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Estimating the Effects of the Trans-Pacific Partnership (TPP) on Latin America and the Caribbean (LAC)

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Estimating the Effects of the Trans-Pacific Partnership (TPP) on LAC

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Abstract

In February 2016, twelve Pacific Rim countries signed the agreement on the Trans Pacific Partnership (TPP), one of the largest and most comprehensive trade deals in history. While there are several estimates of the likely effects of the TPP, there is no systematic study on the effects on all Latin American countries. We present the results from applying a multi-sector model with perfect competition presented by Costinot and Rodriguez-Clare (2014). The exercise, based on input-output data for 189 countries and 26 sectors, shows that (i) Asian TPP members are estimated to benefit most from the agreement, (ii) negative spillovers to non-TPP LAC countries appear to be of a different order of magnitude than the gains of members, and (iii) some non-TPP LAC countries may experience relatively large benefits from joining the TPP. As a cautionary note, however, we point out that even a cursory cross-study comparison shows that there is considerable uncertainty regarding the potential effects of the TPP for both members and non-members.

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Key findings

Asian TPP members are estimated to benefit most from the agreement. Emerging Asian economies appear to be among the members who would benefit most from the agreement. This is likely a result of there being larger spillovers between each other, given that they have proportionally stronger trade links with TPP partners. In LAC, Mexico is estimated to experience gains of relatively similar size, while in comparison the estimated benefits for Chile and Peru are more muted.

Negative spillovers to non-TPP LAC countries appear to be of a different order of magnitude than the gains of members. As an indication, in our estimates the largest real income gain within the TPP is more than 50 times larger than the absolute value of the largest negative spillover within LAC. In general, economies that are more open and have stronger existing trade with TPP members (especially with the U.S., such as many Central America and Caribbean countries) tend to face larger negative spillovers. However, given the TPP's relatively liberal rules of origin, non-members participating in global value chains integrated with TPP partners may actually be able to reap some benefits from the agreement. Non-preferential reductions in non-tariff barriers may also produce positive spillovers to LAC nonmembers.

Some non-TPP LAC countries may experience relatively large benefits from joining the TPP. Out of nine non-TPP LAC countries considered, Colombia and Guatemala are estimated to experience the largest gains from potential inclusion in the TPP: their estimated gains are in fact larger than for some LAC countries in the TPP. Given current tariffs, many LAC countries would experience a negative impact from full tariff liberalization vis-à-vis TPP members; for those countries a potential inclusion in the TPP may require longer negotiations.

I. INTRODUCTION

The TPP agreement, an ambitious trade deal, was signed in February 2016. In February 2016, Mexico, Chile and Peru, together with the United States, Canada and seven Asia-Pacific countries (Australia, Brunei Darussalam, Japan, Malaysia, New Zealand, Singapore and Vietnam) reached agreement on the Trans Pacific Partnership, one of the largest and most comprehensive trade deals in history. Together, the 12 TPP partner countries represent nearly 40 percent of world GDP, and the agreement covers frontier issues such as services, investment, government procurement, SOEs, SMEs, intellectual property, labor, environment, competition policy, etc that would imply a substantial fall in non-tariff barriers.

While there are several estimates of the likely effects of the TPP, there is no systematic study on the effects on all Latin American countries. The aim of the present study to provide a first set of estimates to start filling this gap. We present the results from applying the multi-sector with perfect competition as presented by Costinot and Rodriguez-Clare (2014). The model is simple enough to be able to provide estimates for a large number of countries, some of which are relatively small. The exercise is based on input-output data for 189 countries and 26 sectors.

The rest of the paper is organized as follows. In Section 2 we describe the tariffs and non-tariff barriers of TPP members. Section 3 briefly discussed the model and presents the input-output data to be used. The estimates of the effects of the TPP on members and non-members are presented in Section 4. Section 5 compares and discusses the results in the light of those of other studies. Section 6 considers the potential effects for certain non-TPP LAC countries of being included in an expanded TPP. Section 7 concludes.

II. TARIFF AND NON-TARIFF BARRIERS

Tariff data between TPP countries were obtained from the Market Access Map (MAcMap), which provides an overall ad-valorem equivalent of applied protection.[2] For eight countries (Australia, Brunei Darussalam, Japan, New Zealand, Peru, Singapore, U.S., and Vietnam) the data correspond to 2014. For the remaining four TPP members, latest available data are used (2013 for Canada, 2009 for Mexico, 2008 for Chile, and 2007 for Malaysia). There are 683.6 thousand HS 6-digit lines in the dataset. Tariffs dating from 2012 and later are originally classified in HS 2012, and were converted into HS 2007 using the UN conversion tables.[3] Once all tariff data are in HS 2007 format, they were matched with trade data from Comtrade (HS 2007 classification) for the year 2012 (the same year of the world input-output data used). The merged data were then converted into SITC Rev. 3 classification using UN conversion tables, to finally convert it to the 26-sector classification used by Eora.

Latest available data on applied protection indicate that bilateral tariffs between TPP members are already very low, with some heterogeneity. Average bilateral tariffs (weighted by trade) among TPP countries are very low, with nearly half of them already at less than 1 percent, and over 80 percent below 5 percent of ad-valorem equivalent (Figure 1, left panel). However, some bilateral pairs show somewhat higher levels of protection, such as e.g. Canada for imports coming from New Zealand, Japan for Canadian imports, and Australia for Japanese imports. A summary of the multilateral resistance arising from bilateral tariffs is provided in Figure 1 (right panel), where countries distance to each other is larger the larger their bilateral tariffs. While some countries stand out due to their near-zero protection with most TPP members (especially Singapore), the graph also reveals some degree of heterogeneity across the geographical dimension, with countries on either side of the Pacific rim located towards the north (Americas) and south (Asia and Oceania) of the figure.

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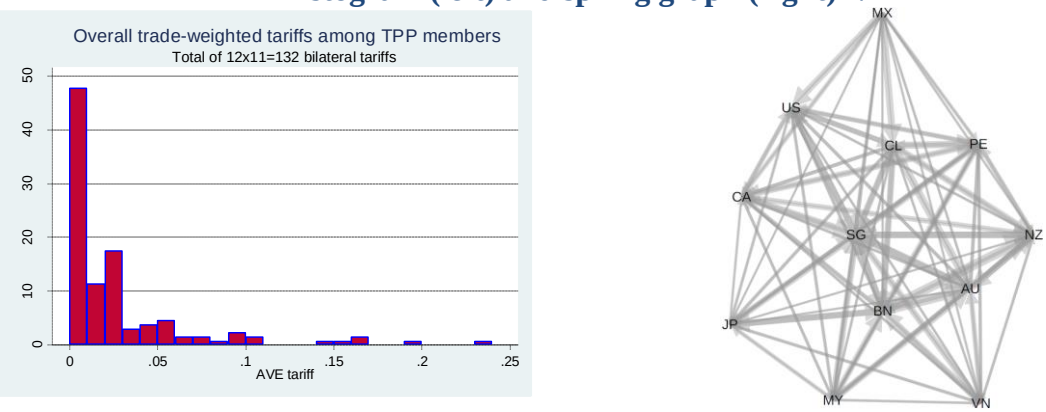
[2] See http://www.macmap.org/SupportMaterials/Methodology.aspx

[3] See http://unstats.un.org/unsd/trade/conversions/HS%20Correlation%20and%20Conversion%20tables.htm. An alternative approach to the one described above would have been, for the countries for which post-2012 tariffs are available, to convert data into SITC format directly using weights coming from trade data in HS 2012 format. As it turns out, however, 2012 trade data is significantly scarcer in HS 2012 than in HS 2007.

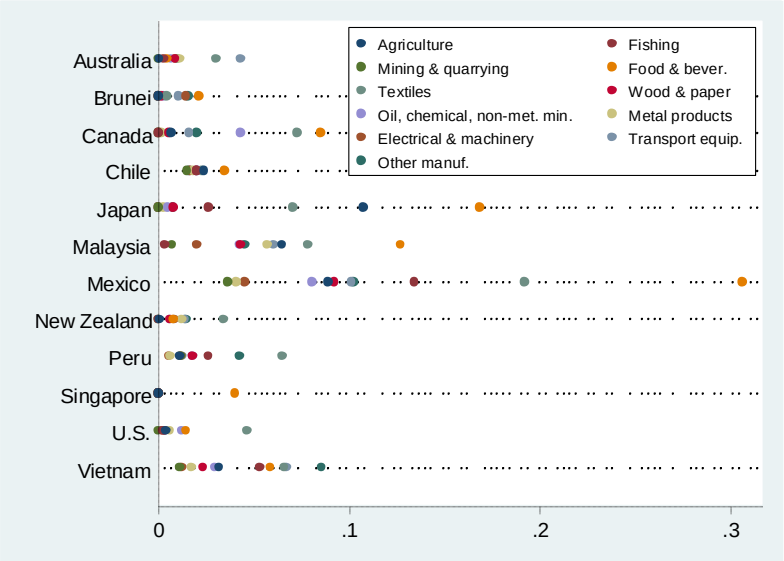
Figure 1. Average bilateral tariffs
Histogram (left) and spring graph (right) 1/



1/ Each arrow in the spring graph acts as a *spring*, tying the source (exporter) and destination (importer) nodes closer together. Spring strengths and widths are proportional to the logarithm of the inverse of bilateral tariffs. We thank F. Diebold and K. Yilmaz for sharing their implementation of the ForceAtlas2 algorithm in Gephi.
Source: Authors' calculations based on MAcMap and Comtrade.

