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Improving the Representation of the U.S. in the MyGTAP Model with the Disaggregation of Labor and Households[1]

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Abstract

The Global Trade Analysis Project (GTAP) modelling framework consists of a global database (Narayanan, Aguiar and McDougall, 2012) used in conjunction with a global applied general equilibrium model (Hertel, 1997). The GTAP model and database have been widely used for the analysis of global policy issues, such as free trade agreements. A limitation of the model is that it assumes just one regional household that captures both the government and private households. Those wishing to examine the impact of a global policy on multiple households in a particular country, while still retaining the rest of the world, are somewhat limited.

The aim of this paper is to include additional detail for the U.S economy into the GTAP framework, thereby allowing for more detailed analysis of U.S. households. The starting point for this paper is the newly developed MyGTAP data program and model (Minor and Walmsley, 2013), which was specifically designed for this purpose. Additional data are gathered for the U.S. to incorporate 22 labor categories and 13 households, and modifications are also made to the MyGTAP model to better accommodate alternative demand structures within value added.

We illustrate the use of this model by applying it to investigate the economic effects of the Trans-Pacific Partnership (TPP) on U.S. households. The TPP agreement is quite extensive, covering a large portion of world trade and the removal of both tariff and non-tariff barriers. We find that the agreement has considerable potential to increase U.S. real GDP and incomes. Moreover, while all households in the U.S. gain as a result of rising employment/wages and falling prices, it is the low income households that gain most.

Keywords: Applied General Equilibrium Model, Trans-Pacific Partnership, Free Trade Agreement, GTAP Data Base, and MyGTAP data and model.

1 INTRODUCTION

The Global Trade Analysis Project (GTAP) framework has been used extensively to analyze the impact of free trade agreements on the global economy. A limitation of the GTAP modeling framework, however, is that the model assumes just one regional household and is restricted to the same fixed number of factors and commodities for every country/region. This means that the ability to conduct a more detailed analysis of the impact of global policies on a particular country, while still retaining the rest of the world, is somewhat limited. In this paper, we are interested in developing a model and dataset that can be used to examine the impact of a global shock on the U.S. economy, and in particular, on multiple factors of production and private households.

One might argue that GTAP should incorporate additional data on multiple households for every region within the GTAP database to facilitate this type of analysis. While this is ideal in theory and has even been done by Gotor and Tsigas (2010), it requires significant data collection and estimation efforts as detailed household information is not readily available in a globally consistent format. Moreover, each country is different and it is extremely difficult to define a common set of households that would be of relevance to all countries, both developing and developed. For instance, (Gotor and Tsigas, 2010) divide households by income; however, in developing countries, policy makers may be more interested in rural versus urban or particular regions (North-East, South-West, etc.). More ad hoc techniques are usually required.

In the past, several techniques have been employed to obtain more detailed analysis of a specific country or sector within the GTAP database. These techniques have included linking the GTAP model to a single country model (Adams, Huff, McDougall, Pearson and Powell, 1996), linking the GTAP model with a PE model (Narayanan, Hertel and Horridge, 2010), using SplitCom (Horridge, 2005) to disaggregate additional sectors,[2] and adding a poverty module (Hertel, Verma, Ivanic and Rios, 2011). Studies have also disaggregated multiple households in the GTAP data for one or two specific countries (Verde, forthcoming, 2014) in order to examine a specific policy questions. All these techniques are intensive in data.

The ability to undertake more detailed analysis at the country level, while retaining the rest of the world, was the motivation behind the development of the MyGTAP modelling framework. The MyGTAP framework includes a data manipulation program (Minor and Walmsley, 2013) and model (Walmsley and Minor, 2013) that can be used to incorporate more detailed information

[2] SplitCom was used in Narayanan, Hertel and Horridge (2010), and to incorporate Biofuels into GTAP, Taheripour, Birur, Hertel and Tyner (2007)

for any country in the GTAP database. Like the other techniques, it is also intensive in data, however, the programs and documentation are relatively user-friendly. The changes that are incorporated using the MyGTAP facility relate to two main improvements in the model: i) separating the behavior of government and the private household in all regions; and ii) the inclusion of multiple households in one or more regions.

The first of these aims requires tracking additional income payments not currently contained in the GTAP database, including: remittance flows on foreign owned capital and migrant labor, foreign aid and transfers between the government and the private household.

The second not only requires further disaggregation of the income and expenditures of the private household across households, but, in most cases, requires additional disaggregation of factors of production. The reason for this is that if there are relatively few factors of production, then the potential for differences in incomes between households is small, and hence the benefits from disaggregating households minimal. Moreover, the inclusion of additional factors of production allows for a much more detailed analysis of the impact of a policy shock on the demand and supply of these different types of labor.

The objective of this paper is to incorporate more detailed information on U.S. occupations and household groups into the GTAP model, to allow for more detailed analysis of the impact of global policies on the U.S. economy and households. For this we start with the MyGTAP modelling framework and data tools. U.S. labor is disaggregated into 22 labor categories in this database, as undertaken in Carrico, Jones and Tsigas (2012). Given the emphasis on labor, the paper also examines two alternative factor demand structures, including a modification proposed by Carrico and Tsigas (2014).

The framework is then used to investigate the economic effects of the potential Trans-Pacific Partnership (TPP), a trade agreement between the U.S., Australia, Brunei Darussalam, Canada, Chile, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam. This extra level of detail allows us to determine the effect of the TPP agreement on 13 aggregate U.S. households' income and consumption patterns.

The use of a global computer general equilibrium (CGE) model to analyze the impact of the TPP agreement is ideal because of the global nature of the policy shock. A CGE model can account for changes in tariffs and non-tariff barriers across many products and countries and how these shocks affect trade, production, and the allocation of factors (capital and labor) to production. In GTAP, the underlying globally balanced trade data set allows for analysis of trade, while the linkage between production and factor markets is provided by the underlying input-output data. Revisions to this methodology, through MyGTAP, also allow us to analyze the impact of the TPP on households in the U.S.

The following section provides a brief review of the TPP agreement and its members. Section 3 summarizes the data sources and the adjustments required to reveal the household and labor detail for the U.S. in the GTAP framework. In section 4, the model and policy simulation design is discussed, followed by the results in section 5. In the final section, the paper is summarized and conclusions drawn.

2 BACKGROUND

The Trans-Pacific Partnership (TPP) started as the Trans-Pacific Strategic Economic Partnership (TPSEP) Agreement, which involved Brunei Darussalam, Chile, Singapore, and New Zealand. These four countries completed negotiations in 2005, and as of January 1st 2006, lowered their tariffs by 90 percent with the commitment to eliminate them completely by 2015. Starting in 2008, other countries began negotiating to enter the group, including: the U.S., Australia, Canada, Malaysia, Mexico, Peru, and Vietnam. Currently, member economies account for U.S. $18.2 trillion or 33 percent of World's GDP and have a combined population of approximately 626 million people. Moreover 34 percent of the World's trade moves through current TPP members (Table 1).

