sooner than others, the time to those events is necessarily shorter. For instance, if our model generates endogenously that countries 1 and 2 form a PTA *before* countries 1 and 3, this suggests that two countries with the joint economic characteristics of countries 1 and 2 will form a PTA *before* two countries with the joint economic characteristics of countries 1 and 3. Since we are only interested in motivating observable economic variables, we omit unobservable ("dynamic") considerations. For more explicit consideration of dynamic aspects of PTA liberalization, see Bond and Park (2002), Zissimos (2007), and Bond (2008).

[27] By contrast, Baier and Bergstrand (2004) used a common exogenous intra-continental bilateral trade cost factor and a common exogenous inter-continental bilateral trade cost factor.

The consumer is assumed to maximize equation (7) subject to the budget constraint:

$$Y_j/L_j = \left[\sum_{i=1}^{N} \int_{n_i} p_{ij}(k) c_{ij}(k) dk \right] = w_j + T_j/L_j, \tag{8}$$

where Y_j denotes national income in j, L_j is the number of households in j, $p_{ij}(k)$ refers to the consumer price of variety k originating from country i and purchased in country j (inclusive of any trade costs and tariffs), w_j is the wage rate of the representative worker in j, and T_j denotes j's total tariff revenue (redistributed in a lump-sum fashion to j's representative household).

Within a country, firms are assumed symmetric and have access to the same technology so that all firms in i charge an identical (mill) price p_i. Consequently, the price the consumer in j pays for any product from country i is $p_{ij}(k) = p_i(1 + a_{ij} + t_{ij})$ for all varieties (or firms) k.[28] At identical consumer prices p_{ij}, all firms in country i face identical demand from consumers in j, c_{ij}. Then, maximizing utility subject to the income constraint yields a set of demand equations for economy j with L_j households:

$$X_{ij}^D = \frac{[p_i(1 + a_{ij} + t_{ij})]^{-\sigma} (1 + a_{ij})}{\sum_{i=1}^{N} n_i [p_i(1 + a_{ij} + t_{ij})]^{1-\sigma}} Y_j, \tag{9}$$

where X_{ij}^D is demand in country j for each good from country i.

A.1.2 Firms

All firms in the industry are assumed to produce under the same technology. The output of goods produced by a firm in country i, denoted by g_i, requires l_i units of labor, as well as an amount ϕ of fixed costs, expressed in terms of the output of the good produced. The production function – similar to that in Krugman (1980) – is given by $l_i = \phi + g_i$. Firms maximize profits subject to the technology, given the demand schedule derived in Section (A.1.1). In this model, profit maximization leads to a constant markup over marginal production costs and there are zero profits in equilibrium due to free entry and exit. Profit maximization ensures $p_i = \frac{\sigma}{\sigma-1} w_i$. Zero profits in equilibrium ensures $g_i = (\sigma - 1)\phi$.

A.1.3 Factor Endowment Constraints

We assume that endowments of labor, L_i, are exogenously given and internationally immobile. Assuming full employment, $L_i = n_i l_i$ or, equivalently, $n_i = (\phi\sigma)^{-1} L_i$.

The zero profit conditions and the clearing of goods and factor markets lead to balanced multilateral trade for each economy.

A.2 Calibration of the Model

Our model can be simulated to motivate several potentially "testable" hypotheses regarding relationships between economic characteristics of pairs of countries and the sequencing of either a PTA formation or enlargement, based upon the demand for and supply of nonmembers and members, respectively. For the utility function, we

[28]We assume away heterogeneous productivity for firms to limit the complexity of the model. Notice that, for the question of interest here, heterogeneous firms would not change the insights qualitatively, cf., Arkolakis, Costinot, and Rodriguez-Clare (2011).

have one parameter, the elasticity of substitution in consumption between varieties of goods (σ); this elasticity is set equal to 4 as in related earlier studies. For technology, we set the fixed cost term in the production function to unity ($\phi = 1$), without loss of generality. Initially, factor endowments of labor are assumed identical across all countries in the symmetric benchmark equilibrium with values of $L_i = 100$ for all countries. In this paper, we focus on one industry, leaving analysis of sectoral differences for subsequent research.

– Supplement Figure S1 about here –

Assumptions regarding international transport costs depart from those in Baier and Bergstrand (2004), or B-B, although *intra*national trade costs are zero (as there). We consider a structure that is consistent with the location of countries on a circle as indicated in Figure S1 (i.e., the "world"). Each country has two "neighbors." The iceberg transport (or "trade") cost factor with the two immediate neighbors is a. For instance this applies for country 1's trade with countries 2 and N. Trade costs with the pair of "second neighbors" (e.g., countries 3 and $N-1$ for country 1) are $2a$, and so on.[29] The corresponding trade cost "stair-case" is displayed in Figure S2, from the perspective of either country 1 (top) or country 6 (bottom). However, we retain symmetry in the sense that the same stair-case applies to every country on the circle. Even though trade costs with the most remote counterpart on the circle may be large depending on the number of economies in the "world," trade flows between all pairs of countries will be positive as long as the number of countries is finite ($N < \infty$). An obvious advantage of assuming stair-case-type trade costs rather than trade costs which are symmetric for all cross-border trade flows is that an increasing number of adjacent PTA members is associated with higher average trade costs for representative intra-PTA trade relationships. This contributes ultimately to a finite elasticity of "supply of memberships." We will assume $a = 0.05$.

– Supplement Figure S2 about here –

The number of firms, product varieties, labor employments, wage rates, consumption levels, and price levels in each country can be determined uniquely given the parameters of the model (σ, ϕ) and initial transport costs, tariffs, and labor endowments. In summary, $\sigma = 4$, $\phi = 1$, $a = 0.05$, $L = 100$, leaving only initial tariff rates to be specified.

As in B-B, we assume the existence in each country of a social planner, which sets tariffs initially at 30 percent ($t = 0.3$).[30] Based upon initial parameter values, the social planner in each country considers whether its representative consumer's utility would be better off or worse off from forming a PTA. For a country's planner to form a new – or join an existing – PTA, the change in utility from doing so must be positive.

[29] Hence, $a_{13} = a_{1,N-1} = 2a$. We have also considered exponentially increasing trade costs; our theoretical results are robust to this alternative specification.

