

THE FARSIGHTED STABILITY OF GLOBAL TRADE POLICY ARRANGEMENTS

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ABSTRACT. In this paper, we study and compare the stability of trade policy arrangements in two different regulatory scenarios, one with and one without Preferential Trade Agreements (PTAs), i.e. current vs. modified WTO rules. Unlike the existing literature, our paper considers an extensive choice set of trade constellations, containing both available PTAs, Customs Unions (CUs) and Free Trade Agreements (FTAs), as well as Multilateral Trade Agreements (MTAs), while assuming unlimited farsightedness of the negotiating parties. With symmetric countries and under both the current and the modified WTO rules, the Global Free Trade (GFT) regime emerges as the unique stable outcome. In the case of asymmetry, the results are driven by the relative size of the countries. If the world is in the vicinity of symmetry and two out of three countries are close to identical while relatively smaller than the other one, the area where the GFT regime is stable increases when prohibiting PTAs. However, when two similar countries are relatively larger, the availability of PTAs is conducive to the stability of the GFT regime. Finally, if the world is further away from symmetry, full trade liberalization is not attainable at all and an area where the Most-Favoured-Nation (MFN) regime is stable appears in the scenario without PTAs. Thus, the direction of the effect of PTAs on trade liberalization depends on the degree of asymmetry among countries.

Keywords: Trade Policy Arrangements, Stability, Unlimited Farsightedness

JEL Classification: F13, F55

1. INTRODUCTION

Following the General Agreement on Tariffs and Trade (GATT) of 1947, an increasing number of signatory countries liberalised their trade policies primarily via two channels: bilateral and multilateral negotiations. To the present day, there have been eight rounds of multilateral trade negotiations with the current ninth one, the Doha Round, still ongoing. At the same time, parallel to the arrangements observed on the multilateral level, the world has seen an ever-increasing number of Preferential Trade Agreements (PTAs) mainly in the wake of bilateral negotiations. Currently, about forty percent of all countries/territories are a member of more than five PTAs while about a quarter participates in more than ten.¹

The World Trade Organization (WTO), successor of the GATT in 1995, provides the rule set for the trade liberalisation process of a significant number of countries.² Its Article I acts as the foundation for any multilateral trade liberalisation by formulating the so-called Most-Favoured-Nation (MFN) principle: Any concession granted to one member needs to be extended to all other members of the WTO.³ In this paper, trade policy arrangements that are consistent with the MFN principle are referred to as Multilateral

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¹Source: <http://www.wto.org>

²All members of the WTO account for 96.4 percent of world trade, 96.7 percent of world GDP, and 90.1 percent of world population as of 2007 (Source: <http://www.wto.org>).

³Article I states that ‘any [...] favour [...] granted by any contracting party to any product originating in or destined for any other country shall be accorded immediately and unconditionally to the like product originating in or destined for [...] all other contracting parties’ (GATT, 1947).

Trade Agreements (MTAs).⁴ Contrary to the core MFN principle, Article XXIV Paragraph 5 explicitly allows countries to form PTAs, specifically Customs Unions (CUs) and Free Trade Agreements (FTAs), that do not need to extend the concessions granted within the arrangement to other countries.⁵ However, Article XXIV Paragraph 5 Subparagraph (a), (b), and (c) each require that these are without (negative) influence on other trade relations.

The (direction of the) influence of Article XXIV Paragraph 5 on the development of trade policy arrangements is a controversial topic and the focus of many papers.⁶ Likewise, the primary purpose of the paper is the analysis of the stability of different trade policy arrangements in two scenarios, that is with PTAs (current WTO rules) and without PTAs (modified WTO rules). In particular, it is our intent to examine whether PTAs act as ‘building blocks’ or ‘stumbling blocks’ on the path towards global free trade (Bhagwati (1993)).

The existing literature usually considers a limited selection of trade agreements or assumes limited farsightedness of the negotiating countries. It certainly allows for a cleaner description of the model and interpretation of its results, but ultimately raises the question about whether or not these restrictions significantly influence the analysis and to what degree these frameworks capture reality. In our opinion, certain empirical observations favour an extensive choice set and full farsightedness. During the past rounds of multilateral trade negotiations, many countries were simultaneously involved in other trade liberalisation processes.⁷ Moreover, such trade negotiations are usually complicated processes with significant effect on the countries’ economies and accompanied by elaborate studies about feasibility and future developments.⁸ Taking these assessments into account, the contribution of our work is an answer to the question concerning the influence on the analysis.

First of all, we consider an extensive set of trade agreements, containing PTAs, i.e., CUs and FTAs, as well as MTAs. Next, endogenizing the formation of trade agreements, each country ranks them based on a three-country two-good general equilibrium model of international trade.⁹ The stability of all trade agreements is then examined using these rankings together with the concept of ‘consistent sets’ as stable sets - a notion proposed by Chwe (1994). As a result, our work expands the set of trade agreements under consideration and also extends the farsightedness of the negotiating parties in comparison to the literature. In fact, to the best of our knowledge, no other paper considers a choice set as extensive as ours.

In the end, our analysis shows that the effect of PTAs on trade liberalisation depends on the size distribution of the countries. As long as the countries are close to symmetric, Global Free Trade (GFT) emerges as the unique stable outcome under both the existing and the hypothetical institutional arrangement. However, when two countries are considerably smaller, a modified WTO without PTAs would facilitate the formation of GFT. By contrast, if two countries are relatively larger, this modified WTO would actually obstruct the development towards GFT. Once the world is further away from symmetry,

⁴Furthermore, we interchangeably use the terms trade policy arrangements, trade agreements, trade constellations, and trade relations.

⁵Article XXIV Paragraph 5 states that ‘[...] this agreement shall not prevent [...] the formation of a customs union or of a free-trade area [...]’ (GATT, 1947).

⁶The next part of the paper contains further information on the related literature.

⁷Maggi (2014) showcases the importance of an extensive set of trade constellations.

⁸Aumann and Myerson (1988) provides a (brief) description of the criticism against the use of limited farsightedness in general: ‘When a player considers forming a link with another one, he does not simply ask himself whether he may expect to be better off with this link than without it, given the previously existing structure. Rather, he looks ahead and asks himself, “Suppose we form this new link, will other players be motivated to form further new links that were not worthwhile for them before? Where will it all lead? Is the end result good or bad for me?”’

⁹A model similar to that of Saggi and Yildiz (2010), which itself is a modification of the one in Bagwell and Staiger (1997). The modified one is also used in Saggi, Woodland and Yildiz (2013).

full trade liberalisation is not attainable at all and abolishing the exception for PTAs might result in the worst possible state from the perspective of overall world welfare, the non-cooperative MFN regime.

Our work is related to the so-called ‘rules-to-make-rules’ literature (Maggi (2014)) that tries to determine the role of PTAs in the global trade liberalisation process. The emphasis of this part of our work is on the methodology of the related papers. Further details, in particular a comparison of the model predictions, we present later.

A number of relevant papers are the work of Saggi, Yildiz and various co-authors. Saggi and Yildiz (2010) considers a three-country trade model where the degree and nature of trade liberalisation, bilateral and multilateral, are endogenously determined. Using Coalition-Proof Nash Equilibria, the authors study the stability of FTAs and MTAs while varying the extent of asymmetry among the countries with respect to their size. In a subsequent paper Saggi, Woodland and Yildiz (2013) study the complementary case by focusing on the combination of CUs and MTAs while leaving everything else fixed (in terms of their framework). By contrast, the paper of Missions, Saggi and Yildiz (2016) analyses the effect of both forms of PTAs, i.e. CUs and FTAs, on attaining global free trade, but excludes MTAs. In a sense, this completes their ‘2 out of 3’ pattern of trade agreements under consideration.

Another related paper (in terms of farsightedness) is the work of Lake (2017), who uses a dynamic approach to understand whether FTAs facilitate or impede the formation of GFT. The approach uses a three-country dynamic model where a fixed protocol specifies for each period the exact nature (and order) of negotiations. Then, on the basis of Markov Perfect Equilibria in pure strategies, the author analyses the effect of country asymmetries on global trade liberalisation.

Furthermore, a variety of research focuses purely on analysing the effect of FTAs. Goyal and Joshi (2006) consider several countries with a homogeneous good in their model and study different degrees of asymmetry across countries. They employ the notion of Pairwise Stability by Jackson and Wolinsky (1996) as the solution method. Furusawa and Konishi (2007) use similar methods but introduce heterogeneity with respect to goods. In a separate section, they also briefly discuss a setting with CUs, but overall focus on FTAs. Another related paper to Goyal and Joshi (2006) is that of Zhang et al. (2013) in which the concept of Pairwise Stability is replaced with Pairwise Farsighted Stability by Herings, Mauleon and Vannetelbosch (2009), thereby comparing myopia with farsightedness in an otherwise fixed framework. Also connected to this is the paper of Zhang et al. (2014), which uses the work of Goyal and Joshi (2006) as a benchmark and analyses the evolutionary effect of the number of countries in a dynamic framework featuring random perturbations. Now, while all of the aforementioned papers employ (different) network-theoretic concepts, there is also Aghion et al. (2007), which features standard cooperative game theory. In the three-country model presented there, a single country takes on the role of negotiation leader and decides to either engage in sequential bilateral or single multilateral bargaining with the other countries.

The stability concept of our approach is that of Chwe (1994). It is (in parts) a response to the criticism of the von-Neumann-Morgenstern stable set (solution).¹⁰ The approach aims to achieve two goals, namely to include unlimited consideration of the future by the participants while simultaneously avoiding emptiness of the stable set that plagues other (more) restrictive solution concepts.¹¹ It is also closely related to the stability concept found in Herings, Mauleon and Vannetelbosch (2009) and its extension (HMV (2014)). In fact, as is noted by the authors, their criterion constitutes a stricter version, but in specific cases (like our model) they coincide.

¹⁰Consult von Neumann and Morgenstern (1944) for a description of this (solution) concept and Harsanyi (1974) for its criticism.

¹¹It is also resistant to the criticism of Ray and Vohra (2015) about the sovereignty of coalitions as their main issues concerned with feasibility and distribution do not apply to our framework. Furthermore, their specific criticism about the explanatory power of Chwe’s approach only applies to transferable utility games.

The remainder of the paper is organised as follows. Section 2 specifies the model, Section 3 analyses the findings while further details are discussed in Section 4, and Section 5 concludes our work.

2. MODEL

In this section, firstly, we briefly discuss trade policy arrangements and present the transition graphs which show what countries can do individually and/or in coalitions. Then we give the necessary theoretical and intuitive details of the stability notion and the related solution concept. In the end, we present the underlying trade model that determines countries' preferences over the trade policy regimes and parametrise the model.

2.1. Trade Policy Arrangements. We consider a three-country world. Countries trade with one another, and each country can (possibly) impose tariffs on the imported goods following the GATT rules. The decision-makers are welfare maximisers. At this stage, this information is sufficient to present all possible trade policy constellations under the articles I and XXIV of the GATT. In the later sections, we shall provide more details. Let $N = \{a, b, c\}$ denote the set of all (three) countries in the world. Furthermore, let t_{ij} denote the tariff imposed by country i on the import from country j , where $i, j \in N$ are distinct. Additionally, W_i denotes the welfare of country $i \in N$. Then all trade policy arrangements in our model are one of four types: MFN, CU, FTA, and MTA. Each type, except for MFN, naturally induces different combinations of insiders and outsiders. Namely, three combinations of two members and one of three (each for CU, FTA, and MTA).¹² Additionally, the case of FTA contains the possibility of a special hub structure with two FTAs at the same time - adding another three combinations. In total, our model allows for 16 different trade policy constellations.¹³ For each of these trade agreements the tariffs are bounded from below and above by zero and the MFN-tariff respectively, which is discussed in more detail in Appendix B.2. The corresponding set of tariffs for country i , i.e. $[0, t_i^{MFN}]$, is denoted by T_i . Any additional restrictions on tariffs, specific to trade agreements, are listed below:

In the baseline case, i.e. MFN, countries do not liberalise their trade relations at all, but the non-discrimination principle still applies. Each country unilaterally chooses its (optimal) tariffs accordingly. Therefore, the optimisation problem of country i is $\max_{(t_{ij}, t_{ik}) \in T_i^{MFN}} W_i$ with $T_i^{MFN} = \{(t_{ij}, t_{ik}) \in \mathbb{R}_{\geq 0}^2 \mid t_{ij} = t_{ik}\}$. Note, that in this reference scenario each tariff is chosen from $\mathbb{R}_{\geq 0}$ instead of T_i .

In case country i and j form CU(i,j), each of them removes any trade restriction on the other country and then jointly imposes an optimal tariff on country k . Thus, the optimisation problem of country i and j is $\max_{(t_{ij}, t_{ik}) \in T_i^{CU}, (t_{ji}, t_{jk}) \in T_j^{CU}} W_i + W_j$ with $T_i^{CU} = \{(t_{ij}, t_{ik}) \in T_i^2 \mid t_{ij} = 0\}$ and T_j^{CU} analogous. Finally, country k simply follows and applies the principle of MFN (as before). However, as soon as all three countries enter a single CU together, the (common) optimisation problem is trivial, because the only possible tariff of each country towards any other country is zero, and the scenario is denoted by CUGFT.

In case country i and j form FTA(i,j), each of them removes any trade restriction on the other country and then unilaterally imposes an optimal tariff on country k . Thus, the (representative) optimisation problem of country i is $\max_{(t_{ij}, t_{ik}) \in T_i^{FTA}} W_i$ with $T_i^{FTA} = \{(t_{ij}, t_{ik}) \in T_i^2 \mid t_{ij} = 0\} (= T_i^{CU})$. The optimisation problem of country k is identical to that of the third country in case of a CU. Further, in case country i forms an FTA both with j and k , that is FTAHub(i), then both tariffs of country i are set

¹²Note that in our model Global Free Trade is essentially listed in three different variations, via CUs, FTAs, and MTAs. The actual welfare is necessarily equal across all three variations, but not their position in the network (Section 2.2). In particular, for our concept of stability it is important which group of countries can create or destroy specific trade agreements (Appendix C.1). Occasionally, all three variants together are going to be referred to as 'GFT' (when applicable).

¹³The framework does not contain combinations of different classes of trade agreement due to the possibly conflicting restrictions on tariffs that the different classes entail. In order to circumvent potential conflicts one would need to fix an (arbitrary) ordering in terms of priority (or importance) of trade agreements, which would reduce the explanatory power more than the inclusion of other combinations of trade agreements would increase it (in our opinion).

to zero by nature of its trade relation with both other countries. Each of the other two countries operates as before: Country j (k analogous) faces $\max_{(t_{ji}, t_{jk}) \in T_j^{FTA}} W_j$ where $T_j^{FTA} = \{(t_{ji}, t_{jk}) \in T_i^2 \mid t_{ji} = 0\}$. Thus, in terms of decision problem, it does not matter for a country whether its partner also forms another trade agreement with the other country. Finally, if all three countries in pairs of two countries form FTAs, then the optimisation problem is identical to the case of CUGFT, denoted FTAGFT, but the actual trade agreement is different in terms of structure and network position, see Section 2.2.

In case country i and j form MTA(i,j), then both jointly change their tariffs with respect to each other and also for the third country (at the same time). Thus, the optimisation problem of country i and j is $\max_{(t_{ij}, t_{ik}) \in T_i^{MTA}, (t_{ji}, t_{jk}) \in T_j^{MTA}} W_i + W_j$ with $T_i^{MTA} = \{(t_{ij}, t_{ik}) \in T_i^2 \mid t_{ij} = t_{ik}\}$ and T_j analogous. As seen before, the optimisation problem of country k is identical to that of the third country in case of a CU. Again, as soon as all three countries enter a single MTA together, the optimisation problem is identical to the case of CUGFT, denoted MTAGFT, but also different in terms of network position, see Section 2.2.

2.2. Transition Graphs. Countries can implement trade policy arrangements depending on whether they act individually or in a coalition with other countries. We represent such possibilities with directed graphs with the trade agreements as vertices and the moves as edges. The coalition of three countries can implement any trade policy constellation. Therefore, the corresponding directed graph of the full coalition is a complete directed graph with loops.

The transition graph for a single country coalition $i \in N$ with $j, k \in N \setminus \{i\}$, $j \neq k$, denoting the other two countries is given in Figure 1. In this case, MFN is connected to a number of other different elements, but not to the three variants of Global Free Trade, CUGFT, FTAGFT and MTAGFT. Now, each of those forms a separate group of connected trade agreements. Thus, the overall transition graph, see Figure 1 (modulo loops), consists of four sub-graphs.