Table 1. Bilateral Trade as a share of World Trade (2007)

	TPP Members	Asia-Pacific	EU	Rest of World	Total Exports
TPP Members	8%	5%	4%	2%	19%
Asia-Pacific	7%	9%	7%	3%	26%
EU	5%	4%	28%	4%	41%
Rest of World	3%	4%	4%	2%	14%
Total Imports	23%	22%	43%	12%	$US15 trillion

Source: GTAP 8.1L Database, Narayanan, Aguiar and McDougall (2012)

The TPP agreement also has considerable potential for further trade liberalization and economic growth due to its openness to potential new members. In addition to the TPP which links Asia and the Americas, there are also agreements being negotiated within Asia: these negotiations are being referred to as the TPP track and the Asia track in the literature (Barfield, 2011, Petri and Plummer, 2012). Eventually it is thought that the two tracks will merge to encompass an FTA covering the whole Asia-Pacific region, FTAAP. The fact that approximately half of the world's international trade flows through the Asia-Pacific region means that this mega agreement is likely to result in considerable growth.

Both Barfield (2011) and Petri, Plummer and Zhai (2012) confirm that the implementation of the TPP would result in significant gains for member countries. Petri, Plummer and Zhai (2012) examine the impact of both tracks and the eventual merging of the two agreements. They find that world real GDP could rise by as much as 1.9 percent by the FTAAP. Their model includes firm

heterogeneity and explicitly considers FDI – they find that 20 percent of the gains coming from FDI and that the results are lower if firm heterogeneity is not considered. Petri, Plummer and Zhai (2012) also find that it is the slightly less ambitious Asia track that is expected to result in most of the gains.

In this paper our aims are much more modest, we only consider the TPP agreement and are primarily interested in its impact on the U.S. economy. Here Petri, Plummer and Zhai (2012) find that U.S. GDP is likely to be 0.4 percent higher by 2025 as a result of the TPP agreement alone. The U.S. trades quite extensively with other members of the TPP. Approximately 29 percent of U.S. imports and 32 percent of their exports are with the TPP members. The composition of that trade also differs from their trade with the rest of the world (Table 2). The U.S. tends to export and import more light manufactures to/from TPP members and less services than it does with the rest of world. Trade in heavy manufactures remains high in both cases.

Table 2. U.S. Trade with TPP Members and the Rest of the World by aggregated commodity in 2007 ($US Millions)

	U.S. Exports to		U.S. Imports from	
	TPP members	Rest of World	TPP members	Rest of World
Grains and Crops	2%	4%	2%	1%
Meat and Livestock	1%	1%	1%	0.2%
Extraction	2%	1%	13%	13%
Processed Food	3%	2%	4%	2%
Textiles and Wearing apparel	2%	1%	3%	6%
Light Manufactures	27%	17%	28%	21%
Heavy Manufactures	48%	44%	43%	41%
Utilities and construction	0%	1%	0%	0%
Transport and Communication	4%	8%	2%	6%
Other Services	11%	22%	4%	11%
Total	442,127	924,085	636,907	1,588,857

Source: GTAP 8.1L Database, Narayanan, Aguiar and McDougall (2012)

Another interesting facet of the TPP and the Asia track negotiations is that they cover a broad spectrum of trade restrictions and policy instruments, including behind-the-border barriers. The TPP is considered a 21st century FTA because it sets out rules for government procurement, intellectual property rights, foreign direct investment, competition, state enterprises, labor, capacity building among others (Barfield, 2011). In this paper, we focus on the reduction of tariffs, export subsidies and non-tariff barriers on goods, as found in the GTAP Data Base and estimated by Kee, Nicita and Olarreaga (2009), respectively.

3 THE DATA

The GTAP 8.1L Data Base is constructed based on input-output tables, macroeconomic data, tariff and trade data for 134 regions, including 114 separately identified countries and 20 aggregated regions (Narayanan, Aguiar and McDougall, 2012). The database identifies 57 sectors (Table A1), 8 factors, of which there are 5 labor types (Walmsley and Carrico, forthcoming), and represents the world economy in equilibrium in 2007.

In order to facilitate computation, the number of regions has been aggregated into 14 single countries and 7 aggregated regions (Table 3). All countries in the TPP, except Brunei,[3] are separately identified. The countries within the aggregation are shown in Table A2. The analysis has been undertaken with all 57 sectors (Table A1), although summary results for 10 aggregated sectors (Table 3) are reported in the tables for convenience, with the disaggregated sectoral results provided in the appendix. Table A3 shows the 10 sector aggregation and its relationship to the 57 GTAP sectors.

The GTAP 8.1L Data Base distinguishes five labor skills by industry. These five skills have been disaggregated into 22 occupations using the shares developed by (Carrico, Jones and Tsigas, 2012). They used the Occupational Employment Statistics Survey, from the U.S. Bureau of Labor Statistic (Bureau of Labor Statistics, 2013a) as well as the Census of Agriculture, from the U.S. Department of Agriculture (2012) to produce occupation-by-sector tables for 2007 and 2010 that distinguish 22 occupations by GTAP sectors (Table A4).

The GTAP 8.1L Data Base is then modified using the MyGTAP data program (Minor and Walmsley, 2013). The modifications are implemented using shares so as to retain the underlying values of the GTAP Data Base. The MyGTAP data manipulation program requires the following information to incorporate multiple households for the U.S.: primary factor splits, household consumption splits, and factor ownership shares for redistributing income to the new multiple households. A summary of the modifications is provided below. Those interested in a complete description are referred to Aguiar, Carrico and Walmsley (forthcoming).

The GTAP framework assumes only one regional household per region that receives all the income from taxes and factors of production, and allocates this income to government and private consumption. MyGTAP separates the private and government agents using data already contained in the GTAP database: government consumption depends on government income, which is assumed to obtain income from taxes and the private household from factors. In order to break out multiple private households in the U.S., data on the consumption and income

[3] Unfortunately the GTAP Data Base does not have data for Brunei Darussalam, it is contained in Rest of South East Asia along with Myanmar and Timor Leste. The IO table for Brunei Darussalam has recently been submitted and will be available in the next release.

sources of all the additional private households is needed. U.S. household demand is obtained from the Current Expenditure Share Tables from the Consumer Expenditure Survey (Bureau of Labor Statistics, 2013a). This distinguishes the consumption expenditure shares of 13 cohorts of income, see Table 4. The goods and services listed in the survey are being mapped to the 57 GTAP sectors in order to disaggregate private consumption by household in the GTAP Data Base. These data provide the consumption shares that are applied to the GTAP data. Savings rates by household and household transfers are also incorporated in order to accommodate differential savings rates between different private households.

Table 3. Sectors and Region in the Aggregated Version

Sectors	Regions
Grains and Crops	U.S.
Meat and Livestock	Australia
Extraction	Canada
Processed Food	Chile
Textiles and Wearing apparel	Malaysia
Light Manufactures	Mexico
Heavy Manufactures	New Zealand
Utilities and construction	Peru
Transport and Communication	Singapore
Other Services	Vietnam
	China
	India
	Japan
	Russia
	Central and Rest of South America
	Europe
	The Middle East
	Rest of South East Asia
	Rest of Asia
	Africa
	Oceania

Unfortunately there is currently no data available on factor ownership by households, and hence certain assumptions were made based on what we know about different households. The methodology used to allocate factors to households is described in Aguiar, Carrico and Walmsley (forthcoming). This aspect of the paper can be improved, and we hope that data will become available to enhance the database.