[30] The value of 0.3 was originally chosen in B-B following Frankel (1997). As noted in B-B, the ideal approach would be to consider the Nash equilibrium tariffs; the Nash equilibrium tariffs in a post-integration situation are likely to differ from those in the pre-integration situation. It is interesting to note, however, that the calculation of the Nash equilibrium tariffs in the six-country case of B-B yield a pre-integration tariff rate of approximately 0.3 for all countries (assuming symmetry). Moreover, we also note that Ornelas (2005) finds in a political economy framework strong rationales for governments selecting into PTAs based upon "economic" welfare of their countries. Note that tariff rates of 0.3 seem to be high. However, Anderson and van Wincoop (2004) suggest that trade barriers in a broader sense (including non-tariff barriers) are as high as 70 percent for a representative developed country. As many PTAs reduce trade barriers more broadly than just in terms of ad-valorem tariff rates, it seems justifiable to to work with a trade facilitating effect of PTAs which amounts to 0.3.

A.3 Bilateral Economic Determinants of the Timing of PTA Events

Figure 3 (in the text) summarized three novel "stylized" facts that our numerical GE model can potentially explain. The data in this figure suggest that: (1) PTA events occurred sooner among pairs of countries that were closer; (2) PTA events occurred sooner among pairs of countries that were economically larger; and (3) PTA events occurred sooner among pairs of countries with more similar economic sizes. This section shows how the GE model can motivate theoretically each of these three stylized facts.

A.3.1 Bilateral Distance

As a benchmark, consider initially the case where countries are identical in factor endowments. Figure S3 illustrates the sequencing of PTA agreements for country 1 (chosen arbitrarily); recall that in the presence of a cost to form (join) a PTA, y^{r*}, countries form PTAs one at a time, implying that the sequencing of PTA formations suggests which PTAs form *sooner*. The first step – the foundation for a PTA – takes place at a random address on the circle, say, between countries 1 and 2. By assumption, PTA membership will happen only if every member country gains in welfare from the PTA.[31] The foundation and subsequent enlargement process of a single PTA is illustrated in Figure S3; for simulation, we will assume henceforth that $N = 20$.

– Supplement Figure S3 about here –

In a second step, the two incumbents endogenously decide upon whether to *offer* country 20 (N) membership or not and, at the same time, country 20 endogenously decides whether to *choose to join* the PTA or not.[32] Country 20 will become a PTA member only if neither one of the incumbents nor the potential entrant faces a welfare loss from the PTA's enlargement. In the next step, 1, 2, and 20 decide upon offering membership to country 3. Again, the PTA will enlarge only if every one of the incumbents' and the potential entrant's utilities increase, and so on.

– Supplement Figure S4 about here –

While Figure S3 is illustrative, it does not reveal the relative welfare gains of the sequencing of country 1's PTA. Figure S4 illustrates the relative (marginal and cumulative) welfare gains associated with the initial PTA formation and its enlargement. Figure S4 provides several pieces of information, which we will discuss in turn. Figure S4 displays four lines (including the vertical one labeled "Equilibrium PTA size"). For now, we need only describe the top and bottom lines. The top line shows the (net) welfare effect for a nonmember country of *joining* an existing PTA or – for country 2 – *forming* a PTA with country 1; this influences the "demand" for membership in the PTA. The bottom line shows the welfare effect of an enlargement for the "worst-off" member of the existing agreement; this influences the "supply" of membership in the PTA. A loss of welfare for this member vetoes any expansion under the assumption, as most (if not all) agreements reveal, that every member of the existing agreement must accept the potential entrant (even though members may not share a common external tariff).

[31] In the special case of symmetrically sized economies, country 1 is actually indifferent between considering country 2 or country N. We assume arbitrarily the choice of 2 over N because we have no other economic characteristic to influence relative welfare gains; hence, we assume an infinitesimal epsilon lower cost for neighbors in a clockwise direction.

[32] Due to size symmetry across countries, incumbents 1 and 2 together are indifferent between offering membership to country 20 versus country 3. However, this will change when we consider asymmetrically-endowed countries. Of course, country 1 prefers membership of country 20 over that of country 3 and for country 2 the opposite holds true due to our parametrization of trade costs.

Consider first the effect of trade costs on the formation of a new agreement involving country 1 (recall, we choose country 1 randomly). Clearly, the first point on the top line shows that the model generates endogenously that country 2 – country 1's nearest neighbor – is the *equilibrium* outcome for a partner in the first round. Country 20 would be the next most likely nonmember to form an agreement with country 1 (and consequently country 2). Country 3 is next, and so on. This implies that the closer physically are two countries the more likely they are to form an agreement *sooner*. This suggests PTA events should occur sooner (and the hazard rate should increase) for pairs of countries that have lower trade costs (other things constant).

For empirical purposes, we use bilateral distances and a dummy variable for a common land border, as in gravity-equation analyses of trade. Hence, PTA events should occur sooner the lower two countries' bilateral distance and/or if they share a common land border.

A.3.2 Bilateral Economic Size

In Figure S4, all countries had identical labor stocks and consequently identical economic sizes. We now alter the absolute factor endowments of the 20 countries in our world by shifting labor among countries. In this case, we assume that economically large countries are concentrated in the "North" (with country 1 the largest) and the small countries are concentrated in the "South" (with country 11 the smallest). We attain this by reallocating labor (L_i) such that the largest country (country 1) holds 140 percent of the initial endowment of 100 units and the smallest country (country 11) holds 60 percent of the initial endowment. The gradual increase or decrease in absolute factor endowments as we move around the circle is identical, irrespective of with which country we start.

– Supplement Figures S5a and S5b about here –

Like Figure S4, Figure S5a considers the effects of country 1 pursuing a PTA – but when country 1 and its nearby countries are large. To understand why larger economies form PTAs first, compare Figures S4 and Figure S5a. Both figures illustrate that country 1 benefits the most from – and is likely to form earliest – a PTA with country 2.[33] However, for the PTA between 1 and 2 compare the relative economic gains (vertical axis) in the two figures. When countries 1 and 2 are large relative to other countries (Figure S5a), the welfare effect of a PTA is larger than that when the countries are all identically sized (Figure S4). Moreover, consider an enlargement to include country 20 in the PTA. The marginal welfare effect from adding country 20 when these countries are large (Figure S5a) is much larger than that when the three countries are equally sized (Figure S4).

