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How Bilateral Trade Deals Get in the Way of Multilateral Agreements

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Abstract

Aghion et al. (2007) developed a dynamic bargaining model that considers bilateral versus multilateral trade agreements. Employing a 'Nash in Nash' applied general equilibrium framework, we provide empirical evidence for their approach. Considering the Trans-Pacific Partnership (TPP), our model determines the welfare maximizing set of bilateral trade agreements by sectors (there are ten) and compares that to an agreement involving all countries/sectors. We find that a multilateral agreement generates more collective welfare than most bilateral agreements and that this welfare gain is unlikely to be achieved by countries' individual pursuit of bilateral agreements. We find that superadditivity (i.e., additional welfare associated with the expansion of free trade to additional sectors and countries) holds across all regions and all sectors, but not for every pair of regions and sectors. Thus, it is possible for a set of regions to increase their collective welfare by excluding some sectors from their trade agreement.

Keywords: trade agreements, superadditivity, Nash in Nash, equilibrium, welfare

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1. Introduction

Economists generally agree that free trade is beneficial to the global economy as lower tariffs and more competition generally leads to higher global welfare through lower prices for consumers,[1] but there is some disagreement on the approach to get there. The World Trade Organization (WTO) was formed, in part, to pave the way for large-scale multilateral agreements, but agreements such as the General Agreement on Tariffs and Trade (GATT) and the Uruguay Round have largely been few and far between, while regional trade agreements (RTAs) and bilateral trade agreements have proliferated.[2] Previously, the debate among the appropriate approach to freer trade was primarily focused on large-scale multilateral agreements versus trade agreements involving fewer countries; but, more recently, this debate has shifted to the virtues of bilateral agreements versus multilateral agreements (i.e., an agreement between two countries or an agreement with more than two countries). Perhaps the most well-known case of this is the withdrawal of the Trans-Pacific Partnership (TPP) and the subsequent pivot to bilateral agreements by the United States in 2017.

Those who favor the bilateral approach note that these agreements can achieve more (since they can be individually negotiated rather than considering the incentive structure of more than the two countries) and that multilateral agreements have become too unwieldy and large (Richter, 2014). In addition, it is noted that for wealthier countries, such as the United States,

[1] Of course, there could be localized effects where cheaper imports might crowd out domestic production, but in the aggregate, more trade is thought of as being welfare increasing (Marchand, 2017).

[2] Large-scale multilateral agreements are referred to here as those involving the entire WTO. We refer to multilateral agreements as reciprocal preferential trade agreements between *more* than two partners and bilateral trade agreements as between two countries. Note that the WTO refers to all trade agreements with two or more partners as regional trade agreements.

bilateral negotiations create more leverage given the much greater size of their economy relative to potential partners (Williams, 2018). The opposing view is that bilateral trade agreements take long to negotiate, and that each new agreement must be ratified (by Congress for the United States, for example) (Wharton, 2017). In a global sense, bilateral agreements also have the difficulty that they are often implemented one at a time, so that the gains made in the negotiations, e.g., tariff reductions, opening a new tariff-rate quota (TRQ), removal of non-tariff measures (NTMs), might not be relevant if countries provide more access to others in future agreements.[3] Finally, bilateral agreements may lock countries in second best trade regimes where no further welfare may be gained by liberalizing trade incrementally through additional bilateral agreements even if welfare could be gained by a multilateral agreement.

The debate arguing the merits of the different approaches to freer trade continues,[4,5] but there is very little work comparing the multilateral approach versus the bilateral approach using analytical methods. Mon and Kakinaka (2020), investigate how bilateral and multilateral agreements relate to household income inequality; although they conclude that there is no real evidence on which approach reduces inequality the most. Those that have compared the two approaches, have often used a bargaining model to do so.[6] Aghion et al. (2007) consider whether

[3] For example, Japan is known for having high tariffs, specifically, TRQs on beef (Beckman et al., 2021). This TRQ is often a target in their bilateral agreements, and they often provide better access in each subsequent agreement. Sometimes there is an escalating clause that triggers additional access for an earlier agreement, but this is not always the case.

[4] Regional trade agreements are authorized under the WTO and are encouraged because they might lead to more global multilateral reform. The number of these agreements are over 350 in 2022 (WTO, 2021a).

[5] Gravity models have been the predominate tool to illustrate that trade has largely increased under trade agreements. Some examples include (Baier and Bergstrom, 2007; Baier et al., 2019; Grant and Lambert, 2008). Relative to our work here, however, gravity models typically provide an ex-post approach ex-post approach and provide no insights into the choices a country might make.

[6] As noted in Muthoo (2000), a bargaining model revolves around the situation in which two or more players have a common interest to co-operate but have conflicting interests over exactly how to cooperate.

a country might negotiate trade agreements with subsets of countries or engage in simultaneous multilateral bargaining with all countries at once. Saggiy and Yildiz (2010) use a similar framework but allow all countries to negotiate trade agreements (thus they are not required to choose between joining a single grand coalition with a leading country or staying out), and they allow the formation of multiple agreements.

The previously mentioned papers used bargaining models, but they often exclude any feedback from informing the model. To remedy this, research such as Bagwell et al. (2020); Perroni and Whalley (2000); Saggiy and Yildiz (2010); Yilmazkuday and Yilmazkuday (2014) use an approach referred to as 'Nash in Nash' in that a solution is sought over multiple iterations in which no country is better off, with changes being made based on different model iterations. However, these papers are highly stylized (presenting two-region by two-sector examples, or, at most, three regions or three sectors) and present little evidence on what might happen on a country-by-country basis. In addition, many of them (Ossa 2011; Ossa 2014; Bouët and Laborde 2018) still make some sort of assumption about the Nash equilibrium setup (in these examples, they impose an already known tariff on all countries).

To contribute to the literature on the approach to freer trade, we use the 'Nash in Nash' approach to determine if countries are better off negotiating bilateral trade agreements or in joining a multilateral agreement using an applied general equilibrium model (GTAP), using welfare as our comparison. Using TPP as an example, our model iterates over solutions for bilateral agreements for every combination of traded sectors with every other TPP partner. We assume that the country can negotiate and enter into the bilateral agreement which maximizes its welfare as long as it does not lower the welfare of its partner in the agreement (i.e., every country will accept a deal which does not lower its welfare). In subsequent iterations (i.e., the Nash

aspect), each country reviews its existing bilateral agreements and, depending on the trade agreements that are most beneficial, it may keep the agreements in place, modify them, or even cancel them altogether, again as long as the partner in the agreement is not made worse off. Once we arrive at a Nash equilibrium for the bilateral agreements, we compare the results to one of a multilateral agreement. We also provide a robustness check to our results, using different iterations of the bilateral approach based on different ordering of countries. Another contribution of our work is the use of an applied general equilibrium model to calculate outcomes of the bargaining games. This means that instead of considering broad classes of welfare functions, we were able to solve the bargaining game with specific welfare functions that are implied by the model, including the functions measuring coalition welfare externalities (i.e., welfare implications of other countries concluding a trade agreement for third countries) and the level of coalition superadditivity (i.e., the additional welfare generated by a country joining a trading block).

2. Methodology

In the work most similar work to ours, Aghion et al. (2007) consider sequential versus multilateral bargaining, laying out a game tree and developing some foundation for bargaining and trade agreements. Given that our work is in part a quantitative application to their work we do not develop the theory of bargaining here in detail; but rather provide more information on the practical aspects of our work. To identify a set of bilateral trade agreements among the TPP countries that would be reached by countries acting in their own interest, we formulate and solve an iterative game where each country evaluates all possible bilateral trade agreements with every

other country and enters into such bilateral agreements that maximize its equivalent variation (EV) without making their partners worse off.[7]

The algorithm works as follows: in the first iteration, each region takes turn in deciding on joining a bilateral agreement with every other country among the TPP countries. The order of regions taking turns is fixed as is the order in which every region will be approached, e.g., if a region starts an iteration, it will start all future iteration and it will be the first region to be approached by every other region. We can represent the decision as: region (r) makes an offer of a bilateral agreement with region (s) covering a set of sectors (c) which maximizes region's r EV. We represent the sectors included in trade agreements as a cube (three-dimensional matrix), $T_{r,s,c}$ of ones and zeroes with r, s, c . $T_{r,s,c} = 1$ if sector c is included in the bilateral agreement offered by r to s, otherwise $T_{r,s,c} = 0$. We require that bilateral agreements be symmetrical, e.g., if a sector c is offered to be included in a bilateral agreement between r to s then it will be included in the agreement offered by s to r.