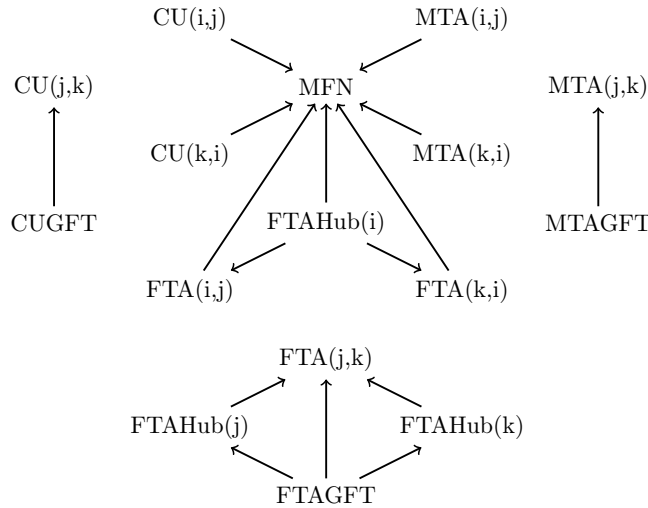


FIGURE 1. The transition graph for coalition $\{i\}$, $i \in N$.

Finally, consider the transition graph for a coalition of two countries $i, j \in N$, $i \neq j$ with $k \in N \setminus \{i, j\}$ denoting the other country. In this case, MFN, CU(i,j), FTA(i,j), and MTA(i,j) are all interconnected. Also, any element connected to one of these is automatically connected to all of them. Thus, in the transition graph, see Figure 2 (again, modulo loops), this group of four corresponds to a complete directed sub-graph pictured as one ‘(super) node’ (dotted box).

Proposition 1. *There uniquely exists a $Y \subseteq X$ such that Y is consistent and $Y' \subseteq X$ consistent implies $Y' \subseteq Y$. The set Y is called the largest consistent set or simply LCS.*

Now, similar to the internal stability captured in the definition of consistent sets, a form of external stability is captured via an incentive to gravitate towards the consistent set:

Definition 3 (External Stability). *Let $Y \subseteq X$ be the largest consistent set. Then, it satisfies the external stability condition if for all $x \in X \setminus Y$ there exists $y \in Y$ such that $x \ll y$.*

The following result characterises one setting in which this condition is satisfied:

Proposition 2. *Let X be finite and the underlying preferences irreflexive. Then, the LCS is non-empty and satisfies the external stability property.*

Finally, let us state a comment on the application and interpretation of the stability concept with respect to our model:

Corollary 1. *In our setting, the (unique) LCS is non-empty and satisfies the external stability property (in addition to the internal stability).¹⁶*

Now, the LCS is going to be the focus point of our analysis. Any trade agreement is considered to be ‘(potentially) stable’ if it is in the LCS, ‘unstable’ otherwise. The nomenclature is a tribute to the fact that the LCS as a stability concept is ‘weak: not so good at picking out, but ruling out with confidence’, because ultimately it ‘does not try to say what will happen but what can possibly happen’ (Chwe (1994)).

2.4. Underlying Trade Model. To study the stability of different trade policy constellations, our framework utilises a three-country, general equilibrium trade model with competition via exports. In this respect, we closely follow the approach used by Saggi and Yildiz (2010). One can potentially use any type of underlying trade model. Still, our choice is guided by the widespread use of the general equilibrium trade model with competition via export in the literature.

Recall that $N = \{a, b, c\}$ denotes the set of countries. Further, let $G = \{A, B, C\}$ denote three (corresponding) non-numeraire goods. Now, each country i is endowed with zero units of good I (corresponding capital letter) and e_i units of the others. Ultimately, it will end up importing I and exporting J and K with $J, K \neq I$. To guarantee the ‘competing exporters’-structure, a general condition needs to be applied to the degree of asymmetry with respect to the endowments of the countries.¹⁷

The preferences of individuals in each country are assumed to be identical. The demand for any non-numeraire good $L \in G$ in country $i \in N$ is given by the function $d(p_i^L) = \alpha - p_i^L$ with p_i^L the price of good L in country i and the (universal) reservation price α .¹⁸ Each country also (possibly) imposes tariffs on the goods imported by them. Let t_{ij} denote the tariff imposed by country i on the import from country j . All prices and tariffs of a specific good $I \in G$ are connected via the following no-arbitrage condition

$$(1) \quad p_i^I = p_j^I + t_{ij} = p_k^I + t_{ik}$$

¹⁶First of all, applying Proposition 1 to our model is trivial, because it is stated without any (additional) requirements on the involved objects. Furthermore, the application of Proposition 2 is straight forward as well: First, the set of outcomes X is clearly finite in our setting as we are only considering a finite number of different trade agreements. Second, any strict preference is automatically irreflexive and our preferences are induced by strict welfare comparisons. Thus, while the definition of the (largest) consistent set in general only guarantees internal stability, our setting actually implies external stability as well.

¹⁷For i and j in N with $i \neq j$, in order for the exports from i to j to be non-negative the condition $3e_j \leq 5e_i$ needs to be satisfied. Thus, the general condition reads:

$$\frac{3}{5} \max\{e_j, e_k\} \leq e_i \leq \frac{5}{3} \min\{e_j, e_k\} \quad \forall i, j, k \in N$$

¹⁸The demand function is derived from a utility function that is additively separable and also quadratic in each non-numeraire good.

where $i, j, k \in N$ are pairwise distinct. In this model, the resulting prices together with the corresponding endowments are the only factors influencing imports and exports. In particular, the level of imports m_i^I of good I to country i is completely determined by the demand function (depending on the price), $m_i^I = d(p_i^I) = \alpha - p_i^I$. The exports x_j^I of good I from country j are the combination of the demand function (or prices) and the corresponding endowment, $x_j^I = e_j - d(p_j^I) = e_j + p_j^I - \alpha$. Now, a market-clearing condition for any good I requires that country i 's import is equal to the total export of the countries j and k (again $i, j, k \in N$ pairwise distinct):

$$(2) \quad m_i^I = x_j^I + x_k^I$$

Ultimately, the objective function of country i is its welfare¹⁹, denoted W_i , which includes Consumer Surplus (CS), "Producer" Surplus (PS), and Tariff Revenue (TR):

$$W_i = \sum_{L \in G} CS_i^L + \sum_{L \in G \setminus \{I\}} PS_i^L + TR_i$$

By using no-arbitrage (1) and market-clearing (2) conditions, we can compute the equilibrium prices:

$$p_i^I = \frac{1}{3} \left(3\alpha - \sum_{j \neq i} e_j + \sum_{j \neq i} t_{ij} \right)$$

As soon as we determine the equilibrium prices, it is possible to calculate imports, exports, and also the welfare of each country up to the value of the tariffs (Appendix B.1). Further note, that the maximisation of welfare with respect to tariffs is going to be restricted depending on the trade agreement under consideration (see Section 2.1). For example in the case of MFN, country i maximises W_i under the restriction that $t_{ij} = t_{ik}$. Therefore, country i aims to maximise its welfare W_i over $(t_{ij}, t_{ik}) \in T_i$ given $(t_{ji}, t_{jk}) \in T_j$ and $(t_{ki}, t_{kj}) \in T_j$, where T_l is the set of possible tariff pairs for country l in a fixed trade agreement.

The full equilibrium of this model is computed as follows. Fix a trade agreement and thereby the restrictions on the tariffs. Compute the best-response functions for each country (with respect to the tariffs) and determine the optimal choices. While Section 2.1 contains all information on the trade agreements that is necessary to compute the equilibria, the actual results are presented in Appendix B.2. Finally, an overview of the (resulting) overall welfare can be found in Appendix B.3.

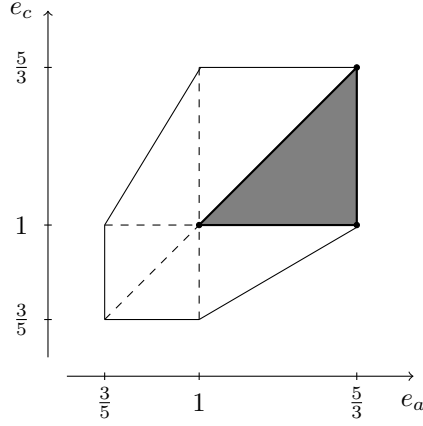
2.5. Algorithm and Parameters. The (additional) explanatory power from the introduction of an extensive set of trade agreements and unlimited farsightedness comes at the cost of a complex computational problem. This problem is solved numerically with the help of an algorithm - the pseudocode of which can be found in Appendix A.²⁰ The parameter space therefore needs to be specified and discretised:

First, recall that the endowments satisfy $\frac{3}{5} \max\{e_j, e_k\} \leq e_i \leq \frac{5}{3} \min\{e_j, e_k\}$ for all $i, j, k \in N$ in order to guarantee the 'competing exporters'-structure, see Section 2.4. Now, without loss of generality, normalise one endowment to one, namely $e_b = 1$. Consequentially, for $i, j \in N \setminus \{b\}$: $e_{\min} := \frac{3}{5} \leq \frac{3}{5} \max\{1, e_j\} \leq e_i$ and $e_i \leq \frac{5}{3} \min\{1, e_j\} \leq \frac{5}{3} =: e_{\max}$. Furthermore, the resulting parameter space, Figure 3, can be split into six right-angled triangles, which are mirror images of one another (in terms of relative endowments). Thus, again without loss of generality, focus on one of them, namely the marked triangle, and then cover it with a grid for the actual computation.²¹

¹⁹In certain cases (depending on the trade agreement) the objective function of a country includes the welfare of other countries as well. See Section 2.1 for the details.

²⁰The authors are grateful to Michael Chwe for the provision of an exemplary algorithm.

²¹The distance is set to 0.0013360053440215 - due to 500 points per dimension of the grid.

FIGURE 3. The parameter space of the endowments with $e_b = 1$

Additionally, to produce plausible results, e.g. positive prices, the factor α needs to be chosen above a minimal value for each tuple of endowments, $\alpha_{\min}(e_a, e_b, e_c)$. Above this minimal value, the results remain unchanged.²² Thus, by taking the maximum over all these minimal values, $\alpha_{\max \min} = \max_{e_a, e_b, e_c} \{\alpha_{\min}(e_a, e_b, e_c)\}$, adding an epsilon, $\alpha = \alpha_{\max \min} + \epsilon$, and using it for all endowments makes sure that all results are plausible and comparable at the same time.²³

3. ANALYSIS

Let us now present the resulting structure of stability among trade policy constellations according to our framework. Figure 4 depicts the parameter space of endowments under consideration - it is the (marked) triangle from before. The analysis starts with the three extreme points, then turns to the connecting intervals, and finishes with the entire interior. In each of these cases, two scenarios are examined. The first scenario corresponds to the current WTO institutional arrangement while the second one assumes modified WTO rules without Article XXIV Paragraph 5, which would prevent the formation of PTAs (specifically CUs and FTAs).

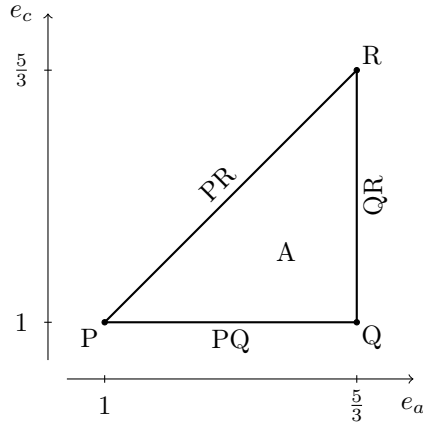


FIGURE 4. Overview of the different points, intervals and areas of interest depending on the (partially normalized) endowment tuple

²²The factor α always enters the welfare of country i as $2\alpha e_i$ (see Appendix B.1). Therefore, any changes above the minimal value leave the welfare levels and therefore the rankings unaffected.

²³In our computation ϵ is simply fixed to 0.01, which yields $\alpha = 1.3988888888888888$.

3.1. Extreme Cases. We start the analysis with three extreme points on the triangle. We devote much of the space to scrutinise the symmetric case, and we thoroughly demonstrate the working of each component of the model. In the other two extreme cases, we present results and provide general overview. Let us start with the symmetric case. The symmetry refers to identical endowments for all countries, i.e. $e_a = e_b = e_c = 1 = e_{\min}$, and corresponds to point P in the triangle of Figure 4. As the countries do not differ from one another, the only thing that matters for welfare is whether a country is an insider or an outsider in a specific trade agreement. In the following, we present the ranking of preferences from the perspective of country a , which represents that of all other countries as well, for fixed $i, j \in N \setminus \{a\}$ with $i \neq j$:

$$\begin{aligned} CU(i, j) \prec_a MFN \prec_a MTA(a, i) \prec_a FTAHub(i) \prec_a FTA(i, j) \prec_a FTA(a, i) \\ \prec_a CU(a, i) \prec_a MTA(i, j) \prec_a GFT \prec_a FTAHub(a) \end{aligned}$$

The case where two countries form a CU is the least favourable trade constellation for the third country. Under such circumstances, the outsider faces the second-highest tariffs (with MFN-tariffs the highest), while the insiders cancel the tariffs among themselves. The exports of country a to the other countries, i and j , are the lowest under CU(i, j) compared to all alternative trade agreements. The same applies to the total imports. In other words, the ‘trade diversion’ effect is the strongest for country a in case of CU(i, j). In general, the MFN regime favours country a when compared to CU(i, j). The tariff revenue remains the same, while the consumer surplus is lower and the producer surplus is higher - the increase offsets the decrease. The MFN regime slackens the ‘trade diversion’ effect present in the case of CU(i, j) by virtue of increased export values of country a .

Among the group of bilateral trade agreements where the country is an insider, the MTAs result in the lowest welfare (for this country). MTA(a, i) itself generates a higher welfare for country a in comparison with the MFN regime on the grounds of increased consumer and producer surplus. The FTAHub(i) constellation results in even further gains in welfare for country a through higher export values and producer surplus accordingly (the tariff revenue and also the consumer surplus are lower under FTAHub(i) compared to MTA(a, i) though). However, country a does not have an incentive to remain in this constellation. The unilateral deviation from FTAHub(i) to FTA(i, j) comes with a decrease of consumer and producer surplus but enough increase in tariff revenue to ultimately ensure higher welfare under the latter constellation. Nonetheless, among FTAs being an outsider is less desirable than being an insider for any country. The drop in tariff revenue is offset by an expansion of the consumer and producer surplus, resulting in higher welfare for country a in case of FTA(a, i) compared to FTA(i, j). As an insider, country a prefers CU(a, i) over FTA(a, i) though. More precisely, in spite of the decline in the consumer surplus, the actual welfare goes up through an expansion of tariff revenue and producer surplus.

The formation of MTA(i, j) guarantees the highest welfare for country a compared to any other bilateral trade agreement. The driving factor is the MFN-principle, which implies that in case of MTA(i, j) the insiders need to apply the same tariff to both each other and the outsider - a form of free-rider problem. At the same time, country a attains the highest possible tariff revenue.

Each country obtains the second-highest welfare level when the world reaches global free trade. Under full trade liberalisation, the producer surplus is also the second-highest among all trade agreements (effectively driving the ranking). It is only surpassed by that of FTAHub(a). The latter constellation brings about the highest possible welfare for country a . But note that such a trade agreement disproportionately favours the hub country over the other countries.