Applied protection is higher in specific sectors (Figure 2). Some sectors have higher levels of protection across most or all TPP member countries, such as food and beverages, textiles, or transport equipment. Specific sectors have relatively high protection in certain countries, such as Agriculture in Japan, or other manufactures in Australia, Peru and Vietnam.[4]

Figure 2. Average tariffs imposed to TPP partners by sector

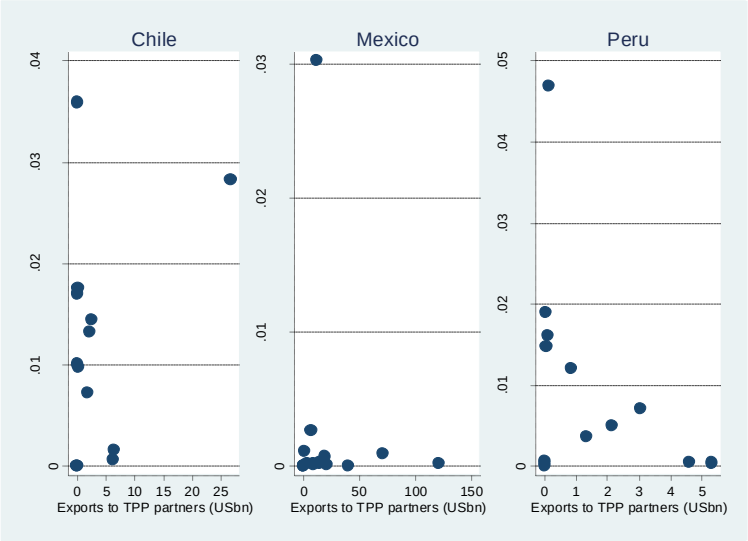


Source: Authors' calculations based on MAcMap and Comtrade.

[4] The relatively high tariffs of Mexico (2009) and Malaysia (2007) could only partially be accounted for by the fact that their data is from before 2014. In particular, it is worth noting that only few FTAs between those countries and TPP members took effect since then. Mexico only entered into an FTA with Peru (2012), while Malaysia signed FTAs with New Zealand (2010), Chile (2012), and Australia (2013). See rtais.wto.org/UI/PublicAllRTAList.aspx.

As of 2014, Chile, Mexico and Peru already faced very low tariffs when exporting to TPP partners. TPP members that belong to LAC all face average tariffs of less than 5 percent when exporting to TPP partners, and even lower than 1 percent for most sectors in which they have significant exports (Figure 3). The only exception is food and beverage exports of Chile, which face tariffs of about 2.8 percent when exporting to TPP partners.

Figure 3. Exports and tariffs faced by LAC TPP members (*by sector)*

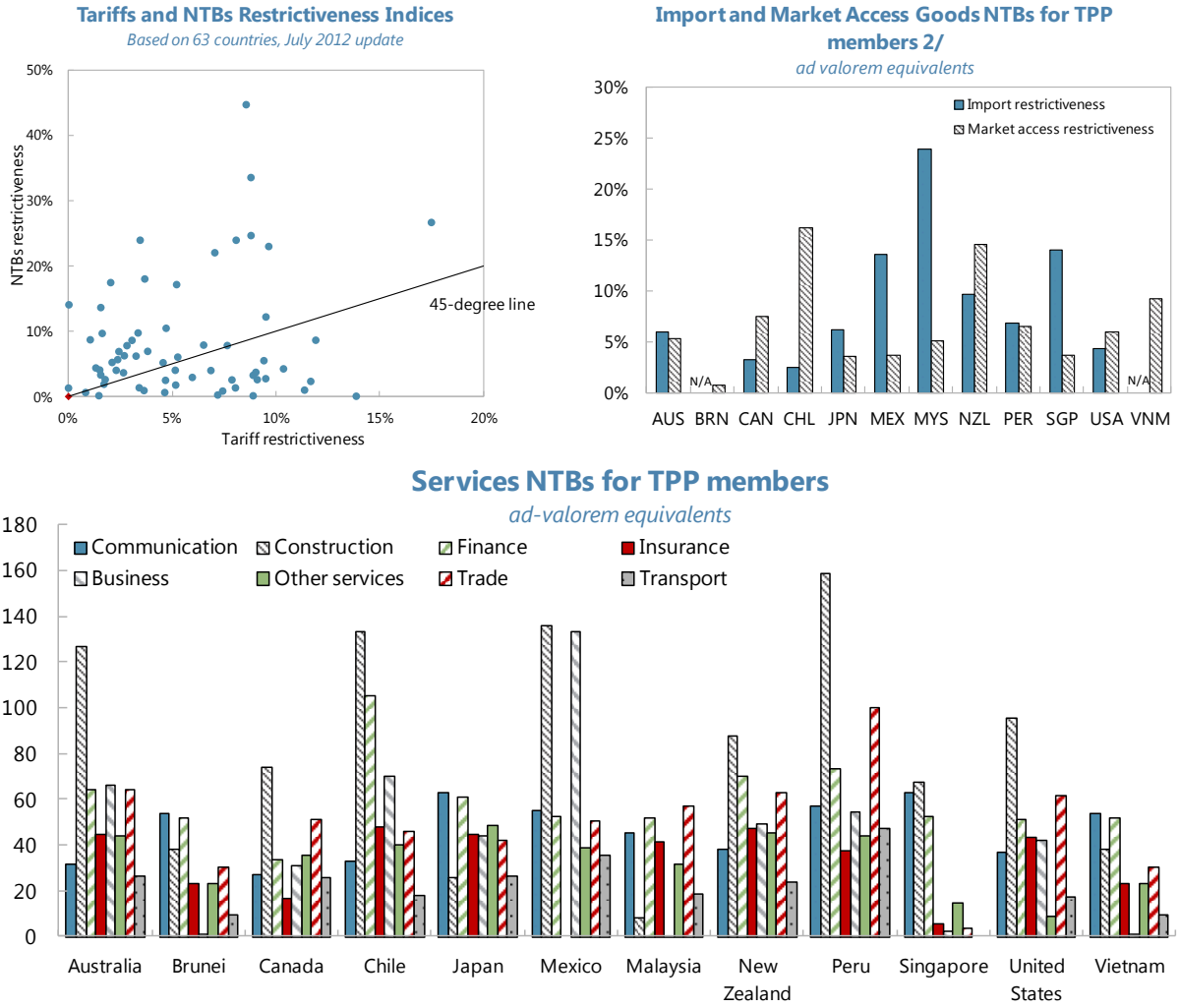


Source: Authors' calculations based on MAcMap and Comtrade.

Non-tariff barriers (NTBs) are in many cases a bigger obstacle to trade than tariffs. The tariff equivalent of non-tariff barriers is, for many countries, substantially higher than the restrictions imposed by tariffs (Figure 4, top left panel).[5] Some TPP members (Malaysia, Mexico, Singapore) impose significant NTBs on goods imports. Furthermore, such barriers pose important restrictions to goods exports for certain TPP exporters, such as Chile, New Zealand and Vietnam (Figure 4, top right panel). Services imports face even higher NTBs in most TPP countries (Figure 4, bottom panel). It is worth noting that these are quantitative assessments of NTBs at the aggregate country level, i.e. they refer to import and export restrictions for each country with the rest of the world as a whole.

[5] Figure 4 is based on the Overall Trade Restrictiveness Index (OTRI) and Tariff-only OTRI (OTRI_T) developed by Kee et al. (2009). Ad-valorem equivalents of NTBs are estimated through a two-step procedure. Using NTB data from UNCTAD (on price control measures, quantity restrictions, monopolistic measures, technical regulations, etc.), Kee et al. first estimate the quantity impact of these barriers on imports. Quantity impacts are then translated into ad valorem equivalents by using import price elasticities obtained in a separate paper (Kee et al. (2008)).

Figure 4. Non-Tariff Barriers 1/



1/ Ad-valorem equivalents of NTBs are estimated for each country as overall restrictions (to all its trading partners), but are not available on a bilateral basis.
2/ Import restrictiveness refers to NTBs imposed, while market access restrictiveness refers to NTBs faced by each country.
Source: World Bank, Kee et al. (2009), Fontagne et al. (2012), and authors' calculations.

III. Estimating the Effects of the TPP: Framework and Data

Quantitative models of trade theory can provide a first approximation to the potential welfare gains from the TPP. In order to provide a quantitative assessment of possible spillovers from reductions in tariff and non-tariff barriers to trade due to the TPP, in this section we apply simple computable general equilibrium (CGE) models of trade presented in recent work by Costinot and Rodriguez-Clare (2014). A key assumption that generates trade in these models is that consumers have a preference for variety, and therefore demand goods

from different sources.[6] Utility is assumed to be linear in real consumption, and the different varieties of goods in the consumption basket are aggregated using a constant elasticity of substitution (CES) function. Since there is no investment or government consumption in the model, and trade balances are zero,[7] it is natural to interpret changes in welfare/real consumption as changes in real income. It is also worth noting that, as a result of these assumptions, access to more varieties of a good can increase real income by reducing the price of one unit of (CES-aggregated) consumption (see e.g. Broda and Weinstein (2006)).