In each iteration, the offering country considers all possible changes to its trade agreements with every other country. We represent the changes to the trade agreements with a three-dimensional matrix B, with offering country, partner country and sector representing the three dimensions. Thus (B) takes three possible values at each cell: 0 to keep the sector in the agreement, -1 to remove a sector from the agreement, and 1 to add a sector to the agreement. Again, we require that changes to agreements be symmetrical, meaning that $T + B$ is

[7] Grossman (2016) notes numerous papers that argue that governments are not motivated by economic concerns but also political concerns.

symmetrical across countries, e.g., if a country proposes removal of a sector from its agreement, its protection will be reinstated by the partner country as well.

In each iteration, the offering country considers all possible B's (changes to the agreement) where its own EV is improved, and the partner's EV is no worse than under the initial state of agreements T; the set of welfare improving Bs is thus:

(1) $B^* = \forall B: EV_{r,T+B} > EV_{r,T} \wedge EV_{s,T+B} \geq EV_{s,T}$

If B^* is not an empty set, the offering country then proposes $\hat{B} \in B^*$ which maximizes its own welfare:

(2) $\hat{B} = \text{argmax}_{B \in B^*} EV_{r,T+B}$

Because $\hat{B}$ does not make the partner country worse off, we assume that this agreement will be accepted.

Finally, once $\hat{B}$ has been accepted, we update the set of trade agreements:

(3) $T = T + \hat{B}$

The following games therefore take into consideration all agreements that have been concluded in the iteration.

Equations (1–2) are ultimately decided based on whether concluding a bilateral agreement leads to greater welfare gains than doing nothing (i.e., keeping the current trade regime). During an iteration, each of the twelve TPP countries evaluates equations (1–2) for all eleven partners, following the same ordering. Because of the inherent asymmetry in equations (1–2) where the first (offering) region seeks the welfare maximizing agreement, while the second region merely accepts anything offered by the first region that does not make it worse off, the equations need to be evaluated 12 x 11 = 132 times. This means that even the country that is last

to negotiate is given the opportunity to offer its own welfare-maximizing bilateral agreements to those countries with which it may have already agreed on different bilateral agreements.

After all the games end in the first iteration, the model continues for additional iterations, under the same assumptions, except the current trade regime now includes the existing bilateral agreements agreed to in the previous iteration. Hence, countries will only adopt new bilateral agreements or modify the existing ones if they maximize the welfare for the first region without making the second region worse off. The Nash equilibrium concept is introduced here in that all regions in the subsequent iterations know what each other is doing—hence they make a participation decision. Countries again make their decisions (going back to step 1), the model concludes at the point when no country benefits by changing their participation decision. The solution obtained from the game is therefore by definition a Nash equilibrium because no country can benefit from changing its strategy when other countries do not change theirs. Using our notation, the set B^* obtained by equation (1) is an empty set for each country. However, because the equilibrium is obtained by countries' taking turns in the same order in each iteration, it is possible that the solution is path-dependent and that multiple Nash equilibria exist for different ordered sets of the negotiating countries.

There are several important restrictions that we included in formulating the game. First, countries are only allowed to consider two possible states for each sector: either a sector is fully included in the bilateral trade agreement, or it is not included, and its tariffs remain unchanged.[8] Second, when countries agree on including a sector in their bilateral trade agreement, its tariff is

[8] This assumption is quite reasonable for the vast majority of sectors, especially for manufacturing where there are only a few instances of a sector being excluded in tariff liberalization (e.g., automobiles or automobile parts). Agriculture is the main exception; hence, our work breaks out agriculture into several different sectors.

reduced to the level that the country indicated during TPP negotiations, and that rate is available to every other country, i.e., if a bilateral agreement is concluded with another country, that country will get the same preferential rates.

Initial tariff rates are noted in Table 1—these provide a range across the sectors and the two largest rates (all bilateral tariffs would require numerous tables, which are available upon request from the authors). Some general trends emerge from this data, which could impact what sectors are included in the bilateral trade agreements. 1st: Brunei, Peru, and Singapore tend to have zero duty rates for most sectors initially. Brunei and Singapore are expected since their small size dictates that they have to be open to trade to keep domestic prices low. The only product that they have a tariff on is processed food, which is the sector that every country in TPP has a tariff on. Peru tends to have low Most Favored Nation (MFN) rates, in general (WTO, 2021b)—and they also have a trade agreement with almost every country in TPP. 2nd: No country has a tariff on services. Jafari and Tarr (2017) note this, and they also calculate NTMs on services, but in this work, we only consider tariffs. 3rd: All countries have a tariff on manufacturing, except for Singapore. Australia and New Zealand tend to have their highest tariffs on manufacturing. 4th: Dairy is heavily protected by many countries. As noted in Beckman et al. (2017), dairy, along with rice and sugar, TRQs have been maintained in the WTO, which has led to relatively higher tariffs compared to other sectors. 5th: Tariffs on agricultural products tend to be much higher than those for manufacturing. Beckman (2021) notes that only twelve out of 114 countries had a lower average tariff on agriculture compared to non-agriculture—and 10 of those twelve have very low tariffs on both sectors.

The TPP rates are noted in Table 2 and indicate that most tariff rates would have been reduced to zero. Most protection that was to remain was in agriculture, the exception being

manufacturing in Japan. The tariff in this sector of 9.03 percent is largely because of the tariff on petroleum/coal products. For those remaining sectors with tariffs, Canada's dairy and Japan's rice and beef tariffs are the most prominent, but apart from Japan's rice, they do represent improvements on the initial rates (which were 50 and 35 percent in the highest instances). One other consideration is that many of the TPP countries had bilateral trade agreements with each other (or a regional agreement, in the case of the North American Free Trade Agreement (NAFTA)), but tariff rates still existed on many sectors. TPP would have replaced many of these with duty-free access.[9]

To make our framework operational, we use the latest (version 11) GTAP database and GTAP model to evaluate each bilateral trade agreement's impact.[10] In our scenario, we consider twelve countries (those that were part of the TPP) out of fifteen regions included in the model, and ten sectors (see Appendix 1 and 2 for the regions and sectors in the model). The smaller number of sectors is required to limit the number of possible bilateral trade agreements for each country to consider and to save computing time—the maximum number of unique bilateral trade agreements that each country must evaluate is 1,024 if each sector can be further liberalized.

[9] One other point regarding the initial/final rates and existing trade agreements is that the experiment takes the rates as is, without any information regarding existing trade agreements. The results that we present could be viewed as being indicative that a country would not have such an agreement if presented with the option again, or no more trade could be gained--since tariffs are likely lower than MFN in the initial set up. We think if a bilateral pair is not selected, it is more likely the case of the latter.

[10] The model we use assumes perfect competition and constant returns to scale. Our implications could be sensitive to different types of market structure, i.e., Armington vs monopolistic competition or Melitz vs Ricardian; but we are confident in that the overall result would hold. Future work could test this assumption, perhaps using the information that the monopolistic competition setup provides information on gains from trade (Feenstra, 2018; Krugman, 1979); or the breakdown of allocative efficiency offered by Holmes et al. 2014; or the finding that in the Armington model all adjustments take place on the consumption side, while in other models, adjustments are also made in labor (Arkolakis et al., 2012).