Countries’ strong preference rankings are the crucial ingredient for computing the LCS. In fact, for each country all three variants of global free trade are ranked as second-best option while each first-best

option, a hub structure, is ranked considerably lower for the other countries. Intuitively, global free trade seems like a stable compromise. The following proposition and its proof reinforce this:

Proposition 3. *Under symmetry and with the current institutional arrangement of the WTO, the LCS contains three elements: CUGFT, FTAGFT, and MTAGFT. In other words, (the trinity of) global free trade is the unique stable outcome.*

Proof. Based on the definition of indirect dominance and the transition graphs, see Section 2.3 and 2.2, the preference rankings from earlier allow us to derive the indirect dominance matrix. If the entry in the matrix is equal to one (resp. zero), then the trade arrangement corresponding to the row of the entry is (resp. isn't) indirectly dominated by the one corresponding to the column of the entry. For example, $FTAHub(a)$ is indirectly dominated by $CUGFT$ as there exists a (finite) sequence of outcomes and coalitions such that all coalitions in the sequence prefer the final outcome over the current one:

$$FTAHub(a) \rightarrow_{\{b,c\}} CU(b,c) \rightarrow_{\{a,b,c\}} CUGFT$$

Checking for all possible sequences yields the following indirect dominance matrix:²⁴

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 MFN	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2 $CU(a,b)$	0	0	0	0	1	0	0	0	1	1	0	1	0	1	1	1
3 $CU(b,c)$	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	1
4 $CU(c,a)$	0	0	0	0	1	0	0	0	1	0	1	1	1	1	0	1
5 $CUGFT$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 $FTA(a,b)$	0	1	1	1	1	0	0	0	1	1	0	1	0	1	1	1
7 $FTA(b,c)$	0	1	1	1	1	0	0	0	0	1	1	1	1	0	1	1
8 $FTA(c,a)$	0	1	1	1	1	0	0	0	1	0	1	1	1	1	0	1
9 $FTAHub(a)$	0	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1
10 $FTAHub(b)$	0	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1
11 $FTAHub(c)$	0	1	1	1	1	1	1	1	0	0	0	1	0	0	0	1
12 $FTAGFT$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 $MTA(a,b)$	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
14 $MTA(b,c)$	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
15 $MTA(c,a)$	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
16 $MTAGFT$	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0

Note that intuitively any outcome is stable if all deviations from it are deterred. Also, a deviation from the outcome is hindered if there is a stable outcome which might be reached and some member of the deviating coalition does not prefer it over the initial outcome. In the following procedure, start with the full set and then keep removing elements that are unstable until the remaining ones are stable

Take $x \in \{MFN, FTA(i,j), CU(i,j), MTA(i,j)\}$, where $i, j \in N$ with $i \neq j$, and then consider the joint deviation $x \rightarrow_{\{a,b,c\}} FTAGFT$. The $FTAGFT$ regime is not indirectly dominated by any other outcome (see the matrix above) and also $x \prec_{\{a,b,c\}} FTAGFT$ for each of those x . Thus the deviation $x \rightarrow_{\{a,b,c\}} FTAGFT$ cannot be deterred and therefore no such x can be part of the stable set.

Consider $FTAHub(i)$, $i \in N$, and the deviation $FTAHub(i) \rightarrow_{\{j,k\}} FTAGFT$, $j, k \in N \setminus \{i\}$ with $j \neq k$. Using $FTAHub(i) \prec_{\{j,k\}} FTAGFT$ together with the logic from before eliminates $FTAHub(i)$ for each $i \in N$.

Focus on the set of remaining elements $Y = \{CUGFT, FTAGFT, MTAGFT\}$. Start with any element y in Y . If there is a deviation to any element $x \in X \setminus Y$, then there always exists an indirect dominance path (see indirect dominance matrix) $x \ll y'$ coming back to an element $y' \in Y$. In addition, for any

²⁴Appendix A contains the pseudocode for this procedure.

$y_1, y_2 \in Y$, $y_1 \neq y_2$, there does not exist a coalition $S \subseteq N$, $S \neq \emptyset$, for which $y_1 \prec_S y_2$. Thus, the set Y satisfies the (internal) stability condition while being maximal, i.e. $Y = LCS$. \square

In the symmetric case, under the current institutional arrangement of the WTO, the global free trade variations appear as the only stable constellation according to our framework. But what would happen without Article XXIV? In this case, countries would not have the option to liberalise trade through the formation of CUs or FTAs - leaving MTAs as the only possibility. The representative preference ranking of country a would look as follows:

$$MFN \prec_a MTA(a, i) \prec_a MTA(i, j) \prec_a MTAGFT$$

Each country achieves the peak welfare under MTAGFT. Thus, it is reasonable to conjecture stability of MTAGFT. The following proposition proves this intuition:

Proposition 4. *Under symmetry and with the modified institutional arrangement of the WTO (no PTAs), the LCS contains one element: MTAGFT. In other words, global free trade is the unique stable outcome.*

Proof. The indirect dominance matrix is derived as before:

$$\begin{array}{c} 1 \text{ } MFN \\ 2 \text{ } MTA(a, b) \\ 3 \text{ } MTA(b, c) \\ 4 \text{ } MTA(c, a) \\ 5 \text{ } MTAGFT \end{array} \begin{pmatrix} 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Let us start with the full set of trade agreements again (limited to the setting). If the grand coalition moves from MFN to $MTAGFT$, then the only possibility is to stay there, as $MTAGFT$ is not indirectly dominated by any other outcome. Moreover, $MFN \prec_{a,b,c} MTAGFT$. Thus, MFN cannot be stable. Furthermore, if the grand coalition moves from any bilateral MTA regime to $GFTMTA$, by the same argument, it is clear that no bilateral MTA can be stable. Finally, any deviation from $MTAGFT$ will come back to itself due to the indirect dominance. Consequentially, the set $Y = \{MTAGFT\}$ is consistent and also the largest one. \square

If symmetry among all countries holds, then Article XXIV does not change anything in terms of stability and corresponding welfare, both individual and overall. The only stable trade constellation is (the trinity of) global free trade.

Now we turn to the analysis of the asymmetric case by considering its two extreme cases, which correspond to the points Q and R in the triangle of Figure 4.

First, consider the case of two small and one large country. In this scenario, fix $e_a = e_{max}$ and $e_b = e_c = e_{min}$ (point Q). Let us start with the ranking of preferences for country a and another country $i \in N \setminus \{a\}$ - representing also $j \in N \setminus \{a, i\}$:

$$\begin{aligned} CU(i, j), FTA(i, j) &\prec_a FTAHub(i) \prec_a MFN, MTA(i, j) \prec_a FTA(a, i) \\ &\prec_a MTA(a, i) \prec_a CU(a, i) \prec_a GFT, FTAHub(a) \\ MTA(a, i) &\prec_i GFT, FTAHub(a) \prec_i CU(a, i) \prec_i FTA(a, i) \prec_i CU(a, j) \\ &\prec_i MFN, MTA(i, j) \prec_i FTAHub(i) \prec_i FTA(a, j) \prec_i MTA(a, j) \\ &\prec_i FTAHub(j) \prec_i CU(i, j), FTA(i, j) \end{aligned}$$

One immediately notices that small and large countries have different rankings. A large country profoundly dislikes the scenarios where it is an outsider; while the small countries, by contrast, dislike

any trade arrangements with the large country. Note that in certain cases countries actually do not differentiate between different trade constellations.²⁵ For example, $CU(i,j)$ and $FTA(i,j)$ result in same welfare for all countries. In this case, under the given pattern of endowments, the optimal tariffs of the small countries for CU and FTA are above the MFN-tariff. However, the Sub-paragraphs of Article XXIV Article 5 rule this out and therefore the tariffs are capped at the MFN-level. A similar argument applies to the case of $FTAHub(a)$. Here, the optimal tariffs of the small countries would be negative. By restricting tariffs from below by zero implies that $FTAHub(a)$ corresponds to GFT, or rather a Pseudo-GFT. Finally, the MTA between the small countries actually coincides with the MFN regime because of identical optimal tariffs for both cases.

Using the preference rankings to derive the LCS yields the following proposition:

Proposition 5. *With the endowments given by $e_a = e_{max}$ and $e_b = e_c = e_{min}$, and under the current institutional arrangement of the WTO, the stable constellations are the PTAs between the two small countries, that is $CU(b,c)$ and $FTA(b,c)$.*

Even though global free trade is the most desirable regime for the large country, the two small countries do not have any incentive to form such a constellation and the large country can not enforce it. As a consequence, country a ends up with the worst trade agreement (from its perspective). Thus, in this scenario the size advantage of the large country does not translate into a favourable stable regime. Moreover, this specific case showcases the relevance of the restrictions on PTAs (remember that insiders are not allowed to raise tariffs on outsiders). The constraint makes the small countries be indifferent between the two forms of PTAs.

Now we turn to the hypothetical scenario without Article XXIV Paragraph 5. Here, the ranking of preferences for the countries, with country a the large one and country b and c small (represented by i and j), are as follows:

$$MTA(i,j), MFN \prec_a MTA(a,i) \prec_a GFT$$

$$MTA(a,i) \prec_i MTA(a,j) \prec_i MTA(i,j) \prec_i MFN, MTA(i,j) \prec_i MTA(a,j)$$

As a result, the best outcome for a small country i is the $MTA(i,j)$ regime, as the PTAs are not available anymore. The next proposition presents the new LCS as a consequence of these changes:

Proposition 6. *With the endowments given by $e_a = e_{max}$ and $e_b = e_c = e_{min}$, and under a modified institutional arrangement of the WTO, the stable constellations are MFN and $MTA(b,c)$.*

In summary, when there are two small and one large country, the GFT regime is unstable under the current and hypothetical institutional set-up of the WTO. At best, world trade can be partially liberalised. Additionally, the small countries profit when they can form a PTA instead of an MTA, as the limiting MFN principle can be avoided that way.

Finally, we consider the case of one small and two large countries, another example of extreme asymmetry in the space of endowments. Fix $e_b = e_{min}$ and $e_a = e_c = e_{max}$ (point R). Let us start with the ranking of preferences for country b and another country $i \in N \setminus \{b\}$ - representing also $j \in N \setminus \{b, i\}$:

$$GFT \prec_b CU(i,b) \prec_b FTAHub(i) \prec_b FTA(i,b) \prec_b FTAHub(b) \prec_b MTA(i,b)$$

$$\prec_b MFN \prec_b CU(i,j) \prec_b MTA(i,j) \prec_b FTA(i,j)$$

²⁵Additional details on this can be found in Appendix B.2 and Appendix B.5.1.

$$\begin{aligned}
CU(j, b) \prec_i FTA(j, b) \prec_i MFN \prec_i MTA(i, b), MTA(j, b) \prec_i FTA(i, j) \\
\prec_i MTA(i, j) \prec_i CU(i, j) \prec_i FTAHub(b) \prec_i FTAHub(j) \prec_i GFT \\
\prec_i FTAHub(i) \prec_i FTA(i, b) \prec_i CU(i, b)
\end{aligned}$$

Under the given pattern of endowments, the preference rankings of the countries are considerably different from the previous cases. For the small country, the MFN regime generates higher welfare than any other trade agreement where it is part of. As for a large country, being an outsider is on the lower end of the ranking, while being an insider in a PTA with a small country is on the other end.

Let us compute the LCS under these preference rankings in the next proposition:

Proposition 7. *With the endowments given by $e_b = e_{min}$ and $e_a = e_c = e_{max}$, and under the current institutional arrangement of the WTO, the stable constellation is the CU between the two large countries, that is $CU(c, a)$.*

The small country manages to block many desirable outcomes for large countries. Country b can unilaterally deviate from any trade agreement with higher welfare than $CU(i, j)$ for the large countries. Thus, the majority of countries cannot impose their will on the other country. What the large countries can achieve is the best trade agreement that they can reach without the participation of the small country, in this case one among themselves.

A similar story unfolds in the scenario without Article XXIV Paragraph 5. There, the countries' preference rankings are as follows, with country b the small one and country a and c large (represented by i and j):

$$\begin{aligned}
MTAGFT \prec_b MTA(i, b) \prec_b MFN \prec_b MTA(i, j) \\
MFN \prec_i MTA(i, b), MTA(j, b) \prec_i MTA(i, j) \prec_i MTAGFT
\end{aligned}$$

As the logic of the corresponding preference rankings of the countries is similar to before, let us directly present the proposition:

Proposition 8. *With the endowments given by $e_b = e_{min}$ and $e_a = e_c = e_{max}$, and under a modified institutional arrangement of the WTO, the stable constellation is the MTA between the two large countries, that is $MTA(c, a)$.*

Similar to the other asymmetric case, one small and two large countries allow for partial but not full liberalisation of world trade irrespective of the actual scenario (current vs. modified WTO rules). In terms of overall welfare, the world is better off in the hypothetical scenario without Article XXIV Paragraph 5 though. Individually, the small country is in a better position in case of $MTA(i, j)$ compared to $CU(i, j)$, as it exploits the MFN obligation of the large countries. By contrast, the large countries are better off in the other case. Therefore, while none of the two institutional arrangement facilitate global free trade, they influence the welfare for the stable set (both overall and individual).

3.2. Asymmetric Case - Edges of the Triangle. Let us now turn to the cases where the endowments of countries vary along one dimension - corresponding to the sides PQ, QR, and PR in the triangle of Figure 4. The analysis presented here consists of graphics picturing the composition of the stable sets and accompanying descriptions that explore the underlying mechanics. The exact numerical values for these (sub-)intervals can be found in Section C.2. In order to get an intuitive understanding of the results, we identify specific trade agreements that go from stable to unstable (or the other way around) for certain endowment tuples. Then, we explore the underlying mechanics to understand why the changes happen.

3.2.1. *The case of two small, and one varying country.* First, let us consider the scenario with $e_b = e_c = e_{min}$ and $e_a \in (e_{min}, e_{max})$ (side PQ). In this case, it is possible to rule out some of the trade policy arrangements. For example, MFN, FTAHub(a), and MTA(b,c) never appear in the LCS. The stable set is then presented in Figure 5.²⁶

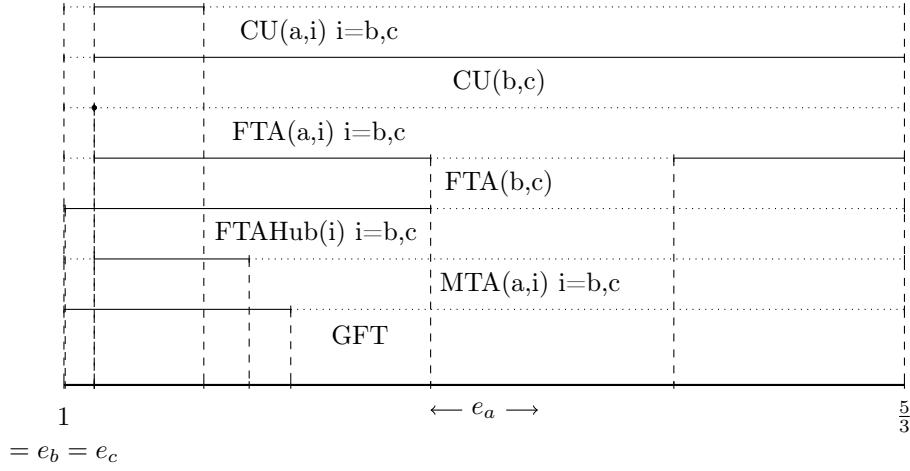


FIGURE 5. Characterisation of the case of small, small, and varying country

In the immediate vicinity around symmetry, the GFT regime is the only element of the LCS (or rather the group of the three variants forms the stable set), but both FTAHub(b) and FTAHub(c) emerge as stable outcomes when moving away from the extreme point. On the whole interval a number of different PTAs and MTAs, mostly between a small and the larger country, appear. Near the other point, only PTAs among the small countries are still stable.

First, the spike in the number of stable constellations close to symmetry actually follows a change in the preferences of the varying country with respect to CU(b,c) and the GFT regimes - it starts preferring the first over the latter. Furthermore, FTA(a,b) and FTA(c,a) become unstable because the small countries start to like the MFN regime more than the GFT variants (or rather these are only stable for that instance where it is not the case). When country a gets sufficiently large, country b prefers FTAHub(c) over CU(a,b) and c prefers FTAHub(b) over CU(c,a). As a consequence, both of these CUs drop out from the LCS. Similarly, when country b and c start preferring FTAHub(c) and FTAHub(b) over GFT, the latter stops being stable. A similar argument also applies to the MTAs. When the size of country a increases even more, both country b and c favour CU(b,c) over their respective hub structure, which results in FTA(b,c), FTAHub(b), and FTAHub(c) becoming unstable. When the endowment of country a gets close to maximum, the small countries are constrained by the MFN-tariffs and do not differentiate between CU(b,c) and FTA(b,c) anymore, which makes FTA(b,c) stable again.

In the scenario without Article XXIV Paragraph 5, the interval of GFT increases significantly. Moreover, over two-thirds of this interval the GFT regime is the unique element in the LCS. Additionally, all possible combinations of MTA appear at some point (mostly close to symmetry). Figure 6 demonstrates the results.²⁷

Around symmetry, GFTMTA is the only element in the stable set. As soon as the small countries start to prefer MTAs with country a over GFTMTA, all three MTAs appear in the LCS. When the size of country a increases, the MTAs drop out from the LCS, because the small countries rank the

²⁶The dot marks a single point again.

²⁷As before, in addition to the mentioned trade agreements, the graphic also contains MFN as a single point, see the dot, at an extreme point (again point Q).