Table 4. Income Brackets

No	Lower	Upper	Code
1	<	$5,000	hhless5
2	$5,000	$9,999	hh5
3	$10,000	$14,999	hh10
4	$15,000	$19,999	hh15
5	$20,000	$29,999	hh20
6	$30,000	$39,999	hh30
7	$40,000	$49,999	hh40
8	$50,000	$69,999	hh50
9	$70,000	$79,999	hh70
10	$80,000	$99,999	hh80
11	$100,000	$119,999	hh100
12	$120,000	$149,999	hh120
13	$150,000	<	hh150m

The inclusion of 22 new labor types into the GTAP database also required defining not only the ownership of these 22 labor types by households, but also their use in the production of each of the 57 GTAP commodities. Data on the use of the 22 labor types was obtained from Carrico, Jones and Tsigas (2012). They are based on the Occupational Employment Statistics Survey (Bureau of Labor Statistics, 2013c), as well as the Census of Agriculture (U.S. Department of Agriculture, 2012).

4 MODEL, CLOSURE AND POLICY SCENARIOS

This paper uses the newly developed MyGTAP Model developed by Walmsley and Minor (2013). The MyGTAP model is an extension of the standard GTAP model (Hertel, 1997), that modifies the original single regional household to allow for multiple private households and a separate government.

In the standard GTAP model, all incomes from taxes and factors of production (land, labor, and capital) are combined and then distributed to private and government consumption, and total savings based on a Cobb-Douglas function. In MyGTAP, the government and private household is separately identified in all regions. The private household receives income from all of the factors of production, as well as foreign remittances from labor and capital. This income is then consumed and saved. MyGTAP also allows the private household in the region(s) of interest (in this case, the U.S.) to be further sub-divided into multiple households. Foreign remittances from capital and labor are assumed to adjust with changes in foreign factor prices.

The separation of the government allows for more flexibility in modelling the behavior of the government. MyGTAP assumes that the government gains income from taxes and foreign aid (in). Government income is reduced by foreign aid (out) and other transfers from government to

private households. Foreign aid (out) is assumed to be a fixed share of government income, and therefore rises as government income rises. Any change in total foreign aid is then allocated across recipients according to their current share of total foreign aid.

Another feature of the MyGTAP model is that it offers both the constant difference of elasticity (CDE) expenditure function used in GTAP[4] and the Linear Expenditure System (LES) for specifying private consumption expenditure. The CDE function generates classical "Engels" curves, which may be preferred when modeling private consumption across a broad range of households and countries. The Linear Expenditure System (LES), on the other hand, is ideal when considering multiple households in developing countries where the poorest household have high levels of subsistence expenditure. In this paper, the CDE function is selected because it is more appropriate for the developed U.S. economy.

4.1 Modifications to the Demand and Supply of Labor

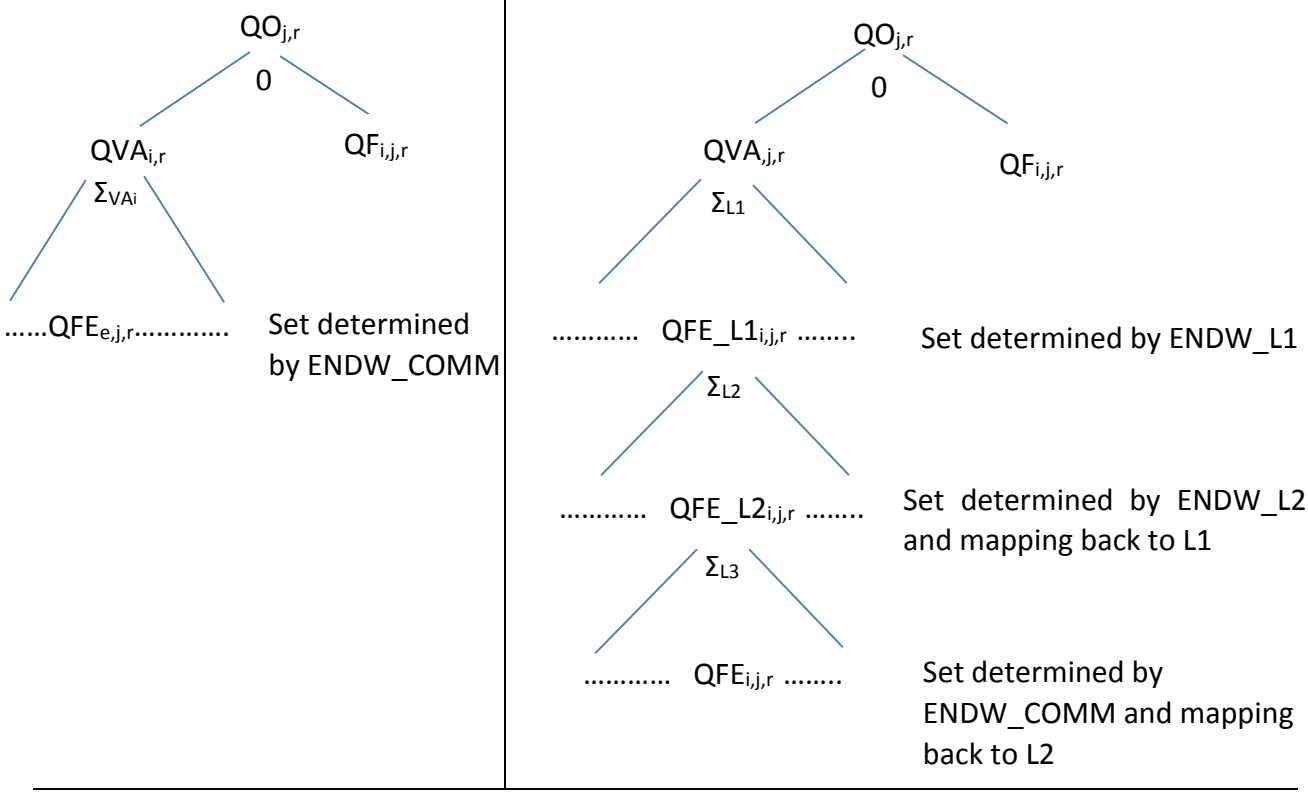
The high level of disaggregation of labor (22 occupations in the U.S.) in this study suggests that special attention ought to be paid to modeling the demand and supply of labor, including examining the impact of alternative forms of nesting of value added to better account for how firms substitute between the 22 occupational groups and with other value added.

The standard GTAP and MyGTAP models assume the same structure in the demand for value added and intermediates (left hand side of Figure 1). As in standard GTAP, firms would demand value added (qva) and intermediates (qf). Intermediate products could be domestic (qfd) or imported (qfm).[5] Then, within value added, firms substitute between all the factors (qfe), which in standard GTAP model includes land, skilled, unskilled, capital and natural resources. For the U.S., factors include land, capital, and all the occupations listed in Table A4. Hence the 22 new labor categories in this MyGTAP-US version would simply enter below value added creating more endowments (set ENDW_COMM) between which a firm could substitute.

[4] The CDE parameters can also be adjusted to accommodate other functional forms, such as Cobb-Douglas, Leontief and the CES.

[5] Imports are distinguished by origin using the Armington elasticities of substitution.