3. Modeling Results

3.1 Bilateral Agreements in TPP

As mentioned before, the model goes through several iterations to reach the equilibrium. At each new iteration, countries know what other countries are doing, and they can alter their welfare maximizing decision. For one scenario of a particular ordering of countries whose results we describe here, it takes 20 iterations to arrive at the final solution—as there are changes in each iteration before that, and the algorithm stops when there are no more changes. First, we note that there is an increase in welfare for TPP partners of $24.5 billion (in the final Nash solution). Despite the increase in total welfare for the TPP countries, some countries have a decrease in welfare in this simulation—Brunei, Malaysia, and the USA (Table 3).[11] These three countries all have an increase in their exports but examining the welfare results in detail can provide information on the welfare loss. Welfare is broken out into three components in our model (Beckman, 2021): allocative efficiency—an optimal distribution of goods and services—which involves the redistribution of resources to other sectors; terms of trade (ToT), which is the ratio of export prices to import prices for a region; and investment, how well a region can attract foreign investment, based on the profitability of the region given the change in scenario. As noted in the first column of Table 3, all TPP countries have an increase in allocative efficiency—the increase is highest for Japan, indicating that trade agreements lead Japan to reallocate resources to more efficient producing sectors. ToT effects are mixed. In general, ToT effects globally will be around zero—the total impact for TPP countries is positive ($12.9 billion),

[11] Gilbert et al. (2018) also estimate that some countries would experience welfare losses—and similar to our result, Japan and Vietnam are among the countries that have the largest welfare gains. Even though these countries are estimated to have a loss in welfare, the loss would be greater if they do not join TPP.

indicating that the rest of the world not involved in TPP loses welfare from this measure. But within the TPP countries, some countries have a ToT loss. This drives the total loss for Brunei, Malaysia, and the USA. The impact is relatively small except for the latter, investigating further indicates that the USA has a loss from a decrease in the price of their manufacturing and services exports. Note that Japan is also estimated to have a decrease in their ToT, but the larger increase in allocative efficiency outweighs this loss. The change in welfare from investment is relatively small.

Chile has the biggest welfare increase, and at the same time, the largest decrease in total exports. This result is largely because they have a large decrease in exports (and production) of almost every sector except for the resources sector. There, they have an increase in exports of 38 percent, which coupled with an increase in the price of their resources, leads to the large welfare gain. Thus, the bilateral agreements seem to encourage a shift in production/trade focus for Chile—which bilateral agreements are now discussed.

Table 4 presents the results for what sectors and what countries have bilateral trade agreements for the initial simulation. This initial simulation is when countries have exclusive access to their potential bilateral trade partner's market. There are 66 potential bilateral agreements that could be reached, and 9 sectors which these bilateral agreements could cover. First, note that results indicate that no bilateral agreement would include tariff reform in all 9 sectors. The most is 7 sectors in the Mexico-New Zealand agreement. There are 5 other additional agreements that cover 6 sectors (Australia-Canada, Australia-Mexico, Australia-USA, Canada-Singapore, and Japan-New Zealand). In total there is the possibility for a trade agreement covering 66*9=594 sectors/partners, but the results only indicate that agreements would be in place for 110 (so, less than 20 percent of the total sectors/partners would be

covered). And results indicate that one country (Malaysia) would not enter in an agreement with any other TPP partner. The model indicates that the USA would only enter into an agreement with Australia—a country that they already have an agreement with. The model indicates that Australia would enter into the most trade agreements—with all countries except for Malaysia and Singapore.

The final Nash solution indicates some differences from the initial scenario in terms of sectors/partners (Table 5), indicating that countries change their decision based on what others are doing (the specific welfare-CGE results presented before in Table 3 are based on this final Nash solution, rather than the initial solution). The first thing to notice is that there are more agreements than what occurred in the initial iteration. That is, in the first iteration, the model estimates that just a little over half (34 of the 66 possibilities) of the bilateral agreements would not take place. In the Nash equilibrium, there are only 12 instances where a bilateral agreement does not take place. Thus, once regions are aware that others are making agreements, they make similar agreements so that they do not lose more welfare from not doing anything. There are 11 instances where a bilateral agreement features only tariff reform of a single sectors; but many of the agreements feature reform for several sectors. There are 17 instances of agreements including at least half of the sectors.

Finally, we note that there are some sectors that tend to be included in the bilateral agreements more than others (and likewise, those that are not often included). Figure 1 presents those sectors that are included in a bilateral trade agreement, for both the initial simulation and the final Nash equilibrium. First, note that those sectors with the highest average tariff across all TPP countries tend to be those included in trade agreements the least. Those are the agricultural sectors: cbf (beef), dai (dairy), and ric (rice). These three sectors also tend to have the largest

increase in inclusion in trade agreements between the initial and the Nash solution—indicating that as more countries get access, more countries join so that they also receive access. For example, rice was only included once in the first iteration, and 6 times in the final iteration. Apart from having one of the three highest initial tariffs, rice was also the highest tariff for all of the instances where it was reformed in the Nash scenario—often involving Malaysia. Second, those instances that tend to be included in bilateral agreements the most, also tend to have the highest trade values. Mfg (manufacturing) is the sector included in the most agreements for both the initial and the Nash solutions, and its trade value is more than 3 times that of all the other sectors combined (except for services, which, since there is no change in the tariff, is not considered). The two other sectors with the largest trade values (res (resources) and pfd (processed food)) are the also the sectors that are included the 2nd and 3rd most across both the initial and Nash solutions.

3.2 Multilateral Agreement Results

To address the question of bilateral versus multilateral agreements, we also discuss the results for the multilateral simulation (i.e., TPP). First, note that the multilateral agreement with all the TPP countries would lead to an increase in their welfare by $27.4 billion (Figure 2). This is depicted as the red line in the figure. (The simulations noted in the figure represent further scenarios that we undertake, as will be explained later.) This welfare increase is higher than that for the bilateral case—indicating that (at least in the case of TPP), a multilateral agreement leads to a larger welfare than that for bilateral agreements.[12] But, as noted in Table 3, welfare is not always

[12] Although many of the TPP studies in the literature consider complete tariff liberalization, Gilbert et al. (2018) notes that excluding some products leads to a drastic cut in trade gains—in particular, for agriculture. Their results, excluding liberalization in sensitive products are echoed here as not all sectors are liberalized in each agreement.

greater for each individual country. The difference is only $1 million for Brunei, but the USA (a difference of $1 billion), Mexico (a difference of $170 million) and Malaysia (a difference of $21 million) all have sizeable differences between bilateral and multilateral agreements. The largest welfare difference occurring for the USA suggests that their bilateral approach to TPP could have been warranted.

Table 3 also breaks down the welfare change by type, which sheds some light into why the USA has a larger welfare decrease. Again, the USA has an increase in allocative efficiency, but also a larger decrease in ToT. The ToT decrease is despite the USA having the largest increase in exports (tied with Vietnam), as the sectors that they are exporting more of have a decrease in their export price. In addition to the larger decrease in welfare from ToT, the USA also has a larger decrease in welfare from investment in the multilateral scenario.

In terms of countries who gain the most from a multilateral agreement, Japan now has the largest welfare increase (as the ToT result is basically flipped). Japan had previously entered into a large number of bilateral agreements (covering more than half of the sectors), but the multilateral agreement that forces reform in almost every sector (except for rice, beef, and manufacturing) leads to greater welfare gains. The two countries with the next largest welfare under the multilateral agreement have very little change from the bilateral agreements. Canada ($484 million) and Singapore ($231 million) are the countries that gain the most in terms of multilateral versus bilateral agreements.

3.3 What if countries negotiate their bilateral trade agreements in a different order?

The previous scenario specified the order of countries deciding on a bilateral agreement using an alphabetical order—so Australia would be first, followed by Brunei and so on (the exception is

that the USA was last, not Vietnam). We conduct alternative scenarios that ask if the results would differ if the order is different. Although this is more a computational exercise, it could mimic real world behavior where bilateral agreements are entered into at different times, with no specified order. For example, Japan might have a trade agreement with Australia first, then enter into an agreement with the USA later. The purpose of this exercise is to effectively say whether welfare under bilateral agreements could ever be more than that for a multilateral agreement using multiple combinations of bilateral agreements.