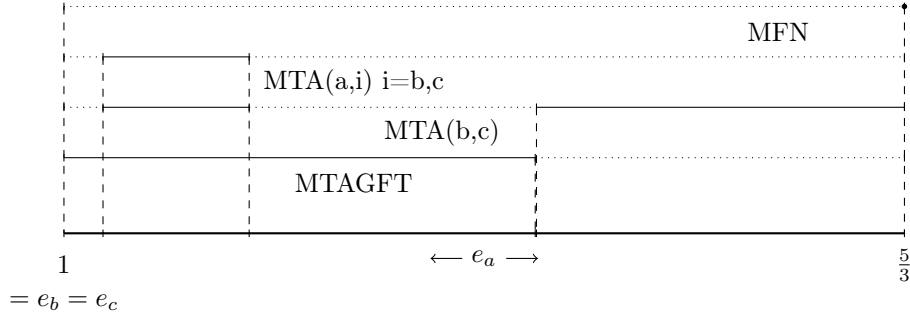


FIGURE 6. Characterisation of the case of small, small, and varying country

one with the large country as the worst trade agreements (switching last place with the MFN regime), which actually also influences the stability of the MTA among themselves. Furthermore, the GFT regime becomes unstable when the small countries start to prefer their joint MTA over GFTMTA.

To conclude, the effect of the PTAs on the stability of the GFT regime is significant - essentially the abolishment of Article XXIV Paragraph 5 would facilitate the formation of GFT as long as there are two small countries and the third country is not substantially larger.

3.2.2. The case of one small, and two varying countries. Now, let us turn to the case where $e_b = e_{min}$ and $e_a = e_c \in (e_{min}, e_{max})$ (side PR). In this scenario, depending on the size of the larger countries, any trade agreement can be part of the stable set. The exact composition of the LCS is the basis for Figure 7.

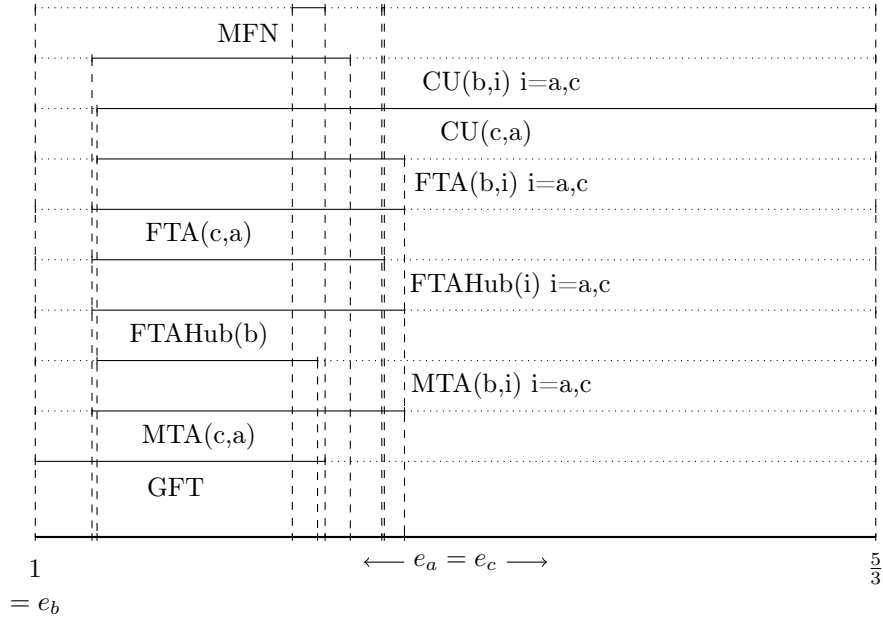


FIGURE 7. Characterisation of the case of small, varying, and varying country

In the interval around symmetry, the GFT variants are stable and stay the unique elements of the stable set for longer (compared to the previous case). Also, a collection of different trade agreements is stable relatively close to symmetry. However, near the other extreme point, the CUs between the varying countries is the unique stable outcome. Also, MFN is stable in two small, separated, regions.

Again, the peak in stability near symmetry comes from a shift in the preferences of the varying countries with respect to CUs. At that point, both of these start to prefer a CU with the small country over the

different forms of GFT. The occurrence of the MFN regime actually follows a preference of the small country of MFN over GFT (the first region) and then FTAHub(a) and FTAHub(c) (the second region). As countries a and c are getting bigger, first MTA(a,b) and MTA(b,c) drop out from the LCS when they rank the lowest according to the preferences of country b . The three variants of GFT become unstable once the small country prefers CU(c,a). Next, CU(a,b) and CU(b,c) follow as the small country starts to prefer to be in the MFN regime over a CU with any of the larger countries. As soon as CU(c,a) becomes the more desirable trade agreement for country b when comparing it to any FTA where b participates or any hub structure with a large country as hub, all aforementioned constellations drop out from the LCS.

Contrary to the previous case, switching off Article XXIV Paragraph 5, actually decreases the interval where the GFT regime is part of the stable set. However, this effect is considerably smaller. A similar observation holds for the range where the GFT regime is the unique stable outcome. The exact composition can be seen in Figure 8.

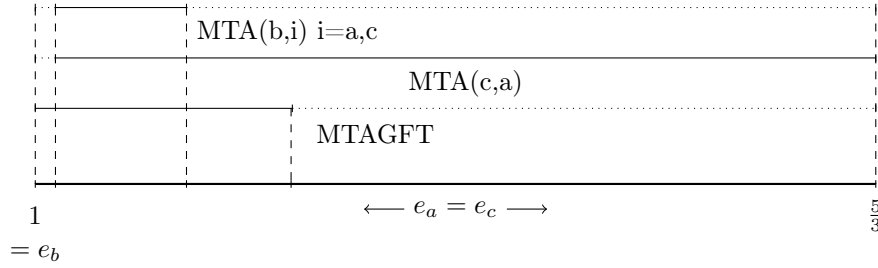


FIGURE 8. Characterisation of the case of small, varying, and varying country

The main driving force behind the stability are alterations in the preferences of the small country over the interval. More precisely, it is important where exactly the small country places the MFN regime in its ranking of preferences compared to the other trade agreements. As soon as country b prefers MFN over another constellation, the latter drops out from the LCS. After a certain point, the MTA between the large countries remains the only stable outcome.

Similar to the previous pattern of endowments, this case makes a clear analysis in the first scenario difficult, especially around symmetry where, as before, almost all constellations are stable. The effect of Article XXIV Paragraph 5 actually works in the other direction on the stability of the GFT regime when compared to the previous case though.

Before moving to the analysis of the last edge of the triangle, it is worth pause and try to understand the role that the farsightedness play in the determination of the stable trade policy arrangements. Literature does not allow the full comparison of the results due to differences in the choice of trade policy arrangements analysed. But in specific cases it is actually possible to directly compare the composition of the stable sets of the paper with those of Saggi, Woodland and Yildiz (2013) for example. In fact, their ‘multilateralism game’ fits our scenario of a modified institutional arrangement without PTAs. Compare Figures 2 and 5 of Saggi, Woodland, and Yildiz (2013) with Figures 8 and 6 in our work correspondingly. In the case with one small country and the other two varying, both approaches predict the same stable sets near the endpoints of the interval. In our work GFT stays part of the stable set even when MTAs, either between the large countries or a small and a large country, become stable as well - which is in contrast to Saggi, Woodland, and Yildiz (2013). A similar observation follows for the case of two small and one varying country, i.e. near the endpoints of the interval results coincide while the appearance of MTAs does not prevent GFT from staying in the stable set. Furthermore, in our model there exists an interval where GFT becomes the unique stable element once more. It seems that one effect of the unlimited farsightedness is the proliferation of GFT.

More details can be added here!

3.2.3. The case of one small, one large, and one varying country. Finally, let us consider the case $e_b = e_{min}$, $e_a = e_{max}$, and $e_c \in (e_{min}, e_{max})$ (side QR). Under the given pattern of the endowments, a number of trade agreements can be completely ruled out (with respect to the LCS). The MFN and GFT regimes for example are never part of the stable set. Additionally, none of the PTAs between the small and the large country appear as a stable outcome. The same holds for the hub structures where either the small or the large country is the hub node. As for the actual composition of the LCS, see Figure 9 for a graphical representation.

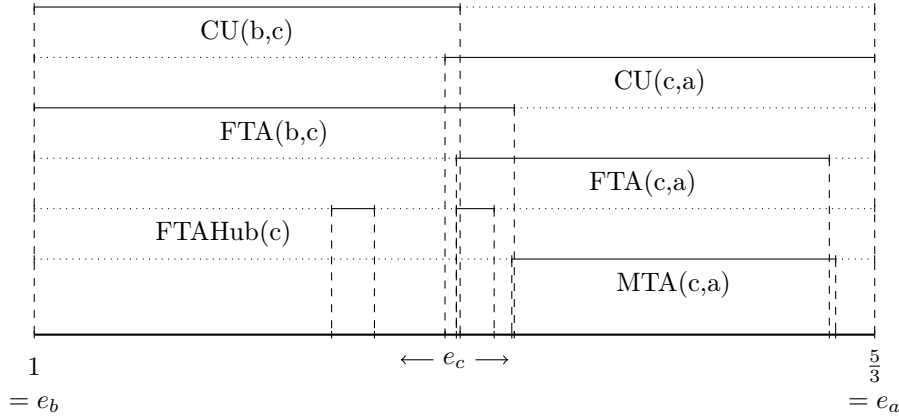


FIGURE 9. Characterisation of the case of small, varying, and large country

The general observation is that when the varying country is close in size to the small country, then the PTAs between these smaller countries appear as elements in the stable set. When the country becomes larger the trade constellation between the larger countries replaces these. Additionally, there are two small, separated, regions in the middle of the interval where $FTAHub(c)$ is stable.

Start with the PTAs between country b and c , the small and the varying one. Interestingly, the only factor driving their stability are the preferences of country b (with fixed minimal endowments). Once the MFN regime becomes more desirable than $CU(b,c)$ for country b , the constellation $CU(b,c)$ drops from the stable set. Now, an identical story holds for the case of $FTA(b,c)$. Thus, for both constellations it only requires a single change in the preference ranking of country b to influence the stable set.

The PTAs and MTAs between country a and c start to appear in the LCS when country c is becoming relatively large and closer to country a in size. At first both countries actually prefer to form a CU with country b , that is when country c is relatively small (and $CU(b,c)$ actually is an element in the stable set). However, once it is preferable for country b to be the outsider instead of the insider in a CU, $CU(c,a)$ emerges as a stable outcome (even though $CU(b,c)$ still remains stable). Moreover, as soon as country c prefers $FTA(c,a)$ respectively $MTA(c,a)$ over the MFN regime, each of them becomes part of the LCS as well. For the interval where all PTAs and MTAs between country a and c are stable, both countries have fixed preference relations over these outcomes:

$$FTA(c,a) \prec_a CU(c,a) \prec_a MTA(c,a)$$

$$MTA(c,a) \prec_c FTA(c,a) \prec_c CU(c,a)$$

However, as soon as country c also prefers $MTA(c,a)$ over $FTA(c,a)$, the joint FTA drops out of the LCS. Similarly, as soon as country a prefers $CU(c,a)$ over $MTA(c,a)$, this also applies to the joint MTA - leaving $CU(c,a)$ as the only stable outcome.

FTAHub(c) is stable in the two small, separated, regions in (or near) the middle of the interval. In the first region, the stability is driven by the fact that country b starts to value FTAHub(c) more than FTA(b,c) and gets in unison with country a in this respect. Once the preferences of country b over these outcomes get reversed, FTAHub(c) drops out of LCS again. In the second region, the stability of the same hub structure is largely determined by the change in the preferences of country c . Now, as soon as it starts to value FTA(c,a) over the MFN regime, which also puts FTA(c,a) in the LCS, both FTAs with c as a partner are stable and consequentially the corresponding hub structure is stable as well. As soon as the free-riding incentives of country b increase (valuing the MFN regime more than FTAHub(c)), this hub structure is not part of the stable set anymore.

The hypothetical institutional arrangement without Article XXIV Paragraph 5 does not promote the appearance of GFT as part of the stable set. GFTMTA, but also MTA(a,b) and MTA(b,c) never emerge as stable outcomes. Varying the size of country c generates either the MFN regime or MTA(c,a) as the stable element. Figure 10 presents these findings.²⁸

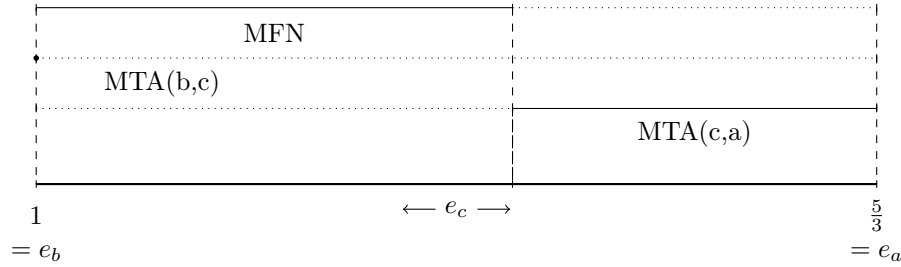


FIGURE 10. Characterisation of the case of small, varying, and large country

Over the whole interval, country b does not have any incentive to form an MTA with any of the other countries. This is one reason why the MFN regime is stable over the specific range of the interval. The other reason is that country c prefers to not have a trade agreement with country a as long as its own size is not too large. Once country c gets sufficiently large though, MTA(c,a) presents a better option than the MFN regime. As a consequence, MTA(c,a) replaces the MFN regime as the stable set.

As a side note, while in the first scenario (with PTAs), the LCS near and at each respective extreme point corresponded to each other (continuity), the situation is different in the second scenario (without PTAs). When country c and b are equal in size, MTA(b,c) appears in the LCS even though it is not there before. Here, both the MFN regime and MTA(b,c) generate the same welfares for all countries (see also the discussion on point Q in Section ??).

Finally, under this given pattern of endowments, the GFT regime does not appear as part of the stable set independent of the scenario (with and without PTAs). However, the choice of rules does determine whether partial trade liberalisation takes place or not. The possibility of forming PTAs reduces the incentive of the small(est) country to free ride. Otherwise, the MFN regime is the unique stable outcome when there is one small, one large, and one comparably small country.

3.3. Asymmetric Case - Interior of the Triangle. In the following (and final) part of the analysis, the focus lies on the interior of the triangle of Figure 4. Here, unlike in the previous discussions, both CU and FTA appear together under the label of PTA. However, a variation of the graphics of this analysis that actually distinguishes between the two can be found in Appendix C.1. For the purpose of a general overview, this level of abstraction suffices though - in fact, the members of a specific trade agreement are suppressed for clarity as well, i.e. who is insider and outsider.

²⁸In addition to the aforementioned elements, it also pictures MTA(b,c) as a single point, see the dot, but this appears only for completion sake because that point corresponds to one of the extreme cases (point Q) discussed earlier.

First, we consider the existing institutional set-up, where PTAs are available to the countries. Figure 11 shows the (simplified) stable sets. In a small region close to symmetry, region one, the trinity of GFT regimes is the unique stable element. In both a neighbouring and another distant area, region two, PTAs become stable as well. The connecting area, region three, adds MTAs as another stable element. In a tiny area near the diagonal, region four, no form of trade agreement can actually be excluded from the stable set. Further along the diagonal and in the asymmetric corners, region five, PTAs are the only stable trade constellation. In between, region six, MTAs are also stable. In another tiny area, also close to the diagonal, region seven, MFN enters the stable set as well. In general, with a certain degree of asymmetry among countries at most partial trade liberalisation can be expected.

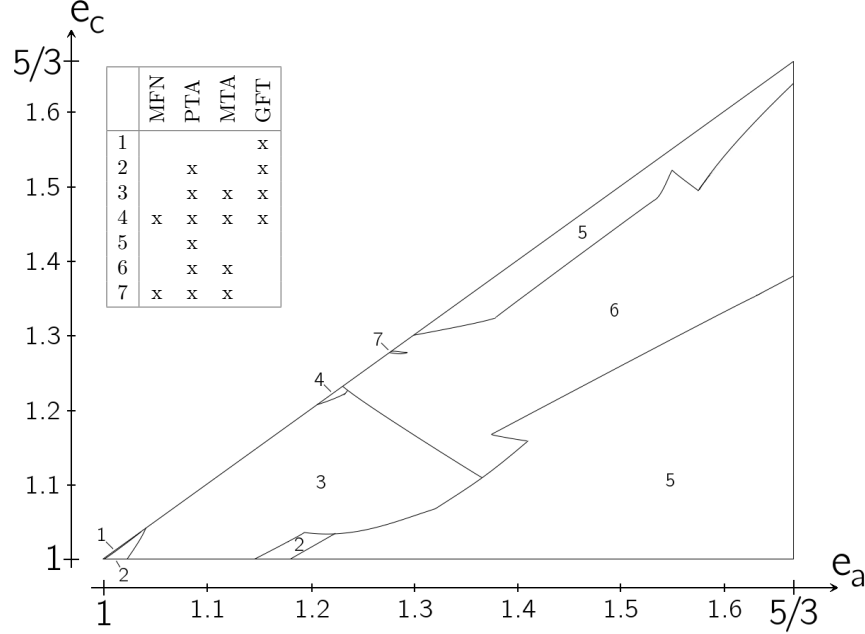


FIGURE 11. Simplified Overall Stability with PTAs

Next, we consider a modified institutional set-up, where PTAs are not available. Figure 12 depicts the corresponding stable sets. In an area near symmetry as well as in a sizeable area away from it, region one, GFT is again the unique stable element. Connected to these are two areas, region two, where MTAs become stable as well. Moving towards the asymmetric corners, region three, yields MTAs as the only stable element. In between, region four, only MFN remains in the stable set.