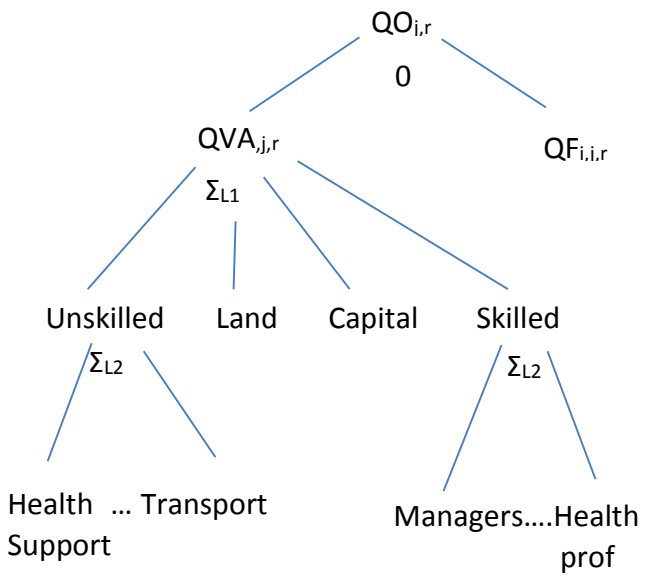
Figure 1: Model Structure



Source: Modification of Figure 2.6 in Hertel and Tsigas (1997).

Alternative demand structures for value added are increasingly being adopted in applied analysis due to the growing importance of labor issues since the financial crisis in 2007-8. In addition to Carrico and Tsigas (2014), the GLOBE model (McDonald and Thierfelder, 2013) also contains multilevel nesting of labor. For this study, additional nesting levels in value added are added to allow (and control) for more or less substitution between factors. Our aim was to implement this in such a way that the factors in each level can be flexibly defined by the user through the specification of a number of sets and subsets (e.g., ENDW_L1, ENDW_L2, ENDW_L3, where L3 is equivalent to ENDW_COMM) and mappings (L1_to_L2 and L2_to_L3). Figure 1 illustrates how the structure is set up in the model. The model allows for up to three levels. Figure 2 provides the example used in this study, which is two levels. In the first nest (L1) skilled and unskilled labor are treated as composite aggregates. In level 2 (L2) skilled and unskilled are broken down further into the 22 categories contained in the U.S. data, making it more akin to standard GTAP. Unskilled are mapped to what are considered to be the unskilled occupations, including health support services, food preparation and transportation; while skilled are mapped to the management occupations, health care professionals etc. Table A4 depicts the allocation of occupations between skilled and unskilled. This allocation is based on education attainment by occupation, from the Bureau of Labor Statistics (2013b).

Figure 2: Actual Model Structure



ENDW_L1	ENDW_L2	ENDW_COMM (L3)
Land	Land	Land
Skilled	Managers …. Health professionals	Managers …. Health professionals
Unskilled	Health support workers ….. Transport (Table A4)	Health support workers ….. Transport (Table A4)
Capital	Capital	Capital

Source: Modification of Figure 2.6 in Hertel and Tsigas (1997).

This structure permits us to implement a lower substitutability between the skilled and unskilled worker composites than between occupations within each skilled or unskilled worker composite.[6] We follow Dixon and Rimmer (2010) by assuming a low elasticity of substitution between occupations of 0.35.

The demand structure is flexible and can be altered by changing the sets and mapping files in Figure 1. [7] The main constraint is that all of the 'natural' endowment commodities (ENDW_COMM) appear in the bottom level (L3). For example, notice that once land and capital are included in level 1, they must also appear in levels 2 and 3. Also notice that in the example in Figure 2, the third level (ENDW_COMM) is identical to the second (L2). This is because we have chosen to use only two of the three levels available. Once a natural factor is listed in a level, it

[6] This is a flexible structure that allows for different parameters in each nest. For now the same parameter is used, but a larger parameter can be used to represent more substitutability between unskilled workers without affecting skilled workers.

[7] The user can define L1 and L2 levels in the header with the same name in the parameters file (default.prm).

must appear in all lower levels and be matched one to one with itself. This allows the demand structure to be fully flexible.

The sensitivity of the model results to the choice of substitution parameters and to the structure are examined below. We compare the results from this structure with the structure proposed by Carrico and Tsigas (2014) where skilled workers substitute with composite value added, while unskilled workers substitute directly with capital, land and natural resources. Carrico and Tsigas (2014) argue that unskilled workers tend to be more substitutable with capital and land, than skilled workers.

As in standard GTAP, labor and capital are assumed to be mobile across sectors, hence managers will move between the textiles and financial services sectors to equalize the percentage change in wages (not the levels). The model also allows for unemployment of factors, discussed further below.

4.2 Model Closure

In the standard GTAP model, full employment of endowments is typically assumed (land, labor, and capital). The standard GTAP model also assumes perfect competition or zero economic profits, mobile factors (except land which moves sluggishly between agricultural uses), a flexible trade balance, and mobile capital between regions (which responds to variations in rates of return on capital).

In this analysis, we modify the above model closure and allow unemployment on unskilled labor occupations in all countries while maintaining the full employment assumption of skilled labor occupations. The assumption of unemployment in the unskilled labor occupations recognizes that unskilled workers are more vulnerable to unemployment than skilled workers. In the U.S. this is evidenced by the higher rates of unemployment in unskilled occupations, shown in Table A5. We investigate the impact of these unemployment assumption in the analysis. Both skilled and unskilled labor types are mobile between sectors.

Finally, investment is allocated based on rates of return[8], and trade balances are not fixed because the TPP trade agreement involves an important share of world's trading countries and international capital flows are expected to be affected.

4.3 Policy Simulations

The policy scenario used to illustrate this new model and database simulates the potential impact of the Trans-Pacific Partnership (TPP). The TPP is a trade agreement between the U.S., Australia, Canada, Chile, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam. The trade

[8] In GTAP this is controlled by a binary parameter, RORDELTA, which is set to one.

agreement is expected to be quite comprehensive, encompassing many features of economic integration, including the removal of both tariffs and non-tariff barriers on goods and services, barriers to foreign direct investment, the movement of people, and intellectual property rights etc. (Petri and Plummer, 2012).

In this paper, we consider the measurable market access aspects of the agreement which aim to eliminate tariffs and other barriers to goods trade including exports subsidies and non-tariff barriers. The shocks are discussed in turn below.

4.3.1 Tariff Barriers and Export Taxes

Table 5 provides the average tariffs levied by the TPP member countries on aggregated commodity groups to all countries, as well as the average, across all commodities, levied on TPP member countries. The tariff data in GTAP includes tariffs and tariff rate quotas and also takes account of the numerous preferential trade agreements (Boumellassa, Laborde and Mitaritonna, 2009). Tariffs levied by Australia, New Zealand, Singapore, Chile and the U.S. are quite low, except on textiles. The other countries continue to levy high tariffs on food and agriculture (Malaysia, Vietnam, Canada, Mexico and Peru). Petri and Plummer (2012) reveal that recent U.S.-Asian free trade agreements have resulted in tariffs reductions of more than 90 percent, suggesting that significant reductions in tariffs can be expected as part of TPP. In our scenarios, we eliminate all tariffs.