We also considered another scenario where country 1 (11) is the smallest (largest) country. The results of country 1 forming a PTA when 1 and its neighbors are small are shown in Figure S5b. Note that the welfare gain for countries 1 and 2 from forming a PTA is even smaller than that in either Figures S5a or S4. Moreover, the marginal gains from enlargement to country 20 are also smaller in Figure S5b than those in either Figures S5a or S4. A PTA between two large partners increases the volume of trade (at the intensive margin) in more varieties than a PTA between two small partners, and reduces trade (at the intensive margin) in fewer varieties from nonmembers than two small partners, improving utility more in large countries relative to small countries, for any values of transport costs. Also, the consequent larger increase in trade among two large economies causes a larger net expansion of demand and hence a larger rise in real income. Small countries face considerable trade diversion when large countries have a PTA; the excess relative supply of factors in the small countries causes an erosion in their terms of trade. This suggests PTA events should occur sooner (and the hazard rate should increase) for pairs of countries with larger GDPs.

[33]Once again, we assume arbitrarily that country 2 is "epsilon" closer to country 1 than country 20 is, and so on for 3 vs. 19, etc.

It is important to note that – even for economically small countries – there are net positive benefits from close partners forming a PTA.[34] Also, Figure S5b illustrates that at some point the trade diversion exceeds the trade creation from further enlargement for the "worst-off" (existing) member, ending expansion. This halt of expansion over time in our model is due to net trade diversion, akin to the net trade diversion from simultaneous continental PTAs at low intra- and inter-continental transport costs in the static models of Frankel (1997) and B-B. We address the importance of this limiting-size effect later.[35]

A.3.3 Bilateral Similarity of Economic Sizes

Figure 3 (in the text) shows empirically that PTAs have occurred sooner among pairs of countries that are more similar in economic size. In our 20-country world, the potential effect of increasing two countries' economic-size similarity – for given absolute economic size of the two countries – is qualitatively the same as increasing their absolute economic sizes. Intuitively, we know from the Krugman (1980) and the Baier and Bergstrand (2004) models that bilateral economic size and similarity have qualitatively similar impacts. In Figures S5a and S5b, the welfare gains from PTA formations and enlargements are enhanced the larger the GDPs of the countries involved because of greater trade creation and less trade diversion. As size disparity increases, the loss of trade in varieties vis-à-vis the rest-of-the-world (ROW) for the larger country rises relative to its increased trade with a smaller PTA partner. Since one of the countries' welfare declines with size disparity, the time to a PTA formation is delayed. The figure associated with increased bilateral size similarity is qualitatively identical to previous figures, and omitted for brevity. This suggests PTA events should occur sooner (and the hazard rate should increase) for pairs of countries with more similar economic sizes.

A.4 Endogenous Regionalism

In this section, we investigate "endogenous regionalism." Endogenous regionalism refers here to the role that *existing* PTAs play in the timing of countries forming new or joining existing agreements. For tractability, following Baldwin (1995) we categorize the influences of existing PTAs on subsequent PTA events into factors influencing the "demand" for membership and the "supply" of membership.

A.4.1 Distance to the Nearest PTA

Consider now the effect of trade costs on the potential *enlargement* of an existing agreement between countries 1 and 2. Returning for simplicity to the case of symmetric economies and Figure S4, the second point on the top and bottom lines show that the model generates endogenously that country 20 – the next nearest neighbor – is the equilibrium outcome for a partner in the second round (under our assumption of one PTA event at a time). This suggests that a nonmember (country 20) that is bilaterally close to countries that are *already members* of a PTA is more likely to "demand" membership *in that nearby PTA*; this is consistent with Baldwin's domino theory. The bottom line suggests that the welfare effect of the enlargement for the worst-off member of

[34] This is in contrast to the inferences in Frankel (1997, Figure 8.4) and B-B (2004, Figure 3) where – at low intra- and inter-continental transport costs – the net welfare gains from PTAs were negative. However, continental PTAs were formed simultaneously in both those studies; they never considered only one pair forming an agreement.

[35] Even though this is beyond the focus of the present study, notice that Figures S4, S5a, and S5b also suggest that PTAs composed of economically large members (such as NAFTA) will have fewer members and, given the adopted assumption about the timing, will expand over a shorter time span than PTAs composed of economically small members (such as the EU).

the existing agreement (here, country 2) is positive, so that membership is "supplied" by countries 1 and 2 to country 20. Thus, a nonmember is more likely to demand membership in and join an existing PTA sooner the closer the nonmember is to that PTA. In the context of our approach, there is a higher utility gain (to both the potential member and the worst-off existing member) from a nonmember joining a close PTA and hence a nonmember will likely join that PTA *sooner.* This suggests the hazard rate for a country to join another country in an existing PTA decreases as the distance to the nearest PTA increases (distinct from the bilateral distance to its partner).

For empirical purposes, we construct a variable $DISTPTA_{ij,t-5}$, which measures the distance of a country pair to its nearest PTA five years prior. Consequently, a limiting factor in the enlargement of an existing PTA will be the farther a potential entrant is from the nearest PTA, limiting the demand for membership.[36]

A.4.2 The "Degree" of Regionalism

As just established, countries outside of PTAs face potential trade diversion by not becoming part of an existing nearby agreement. However, we do not observe the potential trade diversion caused by the enlargement of the European Union to cause every country to apply to the EU! It is likely that some country pairs instead form new agreements, such as NAFTA or MERCOSUR. Hence, the formation of new agreements is likely to be an *endogenous* response to the intensity, or "degree," of regionalism in the world that creates potential trade diversion and countries' governments becoming concerned about being left out of "competitive liberalization."

Our model can simulate the potential effect of a higher overall degree of regionalism on raising the likelihood of a pair of countries forming an agreement *sooner.* We simulated the model again, returning for simplicity to the case of symmetrically-sized economies, to consider the timing of PTA membership in *two* agreements. In this simulation, we first introduce exogenously a PTA in the "North" as before (beginning with countries 1 and 2). However, in this case, we now *allow endogenously* country 11 in the "South" (the country farthest from country 1) to choose joining the North PTA, forming a new PTA, or doing nothing. (As before, we must assume only one PTA formation or enlargement can occur at a time.) The simulation yields the endogenous outcome that country 11 forms a *new agreement* with country 12, rather than joining countries 1 and 2 in their PTA or doing nothing.[37] The next agreements formed endogenously – in sequence – are country 20 joining the North PTA, country 10 joining the South PTA, country 3 joining the North PTA, country 13 joining the South PTA, and so on. In equilibrium, the North PTA is *exactly* the same 7 countries as before (1, 2, 20, 3, 19, 4, and 18). However, in equilibrium the South PTA also includes 7 countries (11, 12, 10, 13, 9, 14, and 8), owing to the symmetries in economic size and bilateral trade costs.