The comparison of the graphics allows us to deduce two compelling statements. The first noteworthy result is the extent of MFN in each scenario. In the modified institutional arrangement without PTAs the area where MFN is (uniquely) stable increases substantially (note that this effect is present away from symmetry). Under (significant) asymmetry, it seems that PTAs allow countries to move towards their international efficiency frontier (cf. Bagwell et al. (2016)).

The second interesting result is the difference in the extent of stability of GFT in the two regulatory scenarios. First, recall that once the degree of asymmetry surpasses a certain threshold, none of the GFT regimes remains in the stable set, independent of the institutional set-up. Around symmetry the opposite holds in that the GFT regimes are always stable there (in both scenarios). In between, the effect of PTAs on the stability of GFT depends on the structure of asymmetry. See Figure 13 for the different areas of stability depending on the regulatory scenario. Note that region one corresponds to the aforementioned stability around symmetry. In the case of two relatively larger countries (but not too

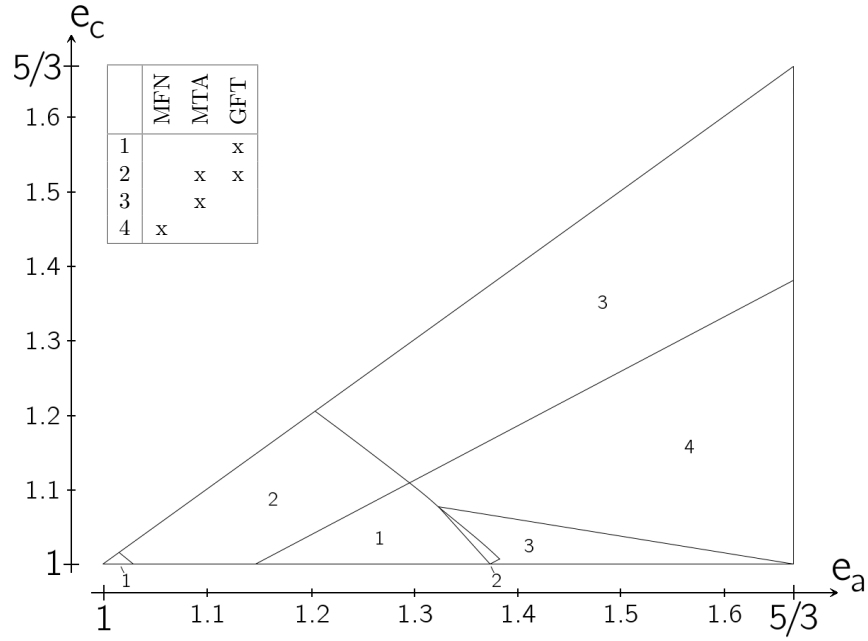


FIGURE 12. Simplified Overall Stability without PTAs

large), the abolishment of PTAs results in a reduction of the area where GFT is stable, see region two. In this instance, PTAs act as ‘building blocks’ on the road to GFT. But when two countries are relatively smaller (but not too small), the same regulatory action yields the exact opposite effect, see region three. Here, PTAs are ‘stumbling blocks’. Thus, whether PTAs are ‘building blocks’ or ‘stumbling blocks’ in the vicinity of symmetry depends on the relative size of the majority of the countries.

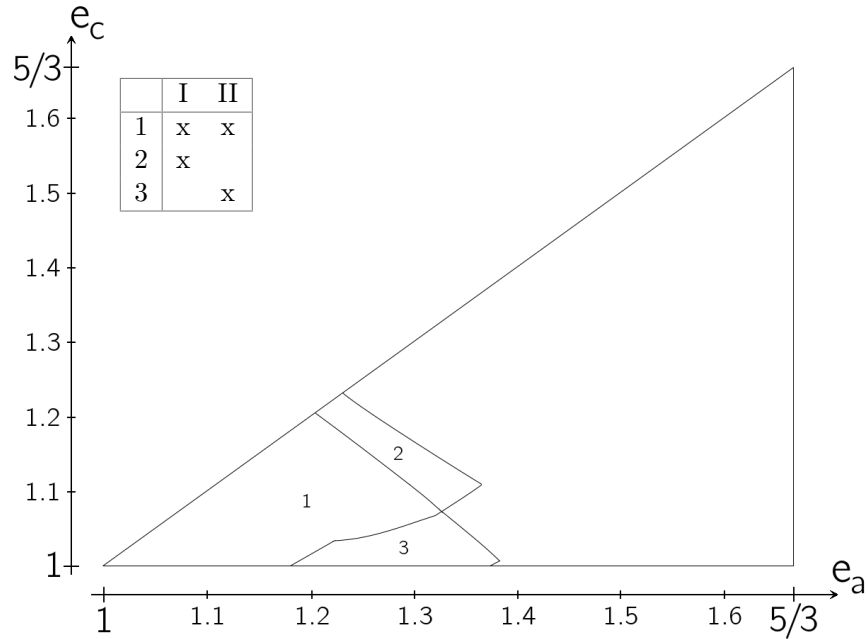
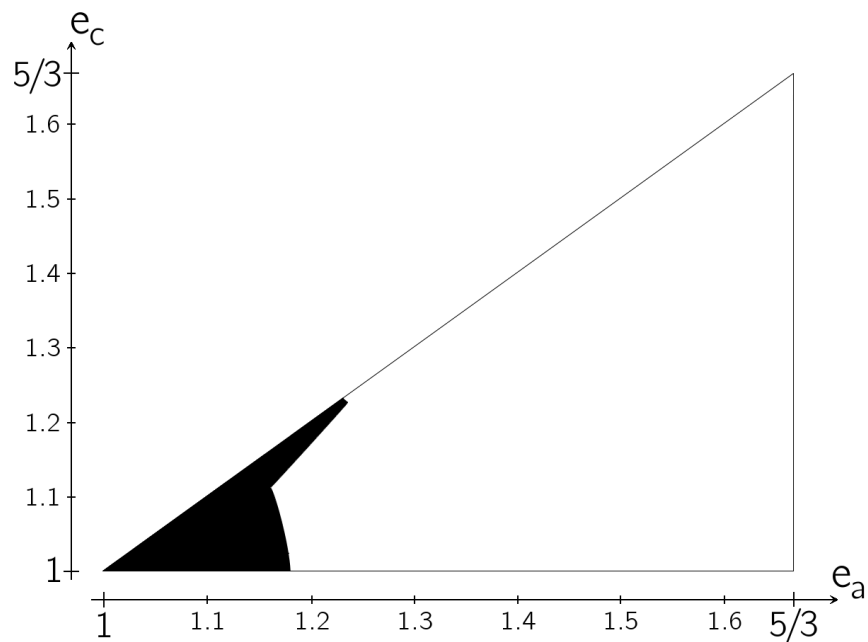
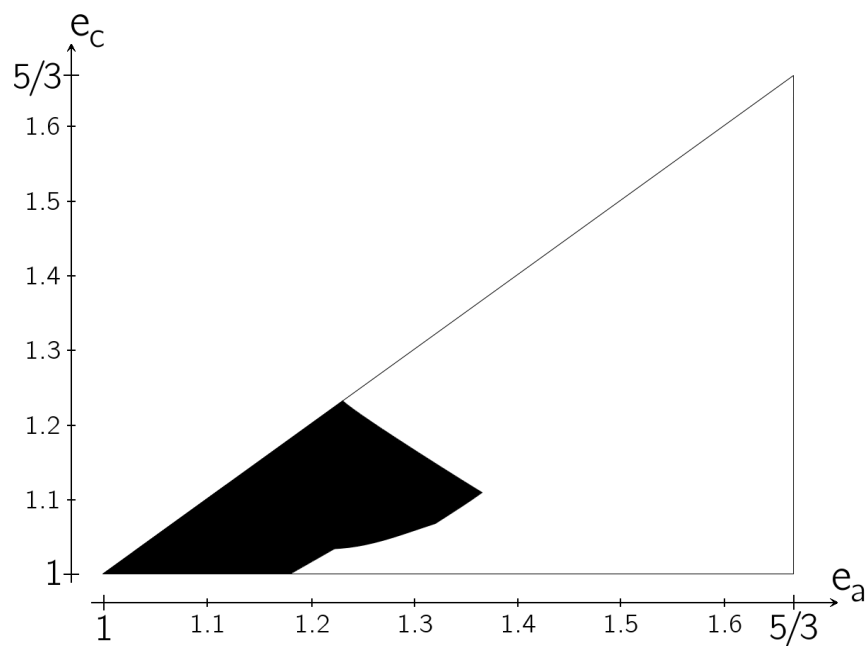


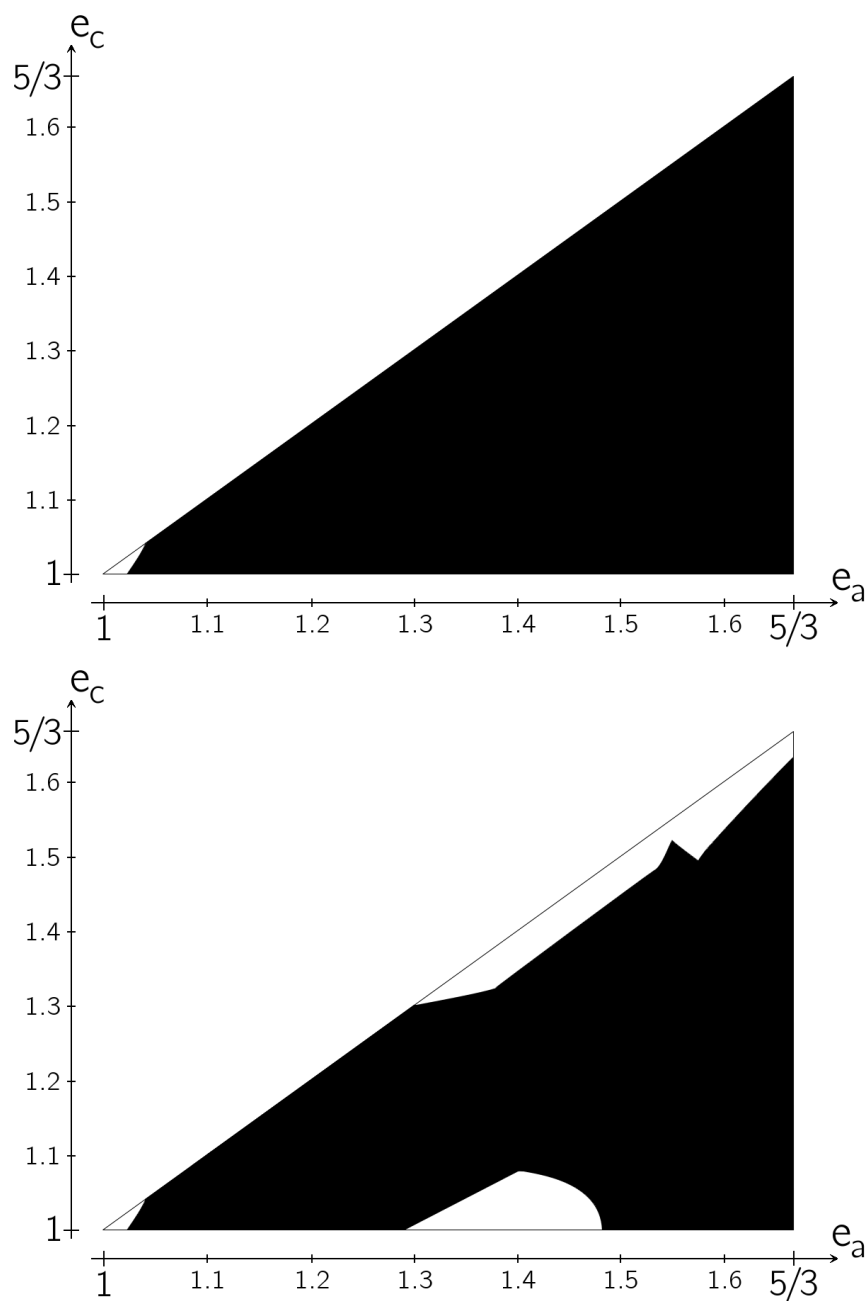
FIGURE 13. The different areas of stability of the GFT regime in the scenario with (I) and without (II) PTAs

We can go one step further and ask - whenever PTAs are conducive to global free trade, which form of PTA is responsible for the result? The next figure sheds light on the question.



Discussion of the role of CUs should follow in the context of CUGFT.

With these graphs, we take into consideration one of Lake's comments. We can go further and discuss FTA vs PTA in the context of bilateral agreements. Then the following graphs matter as well:



In a nutshell: If the world is in the vicinity of symmetry and two out of three countries are close to identical while relatively smaller than the other one, the area where the GFT regime is stable increases when prohibiting PTAs. However, when two similar countries are relatively larger, the availability of PTAs is conducive to the stability of the GFT regime. Finally, if the world is further away from symmetry, full trade liberalisation is not attainable at all and an area where the MFN regime is stable appears in the scenario without PTAs.

4. DISCUSSION

I think we do not need this part. Some of the text should be added to introduction, discussion of the real life examples. Some part of it I have already put where we discuss the edges. That part should be extended as well

5. CONCLUSION

Under the rules of the WTO (previously GATT), a group of countries can engage in both multilateral and preferential trade liberalisation. The formation of global trade agreements is a complex game and the rules of the game influence the nature of the exact outcomes. WTO's Article I aims at creating the global free trade system, while Article XXIV Paragraph 5 allows countries to seemingly circumvent the liberalisation process. In the paper, our focus lies on the stability of trade policy arrangements under two different regulatory scenarios (with and without PTAs) assuming unlimited farsightedness of the participants in the trade negotiations and considering an extensive set of trade agreements - moving our model closer to reality.

Unfortunately, the answer to the question whether PTAs are 'building blocks' or 'stumbling blocks' on the path towards global free trade is not as straightforward as one would like it to be. In the end, the results presented here are mixed and depend on the size distribution of the countries. Under symmetry, GFT is the unique stable trade constellation in both regulatory scenarios. But as soon as one moves away from symmetry, GFT might not be reached at all. In between, the effect of switching off Article XXIV Paragraph 5 depends on the exact asymmetry. In case two countries are relatively smaller, prohibiting PTAs increases the area of stability of the GFT regimes. When two countries are relatively larger, it reduces the area. Once the world is further away from symmetry, abolishing the exception for PTAs might result in the worst possible state from the perspective of overall world welfare, the non-cooperative MFN regime. Therefore, under such circumstances, PTAs act as a mechanism that prevents the MFN regime.

Our research also raises a couple of questions in need of further investigation. First, it would be interesting to study the robustness of the findings with respect to the underlying trade model. While the model of competition via exports remains popular in the related literature, economists also extensively use both oligopoly and competition via imports model. Fortunately, the framework presented here does allow for a different underlying trade model such as the ones mentioned above. Another potential area of inquiry might be an extension of the framework to increase the number of countries. Nowadays, in addition to bilateral negotiations, so-called plurilateral negotiations play an important role in the development of preferential trade liberalisation. Recent examples are the Trans-Pacific Partnership (TTP) and the Regional Comprehensive Economic Partnership (RCEP). Including more than three countries in a model would allow us to investigate the strategic interactions among countries whilst taking these negotiations into account. The introduction of political economy considerations to the underlying trade model is another area of interest²⁹, as it might allow us to understand the nature of tariff peaks occurring after PTAs come into effect. It is our opinion that modifications or extensions of our framework (as mentioned here) are directions worthy of further research.

As a final remark, it is perhaps important, going forward, to move the debate of 'building blocks' vs. 'stumbling blocks' to a level of detail that goes beyond this binary choice.

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²⁹See for example Facchini et al. (2013).

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APPENDIX A. PSEUDOCODE

Note, that a couple of functions and variables are directly baked into the program without any further explanation in the pseudocode below - for example the matrix that determines the general network structure (for each player and all coalitions). The origin and characterization of these can be found in their respective parts in the main paper. The network structure A and the preference relations B both enter as a collection of $|X| \times |X|$ -matrices, $\{A_S\}_{S \subseteq N, S \neq \emptyset}$ and $\{B_S\}_{S \subseteq N, S \neq \emptyset}$ resp., where $(A_S)_{i,j} = \mathbb{1}_{\{i \rightarrow_S j\}}(i, j)$ and $(B_S)_{i,j} = \mathbb{1}_{\{i \prec_S j\}}(i, j)$ for $(i, j) \in X \times X$.