The number of potential bilateral agreements based on rearranging the ordering is vast—thus we conduct a scenario where we run the simulation with the original order in reverse (this is the second column in Table 6), and also a sampling of orders randomly selected (the rest of Table 6). First, Figure 2 presents the welfare results for these bilateral agreements—the figure displays simulations by increasing welfare. As noted, although welfare is higher in many of the simulations relative to the initial bilateral equilibrium, it never exceeds that for the multilateral scenario.

Rather than examining the results of each of these scenarios, to illustrate how the ordering of countries could affect the results, we explain the results from the reverse order scenario. Table 6 presents the results for this scenario, with welfare decomposed as was before. First, notice that even though the USA is now selecting trade agreements first (rather than last in the initial scenario), they still have a decrease in welfare—and again, the largest decrease in welfare. And, the model indicates that the welfare loss for the USA is even larger in this scenario, -$2.4 billion compared to -$2.1 billion. The model estimates that the USA would enter into more bilateral trade agreements if the order is reversed (with every country except for Vietnam), which indicates that they are receiving benefits, since the alternative is to have less

trade agreements (but, they are hampered even more by even lower export prices). Results are available upon request in terms of what countries and what sectors form bilateral agreements, but we do note that the USA and Vietnam would have the largest number of individual agreements—suggesting that the order does play an important role into bilateral trade agreements.

There are 51 bilateral agreements when the order is reversed (in the final Nash equilibrium). This compares to 54 in the initial scenario. And again, many of the agreements feature multiple sectors being included—more than half (30) of the agreements have 5 or more sectors included. This is an increase to the initial scenario. Finally, we note that the regions with the largest welfare gains are largely the same—Chile, Japan, and Vietnam.

Although presenting the results for all of the possible scenarios is not possible, there are some overall observations that can be gleamed. These largely revolve around what happens to the agricultural sector in the TPP scenario. As mentioned before, agriculture tends to have higher tariffs in place than non-agriculture. In addition, the majority of TRQs in place are on agricultural products, and often feature very high over-quota rates that effectively prohibit imports beyond the quota (Beckman et al., 2021). Finally, Li and Beghin (2012) note that NTMs tend to be in place on agricultural products more than non-agriculture; and Beckman and Arita (2017) note that NTMs and TRQs often coexist in the most sensitive agricultural sectors, combining to restrict trade. As such, agricultural sectors that are known to be sensitive and

highly protected (e.g., beef and dairy) are featured in our model to see if they would be liberalized.[13]

Across the 10 simulations that we conducted; the following were the set of bilateral pairs/sectors that were liberalized the least often:

- Dairy from Singapore to Canada (tariff of 46 percent), never liberalized;
- Cattle/beef from Australia to Japan (tariff of 26 percent), never liberalized;
- Cattle/beef from Canada to Japan (tariff of 24 percent), never liberalized;
- Cattle/beef from New Zealand to Japan (tariff of 24 percent), never liberalized;
- Dairy from USA to Canada (tariff of 30 percent), liberalized in 40% of the simulations.

And finally, the last bit of information relates back to Figure 1. We estimate that the probability of including a sector in an agreement is correlated with its tariff (the correlation is 0.34). Of course, the tariff goes both ways, just including the larger tariff leads to a higher correlation (0.44). Although the correlation is strong, as noted in Figure 1, the tariff tends to be lower for sectors that are high value, and these are the sectors that have the largest increases.

3.4 Do bilateral trade negotiations always conclude?

The algorithm that we used to simulate a series of bilateral trade negotiations results in a set of discrete outcomes because countries are not allowed to negotiate tariff rates, only which sectors they would like to include in the agreement. The discrete nature of welfare outcomes creates a possibility that during iterations of negotiations, countries may not reach a stable equilibrium but

[13] One interesting point regarding the disaggregation of agriculture, is that if agriculture is considered in the aggregate—as what has been done in the past with these Nash in Nash models (for simplification reasons), the USA actually has a positive increase in their welfare under the bilateral agreements. This is because a high level of aggregation allows for a lot of substitution (since everything is included in the sector), and there are not the individual nuances of the sensitive sectors that the USA does not get access to when the sectors are disaggregated.

instead will keep negotiating around the equilibrium point in circles.[14] However, even if a stable equilibrium (end to the game) may not always be reachable, because of the extreme large number of discrete choices of sectors and partner regions, the negotiations should converge to a very narrow band of outcomes.

In our simulations, we encountered only once a simulation that did not reach a stable equilibrium. Instead, during simulations after iteration 19, countries found themselves with the same set of bilateral trade agreements as in iteration 13. Even though there were small differences between the agreements reached in iterations 13–19, each iteration differed from all others by at most four sectors across all bilateral agreements. Even more importantly, the total welfare gain of the agreements moved in a very narrow band of welfare gains between $25,957,262,317 and $25,957,255,100 (difference of $7,217).

3.5 Do multilateral agreements always generate more welfare?

In general, all the results presented thus far indicate that a multilateral agreement generates more welfare than bilateral agreements. Next, we address if this is always the case—based on the concept of superadditivity. To establish conclusively whether a multilateral agreement is always better than a set of bilateral ones, we would need to evaluate each possible bilateral agreement. Because there are tens of thousands of possible agreements under our model set up (twelve countries, ten sectors), such a task is beyond our current computational power.

Instead of evaluating each possible bilateral agreement, we instead explore a weaker proposition that removing a single sector between two countries from a multilateral agreement

[14] This is also sometimes the case in actual negotiations. For example, in TPP, dairy negotiations were circular with New Zealand and the USA looking for more access from Canada, Mexico, and the USA (for New Zealand), prolonging negotiations (Successful Farming, 2015).

can improve welfare. If this is, in fact, true, then we can conclude that a multilateral agreement, such as TPP, does not exhibit superadditivity since more welfare may be achieved by excluding parts of trade from the agreement. Finding the opposite would not allow us to draw any conclusions, however. To answer this question, we only needed to run 660 simulations where one sector/exporter/importer component is excluded from the multilateral agreement. In 80 of these cases, we found that the exclusion increased welfare. Although the change is usually small, in one case, welfare was increased by $71 million. Thus, we cannot always conclude that a multilateral agreement will always generate more welfare.

Finding that excluding parts of trade from a multilateral agreement can occasionally be welfare improving, we then turn to the important question whether such exclusions could actually be negotiated as a part of the bargaining game that we introduced earlier. To see which of the 80 cases of welfare would be implemented, we calculate the welfare gains to the countries that would need to negotiate these exemptions; we find that only in eight cases, the exemptions would be mutually beneficial and therefore agreed upon in our bargaining game while the 72 of remaining exemptions would either benefit third countries only or would not benefit both partners and therefore would not be agreed.

Although we find that superadditivity does not hold for the TPP agreement represented by the model at the most granular, bilateral sector level, we consider whether weaker forms of superadditivity may still hold, specifically the superadditivity of countries and superadditivity of sectors (i.e., removing any country/sector makes the combined welfare come down or, at most, remain unchanged). To verify superadditivty of countries, we calculate welfare of 66 simulations where entire trade is excluded between two countries; we find that superadditivity holds at the

country level.[15] We also find that superadditivity holds for sectors by running ten simulations excluding one sectors from the bilateral agreement.

While our findings are by no means surprising, they serve as an important reminder that the analysis of multilateral, multisector trade agreements in an environment of numerous domestic and global connections (including our representation of the world economy with an applied general equilibrium model) cannot be perfectly approximated by stylized assumptions. While multilateral and more comprehensive trade liberalizations tend to be welfare improving, small exceptions are possible.