We can use this simulation to infer the potential effect of a higher "degree of regionalism" in the world on increasing the likelihood of countries forming a PTA sooner. For the North PTA, the associated figure is qualitatively identical to Figure S4; for brevity, we do not provide any new figures. However, the welfare effects associated with potential North PTA entrants and the North PTA's potentially "worst-off" existing member are quantitatively different. In this case, the welfare effects for entrants and the worst-off existing member are all higher in the case where another PTA can form in the South than when one cannot. In effect, the welfare effects for entrants and members of the North PTA from forming and enlarging their PTA are *increased* from the presence of regionalism in the South. In the context of the model, this suggests that they are more likely to form a PTA *sooner.* This suggests the hazard rate for a nonmember to form a new agreement with another

[36]The richness of the model given considerable potential asymmetries in economic size, size similarity, and bilateral trade costs can also explain readily whether a nonmember country would endogenously form a PTA with another nonmember or with a member of an existing PTA. We address this below.

[37]Recall, in the case of symmetric economies, neighbors in a clockwise direction have epsilon smaller trade costs.

country (or join another country in a PTA) increases as the "degree of regionalism" the pair faces increases.

Capturing empirically the influence of the degree of regionalism on potential entrants' demand for membership is no easy task. To measure the effect of the degree of regionalism facing a country pair, we constructed for each pair a variable $WPTA_{ij,t-5}$. This variable is a spatially weighted average of all the PTAs countries i and j face in "third" markets (i.e., ROW), five years earlier. We assume the elements of the weighting matrix to be inversely related to the distance (hence, trade costs) between country-pairs ℓ and m, as in Egger and Larch (2008). For instance, suppose that country-pair ℓ consists of economies i and j and country-pair m consists of countries h and k. We define the distance between pairs ℓ and m as $\text{Distance}_{\ell m} = \left(\sum_{\iota}\sum_{\kappa}\text{Distance}_{\iota\kappa}\right)/4$ with $\iota = i, j$ and $\kappa = h, k$. All diagonal elements of the weights matrix $\mathbf{W}_t$ are set to zero. Consequently, $WPTA_{ij,t-5}$ measures the spatially weighted number of PTAs that country-pair ij faces (in terms of potential trade diversion), with closer PTAs weighted more heavily.[38] Hence, nonmembers' demand for membership in a PTA increases with a higher degree of regionalism (and potential trade diversion) they face.

A.4.3 Number of Members of Nearest PTA

It turns out – for the particular parameterization in Figure S4 (with size-symmetric economies) – that after the PTA enlarges to 7 countries (namely, 1, 2, 20, 3, 19, 4, and 18) – a further enlargement would induce a welfare loss for at least one member, halting expansion of the PTA. Figure S4 (or S5a or S5b) displays four lines. The vertical line demarcates the endogenously-determined *equilibrium* number of members in the agreement. Recall, the top line shows the (net) welfare effect for a nonmember country of *joining* an existing PTA (or, for country 2, forming an PTA with country 1); the net trade creation from having a PTA with a larger group of countries increases with the size of the existing PTA, as discussed above. However, while the potential entrant's welfare gain from joining an existing PTA increases with the PTA's size as discussed above, the other relevant economic characteristic for a potential entrant's actually joining the PTA is the welfare gain or loss of the (marginal) "*worst-off*" existing member – which determines the "supply of membership." Recall that the bottom line shows the welfare effect of enlargement for the "worst-off" member of the existing agreement. A loss of welfare for this member vetoes any expansion under the assumption, as most (if not all) agreements reveal, that every member of the existing agreement must accept the potential entrant (even though members may not share a common external tariff).

The middle line illustrates the welfare effect of a PTA enlargement for the average member as the number of members expands; this is the average of all existing members *and* the potential entrant. This is the *critical* line. In reality, the *number* of members will be determined by the interaction of demand for and supply of membership. The middle line reveals that – at first – the demand for membership dominates. However, eventually the worst-off member's utility limits the size of the agreement; note that the welfare effect of the "average" member peaks when the worst-off member's utility change is negative. Thus, the *middle* line in Figure S4 suggests the hazard rate for a country to join a country in an existing PTA is a hump-shaped function of the number of members in such PTA, due to the influence of supply of membership by the marginal "worst-off" existing member.

For this, we create a variable that is the actual number of members of the closest existing PTA (actually, the number of members 5 years earlier), $NPTA_{ij,t-5}$, as a determinant of the time-to-event. However, since the expected relationship between the hazard rate and the number of members of the closest existing PTA is

[38] The inverse-distance-based weighting scheme exhibits elements $\omega_{\ell m}$ that are based on $w_{\ell m} = e^{-\text{Distance}_{\ell m}/500}$ if $\text{Distance}_{\ell m} < 2000$. We use a cut-off distance of 2000 kilometers in $\mathbf{W}_t$ to avoid problems associated with an excessive memory requirement for matrix elements that are close to zero anyway. We divide the exponent in $w_{\ell m}$ to ensure that the decay of interdependence is slow enough (i.e., that the coverage of third countries is large enough).

quadratic, we also create $SQNPTA_{ij,t-5}$, which is the square of $NPTA_{ij,t-5}$. We expect the hazard rate to be increasing in $NPTA_{ij,t-5}$ and decreasing in $SQNPTA_{ij,t-5}$. This hypothesis reflects the *finite* elasticity of supply of membership here, in contrast to the infinitely elastic supply of membership in Baldwin (1995).

References for Theoretical Supplement

Anderson, James E. and Eric van Wincoop (2004), Trade costs, *Journal of Economic Literature* **42**, 691–751.

Arkolakis, Costas, Arnaud Costinot and Andres Rodriguez-Clare (2012), New trade models, same old gains?, *American Economic Review* **102**, 94–130.