Algorithm Largest Consistent Set

Input: Countries N , Outcomes X , Network Structure A , Preference Relations B **Output:** Largest Consistent Set $\{Y\}$

```

1: procedure PARAMETERSPACELCS( $N, X, A, B$ )
2:    $E = eMaxArea$  ▷ See Section 2.5
3:    $\alpha = \alpha MinValue(E)$  ▷ See Section 2.5
4:   for  $e \in E$  do
5:      $Y = GeneralLCS(N, X, A, B)$ 
6:   return  $\{Y\}$ 

7: function GENERALLCS( $N, X, A, B$ )
8:   for  $S \subseteq N$  do
9:      $C_S = \min\{A_S, B_S\}$ 
10:     $D^0 = \max_{S \subseteq N}\{C_S\}$  ▷ : Direct Dominance
11:     $n = 0$ 
12:    repeat
13:       $n = n + 1$ 
14:      for  $S \subseteq N$  do
15:         $A_S^n = (\mathbb{1}_{\{(A_S \cdot D^{n-1})_{i,j} \neq 0\}}(i, j))_{(i,j) \in X \times X}$ 
16:         $D_S^n = \min\{A_S^n, B_S\}$ 
17:         $D^n = \max_{S \subseteq N}\{D_S^n\}$  ▷ : Indirect Dominance
18:      until  $D^n = D^{n-1}$ 
19:       $D = \mathbb{1}_X + D^n$ 
20:       $Y^0 = (1)_{x \in X}$ 
21:       $m = 0$ 
22:      repeat
23:         $m = m + 1$ 
24:        for  $x \in X$  do
25:          if  $Y_x^{m-1} = 0$  then
26:             $Y_x^m = 0$ 
27:          else
28:             $y = \max_{k \in X, S \subseteq N} \left\{ (A_S)_{x,k} \left( 1 - \max_{z \in X} \{Y_z^{m-1}(D)_{k,z} (1 - (B_S)_{x,z})\} \right) \right\}$ 
29:             $Y_x^m = Y_x^{m-1} - y$ 
30:          until  $Y^m = Y^{m-1}$ 
31:       $Y = Y^m$ 
32:      return  $Y$ 

```

APPENDIX B. MODEL

B.1. Individual Welfare. The following table lists the individual welfare for each (representative) trade agreement, depending on endowments and tariffs, multiplied with the factor 18. Note that for MFN, CUGFT, FTAGFT, and MTAGFT the welfare W_i resembles W_j and W_k . In case of CU(i,j), FTA(i,j), and MTA(i,j) the welfare W_i is similar to W_j . For FTAHub(i) the welfare W_j resembles W_k .

Trade Agreement	Individual Welfare
MFN	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 - 8t_i^2 + t_j^2 + t_k^2 + 4e_i(9\alpha - e_j - e_k - t_j - t_k) + 2e_j(e_k + t_i + t_k) + 2e_k(t_i + t_j)$
CU(i,j)	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 - 11t_{ik}^2 + t_{jk}^2 + t_k^2 + 4e_i(9\alpha - e_j - e_k + t_{jk} - t_k) + 2e_j(e_k - 4t_{ik} + t_k) + 2e_k(5t_{ik} - t_{jk})$
$\hookrightarrow W_k$	$2e_i^2 + 2e_j^2 - 10e_k^2 + 4t_{ik}^2 + 4t_{jk}^2 - 8t_k^2 + 2e_i(e_j - 2e_k + 2t_{jk} + t_k) + 2e_j(-2e_k + 2t_{ik} + t_k) + 4e_k(9\alpha - 2t_{ik} - 2t_{jk})$
CUGFT	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 + 4e_i(9\alpha - e_j - e_k) + 2e_j e_k$
FTA(i,j)	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 - 11t_{ik}^2 + t_{jk}^2 + t_k^2 + 4e_i(9\alpha - e_j - e_k + t_{jk} - t_k) + 2e_j(e_k - 4t_{ik} + t_k) + 2e_k(5t_{ik} - t_{jk})$
$\hookrightarrow W_k$	$2e_i^2 + 2e_j^2 - 10e_k^2 + 4t_{ik}^2 + 4t_{jk}^2 - 8t_k^2 + 2e_i(e_j - 2e_k + 2t_{jk} + t_k) + 2e_j(-2e_k + 2t_{ik} + t_k) + 4e_k(9\alpha - 2t_{ik} - 2t_{jk})$
FTAHub(i)	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 + t_{jk}^2 + t_{kj}^2 + 4e_i(9\alpha - e_j - e_k + t_{jk} + t_{kj}) + 2e_j(e_k - t_{kj}) - 2e_k t_{jk}$
$\hookrightarrow W_j$	$2e_i^2 + 2e_j^2 - 10e_k^2 + 4t_{jk}^2 - 11t_{kj}^2 + 2e_i(e_j - 2e_k + 2t_{jk} - 4t_{kj}) + e_j(-4e_k + 10t_{kj}) + 4e_k(9\alpha - 2t_{jk})$
FTAGFT	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 + 4e_i(9\alpha - e_j - e_k) + 2e_j e_k$
MTA(i,j)	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 - 8t_i^2 + t_j^2 + t_k^2 + 4e_i(9\alpha - e_j - e_k - t_j - t_k) + 2e_j(e_k + t_i + t_k) + 2e_k(t_i + t_j)$
$\hookrightarrow W_k$	$2e_i^2 + 2e_j^2 - 10e_k^2 + t_i^2 + t_j^2 - 8t_k^2 + 2e_i(e_j - 2e_k + t_j + t_k) + 2e_j(-2e_k + t_i + t_k) + 4e_k(9\alpha - t_i - t_j)$
MTAGFT	
$\hookrightarrow W_i$	$-10e_i^2 + 2e_j^2 + 2e_k^2 + 4e_i(9\alpha - e_j - e_k) + 2e_j e_k$

TABLE 14. The individual welfare for each trade agreement depending on endowments and tariffs

B.2. Tariffs. The following describes the tariffs that the countries choose for each trade agreement. In addition to the specific restrictions mentioned in Section 2.1, all tariffs are bounded both from below and above by zero and the MFN-tariff respectively. As per WTO rule, the formation of any PTA does not allow additional tariffs towards others - which results in the upper bound of the MFN-tariff. Also, any form of subsidies is excluded here - which results in the lower bound of zero. Now, the following determines and describes the optimal tariffs for each scenario and the cases where capping occurs:

B.2.1. MFN. In this case, the optimal tariff of country i , given by $t_i^* = \frac{1}{8}(e_j + e_k)$, is always greater than zero as the endowments themselves are greater than zero. Additionally, t_i^* is going to play the role of the maximal tariff for country i for all the other agreements, then denoted t_i^{MFN} .

B.2.2. CU. Consider the scenario CU(i,j), then the optimal tariff of country i towards country k , given by $t_{ik}^* = \frac{1}{5}(2e_k - e_j)$, is always greater than zero but not always less than the MFN-tariff (and the one towards country j , t_{ij}^* , is always zero):

- i) Lower Bound. By assumption on the endowments $e_k \geq \frac{3}{5}e_j$ and thus $e_k > \frac{1}{2}e_j$, which guarantees $t_{ik}^* > 0$.
- ii) Upper Bound. By assumption on the endowments $e_k \leq \frac{5}{3}e_j$ however $t_{ik}^* \leq t_i^{MFN}$ requires $e_k \leq \frac{13}{11}e_j$, which leaves the interval $\frac{13}{11}e_j < e_k \leq \frac{5}{3}e_j$ to require capping. For this interval, the (maximal) MFN-tariff is optimal as the derivative of the joint welfare with respect to t_{ik} is always greater than zero on the interval $[0, t_i^{MFN}]$:

$$\frac{\partial(W_i + W_j)}{\partial t_{ik}} = \frac{1}{9}(-10t_{ik} - 2e_j + 4e_k) \geq \frac{1}{36}(-13e_j + 11e_k) > 0$$

B.2.3. FTA. Consider the scenario FTA(i,j), then the optimal tariff of country i towards country k , given by $t_{ik}^* = \frac{1}{11}(5e_k - 4e_j)$, is neither always greater than zero nor always less than the MFN-tariff (but the one towards country j , t_{ij}^* , is zero):

- i) Lower Bound. By assumption on the endowments $e_k \geq \frac{3}{5}e_j$ however $t_{ik}^* \geq 0$ requires $e_k \geq \frac{4}{5}e_j$, which leaves the interval $\frac{3}{5}e_j \leq e_k < \frac{4}{5}e_j$ to require capping. For this interval, the (minmal) zero-tariff is optimal as the derivative of the welfare with respect to t_{ik} is always lesser than zero on the interval $[0, t_i^{MFN}]$:

$$\frac{\partial W_i}{\partial t_{ik}} = \frac{1}{9}(-11t_{ik} - 4e_j + 5e_k) \leq \frac{1}{9}(5e_k - 4e_j) < 0$$

- ii) Upper Bound. By assumption on the endowments $e_k \leq \frac{5}{3}e_j$ however $t_{ik}^* \leq t_i^{MFN}$ requires $e_k \leq \frac{43}{29}e_j$, which leaves the interval $\frac{43}{29}e_j < e_k \leq \frac{5}{3}e_j$ to require capping. For this interval, the (maximal) MFN-tariff is optimal as the derivative of the welfare with respect to t_{ik} is always greater than zero on the interval $[0, t_i^{MFN}]$:

$$\frac{\partial W_i}{\partial t_{ik}} = \frac{1}{9}(-11t_{ik} - 4e_j + 5e_k) \geq \frac{1}{72}(-43e_j + 29e_k) > 0$$

B.2.4. MTA. Consider the scenario MTA(i,j), then the optimal tariff of country i , given by $t_i^* = \frac{1}{7}(2e_k - e_j)$, is greater than zero and less or equal to the MFN-tariff as per assumption on the endowments $\frac{3}{5}e_j \leq e_k \leq \frac{5}{3}e_j$.

B.2.5. Notes. The analysis considered country i and an agreement with country j , but it naturally extends to all other combinations. Also, the perspective of the third country needs no further analysis as it always chooses the MFN-tariff. Furthermore, the case of FTAHub(i) is simply a combination of FTA(i,j) and FTA(i,k). Finally, the three variants of GFT require no additional analysis as every country always chooses the zero-tariff. Information on another form of GFT, Pseudo-GFT, that technically exists but turns out to be negligible, can be found in Appendix B.5.1.

B.3. Overall Welfare. The following table lists the overall welfare for each (representative) trade agreement, depending purely on endowments, computed modulo $2\alpha (\sum_{n \in N} e_n)$, which is the common term associated with the factor α . Also, the notation l_c and l^c is used to indicate that country l is capped in terms of tariffs from below or above respectively. Note that one specific comparison of trade agreements is presented in more detail in Appendix B.5.2.

Trade Agreement	Overall Welfare
MFN	
\hookrightarrow no cap	$\frac{11}{32}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$
CU(i,j)	
\hookrightarrow no cap	$\frac{1}{1600}(-563e_i^2 - 550e_i e_j - 448e_i e_k - 563e_j^2 - 448e_j e_k - 704e_k^2)$
$\hookrightarrow i^c$	$\frac{1}{1600}(-563e_i^2 - 550e_i e_j - 448e_i e_k - 550e_j^2 - 550e_j e_k - 627e_k^2)$
$\hookrightarrow i^c, j^c$	$\frac{11}{32}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$
CUGFT	
\hookrightarrow no cap	$\frac{1}{3}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$
FTA(i,j)	
\hookrightarrow no cap	$\frac{1}{7744}(-2963e_i^2 - 2662e_i e_j - 1728e_i e_k - 2963e_j^2 - 1728e_j e_k - 3648e_k^2)$
$\hookrightarrow i_c$	$\frac{1}{23232}(-8889e_i^2 - 7986e_i e_j - 5184e_i e_k - 7865e_j^2 - 7744e_j e_k - 9344e_k^2)$
$\hookrightarrow i_c, i_c$	$\frac{1}{192}(-65e_i^2 - 66e_i e_j - 64e_i e_k - 65e_j^2 - 64e_j e_k - 64e_k^2)$
$\hookrightarrow i^c$	$\frac{1}{7744}(-2963e_i^2 - 2662e_i e_j - 1728e_i e_k - 2662e_j^2 - 2662e_j e_k - 3155e_k^2)$
$\hookrightarrow i^c, j^c$	$\frac{11}{32}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$
FTAHub(i)	
\hookrightarrow no cap	$\frac{1}{363}(-153e_i^2 - 81e_i e_j - 81e_i e_k - 146e_j^2 - 121e_j e_k - 146e_k^2)$
$\hookrightarrow j_c$	$\frac{1}{363}(-137e_i^2 - 81e_i e_j - 121e_i e_k - 146e_j^2 - 121e_j e_k - 121e_k^2)$
$\hookrightarrow j_c, k_c$	$\frac{1}{3}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$
$\hookrightarrow j^c$	$\frac{1}{23232}(-8889e_i^2 - 5184e_i e_j - 7986e_i e_k - 9344e_j^2 - 7744e_j e_k - 7865e_k^2)$
$\hookrightarrow j^c, k^c$	$\frac{1}{192}(-66e_i^2 - 66e_i e_j - 66e_i e_k - 65e_j^2 - 64e_j e_k - 65e_k^2)$
FTAGFT	
\hookrightarrow no cap	$\frac{1}{3}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$
MTA(i,j)	
\hookrightarrow no cap	$\frac{1}{3136}(-1083e_i^2 - 1078e_i e_j - 960e_i e_k - 1083e_j^2 - 960e_j e_k - 1216e_k^2)$
MTAGFT	
\hookrightarrow no cap	$\frac{1}{3}(-e_i^2 - e_i e_j - e_i e_k - e_j^2 - e_j e_k - e_k^2)$

TABLE 15. The overall welfare for each trade agreement depending on endowments

B.4. Transition Tables. The following lists the network structure of Section 2.2, specifically Figure 1 and 2, in the form of transition tables:

$x_1 \in X$	$x_2 \in X \setminus \{x_1\}$ with $x_1 \rightarrow_{\{i\}} x_2$
MFN	-
CU(i,j)	MFN
CU(j,k)	-
CU(k,i)	MFN
CUGFT	CU(j,k)
FTA(i,j)	MFN
FTA(j,k)	-
FTA(k,i)	MFN
FTAHub(i)	MFN, FTA(i,j), FTA(k,i)
FTAHub(j)	FTA(j,k)
FTAHub(k)	FTA(j,k)
FTAGFT	FTA(j,k), FTAHub(j), FTAHub(k)
MTA(i,j)	MFN
MTA(j,k)	-
MTA(k,i)	MFN
MTAGFT	MTA(j,k)

(A) The transition table for coalition $\{i\}$, $i \in N$.

$x_1 \in X$	$x_2 \in X \setminus \{x_1\}$ with $x_1 \rightarrow_{\{i,j\}} x_2$
MFN	CU(i,j), FTA(i,j), MTA(i,j)
CU(i,j)	MFN, FTA(i,j), MTA(i,j)
CU(j,k)	MFN, CU(i,j), FTA(i,j), MTA(i,j)
CU(k,i)	MFN, CU(i,j), FTA(i,j), MTA(i,j)
CUGFT	MFN, CU(i,j), CU(j,k), CU(k,i), FTA(i,j), MTA(i,j)
FTA(i,j)	MFN, CU(i,j), MTA(i,j)
FTA(j,k)	MFN, CU(i,j), FTA(i,j), FTAHub(j), MTA(i,j)
FTA(k,i)	MFN, CU(i,j), FTA(i,j), FTAHub(i), MTA(i,j)
FTAHub(i)	MFN, CU(i,j), FTA(i,j), FTA(k,i), MTA(i,j)
FTAHub(j)	MFN, CU(i,j), FTA(i,j), FTA(j,k), MTA(i,j)
FTAHub(k)	MFN, CU(i,j), FTA(i,j), FTA(j,k), FTA(k,i), FTAGFT, MTA(i,j)
FTAGFT	MFN, CU(i,j), FTA(i,j), FTA(j,k), FTA(k,i), FTAHub(i), FTAHub(j), FTAHub(k), MTA(i,j)
MTA(i,j)	MFN, CU(i,j), FTA(i,j)
MTA(j,k)	MFN, CU(i,j), FTA(i,j), MTA(i,j)
MTA(k,i)	MFN, CU(i,j), FTA(i,j), MTA(i,j)
MTAGFT	MFN, CU(i,j), FTA(i,j), MTA(i,j), MTA(j,k), MTA(k,i)

(B) The transition table for coalition $\{i, j\}$, $i, j \in N$, $i \neq j$.