The model is chosen with the aim of providing estimates for a large number of countries. When choosing which model to apply, there is a tradeoff between the model's complexity and the granularity of the data that can be used as inputs. We present the results from applying the multi-sector with perfect competition as presented by Costinot and Rodriguez-Clare (2014).[8] In Section 5, when comparing our results with those found elsewhere in the literature, we discuss some channels that our model of choice does not capture.

Thanks to recent advances in trade theory modeling methods, the data requirements for the quantitative exercise are relatively few. Models of international trade typically feature a series of structural parameters that are very hard to estimate in practice. A case in point are bilateral non-tariff barriers (see the discussion of the previous section), which in trade theory models would add up to "iceberg costs" of trading between pairs of countries. A method popularized by Dekle, Eaton and Kortum (2007) circumvents this problem by simply formulating the equilibrium in *changes* rather than in *levels*. As pointed out by Ossa (forthcoming), the method "[e]ssentially […] imposes a restriction on the set of unknown parameters […] such that the predicted [initial trade flows] perfectly match the observed [trade flows]." Thus, instead of requiring the level of bilateral NTBs before and after the specific trade agreement under study, this method only requires the percent change in these barriers. As will be discussed next, constructing an assumption on how a trade agreement reduces bilateral barriers to trade is not exempt from

Table 1. Elasticities

Sector	Elasticity
Agriculture	8.11
Fishing	8.11
Mining & quarrying	15.72
Food & beverages	2.55
Textiles & wearing apparel	5.56
Wood & paper	10.83
Petroleum, chemica & non-metallic mineral products	19.53*
Metal products	4.50
Electrical & machinery	10.60
Transport equipment	0.69**
Other	5.00

* Simple average of Petroleum (51.08), Chemicals (4.75), and Non-metallic mineral products (2.76).

** Simple average of Auto (1.01), and Other transport (0.37).

Source: Caliendo and Parro (2015)

[6] This idea, first modeled by Armington (1969), was popularized by Dixit and Stiglitz (1977) and first applied to trade by Krugman (1979). In new trade theory models with imperfect competition, economies of scale provide an additional incentive to trade.

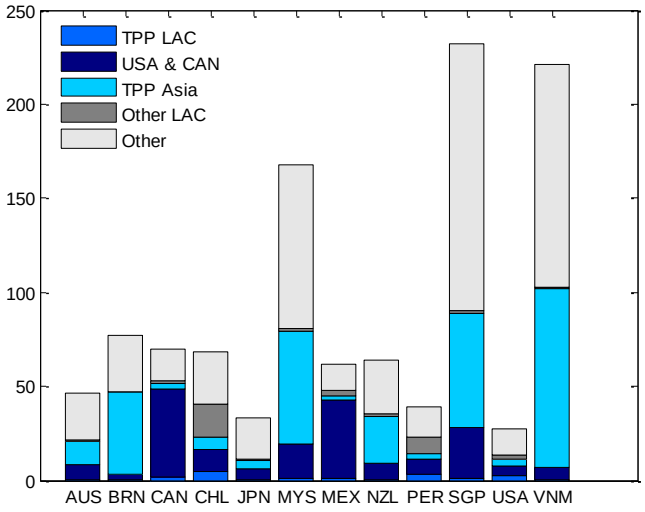
[7] Following what is becoming a standard practice (Costinot and Rodriguez-Clare (2014), Ossa (2015)), the raw data is first purged from trade imbalances by performing the exercise proposed by Dekle et al. (2007).

[8] Appendix I also shows the results when applying the simpler single-sector Armington model. No algorithm was found that could solve the other models presented in Costinot and Rodriguez-Clare (2014) for the large dataset used in this study. Appendix II describes some main features of the model in more detail.

difficulties, but the method nonetheless reduces dramatically the number of parameters the model requires.[9]

The exercise is based on input-output data for 189 countries and 26 sectors. Data on international trade and domestic absorption for 189 countries and 26 sectors for the year 2012 is available from the Eora Multi-Region Input-Output (MRIO) table (Lenzen et al. (2012, 2013)). The tariff data from MAcMap is converted into the Eora sector classification using 2012 HS 6-digit bilateral trade data from Comtrade as weights. In the model with multiple sectors, utility functions consist of two layers. At the higher layer, the elasticity of substitution across different sectors is assumed to be equal to one. The lower level aggregates different varieties of goods within the same sector. Estimating elasticities of substitution for different varieties is beyond the scope of this study. Following the approach of Costinot and Rodriguez-Clare (2014), we instead match the elasticity estimates of Caliendo and Parro (2015) to the sectors in our dataset (Table 1).

Figure 5. TPP members' goods and services trade by selected groups of trading partners
as percent of GDP



Source: Eora MRIO and authors' calculations.

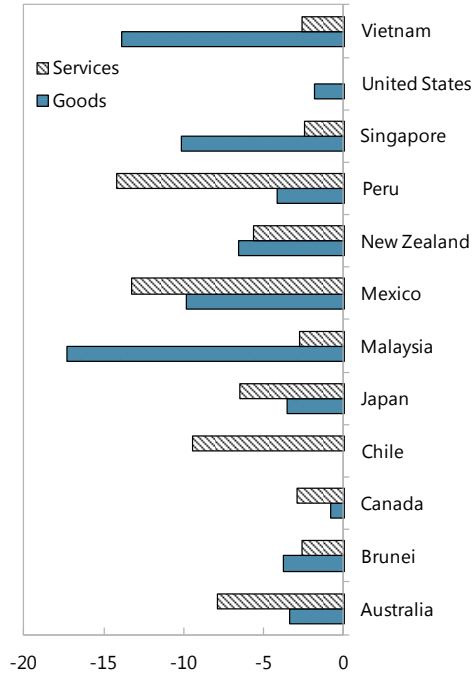
NTBs are assumed to drop to the levels of those TPP members with less restrictive trade regimes. The high level of NTBs of some of the TPP members is expected to be reduced as a result of the agreement.[10] As can be seen in Figure 4 (top right panel), Chile has the lowest level of NTBs applied to goods imports (2.5 percent). In the exercise below, we

[9] For example, in a dataset with 189 countries, solving the Armington (i.e. single-sector) model in levels would require the level of NTBs for 189x188=35,532 directed bilateral pairs, in addition to the post-agreement NTBs between the 12x11=132 directed bilateral pairs between TPP members and the elasticity of substitution across goods from different countries. By only requiring the *change* in NTBs for the 132 directed bilateral pairs in the TPP (alongside the elasticity of substitution), the "exact-hat algebra" technique popularized by Dekle et al. (2007) effectively cuts the cardinality of the parameter set by 35,532.

[10] With the exception of chapters related to tariffs (2-4, 6), labor (19), and environment (20), most chapters in the TPP agreement are expected to lead in some way to a reduction in NTBs among members. Among the ones most closely related are chapters 5 (on custom administration and trade facilitation),7 (sanitary and phitosanitary measures), 8 (technical barriers to trade), 9 (investment), 10 (cross border trade in services), 13 (telecommunications), 14 (electronic commerce), 15 (government procurement), 16 (competition), and 22 (competitiveness and business facilitation).

assume that NTBs for trade in goods between TPP members drop to this level.[11] Ad-valorem equivalents of NTBs on services imports are available at the sector level from Fontagne et al (2012) (see Figure 4, bottom panel).[12] We assume that, with the entry into force of the TPP, NTBs for every TPP country are reduced to the level of the U.S. (unless for that sector NTBs are already lower than those in the U.S.). We then apply the average decrease in NTBs to all the services sectors present in the Eora dataset. Figure 6 summarizes the assumed drop in NTBs in goods and services for every TPP member.[13]

Figure 6. Assumed Reduction in NTBs 1/
in percent



1/ If τ and τ' denote the ad-valorem NTBs before and after the agreement, then the chart shows, for each member, $((1+\tau')/(1+\tau)-1)*100$.
Source: Authors' calculations.

[11] No estimates for Brunei and Vietnam are available in the 2012 World Bank update of trade restrictiveness indices. For Brunei, we took the earlier estimate by Kee et al. (2009). For Vietnam, we imputed the simple average of the indices for Malaysia and Singapore.
[12] Given the lack of estimates for Brunei and Vietnam for services NTBs, we imputed the simple average of the indices for Malaysia and Singapore.
[13] Note that we are assuming that the reduction in NTBs is purely preferential. This is a deliberate choice that *stacks the deck* against non-members, so as to obtain upper bounds on the potential negative effects of the agreement. As highlighted in Henn et al. (2016), some studies assume a certain extent of non-discriminatory reduction in NTBs, although there is no solid empirical evidence of their size.