Bond, Eric W. (2008), Adjustment costs and the sequencing of trade liberalization, *The World Economy* **31**, 97–111.

Bond, Eric W. and Jee-Hyeong Park (2002), Gradualism in trade agreements between asymmetric countries, *Review of Economic Studies* **69**, 379–406.

Krugman, Paul R. (1980), Scale economies, product differentiation, and the pattern of trade, *American Economic Review* **70**, 950–59.

Ornelas, Emanuel (2005), Endogenous free trade agreements and the multilateral trading system, *Journal of International Economics* **67**, 471–497.

Zissimos, Benjamin (2007), The GATT and gradualism, *Journal of International Economics* **71**, 410–433.

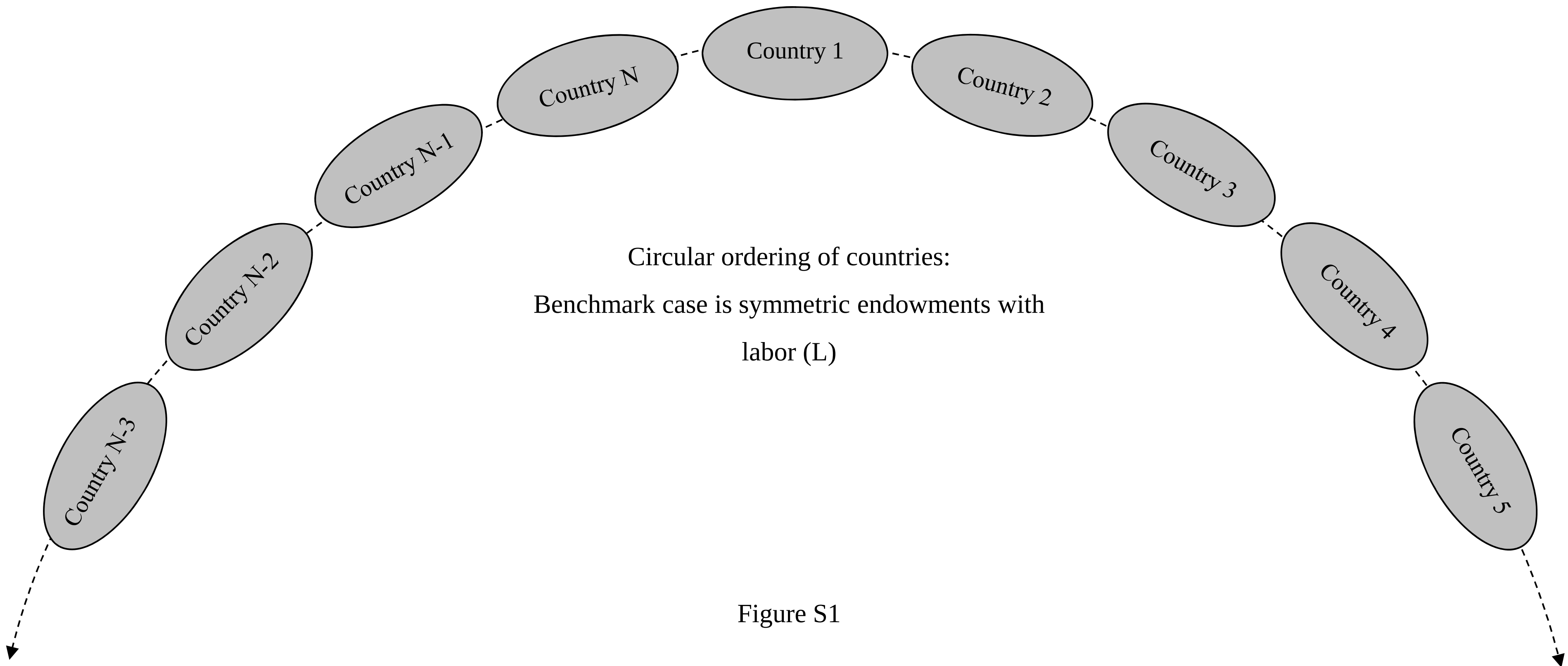
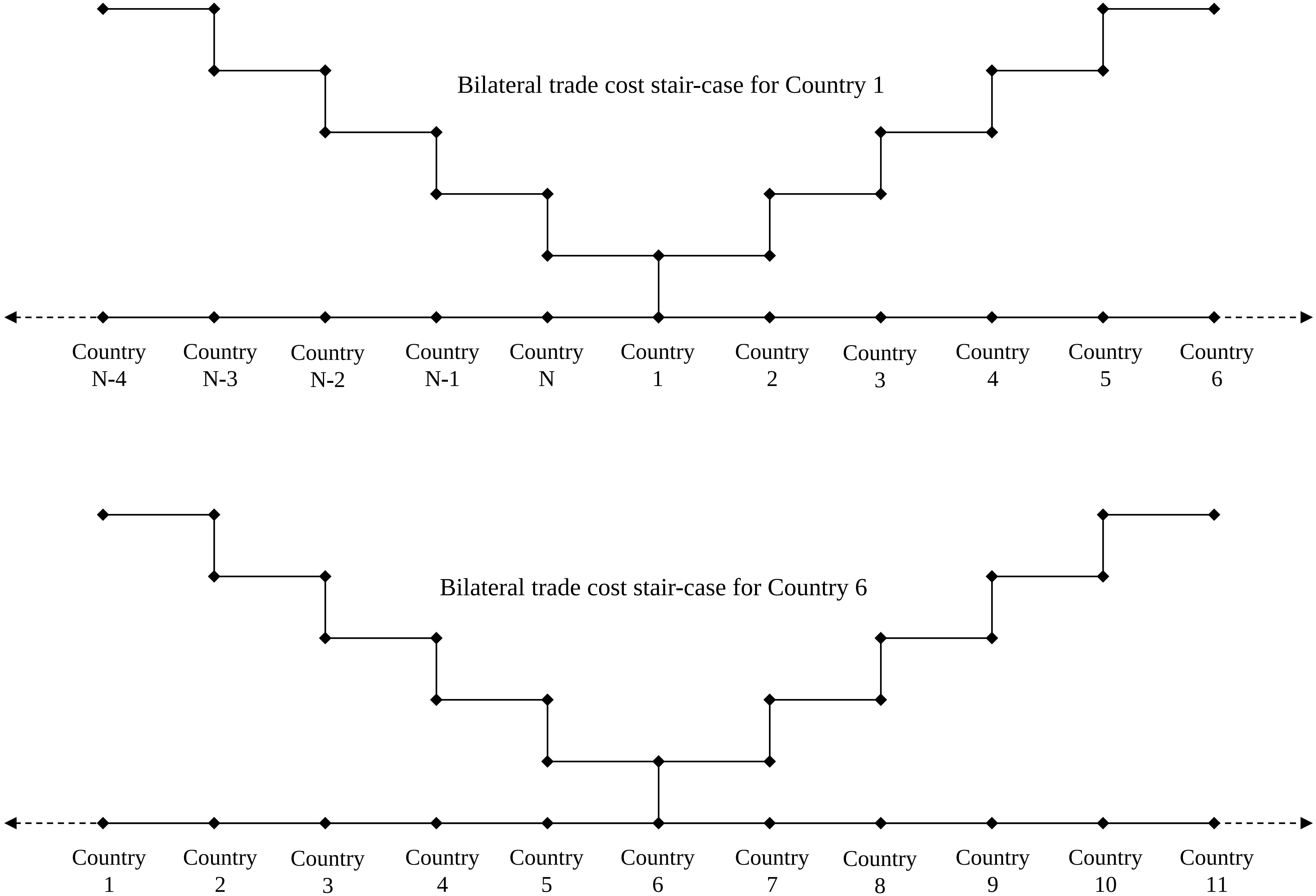