Export taxes and subsidies between TPP member countries are also assumed to be removed as a result of the agreement. These data come from several sources: those on agricultural commodities are based on country submissions to the WTO of export subsidy expenditures, except for EU25 where additional data are collected (Elbehri and Narayanan, 2008), those on textiles are based on the agreement of textiles and clothing (Francois, Worz and Narayanan, 2012); and those for other sectors are from the underlying Input-Output tables.

4.3.2 Non-Tariff Barriers

The other aspect of the TPP agreement that we are able to examine is the partial removal of non-tariff barriers (NTBs) on goods. Estimates of NTBs are obtained from the World Bank (Kee, Nicita and Olarreaga, 2009).[9] The average NTBs over aggregated commodities are shown in Table 6; disaggregated NTBs can be seen in Table A6. The main source of the NTB data used by Kee, Nicita and Olarreaga (2009) is UNCTAD's TRAINS database, which contains detailed information on more than 30 different types of NTBs. Kee, Nicita and Olarreaga (2009) takes account of price

[9] Retrieved from the World Bank website on September 12, 2013:
http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:22574446~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html

control measures (TRAINS codes 6100, 6200 and 6300), quantity restrictions (TRAINS codes 3100, 3200 and 3300)[10], monopolistic measures (TRAINS code 7000), and technical regulations (TRAINS code 8100).[11] They find that NTBs are significant, and in 34 out of the 78 countries in their sample, the restrictiveness of NTBs is larger than the restrictiveness of tariffs, adding (in average) an additional 87 percent to the restrictiveness imposed. Despite having low tariffs, Singapore has amongst the highest NTBs, along with Malaysia. Other countries have high NTBs on agriculture, processed food, oil and gas, and petroleum products.

Unfortunately these estimates do not include all of the potential NTBs under negotiation, for a more detailed analysis of the impacts of TPP see Petri, Plummer and Zhai (2012). We assume that the NTBs are reduced by 25 percent. This reflects the fact that NTBs are much more complex than tariffs and are not expected to be removed completely (Ferrantino, 2013).

How to model the reduction of non-tariff barriers (NTBs) is not trivial (Fugazza and Maur, 2008). We have chosen to model the reduction of NTBs through the variable AMS following Hertel, Walmsley and Itakura (2001). This approach assumes that the NTBs alter preferences for the imported good, rather than raise or lower prices through the removal of rents/tariff equivalents (TMS), export subsidies (TXS)(Andriamananjara, Ferrantino and Tsigas, 2003) or production efficiency (AO). In reality NTBs may affect the supply and/or demand side and may create rents and/or increases costs. Ideally each NTB would be considered independently and treated accordingly in the model, however our knowledge of the NTBs, the availability of data, and accurate measures of these NTBs is insufficient at this point in time to do this. In this paper, we therefore compare results from using the preference shift (AMS) with those obtained from modeling these NTBs as a tariff equivalents (TMS).

Another issue with using tariff equivalents to model NTBs in this paper is that, in the MyGTAP model, revenue or rents from these tariff equivalents will be collected by the government and will affect government spending and saving accordingly. None of these rents will accrue to households.[12] In order to more accurately incorporate these NTBs into the MyGTAP model, further data would be required to ensure that the rents are properly allocated across households and government.

[10] See http://r0.unctad.org/trains_new/tcm_link.shtm for more details on what is included.

[11] Estimates of agricultural domestic support are not included.

[12] This issue is less important in the standard GTAP model because there is a single regional household that collects all income from both taxes and factors, hence there is little difference between the implementation of a rent and a tariff.

Table 5: Average Tariffs levied by TPP partners on aggregate commodities from all sources

	Australia	New Zealand	Malaysia	Singapore	Vietnam	Canada	USA	Mexico	Chile	Peru
Grains and Crops	0%	0%	11%	0%	10%	0%	2%	6%	1%	9%
Meat and Livestock	0%	1%	0%	0%	13%	29%	1%	1%	3%	10%
Extraction	0%	0%	2%	0%	2%	0%	0%	1%	2%	1%
Processed Food	2%	1%	8%	0%	16%	15%	3%	3%	1%	5%
Textiles and Wearing apparel	12%	9%	9%	0%	29%	9%	8%	8%	4%	14%
Light Manufactures	8%	4%	7%	0%	15%	1%	1%	3%	2%	8%
Heavy Manufactures	2%	2%	2%	0%	6%	0%	1%	2%	1%	5%
Utilities and construction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Transport and Communication	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other Services	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Average tariff	3%	2%	3%	0%	10%	1%	1%	2%	1%	5%
Average tariff levied on TPP partners only	1%	1%	1%	0%	8%	1%	0%	1%	0%	6%

Source: Narayanan, Aguiar and McDougall (2012) and Boumellassa, Laborde and Mitaritonna (2009)

Table 6: Average Non-Tariff Barriers in TPP Member countries by Aggregated Commodity[13]

	Australia	New Zealand	Malaysia	Singapore	Vietnam	Canada	USA	Mexico	Chile	Peru
Grains and Crops	24%	25%	48%	49%	-	14%	15%	21%	26%	33%
Meat and Livestock	24%	19%	29%	26%	-	13%	25%	22%	15%	21%
Extraction	22%	11%	33%	34%	-	21%	18%	22%	6%	22%
Processed Food	49%	35%	49%	51%	-	15%	24%	37%	34%	37%
Textiles and Wearing apparel	0%	1%	26%	38%	-	0%	24%	22%	0%	0%
Light Manufactures	2%	7%	33%	38%	-	4%	7%	17%	5%	14%
Heavy Manufactures	9%	11%	29%	34%	-	2%	2%	15%	4%	6%
Utilities and construction	0%	0%	0%	0%	-	0%	0%	0%	0%	0%
Transport and Communication	0%	0%	0%	0%	-	0%	0%	0%	0%	0%
Other Services	0%	0%	0%	0%	-	0%	0%	0%	0%	0%

Source: Ad-Valorem Equivalents of Non-Tariff Measures (Kee, Nicita and Olarreaga (2009))

[13] Note that NTB estimates for Vietnam were unavailable.

Finally, the reductions in NTBs may benefit not only the members of the TPP, but all countries as trade in general is facilitated and regulations harmonized. If this is the case, then the reduction in the NTB should be applied to all trading partners. The alternative scenario is one where instead of removing an NTB the partners chose to acknowledge their TPP partners standards as equivalent – this is known as mutual recognition and requires significantly less negotiation. Implementation of mutual recognition into the model requires that the NTBs are only removed between partner countries (Ferrantino, 2013). In this paper, we make use of the 'Subtotals' command in GEMPack (Harrison and Pearson, 2007) to identify these effects.

5 RESULTS

In this section, we examine the impact of the TPP on each countries' GDP and exports, followed by a deeper analysis of the U.S. economy, including factor prices and supply, output, trade, and households, assuming unemployment of unskilled workers. In the following section, we examine how sensitive these results are to our assumptions regarding unemployment of unskilled workers and the methodology used to incorporate the NTBs, amongst other things.

5.1 Impact of TPP on the Global Economy

As others have found (Barfield, 2011; Petri and Plummer, 2012), the TPP agreement results in considerable gains to its member countries (Table 7). In terms of GDP, the countries that benefit the most from the TPP agreement, as designed in this study, are Malaysia, Singapore, and Vietnam; however, even the other members also receive gains of between 0.4 and 1 percent. Other countries, not party to the agreement, are not significantly impacted by the agreement.