IV. ESTIMATES OF THE EFFECTS OF THE TPP ON MEMBERS AND NON-MEMBERS

The estimated effects of further tariff liberalization on TPP members are relatively small. Table 3 shows the effect of elimination of bilateral tariffs between TPP.[14] Each row shows the welfare (or real consumption/real income) effect, in percent change, on that row's country of the tariff reductions indicated by each column. Columns 2 through 13 correspond to elimination of all tariffs that the TPP member of that column faces when exporting to TPP partners, while the last column (column 14) corresponds to elimination of all tariffs between TPP members. For example, the first column for Australia shows the welfare effects on each TPP member if TPP members eliminated all existing tariffs on Australian exports; Australia's welfare would increase by 0.09 percent, whereas Malaysia's would fall by 0.02 percent. In general, inspection of the diagonal elements of columns 2-13 show that, while all countries would gain from lower tariffs when exporting to TPP partners' markets, the gains are generally small and somewhat heterogeneous. The gains from unilateral better access range from 0.23 percent for New Zealand, to 0.01 percent for Brunei and Mexico. Interestingly, New Zealand's gains from lower tariffs do not generate significant negative effects on the countries reducing their tariffs, with Malaysia's welfare dropping by merely 0.01 percent.[15] Of the three LAC countries, Chile stands most to gain (0.11 percent), which is consistent with the observation of the previous section that Chile faces large tariffs in food and beverages exports to TPP partners. Gains from elimination of all tariffs between TPP members are also small, and in some cases (Peru, and especially Vietnam) negative.

Table 3. Welfare/real income effect of tariff liberalization

	Elimination of tariffs faced by column country's exports to TPP partners												
	Australia	Brunei	Canada	Chile	Japan	Malaysia	Mexico	New Zealand	Peru	Singapore	USA	Vietnam	Full liberalization
Australia	**0.09**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	**0.06**
Brunei	0.00	**0.01**	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	**0.01**
Canada	0.00	0.00	**0.06**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**
Chile	0.00	0.00	0.00	**0.11**	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	**0.07**
Japan	0.01	0.00	0.00	0.00	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**
Malaysia	-0.02	0.00	0.00	0.00	-0.05	**0.05**	0.00	-0.01	0.00	-0.02	0.09	0.00	**0.07**
Mexico	0.00	0.00	-0.02	0.02	-0.02	0.00	**0.01**	0.00	0.00	0.00	-0.02	0.00	**0.01**
New Zealand	0.00	0.00	0.00	0.00	0.01	0.00	0.00	**0.23**	0.00	0.00	-0.03	0.00	**0.20**
Peru	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**	0.00	-0.02	0.00	**-0.01**
Singapore	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	**0.05**	-0.01	0.00	**0.02**
USA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.03**	0.00	**0.03**
Vietnam	0.02	0.00	0.01	0.00	-0.04	-0.01	0.00	0.00	0.00	-0.16	0.00	**0.08**	**-0.11**

Notes: The results are based on a multi-sector model of trade with perfect competition as presented by Costinot and Rodriguez-Clare (2014). Each row shows the welfare effect (in percent change) on that row's country of the tariff reductions indicated by each column. Columns 2 to 13 correspond to elimination of all tariffs that the TPP member of that column faces when exporting to TPP partners. Column 14 corresponds to elimination of all tariffs between TPP members.

Tariff reductions among TPP members are estimated to have negligible effects on LAC non-TPP members. Table 4 shows the effect of tariff reductions among TPP members on

[14] While the TPP agreement incorporates exceptions and different phase-out transitions, the exercise presented in Table 3 shows the maximum scope for welfare gains/losses from tariff reductions. It has been reported that 99 percent of nonzero tariff lines will eventually fall to zero under the TPP (Petri and Plumer (2016)).

[15] In some instances, off-diagonal elements in Table 3 are positive. For example, Vietnam benefits from the elimination of all tariffs on Australian exports to TPP partners. This is a result of Malaysia's goods and services becoming cheaper in world markets.

LAC countries that are not in the TPP. All in all, the results show that further tariff reductions among TPP members would generate minor spillovers in the region.

Table 4. Welfare/real income spillovers in LAC of tariff liberalization

	Elimination of tariffs faced by column country's exports to TPP partners												
	Australia	Brunei	Canada	Chile	Japan	Malaysia	Mexico	New Zealand	Peru	Singapore	USA	Vietnam	Full liberalization
Antigua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	-0.02
Argentina	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
Bahamas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	0.00	-0.03
Barbados	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Belize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Bolivia	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.00
Brazil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cayman Islands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
Colombia	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00
Costa Rica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Cuba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dominican Republic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ecuador	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Salvador	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Guatemala	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.02
Guyana	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haiti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Honduras	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Jamaica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nicaragua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Panama	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Paraguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Suriname	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trinidad and Tobago	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Uruguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Venezuela	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: The results are based on a multi-sector model of trade with perfect competition as presented by Costinot and Rodriguez-Clare (2014). Each row shows the welfare effect (in percent change) on that row's country of the tariff reductions indicated by each column. Columns 2 to 13 correspond to elimination of all tariffs that the TPP member of that column faces when exporting to TPP partners. Column 14 corresponds to elimination of all tariffs between TPP members.

Reductions in NTBs would have heterogeneous effects on TPP members, with developing countries with stronger existing trade links within the TPP experiencing larger gains. Table 5 shows the welfare effects of reductions in NTBs for TPP members. Columns (a)-(c) display the welfare effect from reduction of NTBs in goods sectors, services sectors, and both. Mainly Malaysia, but also Singapore, Vietnam and Mexico, would benefit significantly from the reduction of NTBs. The countries that benefit most, do so mainly through the reduction of NTBs in goods, with the lower services NTBs having comparatively smaller effects. The effect of reducing obstacles to services trade has higher effects than the removal of barriers to trade in goods only for Australia and Chile. Within LAC, Peru and Chile benefit significantly less from NTBs reductions, partly as a result of having weaker trade links with TPP members (especially when compared to the U.S.-Mexico trade), but also because ex-ante it already has one of the least restrictive trade regimes. The welfare effects are also related to the countries' size, as Japan and the U.S. show the smallest welfare gains among all members. For these two countries (as well as for New Zealand and Chile), gains from full tariff liberalization would represent larger shares of the total potential welfare gains (cf. column (c) with the last column in Table 5).

Table 5. Welfare/real income effect of NTBs and tariffs reduction

Reduction of NTBs in:

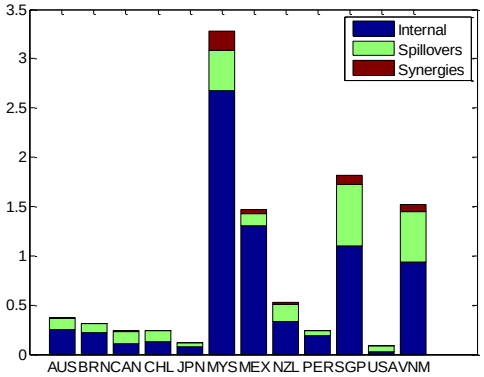
	Goods (a)	Services (b)	**Goods+Services (c)**	**W/full tariff liberalization**
Australia	0.11	0.25	**0.37**	**0.43**
Brunei	0.24	0.07	**0.31**	**0.34**
Canada	0.15	0.09	**0.24**	**0.27**
Chile	0.09	0.15	**0.24**	**0.33**
Japan	0.06	0.06	**0.12**	**0.17**
Malaysia	3.10	0.17	**3.27**	**3.58**
Mexico	1.20	0.29	**1.47**	**1.38**
New Zealand	0.36	0.17	**0.53**	**0.80**
Peru	0.13	0.11	**0.24**	**0.23**
Singapore	1.71	0.11	**1.82**	**1.70**
USA	0.07	0.02	**0.08**	**0.12**
Vietnam	1.17	0.35	**1.52**	**1.23**

Notes: The results are based on a multi-sector model of trade with perfect competition as presented by Costinot and Rodriguez-Clare (2014). Each row shows the welfare effect (in percent change) on that row's country of the NTBs reduction described in the text.

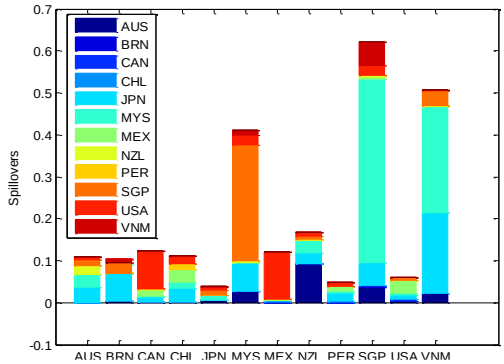
Spillovers from reductions in NTBs appear stronger in Asia. The left panel in Figure 7 decomposes the total benefits in NTBs reduction of Table 5 (column (c)) into three components: the benefits that a TPP member gets for reducing its own NTBs ("Internal effect"), the spillovers from reductions in NTBs of TPP partners, and a residual accounting for general-equilibrium effects ("Synergies").[16] Among the biggest beneficiaries of TPP, Malaysia, Singapore, and Vietnam receive relatively large spillovers, whereas Mexico's gains are mainly related to its own reduction in barriers. The panel on the right of Figure 6 further breaks down the spillovers by origin. Malaysia and Singapore benefit substantially from each other's reduction in trade barriers, while Vietnam's spillovers are mainly related due to Singapore and Japan. The reduction in NTBs by the U.S. benefits Canada and Mexico, but it is not large enough to generate relatively large effects.

Figure 7. Internal Effects, Spillovers, and Synergies

Decomposition



Spillovers



Source: Authors' calculations.