4. Conclusions

The number of global trade agreements continue to increase, and in the absence of a large-scale multilateral agreement in the WTO, these trade agreements have either been bilateral or with more than two countries. Previously, the debate between which path to take for more global trade was between the bilateral approach and WTO multilateral agreements; but the path taken by the U.S. in the Trans-Pacific Partnership (pursuing bilateral agreements rather than the multilateral approach), has led to a debate between the non-WTO approaches. Using a Nash in Nash setup in an applied general equilibrium model, our work provides, perhaps, the first definitive proof that a multilateral, regional trade agreement is generally more welfare enhancing for all parties. But our results show that if countries are left to negotiate their own bilateral agreements, they most frequently stop at some point where they maximize their own EVs and any further liberalization is not possible (no country benefits from altering its agreements). Each of the simulations shows

[15] This is what Aghion et al. (2017) consider in their paper--they do not prove superadditivity has to hold but conclude that free trade follows if it does hold.

how far the countries would get with respect to full liberalization. We never observe that they reach a multilateral agreement, and that gap depends on which countries lead the negotiations.

Interestingly, we also find that the multilateral TPP agreement would not be the most welfare maximizing trade liberalization option. Even though the collective welfare of the TPP countries cannot be increased by removing any single country or any single sector from the agreement, a handful of sectors would be exempted from the TPP agreement at bilateral level benefiting collective welfare and the welfare of the bilateral partners. But we note that the limited number of paths to reach higher welfare in the bilateral scenarios (and the fact that welfare differences are small) dictates that countries might be better off (in terms of time to negotiate the bilateral agreements) starting from the multilateral agreement and excluding certain sectors (which are often the sensitive agricultural sectors in trade negotiations) than trying to reach the welfare-optimal path with bilateral agreements.

Although the primary motivation for this work was to examine if bilateral agreements could lead to more welfare than a multilateral agreement such as TPP, our work makes several other contributions to the literature.

- Results indicate that more bilateral agreements (and covering more sectors) leads to a welfare result closest to the regional, multilateral result.
- Some agricultural sectors remain heavily protected, even if TPP had taken place (in particular, dairy, beef, and rice).
- The 'Nash' aspect of our Nash in Nash simulations highlights that countries will alter their decisions based on what others do when negotiating trade agreements.

- Countries might have a decrease in welfare in a multilateral agreement (or even bilateral agreement). But they would likely lose more if they do not join—as they would completely miss any sort of liberalization and have trade diversion.
- Much like in the real world, our results indicate that the ordering of countries in negotiating trade agreements matter when selecting which bilateral trade agreements they join. I.e., there is a 'first-mover' effect. This could be based on access already granted in previous agreements, or due to the amount of access a country might gain (i.e., if there are no competitors).[16]

Although our work provides evidence on the welfare differences between bilateral and multilateral agreements, there are further refinements that could be made to the process. For example, work could calculate the impacts of all the different potential ordering to be complete, although the computational requirements are difficult. Work could also be done to examine other trade agreements, perhaps comparing bilateral versus a WTO multilateral result—but again, this is computationally intensive. Also, while we focus on welfare as our measuring stick, other measures, such as GDP or trade could be used to compare trade agreements.

While the methods presented here offer a useful strategy for a country deciding what agreements to pursue and what sectors to include we note the political economy nature of trade agreements presents interesting hurdles both in negotiating trade agreements and in modeling them. Grossman and Helpman (1995), Bagwell and Staiger (1999), and Maggi and Rodríguez-Clare (2007) present models related to trade agreements and political pressure. Lake and

[16] It would be interesting to revisit the seminal work from Baier and Bergstrand (2004) on endogenous adoption of FTAs to see if their framework might say something about determining the first mover in agreements; or the 'defensive FTAs' argument by Baldwin and Jaimovich (2012).

Millimet (2016) note that even if a trade agreement would generate net welfare gains for a country as a whole, the distributional impacts could undermine the political viability of the agreement. And Celik et al. (2013) constructed a model of legislative trade policy-making in the realm of distributive politics that shows that legislators may vote for a bill that makes their constituents worse off. These all indicate that understanding the process of trade policy formation is undoubtably an ongoing process.

Finally, we would like to note that the results obtained in our work are based on our applied general equilibrium model and its assumptions, which include Armington's assumption of import differentiation. The welfare calculations of trade agreements are therefore heavily influenced by the Armington substitution elasticities, which influence the amount of welfare lost to trade restrictions. Replicating the results of our work with different model assumptions could provide insight into the sensitivity of our results to the model assumptions.

References

Aghion, Philippe, Pol Antras, and Elhanan Helpman. 2007. Negotiating free trade. *Journal of International Economics*, 73(1), 1-30.

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare. 2012. New trade models, same old gains? *American Economic Review*, 102(1), 94-130.

Bagwell, Kyle, and Robert Staiger. 1999. An economic theory of GATT. *American Economic Review*, 89(1), 215–48.

Bagwell, Kyle, Robert Staiger, and Ali Yurukoglu. 2020. "Nash-in-Nash" tariff bargaining. *Journal of International Economics*, 122, 1-11.

Baier, Scott, and Jeffrey Bergstrand. 2004. Economic determinants of Free Trade Agreements. *Journal of International Economics*, 64, 29-63.

---. 2007. Do free trade agreements actually increase members' international trade? *Journal of International Economics,* 71(1), 72–95.

Baier, Scott, Yoto Yotov, and Thomas Zylkin. 2019. On the widely differing effects of free trade agreements: Lessons from twenty years of trade integration. *Journal of International Economics,* 116, 206–226.

Baldwin, Richard, and Dany Jaimovich. 2012. Are free trade agreements contagious? *Journal of International Economics*, 88, 1-16.

Beckman, Jayson. 2021. Reforming market access in agricultural trade: Tariff removal and the Trade Facilitation Agreement. Economic Research Report Number 280, United States Department of Agriculture.

Beckman, Jayson, and Shawn Arita. 2017. Modeling the interplay between sanitary and phytosanitary measures and tariff-rate quotas under partial trade liberalization. *American Journal of Agricultural Economics,* 99(4), 1078-95

Beckman, Jayson, John Dyck, and Kari Heerman. 2017. The global landscape of agricultural trade, 1995-2014. Economic Information Bulletin Number 181, United States Department of Agriculture.

Beckman, Jayson, Fred Gale, and Tani Lee. 2021. Agricultural market access under tariff-rate quotas. Economic Research Report Number 279, United States Department of Agriculture.

Beckman, Jayson, Munisamy Gopinath, and Marinos Tsigas. 2018. The impacts of tax reform on agricultural households. *American Journal of Agricultural Economics*, 100, 1391–406.

Bouët, Antoine, and David Laborde. 2010. Why Is the Doha Development Agenda Failing? And What Can Be Done? A Computable General Equilibrium–Game Theoretical Approach. *The World Economy,* 33(11), 1486-516.

Burfisher, Mary, John Dyck, Birgit Meade, Lorraine Mitchell, John Wainio, Steven Zahniser, Shawn Arita, and Jayson Beckman. 2014. Agriculture in the Trans-Pacific Partnership. Economic Research Report Number 176, United States Department of Agriculture.

Celik, Levent, Bilgehan Karabay, and John McLaren. 2013. Trade policy-making in a model of legislative bargaining. *Journal of International Economics*, 91, 179-190.

Feenstra, Robert. 2018. Restoring the product variety and pro-competitive gains from trade with heterogeneous firms and bounded productivity. *Journal of International Economics*, 110, 16-27.

Gilbert John, Taiji Furusawa, and Robert Scollay. 2018. The economic impact of the Trans-Pacific Partnership: What have we learned from CGE simulation? *The World Economy*, 41(3), 831-865.

Grant, Jason, and Dayton Lambert. 2008. Do regional trade agreements increase members' agricultural trade? *American Journal of Agricultural Economics*, 90(3), 765–782.