There is about a 0.9 percent change in U.S. GDP under the unemployment closure. This result is more than the effect found by Petri, Plummer and Zhai (2012); however, when we consider the full employment assumption, we find a 0.36 percent increase in GDP, which is very close to their estimated 0.4 percent effect of TPP on U.S. GDP. We obtain a larger effect under the unemployment assumption due to the fact that the reduction of trade barriers increases demand for unskilled labor in the U.S. economy, causing unemployment to fall and, thereby, further enhancing growth in real GDP.

Table 7. Impact of TPP on Real GDP

			Contributions due to (%):			
TPP countries	**Base Value (in millions of 2007 USD)**	**Total (%)**	tariff removal	export tax removal	NTB's on TPP countries	NTB's on other countries (non TPP)
	I	II	III	IV	V	VI
Australia	856,911	0.461	-0.001	0.004	0.181	0.276
New Zealand	138,317	0.711	0.067	0.006	0.282	0.355
Malaysia	186,642	4.620	0.239	0.031	1.289	3.061
Singapore	176,766	5.021	0.009	0.006	1.440	3.567
Vietnam	68,435	1.720	1.613	-0.002	0.512	-0.404
Canada	1,424,063	0.635	0.213	0.000	0.285	0.136
United States	14,061,778	0.863	0.025	0.004	0.262	0.573
Mexico	1,025,580	0.952	0.041	0.001	0.607	0.304
Chile	164,315	0.406	0.011	0.002	0.118	0.276
Peru	107,492	0.472	0.014	0.001	0.140	0.317
Other Countries						
China	3,494,058	0.000	-0.021	0.000	-0.017	0.038
Japan	4,377,945	-0.001	-0.001	0.000	-0.001	0.001
India	1,232,817	-0.012	-0.005	-0.001	-0.008	0.003
Russia	1,299,708	-0.030	0.007	0.000	-0.080	0.043
Rest of the World	207,193	0.000	0.000	0.000	0.000	0.000
European Union	18,203,806	0.001	-0.002	0.000	0.005	-0.002
Middle East	2,133,365	-0.004	-0.001	0.000	-0.001	-0.002
Africa	1,328,607	-0.018	0.000	0.000	-0.012	-0.006
Rest of Americas	2,553,705	-0.006	-0.005	0.000	-0.009	0.008
Rest of South East Asia	864,529	-0.008	-0.008	-0.001	-0.010	0.012
Rest of Asia	1,893,476	-0.022	-0.010	-0.001	-0.008	-0.004
Rest of Oceania	31,830	-0.025	-0.025	-0.002	-0.023	0.025

Source: Authors' calculations based on simulation results.

In Table 7 we also show the contributions to the total effect of each component of the TPP agreement: the import tariff reduction, the reduction of export subsidies, and the reduction of NTBs.[14] In general we find that, with the exception of Vietnam, which has very high initial tariff rates (Table 5) and no NTBs. It is the removal of NTBs that provides the most gains to member countries in the region (columns V and VI, Table 7). This is consistent with the more general

[14] We do this by the utilization of subtotal commands in the shock tab of RunGTAP, (Harrison and Pearson, 2007)

finding that FTAs that negotiate agreements beyond removing tariffs generally have a more positive impact on their members (Hertel, Walmsley and Itakura, 2001).

The impact of the removal of NTBs is divided into the impact of removing NTBs amongst the TPP members versus the removal of NTBs by TPP members on imports from non-TPP members. Recall from the discussion above that, if NTBs are removed by a country, then all trading partners, not just the TPP members, are likely to gain from the removal (i.e., the sum of columns V and VI in Table 7). If, however, the TPP agreement simply results in members acknowledging that adherence to the rules of member countries is equivalent to adherence of their own rules, then the NTBs are only removed amongst TPP members (Column V, Table 7). In general, these results demonstrate that removal of the NTBs (column V plus VI) has a larger impact on the growth of the member economies than this mutual recognition (column V only).

It is somewhat surprising, however, that the removal of NTBs by TPP members on non-TPP countries does not raise the real GDP of those non-TPP countries. Upon further investigation of the removal of NTBs we find that most of the gains from the removal of NTBs are due to own liberalization, rather than the liberalization of others. For instance, 0.84 of the total 0.86 GDP gain in the U.S. from the removal of the NTBs (see Table 7, columns V and VI) are due to their own liberalization. The exception of course is Vietnam, where NTB estimates are missing. In the case of Vietnam, the driving effects are due to the removal of tariffs (column III) by the U.S. on textiles and wearing apparel, since 40 percent of Vietnam's exports to the U.S. are of textiles.

5.2 Impact of TPP on the U.S. Economy

Table 8 depicts the overall macro-economic impact of the TPP agreement on trade and final demand in the U.S. economy. As expected, trade rises as a result of the TPP agreement, with both exports and imports rising from the removal of tariffs and NTBs. The removal of NTBs on non-partner countries also raises imports, albeit exports only marginally increase. Not surprisingly, both domestic investment and foreign investment increases and the trade balance deteriorates further.

Private and government consumption rise with factor income and tax revenue, respectively. Factor incomes and household impacts are discussed further below. Despite the loss of tariff revenue, government income increases due to the increase in income taxes and other taxes paid by households on consumption. This is not surprising since tariffs are relatively low in the underlying data (Table 5) and hence their removal does not have a significant impact on government revenue and hence expenditure.

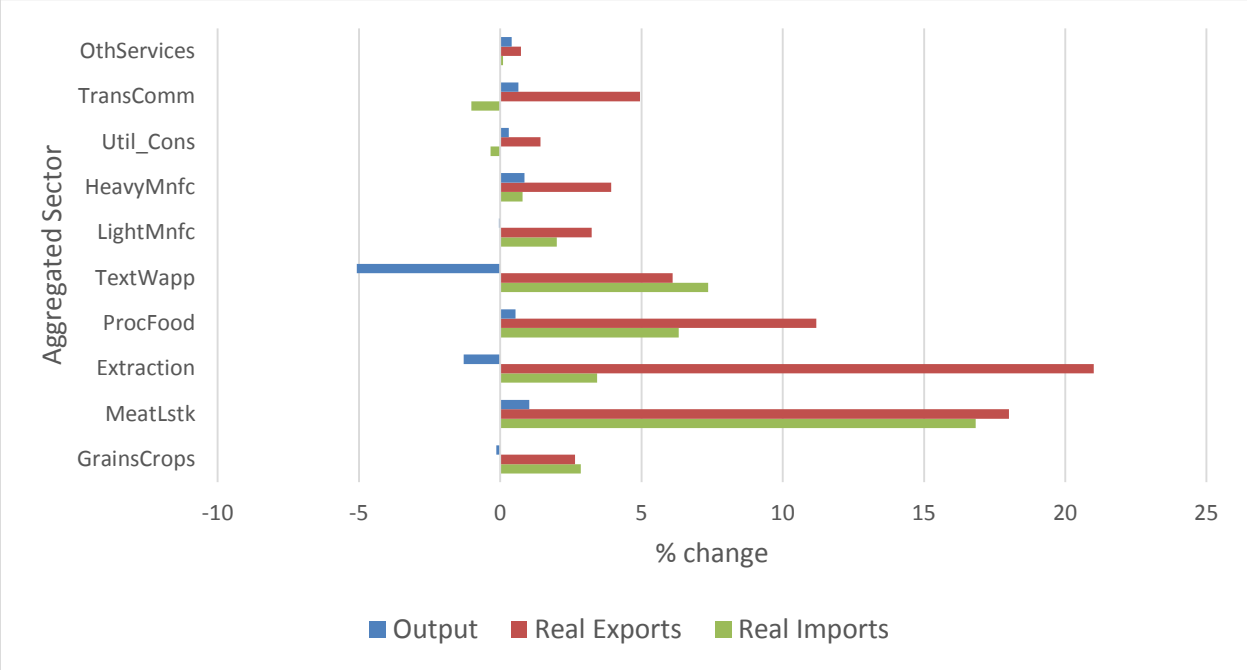
Table 8. Impact of TPP on the US Real GDP, Trade and Final Demand