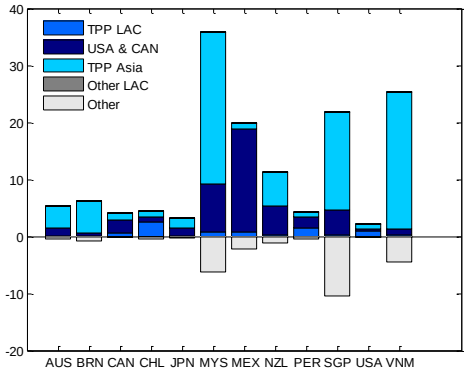
[16] The decomposition is obtained by running the model once for each TPP partner, where each simulation corresponds to a single TPP member unilaterally reducing its barriers with the rest of the membership.

Openness is estimated to increase for all members as a result of the TPP, with limited trade diversion in general and no significant diversion away from LAC non-TPP members.[17] Total trade in goods and services as percent of GDP is estimated to increase by between 2 percent of GDP for the U.S. to nearly 30 percent of GDP for Malaysia (Figure 8, left panel). Mexico's trade to GDP ratio is estimated to increase by about 18 p.p., mainly due to deeper integration with the U.S. and Canada. Even for Chile and Peru, which are estimated to gain relatively less in terms of real income, are estimated to increase their openness by about 4 p.p. Trade diversion appears limited, mostly circumscribed to Singapore, Malaysia and Vietnam. Trade diversion away from LAC is almost negligible, when measured as a percent of the GDP of TPP members. When measured as percent of LAC countries GDP, trade diversion is in the worst cases of less than 0.7 percent of GDP (Figure 10). Of course, LAC non-TPP members do lose out share in trade of TPP members (especially LAC TPP members and the U.S.; see Figure 8, right panel).

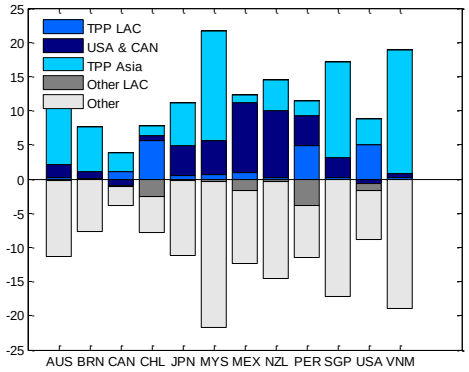
Figure 8. Changes in trade patterns

As percent of GDP

Changes in total trade



Changes in shares of total trade



Source: Authors' calculations.

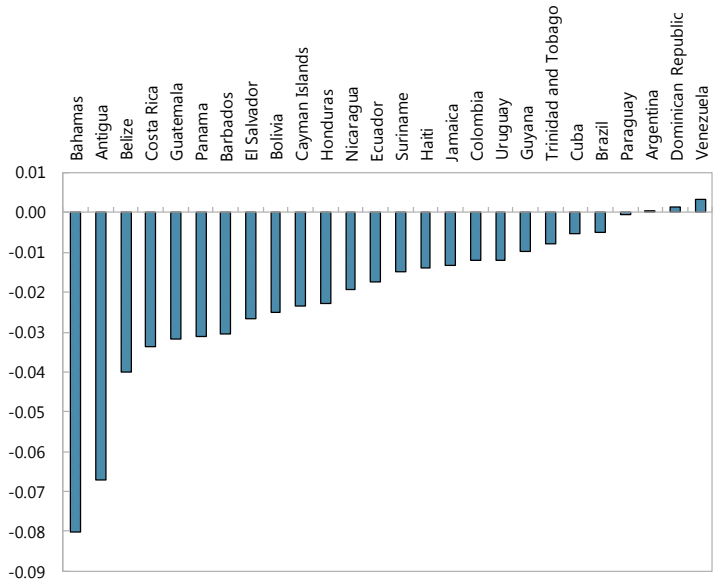
[17] Note that the term "trade diversion" is being used loosely here. Reductions in NTBs among TPP members reduce the cost of supplying goods between them; to the extent that members re-source towards more efficient suppliers this is not *sensu stricto* trade diversion.

Smaller and more open LAC economies and those with stronger links to TPP members may face negative effects, but spillovers are of a different order of magnitude. Figure 9 shows the spillover effects on LAC countries of the reduction in NTBs within the TPP. The negative effects are typically much smaller than those experienced within the TPP. For example, the largest gain within the TPP from reducing NTBs in goods and services (9.85 for Malaysia) is more than 50 times larger than the absolute value of the largest spillover within LAC (-0.05 for Bahamas). In general, economies that are more open and have stronger existing trade with TPP members (especially with the U.S., such as many Central America and Caribbean countries) tend to face larger negative spillovers.

Figure 9. Spillovers to LAC

Percent change in real income/welfare

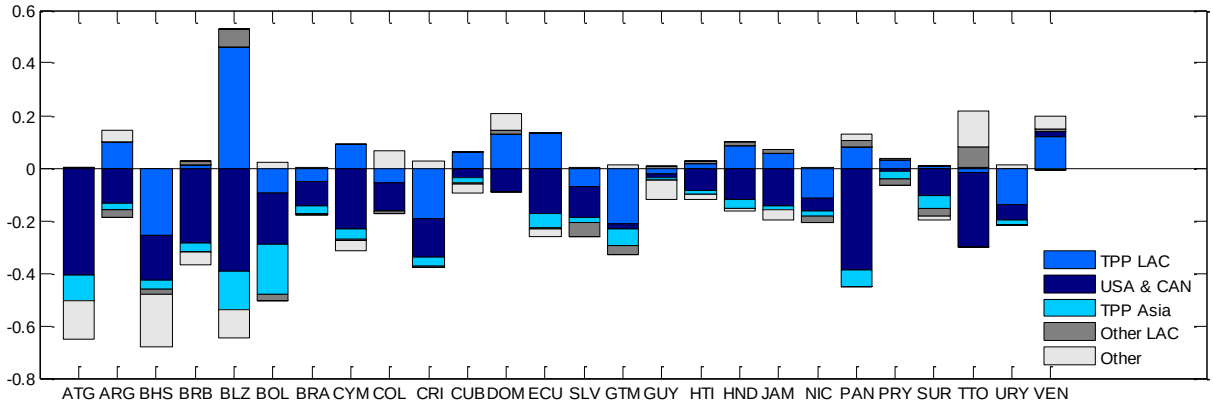
Full tariff liberalization + NTBs reduction within TPP



Source: Authors' calculations.

Figure 10. Changes in LAC trade patterns

In percent of each country's GDP



Source: Authors' calculations.

V. COMPARISON WITH OTHER STUDIES

The results of previous studies focusing on TPP members provide a benchmark for comparison. Petri, Plummer and Zhai (2011) is the most widely cited paper providing CGE estimates of the effects of the TPP (see Henn et al. (2016) for a comprehensive survey of TPP studies). The study's focus is on the effect on members, dividing the world into 24 regions. While agriculture, mining and government services are assumed to operate under perfect competition (as do all sectors in the model used in the present study), manufacturing and private services are produced under monopolistic competition as in Melitz (2003). Thus, reductions in tariffs and non-tariff barriers affect welfare not just through the intensive margin (more trade of the same varieties), but also through the extensive margin (trade of new products). Another important study on the TPP is due to Aichele and Felbermayr (2015), who rely on an extended version of the model by Caliendo and Parro (2015). While the model assumes perfect competition, it differs from the model used above in two dimensions. First, capital is a second factor of production (a feature also present in Petri and Plummer (2011)). Lower tariffs and non-tariff measures can thus lead to gains through higher specialization. Second, by incorporating the production of intermediate goods, it may capture gains for non-members that participate in value chains with members.[18]

Vietnam and Malaysia are consistently found to be among the biggest winners. Table 6 shows how different studies have ranked TPP members according to their gains from the agreement (we include the updated results of Petri, Plummer and Zhai (2011) performed by Petri and Plummer (2016)). Malaysia and Vietnam are consistently ranked among the members who would benefit most from the agreement.

Results differ in terms of the average gains and some countries' relative standing. Some differences in the results across studies are apparent. Perhaps most remarkable are (i) the fact that in the present study gains are smaller on average, and (ii) that we find relatively higher gains for Mexico (Mexico is in fact a loser in Aichele and Felbermayr (2015), due to the loss of preferential access to the U.S.).

Firm entry and the presence of global value chains are likely to amplify gains from the TPP for members. Petri and Plummer (2016) rely on an adaptation of the Melitz (2003) model by Zhai (2008), where manufactures are assumed to be produced under imperfect competition and firms have different productivity. As a result, reductions in trade barriers increase welfare not only via the intensive margin (more exports of the same varieties) but also through the extensive margin (exports of new varieties). This may be an important overlooked channel for developing and emerging TPP partners, as existing trade patterns do not reflect the potential for new exports.[19] Comparing Petri and Plummer (2016) estimates

[18] It is worth noting that the TPP's rules of origin are relatively liberal in some sectors (e.g. requiring 45 percent regional value content for finished cars (Henn et al., 2016)).