Grossman, Gene. 2016. The purpose of trade agreements. NBER Working Paper No. 22070, the National Bureau of Economic Research.

Grossman, Gene, and Elhanan Helpman. 1995. The politics of free-trade agreements. *American Economic Review*, 85(4), 667-690.

Holmes, Thomas, Wen-Tai Hsu, and Sanghoon Lee. 2014. Allocative efficiency, mark-ups, and the welfare gains from trade. *Journal of International Economics*, 94, 195-206.

International Trade Commission. 2021. MAcMap: Market access map. Database.

Jafari, Yaghoob, and David Tarr. 2017. Estimates of ad valorem equivalents of barriers against foreign suppliers of services in eleven services sectors and 103 countries. *The World Economy*, 40(3), 544-573.

Krugman, Paul. 1979. Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9, 469-479.

Lake, James, and Daniel Millimet. 2016. An empirical analysis of trade-related redistribution and the political viability of free trade. *Journal of International Economics*, 99, 156-178

Li, Yuan, and John Beghin. 2012. A meta-analysis of estimates of the impact of technical barriers to trade. *Journal of Policy Modeling*, 34(3), 497-511.

Maggi, Giovanni, and Andrés Rodríguez-Clare. 2007. A political-economy theory of trade agreements. *American Economic Review*, 97(4), 1374-1406.

Marchand, Beyza. 2017. How does international trade affect household welfare? *IZA World of Labor*.

Mon, Yi Yi, and Makoto Kakinak. 2020. Regional trade agreements and income inequality: Are there any differences between bilateral and plurilateral agreements? *Economic Analysis and Policy*, 67, 136-153.

Muthoo, A. 2000. A non-technical introduction to bargaining theory. *World Economics*, 1(2), 145-166.

Ossa, Ralph. 2011. A "new trade" theory of GATT/WTO negotiations. *Journal of Political Economy*, 119(11), 122–152.

---. 2014. Trade wars and trade talks with data. *American Economic Review*, 104(12), 4104-46.

Perroni, Carlo, and John Whalley. 2000. The new regionalism: trade liberalization or insurance? *Canadian Journal of Economics*, 33(1), 1-24.

Petri, Peter, and Michael. Plummer. 2016. The economic effects of the Trans-Pacific Partnership: New estimates. Peterson Institute for International Economics, Working Paper 16-2.

Richter, Anna. 2014. Doha Development Round: Why did it fail? Anchor Academic Publishing.

Saggi, Kamal, and Halis Yildiz. 2010. Bilateralism, multilateralism, and the quest for global free trade. *Journal of International Economics*, 81(1), 26-37.

Sikdar, Chandrima, and Kakali Mukhopadhyay. 2017. Economy-wide impact of TPP: new challenges to China. *Journal of Economic Structures*, 22.

Successful Farming. 2015. TPP trade agreement finalized after dairy talks. Available at: https://www.agriculture.com/news/business/tpp-trade-agreement-finalized-after_5-ar50567

Wharton. 2017. Bilateral or Multilateral: Which Trade Partnerships Work Best? Available at: https://knowledge.wharton.upenn.edu/article/bilateral-multilateral-trade-partnerships-work-best/

Williams, Brock. 2018. Bilateral and regional trade agreements: Issues for Congress. Congressional Research Service, R45198.

World Trade Organization (WTO). 2021a. “Regionalism: friends or rivals?”

---. 2021b. “World tariff profile.”

Yilmazkuday, Demet, and Hakan Yilmazkuday. 2014. Bilateral versus multilateral free trade agreements: A welfare analysis. *Review of International Economics*, 22(3), 513–535.

Table 1: Initial Tariffs for the TPP Countries (ranges, the sectors with highest rates of protection are listed)

	Australia	Burnei	Canada	Chile	Japan	Malaysia	Mexico	New Zealand	Peru	Singapore	Vietnam	USA
Australia	0-2 (mnf: 2)	0-2 (pfd: 2)	0-4 (ocr: 4; dai: 2)	0	0-26 (dai: 26; cbf: 26)	0-40 (ric: 40; pfd: 12)	0-16 (pfd: 16; cbf: 15)	0	0-6 (cbf: 6; pfd: 2)	0	0-7 (pfd: 7; res: 4)	0-3 (pfd: 3; dai: 1)
Burnei	0	0	0-13 (pfd: 13)	0	0-1 (pfd: 1)	0	0-3 (mnf: 3)	0	0-3 (mnf: 3)	0	0-1 (res: 1)	0-9 (mnf: 9)
Canada	0-2 (pfd: 2; mnf: 2)	0-5 (pfd: 5)	0	0-6 (dai: 6)	0-24 (cbf: 24; res: 19)	0-2 (mnf: 2; pfd: 2)	0-2 (pfd: 2)	0	0-1 (pfd: 1)	0	0-12 (cbf: 12; oag: 11)	0-5 (dai: 5; pfd: 1)
Chile	0	0	0	0	0-53 (res: 53; dai: 29)	0-6 (pfd: 6; res: 2)	0	0	0	0	0-15 (pfd: 4; res: 11)	0
Japan	0-6 (mnf: 6)	0-3 (pfd: 3)	0-8 (dai: 8; pfd: 4)	0-2 (res: 2; pfd: 1)	0	0-40 (ric: 40; pfd: 6)	0-18 (cbf: 18; oag: 8)	0-5 (dai: 5; mnf: 5)	0-4 (res: 4; mnf: 2)	0	0-18 (ric: 18; dai: 12)	0-19 (dai: 19; ric: 5)
Malaysia	0	0	0-8 (dai: 8; pfd: 2)	0	0-22 (dai: 22; pfd: 3)	0	0-8 (oag: 8; pfd: 7)	0	0-4 (oag: 4; mnf: 3)	0	0-1 (res: 1; mnf: 1)	0-6 (dai: 6; oag: 2)
Mexico	0-5 (mnf: 5; ocr: 2)	0	0-4 (dai: 4)	0-5 (dai: 5)	0-24 (cbf: 24; res: 12)	0-14 (pfd: 14; mnf: 2)	0	0-4 (ocr: 4; mnf: 3)	0-1 (res: 1)	0-21 (pfd: 21)	0-11 (pfd: 11; oag: 11)	0
New Zealand	0	0	0-6 (dai: 6; oag: 2)	0	0-27 (dai: 27; cbf: 20)	0-1 (pfd: 1; mnf: 1)	0-18 (pfd: 18; cbf: 12)	0	0-6 (res: 6; omt: 3)	0	0-6 (pfd: 6; cbf: 4)	0-18 (oag: 18; dai: 9)
Peru	0-3 (mnf: 3; omt: 2)	0	0	0	0-11 (res: 11; pfd: 2)	0-3 (res: 3; ocr: 3)	0-1 (oag: 1; res: 1)	0-3 (mnf: 3; res: 2	0	0	0-22 (res: 22; oag: 11)	0-1 (pfd: 1)
Singapore	0	0	0-46 (dai: 46; pfd: 12)	0	0-22 (dai: 22; pfd: 11)	0-37 (pfd: 17; ric: 20)	0-11 (mnf: 11; oag: 10)	0	0	0	0-13 (pfd: 13; res: 2)	0
Vietnam	0	0	0-6 (mnf: 6; ocr: 2)	0-3 (ric: 3)	0-18 (dai: 18; pfd: 1)	0-20 (ric: 20; pfd: 7)	0-17 (oag: 17; pfd: 15)	0-1 (mnf: 1)	0-3 (mnf: 3; oag: 2)	0	0	0-7 (mnf: 7; ric: 5)
USA	0-1 (mnf: 1)	0-6 (pfd: 6)	0-30 (dai: 30; pfd: 3)	0	0-35 (pfd: 9; dai: 26)	0-40 (ric: 40; pfd: 20)	0	0-3 (res: 3; mnf: 3	0	0	0-11 (cbf: 11; pfd: 7)	0

Source: ITC, 2021

Note: Cbf represents beef, dai represents dairy, mnf represents manufacturing, oag represents other agriculture, ocr represents other crops, omt represents other meat, pfd represents processed food, res represents resources, ric represents rice. Importers are columns, exporters are rows.