			Contributions due to (%):			
TPP countries	**Initial Value (in millions of 2007 USD)**	**Total (%)**	tariff removal	export tax removal	NTB's on TPP countries	NTB's on other countries (non TPP)
	I	II	III	IV	V	VI
Real GDP	14,061,778	0.863	0.025	0.004	0.262	0.573
Exports	1,394,304	2.323	0.533	0.054	1.172	0.565
Imports	2,225,763	2.775	0.434	0.050	1.123	1.168
Trade Balance	-831,459	-29,551	-1,186	-327	-9,183	-18,855
Terms of Trade	n.a.	-0.210	0.063	-0.003	0.000	-0.270
Real Investment	2,685,577	1.561	0.050	0.014	0.470	1.028
Real Government Expenditure	2,258,359	0.431	-0.028	-0.002	0.150	0.311
Consumer Prices	n.a.	-0.180	0.019	0.010	0.140	-0.349

Source: Authors' calculations based on simulation results.

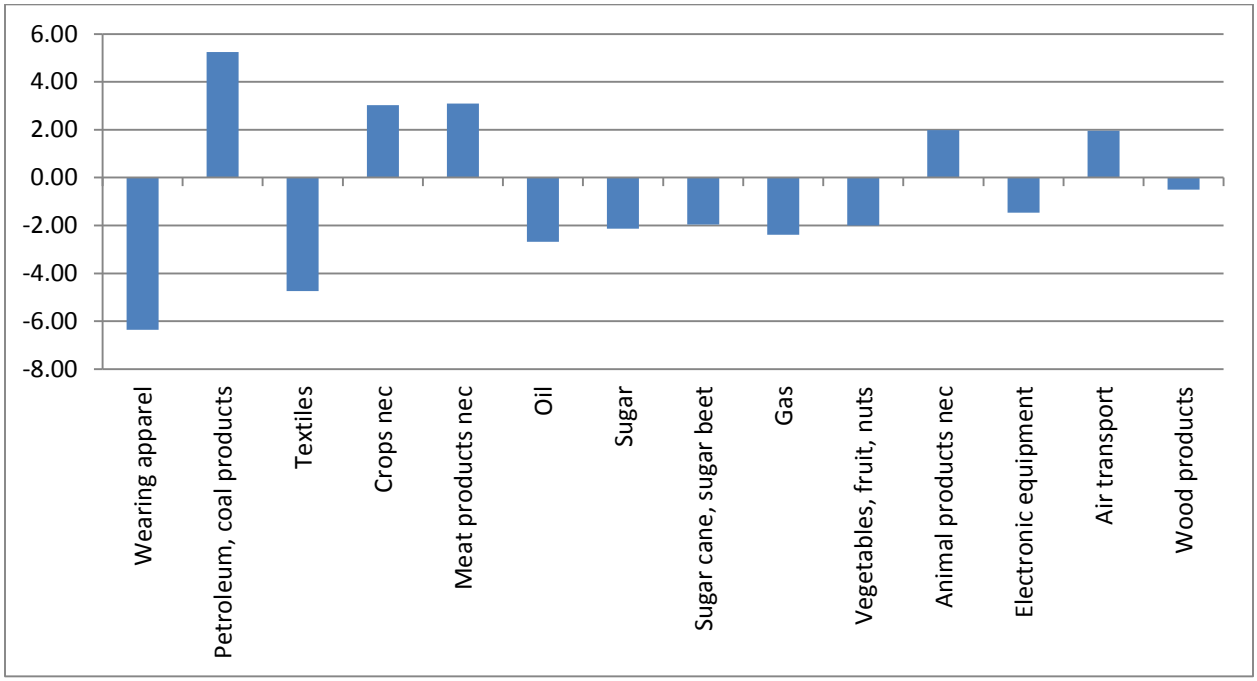
The TPP agreement has a considerable impact on certain sectors in the U.S. Figure 3 shows the results for the 10 aggregated sectors, while selected disaggregated results are shown in Figure 4 (with a full list is located in Table A7). In general, the figure shows large increase in imports, small increases in exports, and mixed results for changes in output.

Figure 3. Changes in output for aggregated U.S. sectors after TPP



Source: Authors' calculations based on simulation results.

Figure 4. Selected U.S. sectors with greater changes in output after TPP (percent change) under unemployment assumption



Source: Authors' calculations based on simulation results.

The decline in production of crops and grains is primarily due to a decline in vegetables and fruit (v_f) and in oil seed (osd). The U.S. has very high NTBs on both these products which, when removed, cause demand to switch towards imports. Imports of vegetables and fruits in particular is very high in the underlying data (60 percent of crop imports) and increases substantially. While production falls, it is interesting to note that exports of crops and grains rises. This increase is due to the increase in exports of wheat to Peru and other crops to Mexico that result from the removal of high tariffs on these two goods by Peru and Mexico, respectively.

The meat and livestock industry in the U.S. also expands, as do imports and exports. Most of this expansion is in other meat products (omt), although imports of bovine meat products (cmt) from Australia and New Zealand also increase significantly as a result of the reduction in Australia's tariffs and both countries' NTBs. The story is even more pronounced on other meat products where the removal of tariffs applied by Canada, Vietnam and Peru increases their imports of U.S. other meat products. Moreover, the partners' removal of large NTBs and tariffs on the other animal products (oap), an important input into production of other meat products, also causes an increase in imported inputs and a fall in the cost of producing other meat products – raising demand even further.

While there are no tariffs applied against oil, the U.S. and its TPP partners have significant NTBs on both oil and gas to the tune of between 33 and 39 percent. Therefore a reduction of NTBs causes an increase in U.S. imports of oil and gas from Canada, the Middle East, Rest of the

Americas, and Africa. The increase in the availability of cheaper imported crude oil affects domestic production of crude oil. In spite of the decline in domestic production of oil, exports of oil increase. This is due to the fact that the domestic demand for domestic oil declines because there is a heavy reliance on imported oil by the domestic electricity (ely) and petroleum and coke industries (p_c) that is further deepened as a result of the reduction in NTBs. Electricity and petroleum and coke products benefit from the less expensive inputs, which allows them to increase production and exports.