[19] Zhai also argues, however, that this should be more important when it comes to tariff reductions, which among TPP members are already relatively small. A large part of the gains from lower non-tariff barriers appear to be in his model due to less waste of resources: he finds estimated gains from lower variable trade costs in models with homogenous firms to be only slightly smaller than in heterogeneous-firm models (see Table 2 in Zhai (2008)).

with the results of the present study (where the extensive margin is inactive), EM TPP partners appear to benefit most from firm entry. Aichele and Felbermayr (2015), however, find a large impact of the TPP despite using the perfect-competition model of Caliendo and Parro (2015), i.e. only the intensive margin is active. Caliendo and Parro (2015) argue that the larger estimated gains that they find for NAFTA (compared to previous studies) arise because their model incorporates intermediate inputs and sectoral linkages. Finally, it is important to note that interactions between the extensive margin (captured by Petri and Plummer (2016)) and participation in GVCs (captured by Aichele and Felbermayr (2015)) may amplify gains of members. This is particularly relevant for LAC members, which currently have a much lower participation in value chains than the Asian EM members.

Results likely differ also due to different assumptions on reductions in NTBs across TPP members. Other studies have typically assumed the same rate of reduction in non-tariff barriers for all TPP members, whereas we assume the effect of the TPP is heterogeneous across members. The assumption is based on the intuition that more advanced economies may have smaller scope for reduction in NTBs. As Mexico is one of the members further away from the frontier in terms of ad-valorem equivalent of non-tariff barriers, its gains are also larger.

Table 6. Comparison with other studies
TPP members ranking according to real income gains
(percent real income change in parenthesis)

	This study	Petri and Plummer (2016) 1\	Aichele and Felbermayr (2015)
Malaysia	1	2	4
	(3.6)	(8.0)	(3.1)
Singapore	2	5	9
	(1.7)	(3.0)	(0.9)
Mexico	3	8	11
	(1.4)	(1.5)	(-0.1)
Vietnam	4	1	2
	(1.2)	(10.0)	(5.4)
New Zealand	5	4	1
	(0.8)	(3.2)	(6.3)
Australia	6	11	3
	(0.4)	(0.5)	(4.5)
Brunei	7	3	N/A
	(0.3)	(5.0)	N/A
Chile	8	10	10
	(0.3)	(0.8)	(0.1)
Canada	9	9	7
	(0.3)	(1.0)	(2.1)
Peru	10	7	5
	(0.2)	(2.0)	(2.4)
Japan	11	6	6
	(0.2)	(2.8)	(2.2)
U.S.	12	12	8
	(0.1)	(0.4)	(2.0)
Mean change (unweighted)	(0.9)	(3.2)	(2.6)

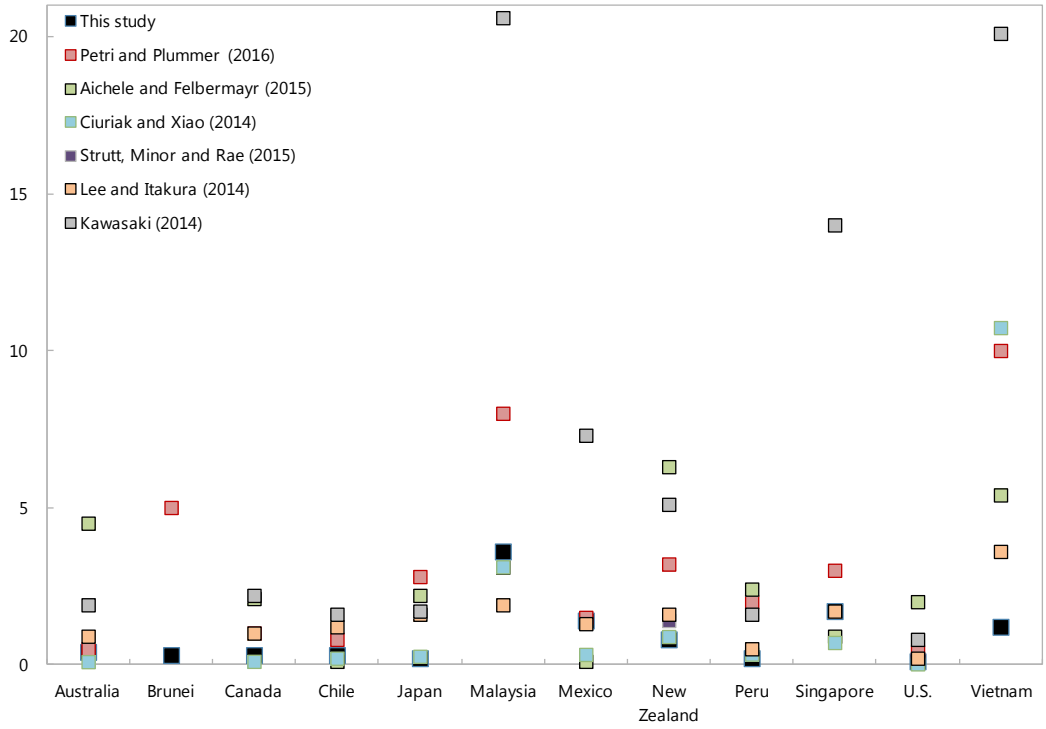
1\ Approximate results, based on Figure 4.1.6 (panel A).

Using the framework of Aichele and Felbermayr (2015), Fleishhaker et al. (2016) also find very small effects of TPP on LAC non-members.[20] Canuto et al. (2016) present the results of Aichele and Felbermayr (2015) for 15 LAC non-members. Since the model includes intermediate inputs, demand effects can have more of a positive impact on non-members. They find positive but small effects of TPP,[21] showing that demand effects outweigh negative diversion effects only by a small margin.

More in general, there is arguably very large uncertainty as to the potential gains from TPP for current members. Quantitative estimates of the effects of the TPP differ partly because they rely on different models that emphasize different channels affecting real income. Moreover, translating the trade pact into equivalent reductions in NTBs has led to diverse sets of assumptions across studies. More broadly, the TPP is a very innovative pact, and no existing model may be able to fully capture all its aspects. The uncertainty on the potential effects of the TPP is reflected in the wide range of estimates found across different studies (see Figure 11).

Figure 11. Uncertain Effects: Existing Estimates of TPP's Impact

Percent change in real income/welfare



Estimates of the effect on non-members have less dispersion, and tend to be small. Figure 12 shows the existing estimates of the effects of TPP on non-members. The dispersion

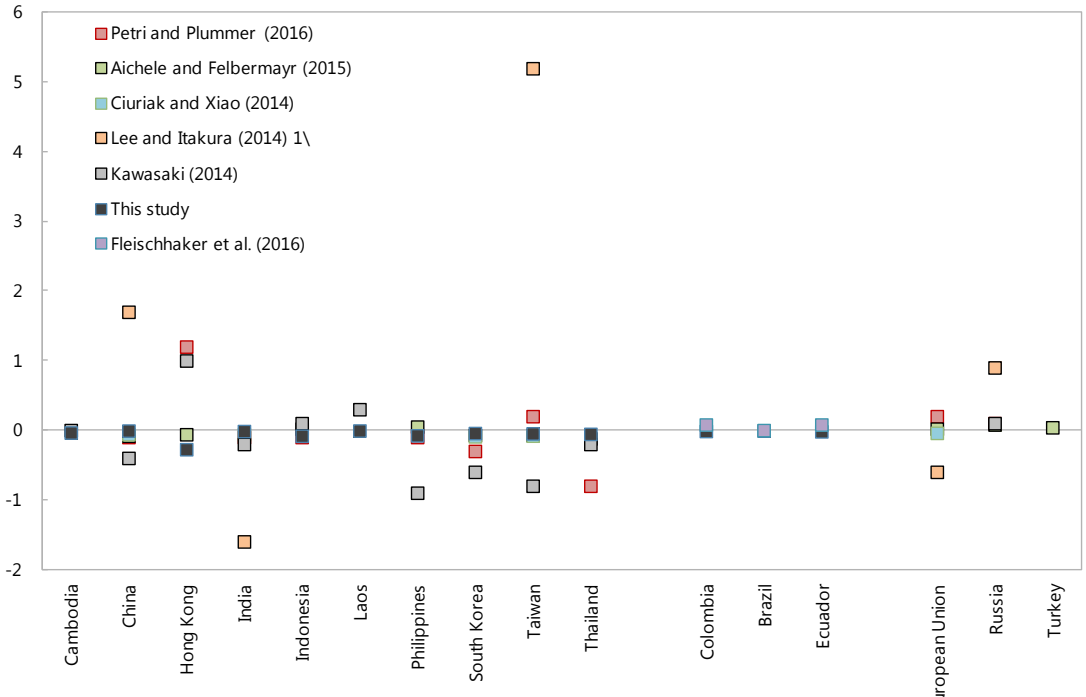
[20] The paper by Fleishhaker et al. (2016) is also discussed in the article by Canuto, George and Fleishhaker, "TTIP and TPP – A threat to Latin America?" Huffington Post, March 21, 2016.

[21] Panama, Belize, Nicaragua and Honduras gains are of approximately 0.3 percent. Other countries gains are of about 0.1-0.2 percent, with the exception of Brazil and Argentina which experience very small negative effects.

in the results reflects not only modeling choices, but also different assumptions on the extent to which reductions in NTBs are non-discriminatory. Given the absence of sound empirical evidence, in this paper we opted for assuming that reductions in NTBs are purely preferential. That is, the NTBs of each TPP member are assumed to be reduced only for imports coming from other TPP partners.[22] While negative spillovers tend to be very limited in model estimates, it is important to note that most of these studies (including the present one) neglect foreign direct investment (FDI).[23] The TPP can prompt FDI diversion away from non-members, with negative implications in terms of reduced trade and reduced technology spillovers.