Table 2: Final Tariffs Negotiated Under the TPP

	Australia	Burnei	Canada	Chile	Japan	Malaysia	Mexico	New Zealand	Peru	Singapore	Vietnam	USA
Rice	0	0	0	0	243.25	0	0	0	0	0	0	0
Other crops	0	0	0	0	0	0	0	0	0	0	0	0
Other agriculture	0	0	0	0	0.00	0.00	0	0	0	0	0	0
Beef	0	0	0	0	4.77	0	0	0	0	0	0	0
Other meat	0	0	0.00	0	0.00	0	0	0	0	0	0	0
Dairy	0	0	23.87	0	0	0	0	0	0	0	0	0
Processed food	0	0	0.09	0	0	0.00	0	0	0	0	0.00	0
Resources	0	0	0	0	0.00	0	0	0	0	0	0	0
Manufacturing	0	0	0.00	0	9.08	0.00	0	0	0	0	0	0
Services	0	0	0	0	0	0	0	0	0	0	0	0

Source: ITC, 2021

Note: A '0.00' refers to the presence of a tariff in the sector; however, aggregating all the products within the sector leads to a final tariff that is not different than zero.

Table 3: CGE Results from the Scenario Comparing Bilateral with a Multilateral Agreement

	Bilateral Agreements				Multilateral Agreement			
	Welfare ($ million)				Welfare ($ million)			
	Allocative efficiency	Terms of Trade	Investment	Total	Allocative efficiency	Terms of Trade	Investment	Total
Australia	547	658	-14	1,191	547	680	-17	1,210
Brunei	0	-111	37	-73	0	-112	37	-75
Canada	221	1,162	6	1,388	340	1,498	35	1,873
Chile	263	9,050	148	9,461	263	9,083	150	9,496
Japan	9,286	-1,716	260	7,830	9,569	-1,279	451	11,299
Malaysia	250	-310	3	-57	257	-333	-3	-79
Mexico	139	807	-71	875	122	636	-53	705
New Zealand	28	294	-15	308	46	315	-14	347
Peru	3	147	-10	140	3	169	-10	164
Singapore	244	685	-45	884	323	852	-59	1,116
Vietnam	504	4,058	20	4,581	505	3,860	22	4,387
USA	442	-1,847	-648	-2,053	478	-2,557	-975	-3,053

Table 4: Bilateral Partnerships from the First Iteration of the Bilateral Scenario

	Australia	Burnei	Canada	Chile	Japan	Malaysia	Mexico	New Zealand	Peru	Singapore	Vietnam	USA
Australia	---	---	---	---	---	---	---	---	---	---	---	---
Burnei	mnf, pfd	---	---	---	---	---	---	---	---	---	---	---
Canada	dai, mnf, oag, ocr, pfd, res		---	---	---	---	---	---	---	---	---	---
Chile	mfn, pfd			---	---	---	---	---	---	---	---	---
Japan	mnf, res		mnf, res	mnf, res	---	---	---	---	---	---	---	---
Malaysia						---	---	---	---	---	---	---
Mexico	cbf, mnf, ocr, omt, pfd, res		oag, res	dai	oag, ocr, omt, pfd, res		---	---	---	---	---	---
New Zealand	res		mnf, oag, ocr, omt, res	mnf	dai, oag, ocr, omt, pfd, res		cbf, dai, mnf, oag, omt, pfd, res	---	---	---	---	---
Peru	mnf, omt, pfd, res				oag, ocr, pfd, res		mnf, oag, pfd, res	mnf, ocr, omt, pfd, res	---	---	---	---
Singapore			mnf, oag, ocr, omt, pfd, res	mnf	dai, omt, pfd, res		mnf, oag, omt, pfd, res		mnf, pfd	---	---	---
Vietnam	mnf		cbf, mnf, oag	mnf, omt, ric	dai, oag, pfd, res		mnf, oag, omt, pfd	mnf	mnf, oag		---	---
USA	dai, oag, mnf, omt, pfd, res											---

Note: Cbf represents beef, dai represents dairy, mnf represents manufacturing, oag represents other agriculture, ocr represents other crops, omt represents other meat, pfd represents processed food, res represents resources, ric represents rice.

Table 5: Bilateral Partnerships from the Last Iteration of the Bilateral Scenario

	Australia	Burnei	Canada	Chile	Japan	Malaysia	Mexico	New Zealand	Peru	Singapore	Vietnam	USA
Australia	---	---	---	---	---	---	---	---	---	---	---	---
Burnei	pfd	---	---	---	---	---	---	---	---	---	---	---
Canada	dai, mnf, oag, ocr, omt, pfd, res	mnf, pfd	---	---	---	---	---	---	---	---	---	---
Chile	pfd		oag	---	---	---	---	---	---	---	---	---
Japan	dai, mnf, oag, ocr, pfd, res	mnf	mnf, ocr, res	dai, mnf, oag, omt, res	---	---	---	---	---	---	---	---
Malaysia	ric		mnf, oag, ocr	mnf		---	--	---	---	---	---	---
Mexico	cbf, mnf, ocr, omt, pfd, res		oag, res	dai	cbf, oag, omt, pfd, res	mnf, oag, ocr, omt, pfd, res	---	---	---	---	---	---
New Zealand	mnf, res		mnf, oag, ocr, omt, res	mnf	dai, oag, ocr, omt, pfd, res	mnf, oag, ocr, pfd	cbf, dai, mnf, oag, omt, pfd, res	---	---	---	---	---
Peru	mnf, omt, pfd, res		cbf, ocr, res		oag, ocr, pfd, res	oag, ocr, res	mnf, oag, pfd, res	cbf, mnf, omt, pfd, res	---	---	---	---
Singapore			mnf, oag, ocr, omt, pfd, res	mnf	dai, omt, pfd, res	mnf, oag, pfd, ric	mnf, oag, omt, pfd, res		mnf, pfd	---	---	---
Vietnam	mnf		cbf, mnf, oag	mnf, omt, pfd	dai, oag, pfd, res	oag, pfd, ric	cbf, mnf, oag, ocr, omt, pfd	mnf, omt	mnf, oag, ocr, omt	mnf, ocr	---	---
USA	mnf, res	pfd, res		dai, mnf	cbf, dai, oag, ocr, omt, pfd, res, ric	dai, mnf, oag, ocr, omt, pfd, res, ric	dai, mnf, res	cbf, mnf, oag, ocr, omt, pfd, res	dai, mnf, ocr, omt	oag	cbf, dai, mnf, oag, ocr, omt, pfd, ric	---

Note: Cbf represents beef, dai represents dairy, mnf represents manufacturing, oag represents other agriculture, ocr represents other crops, omt represents other meat, pfd represents processed food, res represents resources, ric represents rice.