Country 1
Country 2
Country 3
Country 4
Country 5
Country N
Country N-1
Country N-2
Country N-3
Circular ordering of countries:
Benchmark case is symmetric endowments with
labor (L)

Figure S1

Figure S2


Bilateral trade cost stair-case for Country 1
Country N-4
Country N-3
Country N-2
Country N-1
Country N
Country 1
Country 2
Country 3
Country 4
Country 5
Country 6
Bilateral trade cost stair-case for Country 6
Country 1
Country 2
Country 3
Country 4
Country 5
Country 6
Country 7
Country 8
Country 9
Country 10
Country 11

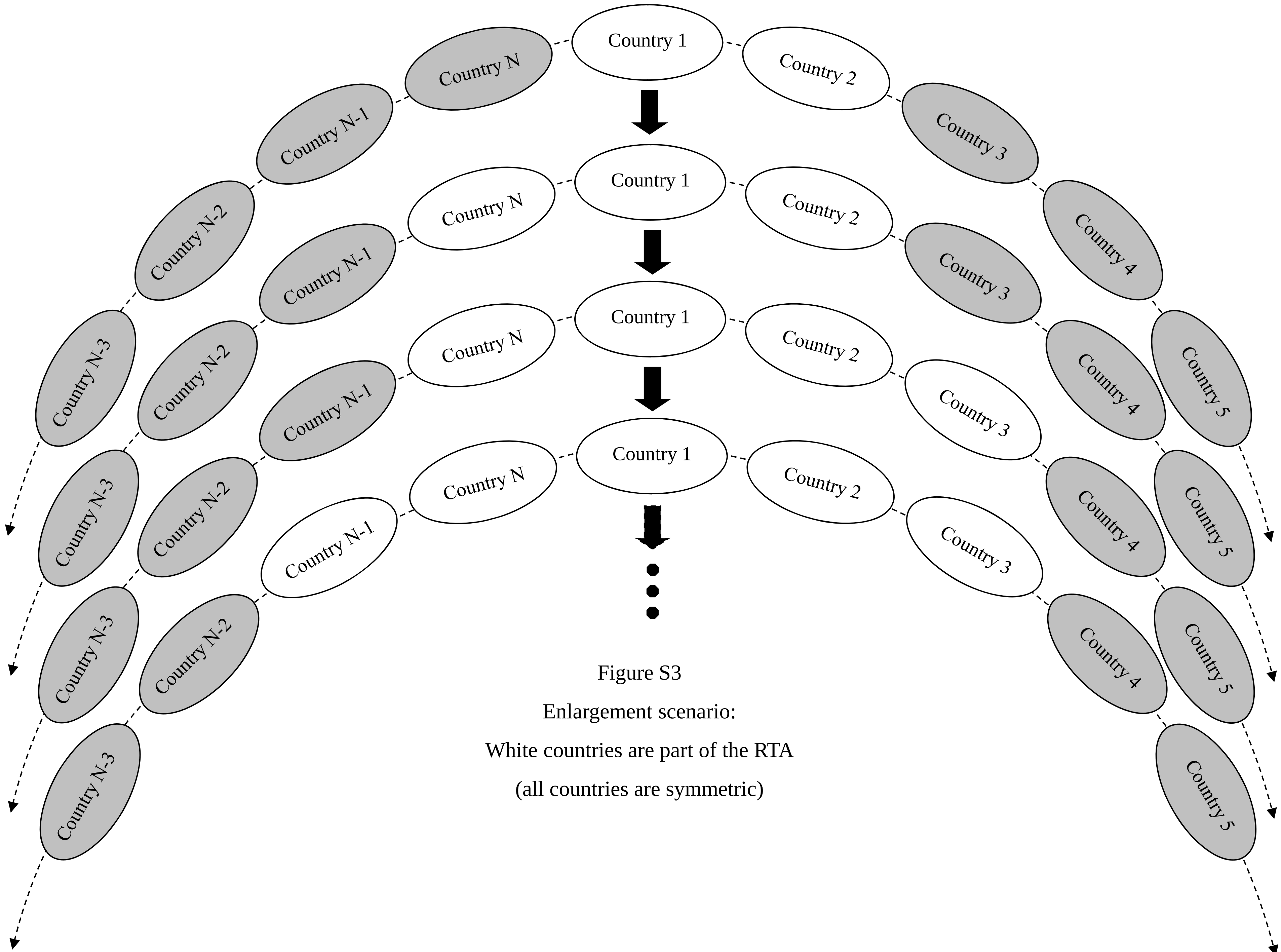