Figure 12. Existing Estimates of TPP's Impact on Non-Members

Percent change in real income/welfare



1\ Lee and Itakura (2014) also present results for South Korea, Indonesia, Philippines, and Thailand, but assuming they will have joined the agreement by 2030.

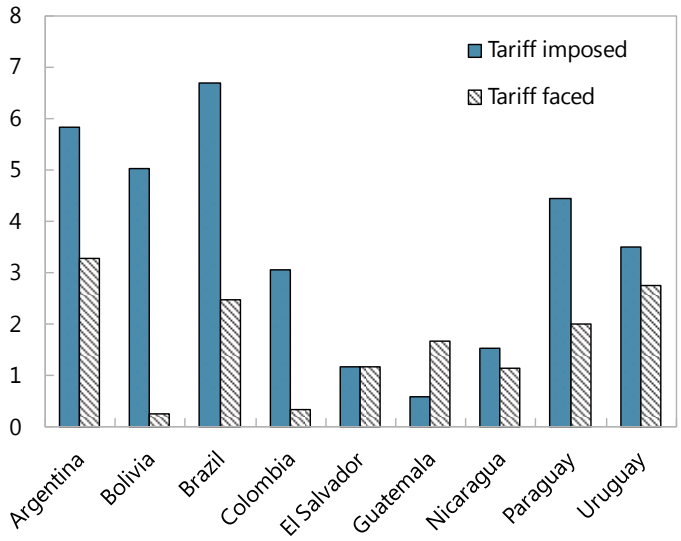
[22] Petri and Plummer (2016) assume that 20 percent of the reduction in non-tariff barriers is non-preferential. In Kawasaki (2014), this figure is as high as 50 percent. Other studies, on the other hand, assume that reductions in NTBs are purely preferential (Ciuriak and Xiao (2014), Lee and Itakura (2014), Cerdeiro (2016)). The various assumptions made in the literature reflect the absence of empirical evidence on the extent to which provisions in trade agreements are discriminatory. Baldwin (2014) argues that discrimination is difficult in practice, even with tariffs as nationality is difficult to pin down when applying rules of origin. Arguably, there are aspects of TPP, such as increased regulatory transparency, that should benefit all trade partners equally. Aggarwal and Evenett (2015), however, illustrate several ways through which discrimination can work in practice, including more favorable evidential standards and expedited reviews.

[23] Petri and Plummer (2016) incorporate FDI, albeit in an exogenous fashion. In a first stage, the authors regress FDI stocks on (the logs of) real GDP, real GDP per capita, and countries' Doing Business (DB) rank. TPP is assumed to increase FDI stocks by bringing members to the 90th percentile of the DB ranking, and closing by half the regression residuals of those countries with an unfavorable residual. Based on a reduced-form ad-hoc model, this is translated into a welfare gain equivalent to 1/3 of the increased value of FDI stocks, with the gain being evenly split between source and host countries.

VI. EXPANDING THE TPP

The exercise of the previous sections can be expanded to assess potential effects from being included in the TPP for current non-members. As the TPP moves forward, current non-members may consider applying for membership. Using the same methodology as before, what would be the effect for different countries of being included in an expanded TPP? The current section answers this question for nine non-TPP LAC economies (Argentina, Bolivia, Brazil, Colombia, El Salvador, Guatemala, Nicaragua, Paraguay and Uruguay).[24]

Figure 13. LAC countries' average tariffs with TPP members
in percent



Source: Authors' calculation s based on MAcMap and Comtrade.

Tariffs that TPP members impose on LAC countries tend to be smaller than the ones LAC countries impose on TPP members. Figure 13 shows (trade-weighted) average tariffs between selected LAC countries and TPP members. With the exception of El Salvador and Guatemala, the tariffs that the selected countries face when exporting to the TPP members are smaller. Figure 14, on the other hand, shows the implied reduction in non-tariff barriers that each country would attain if it were to be included in the TPP using the same approach as the one used above for TPP members. Given its current level of trade restrictiveness in goods, inclusion in the TPP would generate larger effects on Brazil, Guatemala, Nicaragua and Colombia, and have little effect on Argentina and El Salvador. As for trade in services, catching up with TPP levels of restrictiveness would have larger effects on Paraguay, Brazil and Colombia.

Of the nine LAC countries considered, Colombia and Guatemala are estimated to gain the most from inclusion in the TPP. Colombia (+0.42) and Guatemala (+0.40) would experience the largest welfare gains from inclusion in the TPP (Table 7). In fact, these two

[24] The selection of countries is driven by data availability. Data on tariffs are usually available for most LAC countries. We decided to exclude LAC countries for which the restrictiveness index for trade in goods was not available, which left us with the nine countries mentioned above. The restrictiveness indices for trade in services is not available for four of these nine countries (Bolivia, Guatemala, Nicaragua, and El Salvador). For those cases we assumed an average of the other five countries.

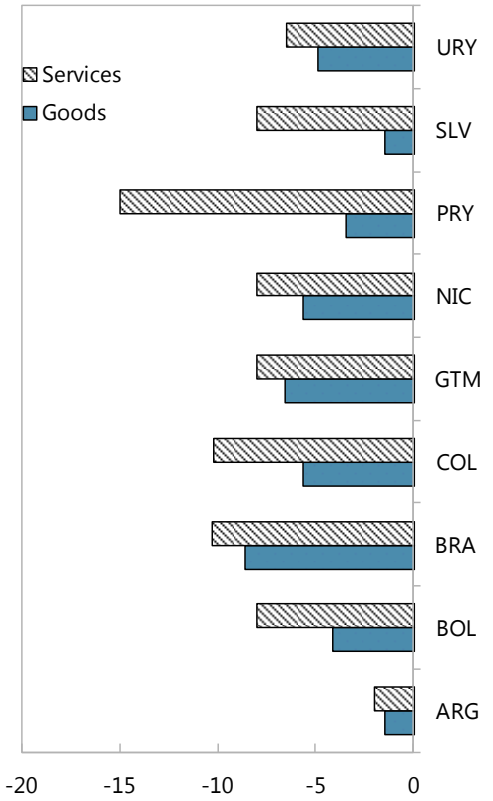
countries would gain more than what either Chile or Peru are estimated to gain from joining the TPP. It is also worth mentioning that, with the exception of Argentina, Nicaragua and Paraguay, the countries considered would experience a negative impact from tariff liberalization vis-à-vis existing TPP members. The issue is particularly stark in the case of Bolivia, who without the tariff liberalization would actually be the country with the largest gains of all nine countries. The reason for this is that the current tariffs that Bolivia imposes on existing TPP members are on average significantly higher than the tariffs Bolivia currently faces when exporting to TPP countries. As shown in Figure 13, with the exception of El Salvador and Guatemala, the brunt of the liberalization effort between existing members and LAC non-members would be borne by the latter.

Table 7. Welfare/real income effect of TPP inclusion

	NTBs reduction in	W/full tariff liberalization
Argentina	0.10	0.12
Bolivia	0.46	0.31
Brazil	0.25	0.18
Colombia	0.45	0.42
Guatemala	0.44	0.40
Nicaragua	0.31	0.32
Paraguay	0.18	0.19
El Salvador	0.31	0.29
Uruguay	0.10	0.09

Notes: The results are based on a multi-sector model of trade with perfect competition as presented by Costinot and Rodriguez-Clare (2014). Each row shows the welfare effect (in percent change) on that row's country of being included in the TPP based on the assumptions explained in the text.

Figure 14. Assumed Reduction in NTBs
in percent



1\ If τ and τ' denote the ad-valorem NTBs before and after the agreement, then the chart shows, for each member, ((1+ τ')/(1+ τ)-1)*100.
Source: Authors' calculations.

VII. CONCLUDING REMARKS

There is considerable uncertainty as to the potential gains from TPP for current members. Quantitative estimates of the effects of the TPP differ partly because they rely on different models that emphasize different channels affecting real income. More broadly, however, the TPP is a very innovative pact and no existing model may be able to fully capture all its aspects. It is clear from the data presented above that the TPP is much more than a tariff-liberalization agreement. While quantitative studies typically are also able to incorporate some measure of reduction in non-tariff barriers, there is a potentially very rich set of aspects (foreign direct investment decisions, dynamic productivity gains, redistributive aspects, labor market dynamics) that no single model may be able to fully capture.

Despite the uncertainty, a common finding across studies is that emerging Asian TPP members may be among those who benefit the most from the agreement. Emerging Asian economies (in particular Malaysia and Vietnam) are consistently ranked among the members who would benefit most from the agreement. This is likely a result of there being larger spillovers between each other, given that they have proportionally stronger trade links among them.