Table 6: Order of Countries in Selecting Bilateral Trade Agreements

First	Reversed	Random	Random	Random	Random	Random	Random	Random	Random
Australia	USA	Mexico	Malaysia	Malaysia	Vietnam	Malaysia	Singapore	USA	Japan
Brunei	Vietnam	Brunei	Australia	Vietnam	Peru	Peru	Mexico	Australia	Singapore
Canada	Singapore	Peru	Mexico	Australia	Australia	Australia	Vietnam	Vietnam	Mexico
Chile	Peru	Chile	USA	Singapore	USA	Singapore	Chile	Brunei	Canada
Japan	New Zealand	Vietnam	Peru	Japan	Chile	Brunei	Australia	Peru	Chile
Malaysia	Mexico	Singapore	New Zealand	USA	Singapore	New Zealand	New Zealand	Japan	USA
Mexico	Malaysia	Canada	Japan	Mexico	Canada	USA	USA	New Zealand	New Zealand
New Zealand	Japan	New Zealand	Vietnam	Brunei	Brunei	Vietnam	Canada	Chile	Vietnam
Peru	Chile	USA	Brunei	Chile	Japan	Mexico	Brunei	Singapore	Australia
Singapore	Canada	Australia	Canada	Peru	Mexico	Canada	Malaysia	Malaysia	Malaysia
Vietnam	Brunei	Malaysia	Singapore	New Zealand	Malaysia	Chile	Japan	Canada	Brunei
USA	Australia	Japan	Chile	Canada	New Zealand	Japan	Peru	Mexico	Peru

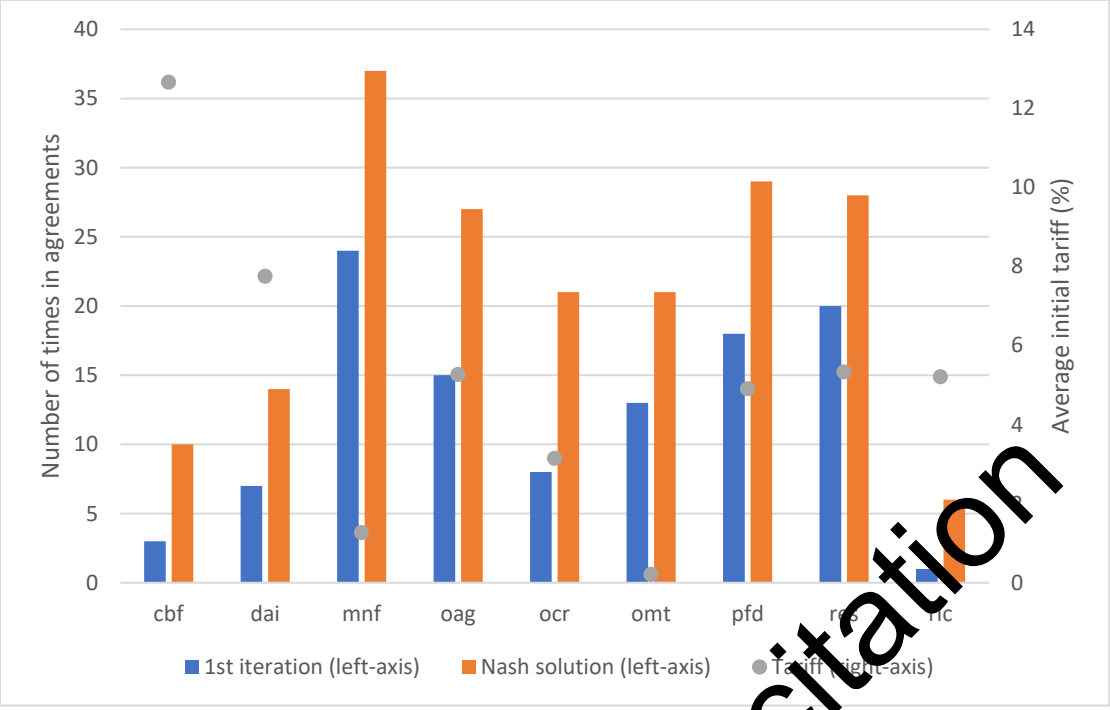

Figure 1. Number of Times a Sector is Included in a Trade Agreement for the Bilateral Scenario
Note: Cbf represents beef, dai represents dairy, mnf represents manufacturing, oag represents other agriculture, ocr represents other crops, omt represents other meat, pfd represents processed food, res represents resources, ric represents rice.

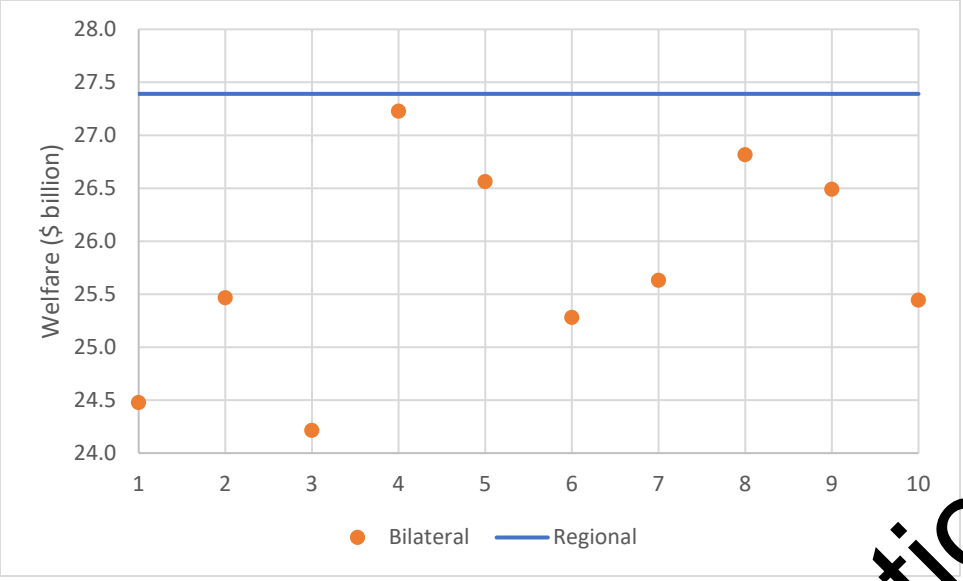

Figure 2. Welfare Change by Simulations
Note: Simulation 1 is the initial simulation, and simulation 2 is the reverse order. All other simulations are based on the random order simulations.

Appendix 1. Region Aggregation Scheme

No.	Country/region	Description	Included GTAP country/regions
1	Australia	Australia	aus
2	Brunei	Brunei	brn
3	Canada	Canada	can
4	Chile	Chile	chl
5	Japan	Japan	jpn
6	Malaysia	Malaysia	mys
7	Mexico	Mexico	mex
8	New Zealand	New Zealand	nzl
9	Peru	Peru	per
10	Singapore	Singapore	sgp
11	Vietnam	Vietnam	vnm
12	USA	United States	usa
13	EU	European Union	aut, bel, bgr, cyp, cze, dnk, est, fin, fra, deu, grc, hrv, hun, irl, ita, lva, ltu, lux, mlt, nld, pol, prt, rou, svk, svn, esp, swe
14	China	China	chn
15	ROW	Rest of the World	gur, xoc, twn, mng, xea, bgd, npl, lka, xsa, xna, arg, bol, bra, col, ecu, pry, ury, ven, xsm, cri, gtm, hnd, nic, pan, slv, xca, dom, jam, pri, tto, xcb, nor, xef, alb, blr, rus, ukr, xee, xer, kaz, kgz, xsu, arm, aze, geo, bhr, irn, isr, jor, kwt, omn, qat, sau, tur, are, xws, egy, mar, tun, xnf, ben, bfa, cmr, civ, gha, gin, nga, sen, tgo, xwf, cmr, xcf, xac, eth, ken, mdg, mwi, mus, moz, rwa, tza, uga, zmb, zwe, xec, bwa, nam, xsc, xtw

Appendix 2. Sector Aggregation Scheme

No.	Name	Description	GTAP sector code
1	ric	Paddy and milled rice	pdr, pcr
2	ocr	Other crops	wht, gro, osd
3	oag	Other agriculture	v_f, c_b, pfb, ocr
4	cbf	Cattle/beef	ctl, cmt
5	dai	Raw dairy and dairy products	rmk, mil
6	omt	Other meat	oap, wol, omt
7	res	Resources	frs, fsh, coa, oil, gas, oxt
8	pfd	Processed food	sgr, vol, ofd, b_t
9	mnf	Manufacturing	lum, ppp, gdt, p_c ely, omn, nmn, tex, wap, lea, chm, bph, rpp, i_s, nfm, fmp, mvh, otn, ele, ome, omf
10	services	Services	wtr, cns, trd, otp, wtp, atp, cmn, ofi, isr, obs, ros, osg, dwe