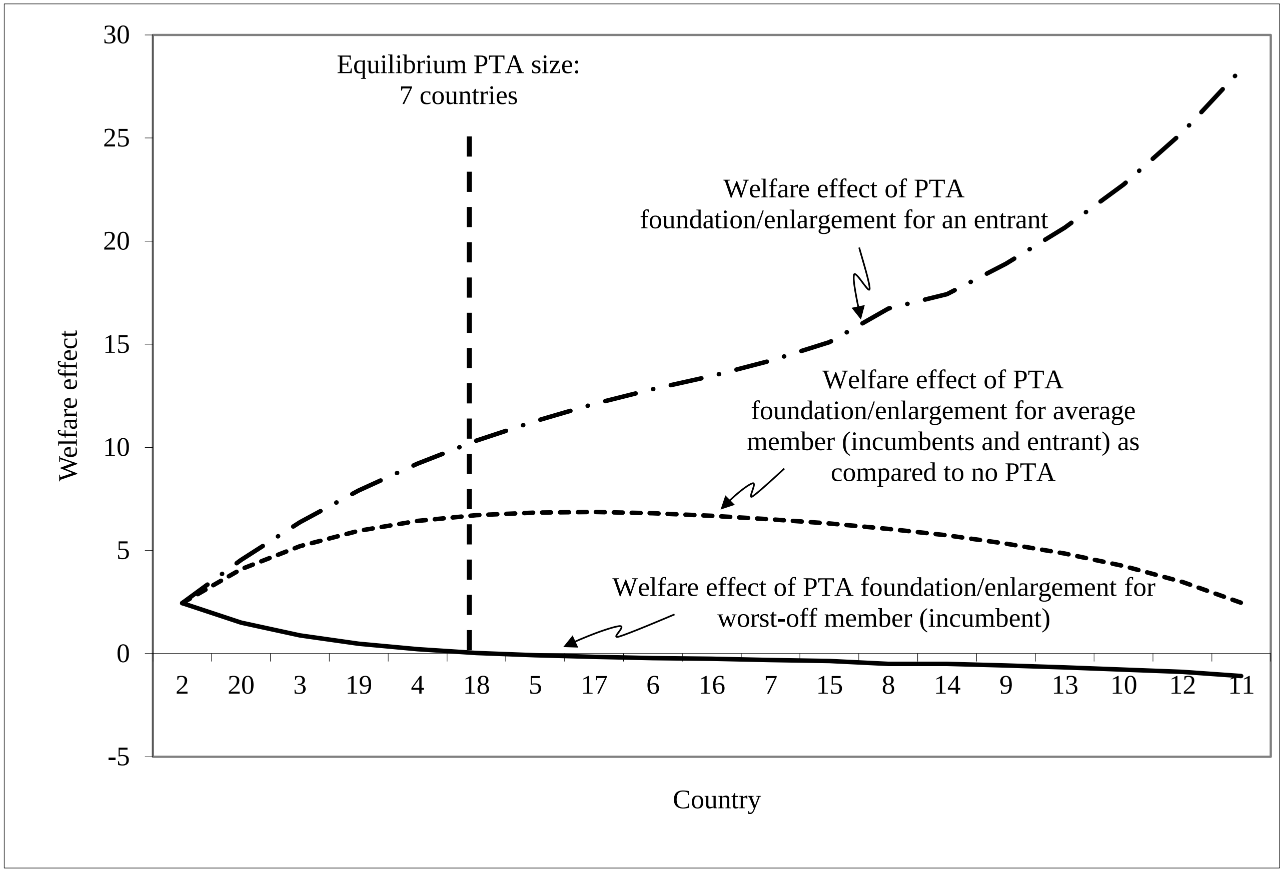
Figure S3

Enlargement scenario:

White countries are part of the RTA

(all countries are symmetric)

Figure S4



30
25
20
15
10
5
0
-5
Welfare effect
Equilibrium PTA size:
7 countries
Welfare effect of PTA foundation/enlargement for an entrant
Welfare effect of PTA foundation/enlargement for average member (incumbents and entrant) as compared to no PTA
Welfare effect of PTA foundation/enlargement for worst-off member (incumbent)
2
20
3
19
4
18
5
17
6
16
7
15
8
14
9
13
10
12
11
Country