Negative spillovers to non-TPP LAC countries appear to be of a different order of magnitude than the gains of members. For example, in our estimates the largest gain within the TPP from reducing NTBs in goods and services (3.27, for Malaysia) is more than 50 times larger than the absolute value of the largest spillover within LAC (-0.06, for Bahamas). In general, economies that are more open and have stronger existing trade with TPP members (especially with the U.S., such as many Central America and Caribbean countries) tend to face larger negative spillovers. In general, non members could potentially benefit in two ways not accounted for in the model results presented above. First, given the TPP's relatively liberal rules of origin, non-members participating in global value chains integrated with TPP partners may actually be able to reap some benefits from the agreement. Second, some reductions in NTBs may prove to partly be non-preferential, effectively lowering the barriers to imports coming from non-members.

Some non-TPP LAC countries may experience relatively large benefits from joining the TPP. Of nine non-TPP LAC countries considered, Colombia and Guatemala are estimated to experience the largest welfare gains from potential inclusion in the TPP: their estimated gains are in fact larger than for some LAC countries in the TPP. Given current tariffs, many LAC countries would experience a negative impact from full tariff liberalization vis-à-vis TPP members, suggesting that for those countries inclusion in the TPP may require longer negotiations.

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Appendix 1

Tables A.1 and A.2 compare the results shown in the main text for the multi-sector (MS) perfect competition model, with the ones obtained with the simpler Armington model. While for most countries the results are roughly similar, larger discrepancies appear in the cases of Singapore and Vietnam. Under the Armington model, these countries benefit by about 1 p.p. more than in the MS model. This would favor the use of a multi-sector model where no blanket assumption needs to be made on the elasticity of all sectors.

Table A.1. Welfare/real income effect of tariffs and NTBs reduction with MS and Armington model

	MS	Armington
Australia	0.43	0.25
Brunei	0.34	0.49
Canada	0.27	0.22
Chile	0.33	0.13
Japan	0.17	0.13
Malaysia	3.58	3.82
Mexico	1.38	1.03
New Zealand	0.80	0.56
Peru	0.23	0.15
Singapore	1.70	2.77
USA	0.12	0.10
Vietnam	1.23	2.26

Notes: The results are based on Armington and multi-sector models of trade with perfect competition as presented by Costinot and Rodriguez-Clare (2014). Each row shows the welfare effect (in percent change) on that row's country of the NTBs reduction described in the text.

Table A.2. Welfare/real income spillovers in LAC of tariffs and NTBs reduction with Armington model

	MS	Armington
Antigua	-0.07	-0.04
Argentina	0.00	0.00
Bahamas	-0.08	-0.04
Barbados	-0.03	-0.01
Belize	-0.04	-0.01
Bolivia	-0.03	-0.01
Brazil	-0.01	0.00
Cayman Islands	-0.02	-0.01
Colombia	-0.01	0.00
Costa Rica	-0.03	0.00
Cuba	-0.01	0.00
Dominican Republic	0.00	0.01
Ecuador	-0.02	0.00
El Salvador	-0.03	0.01
Guatemala	-0.03	0.00
Guyana	-0.01	0.00
Haiti	-0.01	0.00
Honduras	-0.02	0.01
Jamaica	-0.01	-0.01
Nicaragua	-0.02	0.00
Panama	-0.03	-0.01
Paraguay	0.00	0.00
Suriname	-0.02	-0.01
Trinidad and Tobago	-0.01	0.01
Uruguay	-0.01	0.00
Venezuela	0.00	0.01

Notes: The results are based on Armington and multi-sector models of trade with perfect competition as presented by Costinot and Rodriguez-Clare (2014). Each row shows the welfare effect (in percent change) on that row's country of the NTBs reduction described in the text.

Appendix 2

This appendix describes some main features of the model. For a full description, the reader is referred to Costinot and Rodriguez-Clare (2014), and their Online Appendix.[1]
The representative consumer of country j maximizes

$$C_j = \prod_{s=1}^{S} C_{j,s}^{\beta_{j,s}},$$

where $\beta_{j,s}$are exogenous non-negative preference parameters that add to one, and $C_{j,s}$ is the consumption of the composite good of sector s, with a constant elasticity of substitution $\sigma_s$across varieties, i.e.

$$C_{j,s} = \left(\sum_{i=1}^{n} C_{ij,s}^{(\sigma_s-1)/\sigma_s}\right)^{\sigma_s/(\sigma_s-1)}.$$

The prices of one unit of consumption/utility, P_j, and of one unit of the composite good of sector s, $P_{j,s}$, are

$$P_j = \prod_{s=1}^{S} P_{j,s}^{\beta_{j,s}}, \text{ and}$$

$$P_{j,s} = \left(\sum_{i=1}^{n} P_{ij,s}^{1-\sigma_s}\right)^{1/(\sigma_s-1)}.$$

Trade is subject to iceberg trade costs: selling one unit of the good of sector s from country i to country j requires shipping $\tau_{ij,s} \geq 1$ units (with $\tau_{ij,s} = 1$ for all s). Besides these non-tariff barriers, trade flows are subject to ad-valorem tariffs $t_{ij,s}$, so that the consumer price of good from sector s imported to country j from country i satisfies

$$P_{ij,s} = Y_i \varphi_{ij,s} / Q_i,$$

where $\varphi_{ij,s} = \tau_{ij,s}(1 + t_{ij,s})$, Y_i is the factor income (GDP net of foreign trade tax revenues) of country i, and Q_i is the (inelastic) labor supply which is used to produce in every sector under constant returns to scale. Note that the description of the model so far suffices to see that gains from reductions in tariff and non-tariff barriers will come from cheaper access to varieties.
Total expenditure of country j satisfies

$$E_j = Y_j + D_j + T_j,$$

[1] As of April 14, 2016, the Online Appendix was available at http://economics.mit.edu/files/9215.

where D_j are transfers to cover trade deficits/surplus, and $T_j = \sum_{i=1}^{n}\sum_{s=1}^{S}\frac{t_{ij,s}}{1+t_{ij,s}}X_{ij,s}$ are tariff revenues.[2] Given Cobb-Douglas aggregation between different sectors, total expenditure on varieties from sector s is equal to[3]

$$E_{j,s} = \beta_{j,s}\left(Y_j + D_j + T_j\right)$$

Let $\lambda_{ij,s}$ denote the share of country j's expenditure on goods from sector s that is purchased from country i (so that e.g. $X_{ij,s} = \lambda_{ij,s}E_{j,s}$). The presence of tariffs introduces a wedge between what consumers pay and what producers receive, so that total income from sector s by country i equals

$$R_{i,s} = \sum_{j=1}^{n}\frac{1}{1+t_{ij,s}}\lambda_{ij,s}E_{j,s},$$

and total factor income is $Y_i = \sum_{s=1}^{S}R_{i,s}$.

Equilibria are defined through standard first-order conditions for CES utility functions. For comparative statics, the strategy is to use the "exact-hat algebra" described in the main text (see Ossa (forthcoming) for a careful description of how to apply the technique). Specifically, let x and x' denote equilibrium values of a variable in an initial equilibrium, and an equilibrium where some exogenous parameter(s) has (have) been changed. Then we define $\hat{x} := x'/x$. With changes defined in this way, we have that (cf. eqs. (13)-(19) in the Online Appendix of Costinot andRodriguez-Clare (2014)):

$$\hat{c}_{i,s} = \hat{Y}_i,$$

$$\hat{P}_{i,s} = \left(\sum_{l=1}^{n}\lambda_{li,s}\left(\hat{\varphi}_{li,s}\hat{c}_{l,s}\right)^{-(\sigma_s-1)}\right)^{-\frac{1}{\sigma_s-1}},$$

$$\hat{\lambda}_{ij,s} = \frac{\left(\hat{\varphi}_{ij,s}\hat{c}_{i,s}\right)^{-(1+\sigma_S)}}{\sum_{l=1}^{n}\lambda_{lj,s}\left(\hat{\varphi}_{lj,s}\hat{c}_{l,s}\right)^{-(1+\sigma_S)}},$$

$$\hat{E}_{j,s}E_{j,s} = \frac{\beta_{j,s}}{1-\sum_{i=1}^{n}\sum_{k=1}^{S}\frac{t'_{ij,k}}{1+t'_{ij,k}}\hat{\lambda}_{ij,k}\lambda_{ij,k}\beta_{j,k}}\left(\hat{\omega}_j Y_j + \hat{\chi}_j\hat{Y}_j D_j\right),$$

$$\hat{R}_{i,s}R_{i,s} = \sum_{j=1}^{n}\frac{\hat{\lambda}_{ij,s}\lambda_{ij,s}}{1+t'_{ij,s}}\hat{E}_{j,s}E_{j,s},$$

$$\hat{Y}_i Y_i = \sum_{s=1}^{S}\hat{R}_{i,s}R_{i,s},$$

[2] As noted, since the model is static, deficits D_j are modeled as lump-sum transfers, namely as $D_j = \chi_j Y_j$. To purge the data from trade imbalances, it will later be assumed that $\chi'_j = 0$ for all j (or, equivalently, $\hat{\chi}_j = 0$).

[3] The parameters $\beta_{j,s}$are in fact calibrated based on shares of consumption.

$$\sum_{i=1}^{n} \hat{Y}_i Y_i = 1,$$

where the last equation comes from world GDP being numeraire in all equilibria. The model is solved by using the interior point algorithm, maximizing a constant function subject to the constraint that all "hat" equations above are satisfied.