TABLE 16. The network structure as transition tables

B.5. Additional Remarks.

B.5.1. *Pseudo-GFT.* In Appendix B.2 a special case of ‘Pseudo-GFT’ is a possibility. Namely, in the case of a hub structure with both non-hub nodes capping at zero the trade agreement amounts to the same tariff structure (and welfare) of a GFT. If it were ever part of the stable set, then it would necessarily need to be considered de facto GFT even though it is not de jure GFT. However, in our analysis this case never occurred and it is therefore a negligible oddity.

B.5.2. *A Special Case.* As can be seen in Table 15 the overall welfare is equal in case of MFN, $CU(i^c, j^c)$, and $FTA(i^c, j^c)$ even though the tariff structure is different. The following explores this equivalence in order to provide an insight into the underlying mechanics. In terms of tariff structure both $CU(i^c, j^c)$ and $FTA(i^c, j^c)$ are the same and therefore it is sufficient to compare MFN with $CU(i^c, j^c)$ when only interested in (effects on) welfare. Now, Table 17 shows us the differences in the welfare (components) both on the individual as well as on the joint/overall level, which are computed from the expressions in Table 18 and 19.

$\Delta(MFN, CU(i^c, j^c))$	
TR_i	$1/24(e_j + e_k)(2e_j - e_k)$
CS_i	$(32e_i^2 + 64e_i e_k - 13e_j^2 - 26e_j e_k + 19e_k^2)/1152$
PS_i	$1/12e_i(-e_i - e_k)$
W_i	$(-64e_i^2 - 32e_i e_k + 83e_j^2 + 22e_j e_k - 29e_k^2)/1152$
TR_j	$1/24(e_i + e_k)(2e_i - e_k)$
CS_j	$(-13e_i^2 - 26e_i e_k + 32e_j^2 + 64e_j e_k + 19e_k^2)/1152$
PS_j	$1/12e_j(-e_j - e_k)$
W_j	$(83e_i^2 + 22e_i e_k - 64e_j^2 - 32e_j e_k - 29e_k^2)/1152$
TR_k	0
CS_k	$19(-e_i^2 - 2e_i e_k - e_j^2 - 2e_j e_k - 2e_k^2)/1152$
PS_k	$1/24e_k(e_i + e_j + 2e_k)$
W_k	$(-19e_i^2 + 10e_i e_k - 19e_j^2 + 10e_j e_k + 58e_k^2)/1152$

(A) The difference in the individual welfare (components) depending on endowments

$\Delta(MFN, CU(i^c, j^c))$	
$TR_i + TR_j$	$1/24(2e_i^2 + e_i e_k + 2e_j^2 + e_j e_k - 2e_k^2)$
$CS_i + CS_j$	$19(e_i^2 + 2e_i e_k + e_j^2 + 2e_j e_k + 2e_k^2)/1152$
$PS_i + PS_j$	$1/12(-e_i^2 - e_i e_k - e_j^2 - e_j e_k)$
$W_i + W_j$	$(19e_i^2 - 10e_i e_k + 19e_j^2 - 10e_j e_k - 58e_k^2)/1152$
$\sum_{n \in N} TR_n$	$1/24(2e_i^2 + e_i e_k + 2e_j^2 + e_j e_k - 2e_k^2)$
$\sum_{n \in N} CS_n$	0
$\sum_{n \in N} PS_n$	$1/24(-2e_i^2 - e_i e_k - 2e_j^2 - e_j e_k + 2e_k^2)$
$\sum_{n \in N} W_n$	0

(B) The difference in the joint/overall welfare (components) depending on endowments

TABLE 17. The difference in the welfare (components) depending on endowments

Now, recall that capping at the MFN-tariff for both members of a customs union, in this case $CU(i^c, j^c)$, occurs when the endowment of the non-member is above a minimal value determined by the endowments of the members, $\max\{e_i, e_j\} < \frac{11}{13}e_k$ (Appendix B.2). Using this together with the general assumptions on the relation of endowments, the following effects on welfare (components) take place, where each expression of the type ‘+c’ for some c is positive and each ‘-c’ negative:

Welfare Components	
MFN	
TR_i	$(e_j + e_k)^2/32$
CS_i	$(18e_i^2 + 13e_j^2 + 13e_k^2 + 8e_j e_k + 18e_i(e_j + e_k))/128$
PS_i	$-e_i(-16\alpha + 6e_i + 3e_j + 3e_k)/8$
TR_j	$(e_i + e_k)^2/32$
CS_j	$(13e_i^2 + 18e_j^2 + 13e_k^2 + 8e_i e_k + 18e_j(e_i + e_k))/128$
PS_j	$-e_j(-16\alpha + 3e_i + 6e_j + 3e_k)/8$
TR_k	$(e_i + e_j)^2/32$
CS_k	$(13e_i^2 + 13e_j^2 + 18e_k^2 + 8e_i e_j + 18e_k(e_i + e_j))/128$
PS_k	$-e_k(-16\alpha + 3e_i + 3e_j + 6e_k)/8$
$CU(i^c, j^c)$	
TR_i	$-(5e_j - 7e_k)(e_j + e_k)/96$
CS_i	$(65e_i^2 + 65e_j^2 + 49e_k^2 + 49e_j e_k + e_i(81e_j + 49e_k))/576$
PS_i	$-e_i(-48\alpha + 16e_i + 9e_j + 7e_k)/24$
TR_j	$-(5e_i - 7e_k)(e_i + e_k)/96$
CS_j	$(65e_i^2 + 65e_j^2 + 49e_k^2 + 49e_i e_k + e_j(81e_i + 49e_k))/576$
PS_j	$-e_j(-48\alpha + 9e_i + 16e_j + 7e_k)/24$
TR_k	$(e_i + e_j)^2/32$
CS_k	$(17e_i^2 + 17e_j^2 + 25e_k^2 + 25e_i e_k + 25e_j e_k + 9e_i e_j)/144$
PS_k	$-e_k(-24\alpha + 5e_i + 5e_j + 10e_k)/12$

(A) The individual welfare (components) depending on endowments

Welfare Components	
MFN	
$TR_i + TR_j$	$1/32(e_i^2 + 2e_i e_k + e_j^2 + 2e_j e_k + 2e_k^2)$
$CS_i + CS_j$	$1/128(31e_i^2 + 36e_i e_j + 26e_i e_k + 31e_j^2 + 26e_j e_k + 26e_k^2)$
$PS_i + PS_j$	$1/8(-6e_i^2 - 6e_i e_j - 3e_i e_k - 6e_j^2 - 3e_j e_k) + 2\alpha(e_i + e_j)$
$\sum_{n \in N} TR_n$	$1/16(e_i^2 + e_i e_j + e_i e_k + e_j^2 + e_j e_k + e_k^2)$
$\sum_{n \in N} CS_n$	$11/32(e_i^2 + e_i e_j + e_i e_k + e_j^2 + e_j e_k + e_k^2)$
$\sum_{n \in N} PS_n$	$1/4(-3e_i^2 - 3e_i e_j - 3e_i e_k - 3e_j^2 - 3e_j e_k - 3e_k^2) + 2\alpha(\sum_{n \in N} e_n)$
$CU(i^c, j^c)$	
$TR_i + TR_j$	$1/96(-5e_i^2 + 2e_i e_k - 5e_j^2 + 2e_j e_k + 14e_k^2)$
$CS_i + CS_j$	$1/288(65e_i^2 + 81e_i e_j + 49e_i e_k + 65e_j^2 + 49e_j e_k + 49e_k^2)$
$PS_i + PS_j$	$1/24(-16e_i^2 - 18e_i e_j - 7e_i e_k - 16e_j^2 - 7e_j e_k) + 2\alpha(e_i + e_j)$
$\sum_{n \in N} TR_n$	$1/48(-e_i^2 + 3e_i e_j + e_i e_k - e_j^2 + e_j e_k + 7e_k^2)$
$\sum_{n \in N} CS_n$	$11/32(e_i^2 + e_i e_j + e_i e_k + e_j^2 + e_j e_k + e_k^2)$
$\sum_{n \in N} PS_n$	$1/24(-16e_i^2 - 18e_i e_j - 17e_i e_k - 16e_j^2 - 17e_j e_k - 20e_k^2) + 2\alpha(\sum_{n \in N} e_n)$

(B) The joint/overall welfare (components) depending on endowments

TABLE 18. The welfare (components) depending on endowments

Trade Agreement	Individual/Joint/Overall Welfare
MFN	
$\hookrightarrow W_i$	$1/128(-78e_i^2 + 256\alpha e_i - 30e_i e_j - 30e_i e_k + 17e_j^2 + 16e_j e_k + 17e_k^2)$
$\hookrightarrow W_j$	$1/128(17e_i^2 - 30e_i e_j + 16e_i e_k - 78e_j^2 + 256\alpha e_j - 30e_j e_k + 17e_k^2)$
$\hookrightarrow W_k$	$1/128(17e_i^2 + 16e_i e_j - 30e_i e_k + 17e_j^2 - 30e_j e_k - 78e_k^2 + 256\alpha e_k)$
$\hookrightarrow W_i + W_j$	$1/128(-61e_i^2 - 60e_i e_j - 14e_i e_k - 61e_j^2 - 14e_j e_k + 34e_k^2) + 2\alpha(e_i + e_j)$
$\hookrightarrow \sum_{n \in N} W_n$	$1/32(-11e_i^2 - 11e_i e_j - 11e_i e_k - 11e_j^2 - 11e_j e_k - 11e_k^2) + 2\alpha(\sum_{n \in N} e_n)$
CU(i^c, j^c)	
$\hookrightarrow W_i$	$1/576(-319e_i^2 + 1152\alpha e_i - 135e_i e_j - 119e_i e_k + 35e_j^2 + 61e_j e_k + 91e_k^2)$
$\hookrightarrow W_j$	$1/576(35e_i^2 - 135e_i e_j + 61e_i e_k - 319e_j^2 + 1152\alpha e_j - 119e_j e_k + 91e_k^2)$
$\hookrightarrow W_k$	$1/288(43e_i^2 + 36e_i e_j - 70e_i e_k + 43e_j^2 - 70e_j e_k - 190e_k^2 + 576\alpha e_k)$
$\hookrightarrow W_i + W_j$	$1/288(-142e_i^2 - 135e_i e_j - 29e_i e_k - 142e_j^2 - 29e_j e_k + 91e_k^2) + 2\alpha(e_i + e_j)$
$\hookrightarrow \sum_{n \in N} W_n$	$1/32(-11e_i^2 - 11e_i e_j - 11e_i e_k - 11e_j^2 - 11e_j e_k - 11e_k^2) + 2\alpha(\sum_{n \in N} e_n)$

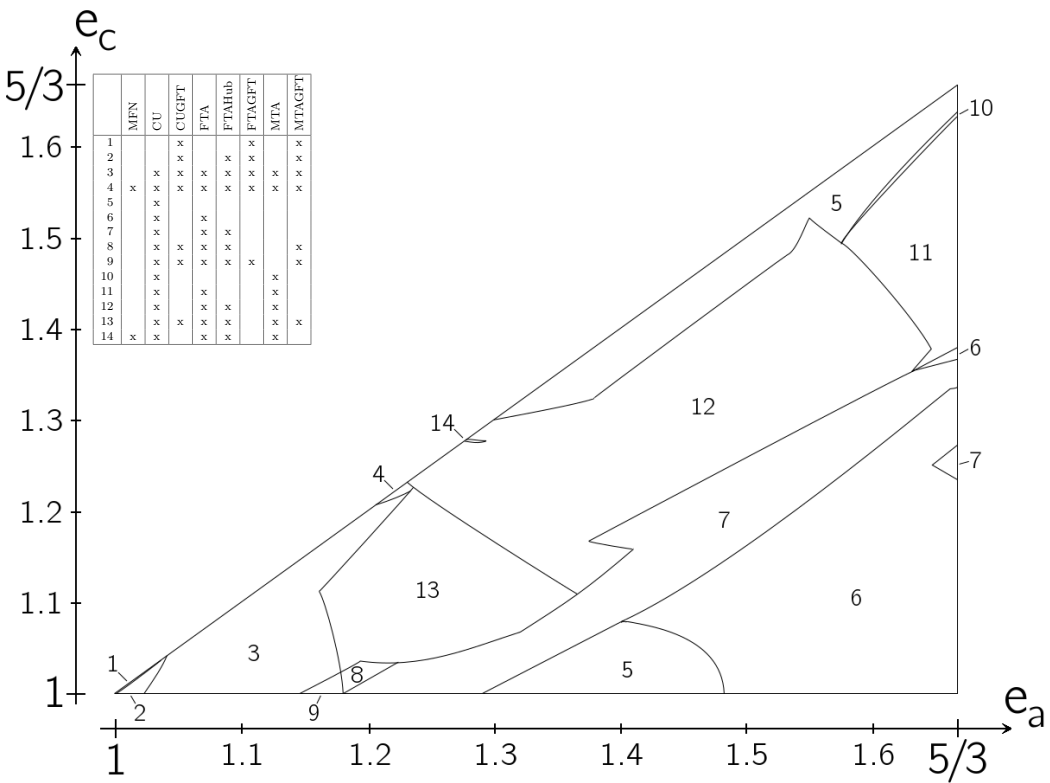
TABLE 19. The welfare depending on endowments

$\Delta(MFN, CU(i^c, j^c))$		
Country i	Country j	Country k
TR		
$+\tau_i$	$+\tau_j$	0
$+\tau_{ij}$		0
$+\tau$		
CS		
$+\gamma_i$	$+\gamma_j$	$-\gamma_k$
$+\gamma_{ij}$		$-\gamma_k$
0		
PS		
$-\rho_i$	$-\rho_j$	$+\rho_k$
$-\rho_{ij}$		$+\rho_k$
$-\rho$		
W		
$\pm\omega_i$	$\pm\omega_j$	$+\omega_k$
$-\omega_{ij}$		$+\omega_k$
0		

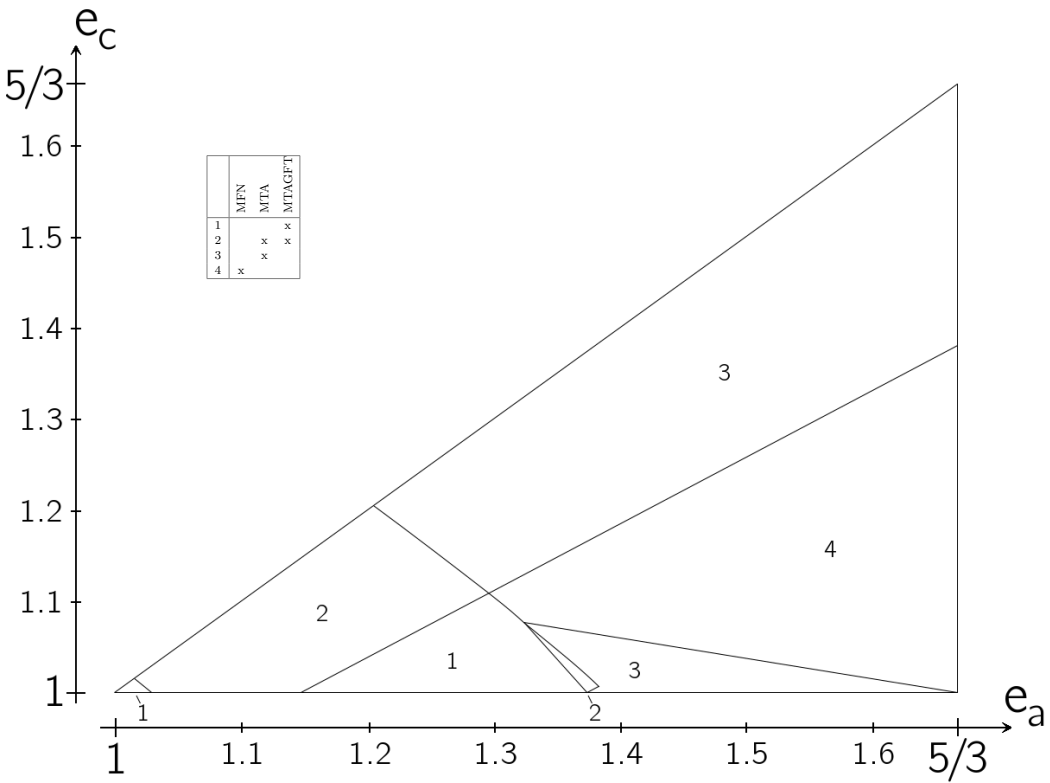
TABLE 20. The effect on the welfare (components)