Figure S5a

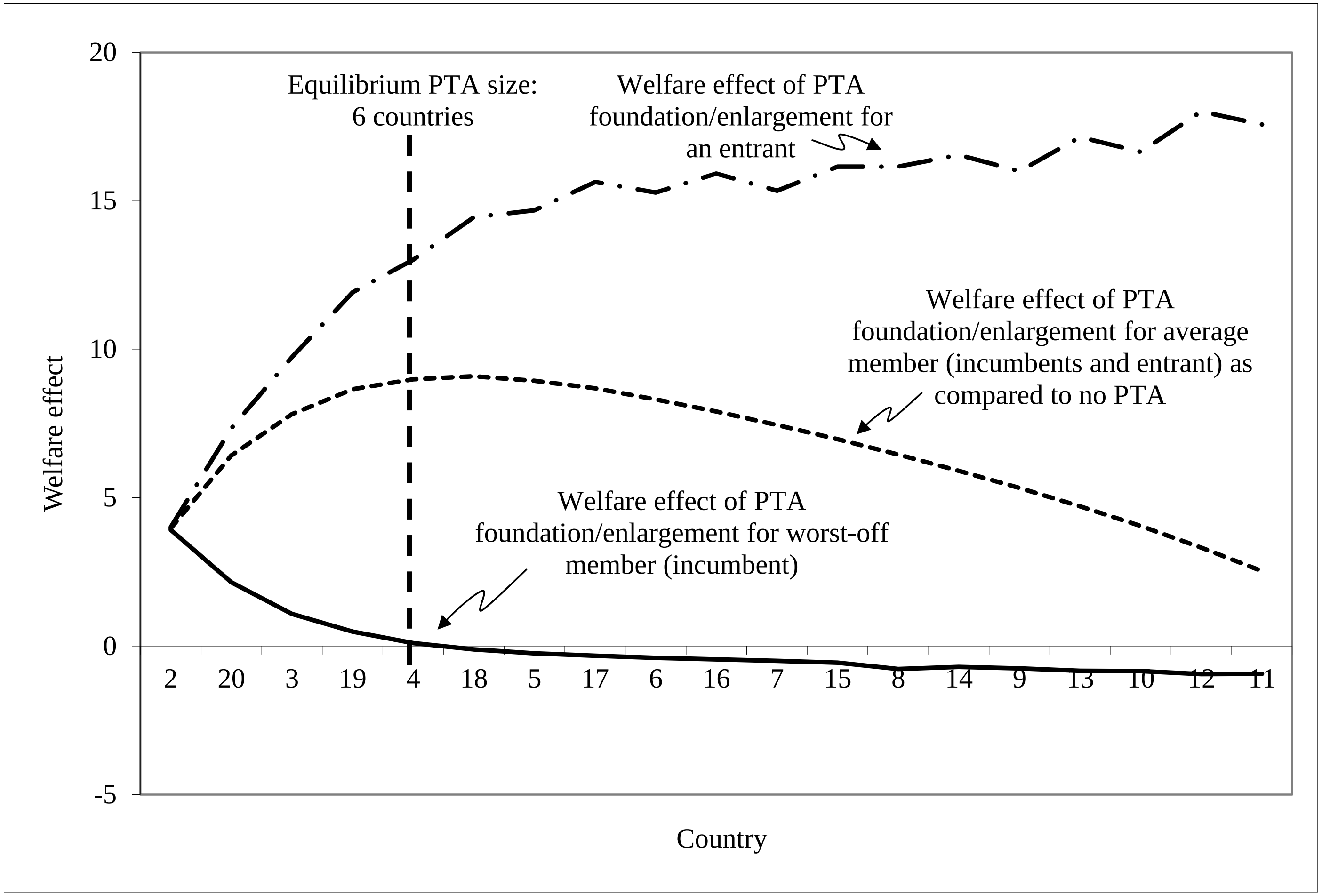
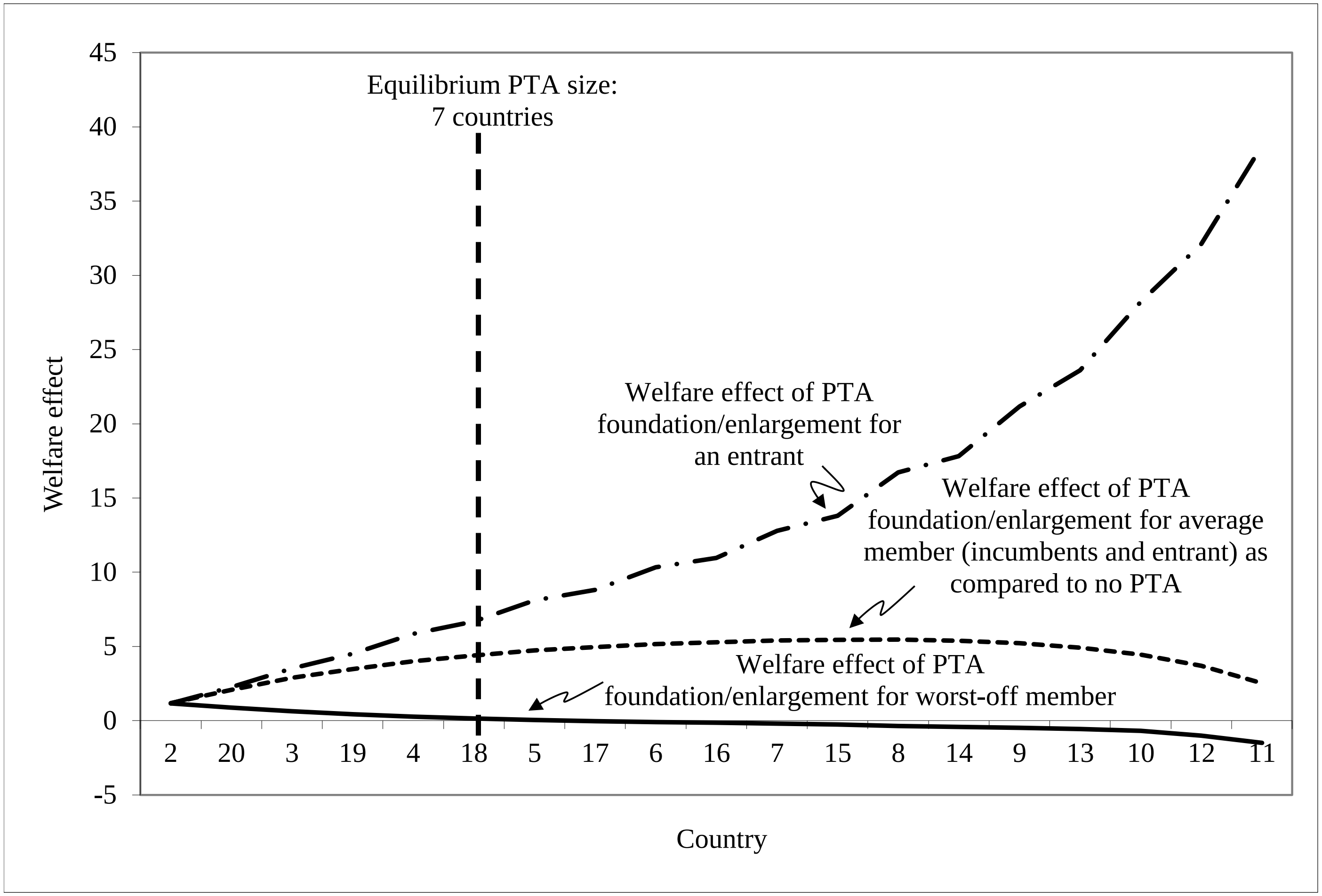

20
15
10
5
0
-5
Welfare effect
Equilibrium PTA size:
6 countries
Welfare effect of PTA
foundation/enlargement for
an entrant
Welfare effect of PTA
foundation/enlargement for average
member (incumbents and entrant) as
compared to no PTA
Welfare effect of PTA
foundation/enlargement for worst-off
member (incumbent)
2 20 3 19 4 18 5 17 6 16 7 15 8 14 9 13 10 12 11
Country

Figure S5b



45
40
35
30
25
20
15
10
5
0
-5
Welfare effect
Equilibrium PTA size:
7 countries
Welfare effect of PTA
foundation/enlargement for
an entrant
Welfare effect of PTA
foundation/enlargement for average
member (incumbents and entrant) as
compared to no PTA
Welfare effect of PTA
foundation/enlargement for worst-off member
2 20 3 19 4 18 5 17 6 16 7 15 8 14 9 13 10 12 11
Country