APPENDIX C. ANALYSIS

C.1. Additional Graphics. The following provides detailed figures:



(A) Overall Stability with PTAs



(B) Overall Stability without PTAs

FIGURE 21. Overall Stability with and without PTAs

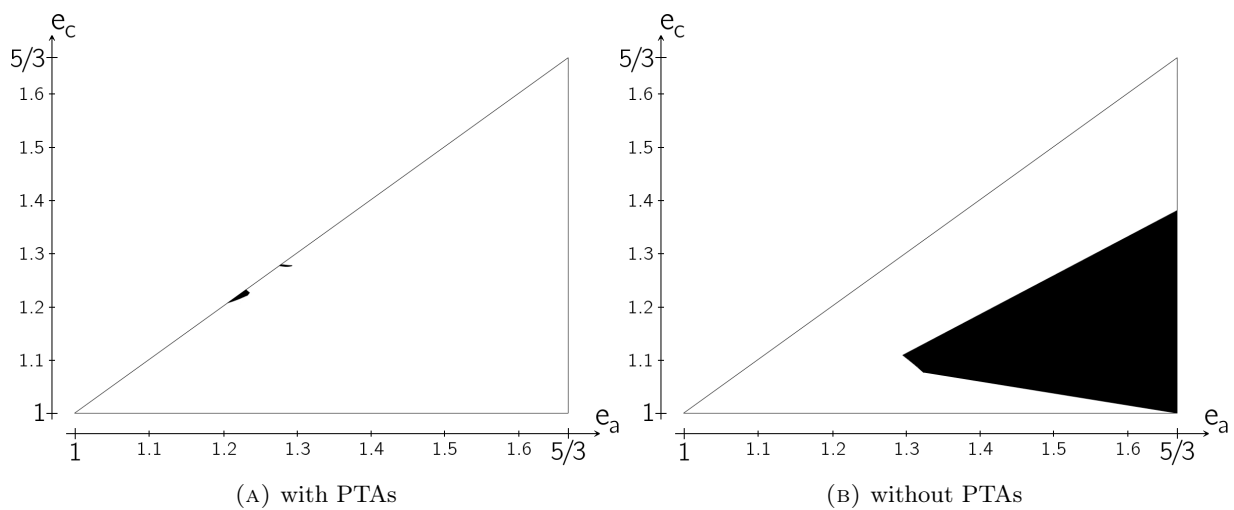


FIGURE 22. Stability of MFN

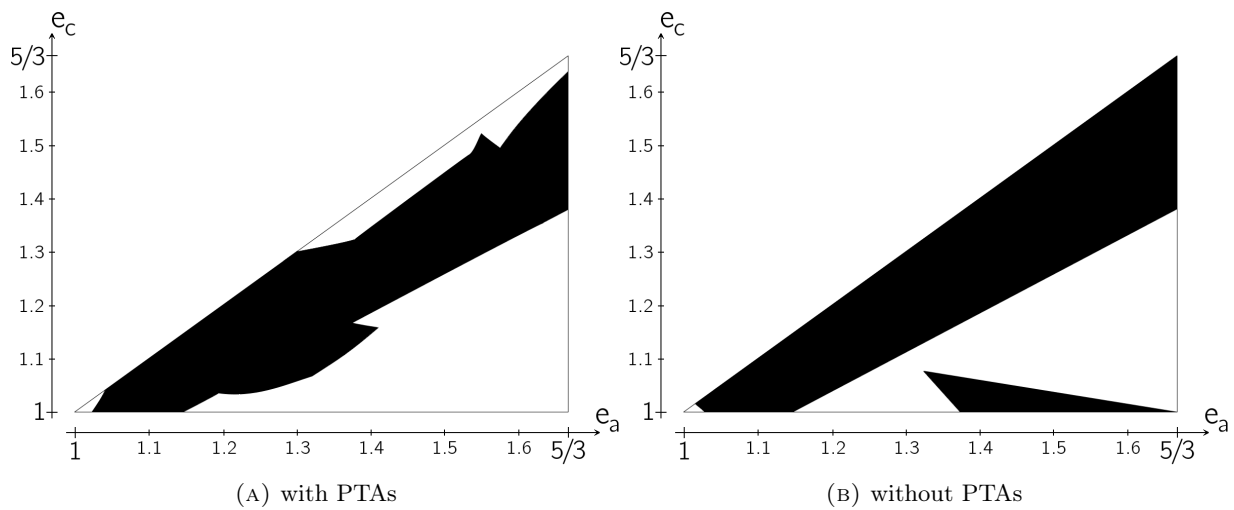


FIGURE 23. Stability of MTA

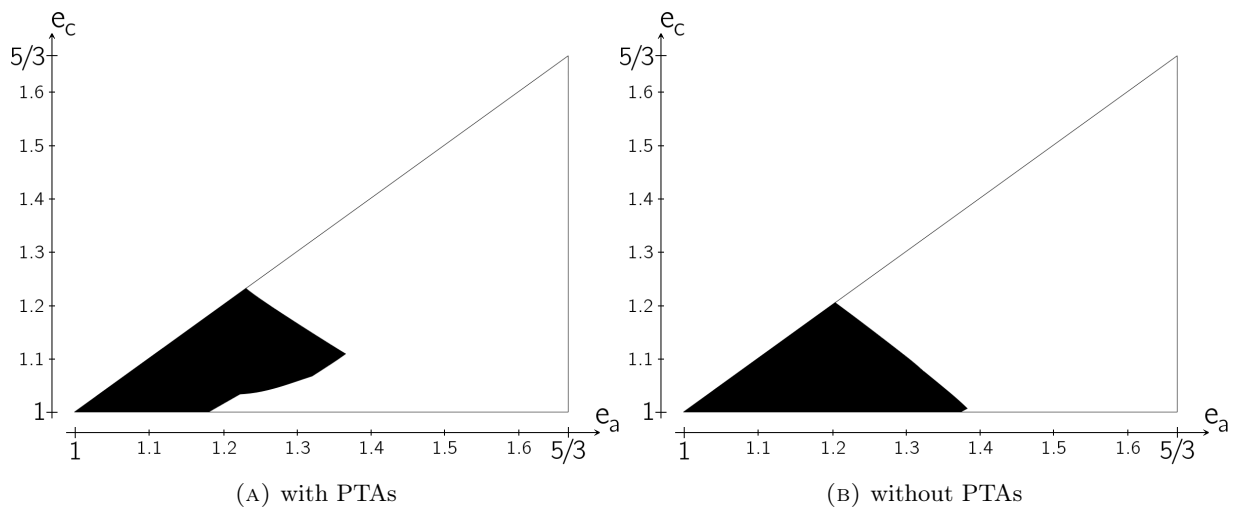


FIGURE 24. Stability of MTAGFT

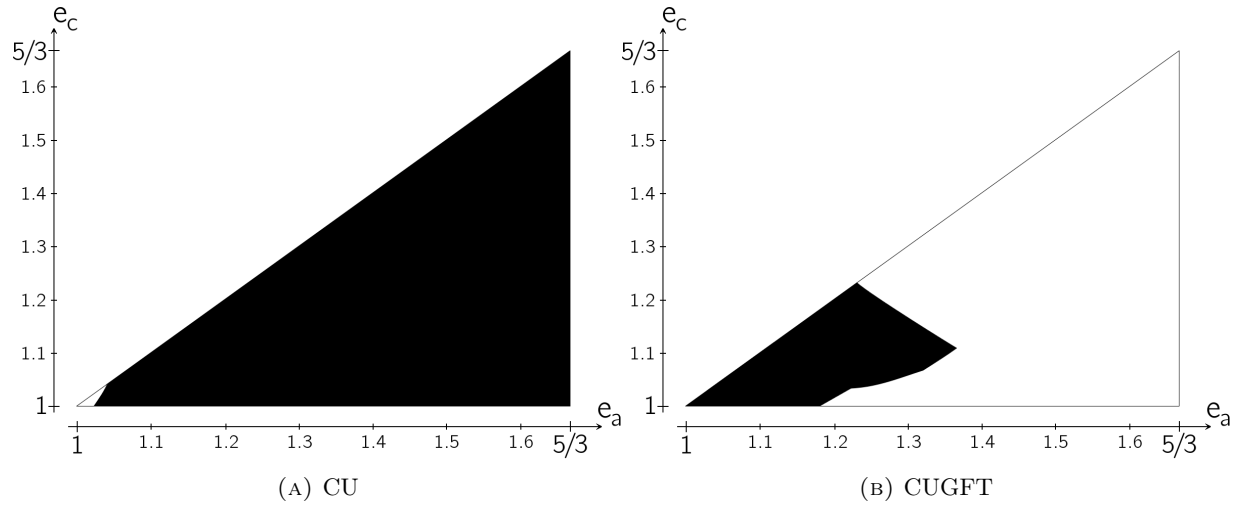


FIGURE 25. Stability of CU

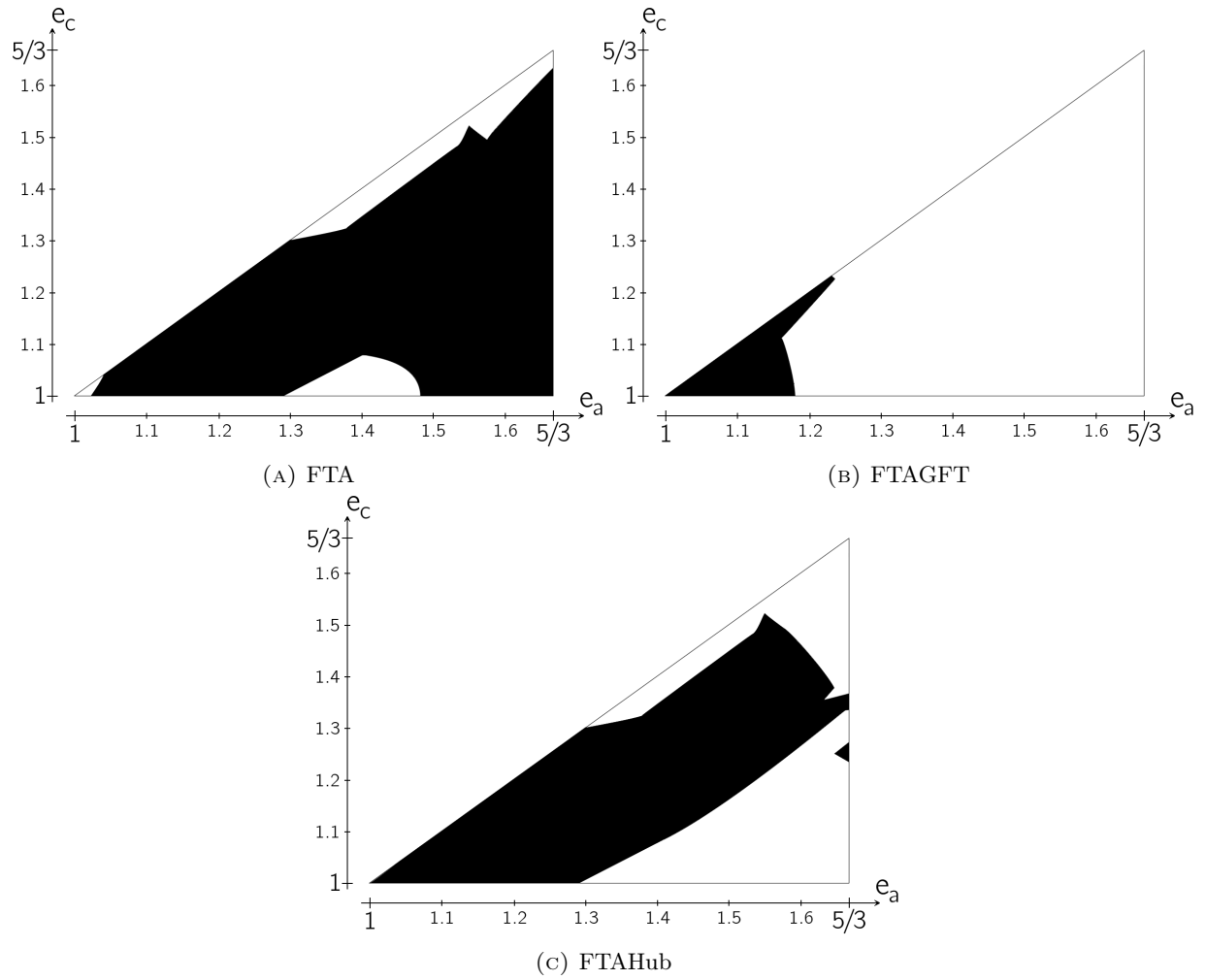


FIGURE 26. Stability of FTA

C.2. Exact Intervals. The table here lists the exact intervals where each specific trade agreement is part of the stable set (for the border of the parameter space):

Trade Agreement	Exact Interval(s)
$e_b = e_{\min} \leq e_c \leq e_{\max} = e_a$	
CU(b,c)	[1.0000000000000000,1.3380093520374081]
CU(c,a)	[1.3259853039412157,1.6666666666666667]
FTA(b,c)	[1.0000000000000000,1.3807615230460921]
FTA(c,a)	[1.3353373413493654,1.6305945223780896]
FTAHub(c)	[1.2364729458917836,1.2698730794923179]
	[1.3353373413493654,1.3647294589178356]
MTA(c,a)	[1.379425517702071,1.635938543754175]
$e_b = e_c = e_{\min} \leq e_a \leq e_{\max}$	
CU(a,b)	[1.0240480961923848,1.1108884435537743]
CU(b,c)	[1.0240480961923848,1.6666666666666667]
CU(c,a)	[1.0240480961923848,1.1108884435537743]
CUGFT	[1.0000000000000000,1.1803607214428857]
FTA(a,b)	[1.0240480961923848,1.2404809619238477]
FTA(b,c)	[1.0240480961923848,1.29124916499666]
	[1.483633934535738,1.6666666666666667]
FTA(c,a)	[1.0240480961923848,1.2404809619238477]
FTAHub(b)	[1.0013360053440215,1.29124916499666]
FTAHub(c)	[1.0013360053440215,1.29124916499666]
FTAGFT	[1.0000000000000000,1.1803607214428857]
MTA(a,b)	[1.0240480961923848,1.1469605878423514]
MTA(c,a)	[1.0240480961923848,1.1469605878423514]
MTAGFT	[1.0000000000000000,1.1803607214428857]
$e_b = e_{\min} \leq e_a = e_c \leq e_{\max}$	
MFN	[1.2044088176352705,1.2297929191716768]
	[1.2752171008684035,1.276553106212425]
CU(a,b)	[1.0454241816967267,1.2498329993319974]
CU(b,c)	[1.0454241816967267,1.2498329993319974]
CU(c,a)	[1.0494321977287908,1.6666666666666667]
CUGFT	[1.0000000000000000,1.2297929191716768]
FTA(a,b)	[1.0494321977287908,1.2925851703406814]
FTA(b,c)	[1.0494321977287908,1.2925851703406814]
FTA(c,a)	[1.0454241816967267,1.2925851703406814]
FTAHub(a)	[1.0454241816967267,1.276553106212425]
FTAHub(b)	[1.0454241816967267,1.2925851703406814]
FTAHub(c)	[1.0454241816967267,1.276553106212425]
FTAGFT	[1.0000000000000000,1.2297929191716768]
MTA(a,b)	[1.0494321977287908,1.2244488977955912]
MTA(b,c)	[1.0494321977287908,1.2244488977955912]
MTA(c,a)	[1.0454241816967267,1.2925851703406814]
MTAGFT	[1.0000000000000000,1.2297929191716768]

TABLE 27. The exact intervals of stability with PTAs

Trade Agreement	Exact Interval(s)
$e_b = e_{\min} \leq e_c \leq e_{\max} = e_a$	
MFN	[1.0000000000000000,1.3780895123580494]
MTA(b,c)	[1.0000000000000000,1.0000000000000000]
MTA(c,a)	[1.379425517702071,1.6666666666666667]
$e_b = e_c = e_{\min} \leq e_a \leq e_{\max}$	
MFN	[1.6666666666666667,1.6666666666666667]
MTA(a,b)	[1.0307281229124916,1.1469605878423514]
MTA(b,c)	[1.0307281229124916,1.1469605878423514]
MTA(c,a)	[1.3754175016700068,1.6666666666666667]
MTAGFT	[1.0000000000000000,1.3740814963259853]
$e_b = e_{\min} \leq e_a = e_c \leq e_{\max}$	
MTA(a,b)	[1.0160320641282565,1.1202404809619237]
MTA(b,c)	[1.0160320641282565,1.1202404809619237]
MTA(c,a)	[1.0160320641282565,1.6666666666666667]
MTAGFT	[1.0000000000000000,1.203072812291249]

TABLE 28. The exact intervals of stability without PTAs