The processed food industry is subject to a number of tariff and NTBs that would be reduced as a result of the TPP. The reduction of these barriers in general raises imports, reduces costs and increases production and exports, particularly in the two largest sectors – other food products (ofd) and beverages and tobacco (b_t).

Only the dairy (mil) and sugar (sug) industries contract. In the case of sugar, U.S. production is very small and U.S. tariffs against Australia, Mexico, and Peru are very large. The removal of barriers simply causes substitution towards imports from these three countries and a decline in domestic production. The reduction of tariffs on dairy by Canada, Vietnam, Peru, and New Zealand raises U.S. exports to these countries, while a reduction in the U.S. tariffs raises imports. With no tariffs or NTBs on raw milk (rmk), an important input into dairy, there is little decline in the production costs that assisted many of the other industries listed above (e.g., other meat products); hence the industry does not benefit from the TPP and contracts.

The story is similar for the U.S. textiles (tex) and wearing apparel (wap) industries. The U.S. levies high tariffs on textiles and wearing apparel from Malaysia, Peru, and Vietnam, and their removal causes an increase in imports. Although textiles are an important input into the wearing apparel industry, imported textiles are not important to the U.S. industry. The reduction in tariffs and NTBs on textiles is therefore not sufficient to reduce the cost of production of domestic wearing apparel and cause demand to increase. Finally, services and transportation also gain as a result of the TPP due to the general increase in incomes and trade.

5.3 Impact on Factors and U.S. Households

The effect of the TPP agreement on factor incomes depends on three elements:

1. the demand structure given in our original data base (see Table 9);
2. the supply assumption, typically a full employment assumption is chosen, although here we have specified an unemployment closure for unskilled workers; and
3. the effects of the policy simulation

If production expands, then demand for the inputs used in the production of this good also increases. The impact would be larger for those intermediate and factors inputs used most intensively in production, and vice versa. The sectors where production contracts will release factors, which will then be absorbed by those sectors that expand. Under the full employment assumption for unskilled workers, wages will fall (rise) depending on whether the release of labor

by the declining sectors exceeds (fall short of) those expanding sectors that demand more labor. Under the unemployment closure assumed for unskilled workers, wages/factor prices are fixed and supply is elastic. In this case supply will adjust to meet demand: that is, employment will fall (rise) depending on if the release of labor by the declining sectors exceeds (fall short of) demand by the expanding sectors.

The results of our simulation show that the TPP agreement has a positive effect on the meat and livestock sector while it has a large negative effect on the textile and wearing apparel sector (Figure 4). As can be seen from Table 9, both of these aggregate sectors have intensive use of production workers. In the textile and wearing apparel sector, production workers represent 42 percent of total factors while for the meat and livestock sector they represent 31 percent. The contraction of the textile sector would release inputs, and in particular production workers. The demand for factors by the textile sector decreases between 4 and 6 percent, see Table 10. On the other hand, the meat sector will demand more production workers in order to satisfy increased local and foreign demands. Overall employment of production workers increases, but by much less than employment of the other factors (0.49 percent as opposed to over 0.5 - 1.6 percent for most of the other sectors, Table 11).

Table 11 shows the change in the real returns (wages) or employment of the factors, depending on the supply assumption. The returns to land, capital, and skilled workers rise driven by the increase demand by expanding sectors due to the TPP. The returns to natural resources, on the other hand, decrease due to the contraction of the extraction sectors due to the TPP. Unskilled occupation workers do not see real wage gains in the first scenario because, by assumption, their real wage is being held constant to allow for changes in the demand of unskilled workers to adjust to the scenario shocks. In terms of unskilled workers, not all occupations reduce unemployment equally, we observe that it ranges from 0.49 percent for production occupations to 1.60 percent for personal care occupations.

Table 9. Share of Factor Demands in Total Factor Demand by Aggregate Products

	GrainsCrops	MeatLstk	Extraction	ProcFood	TextWapp	LightMnfc	HeavyMnfc	Util_Cons	TransComm	OthServices
Land	29.2%	11%	0%	0%	0%	0%	0%	0%	0%	0%
Capital	35.6%	26.5%	43.4%	47.1%	21.4%	23.2%	30.4%	27.0%	29.7%	29.9%
NatRes	0.0%	0.0%	33.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
management	28.0%	14.0%	4.5%	5.6%	8.6%	8.8%	10.2%	7.8%	6.1%	7.9%
bus_finance	0.0%	0.8%	1.6%	1.5%	1.8%	3.7%	3.3%	3.1%	2.1%	7.6%
comp_math	0.0%	0.1%	0.4%	0.4%	0.9%	3.5%	3.0%	0.3%	1.9%	3.2%
arch_enginr	0.0%	0.2%	1.9%	0.5%	1.0%	5.5%	8.1%	1.6%	0.5%	1.6%
sciences	0.0%	0.3%	1.3%	0.9%	0.3%	0.4%	2.0%	0.2%	0.2%	1.2%
social_serv	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
Legal	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	1.5%
education	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%
entertain	0.0%	0.0%	0.0%	0.1%	1.9%	3.2%	0.4%	0.1%	0.8%	1.4%
health_prac	0.0%	0.2%	0.1%	0.1%	0.0%	0.1%	0.2%	0.0%	1.4%	8.3%
health_sup	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.8%
protective	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	2.3%
food_service	0.0%	0.1%	0.0%	1.0%	0.0%	0.1%	0.0%	0.0%	9.8%	1.1%
build_maint	0.0%	0.6%	0.0%	0.7%	0.4%	0.2%	0.2%	0.2%	0.9%	1.7%
pers_care	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	1.5%	1.8%
Sales	0.0%	0.8%	0.4%	3.5%	3.5%	3.6%	3.1%	1.8%	18.0%	3.6%
admin_supp	0.0%	2.3%	1.5%	4.3%	8.0%	6.3%	5.5%	6.0%	9.1%	11.6%
farm_occup	7.0%	3.0%	0.4%	0.5%	0.0%	0.2%	0.0%	0.0%	0.1%	0.1%
constructn	0.0%	0.1%	4.8%	0.3%	0.3%	2.3%	0.9%	41.2%	0.3%	0.8%
maint_repr	0.0%	3.2%	1.8%	4.3%	4.9%	3.5%	3.6%	6.0%	5.2%	1.2%
production	0.1%	30.5%	2.0%	19.9%	41.8%	30.5%	25.4%	2.3%	1.8%	0.7%
transport	0.0%	6.4%	2.7%	9.3%	5.1%	4.6%	3.7%	2.0%	10.4%	1.6%

Source: Narayanan, Aguiar and McDougall (2012)

Table 10. Percent Changes in factor demand after TPP by aggregate product

	GrainsCrops	MeatLstk	Extraction	ProcFood	TextWapp	LightMnfc	HeavyMnfc	Util_Cons	TransComm	OthServices
Land	-0.15	0.51	-	-	-	-	-	-	-	-
Capital	-0.34	0.49	-2.77	0.22	-5.86	-0.58	-0.52	0.37	-0.06	0.22
NatRes	-	-	0.00	-	-	-	-	-	-	-
management	-0.14	0.55	-1.77	0.18	-6.04	-0.54	-0.76	0.29	-0.13	0.27
bus_finance	-	0.59	-3.25	0.07	-6.17	-0.83	-0.92	0.18	-0.19	0.13
comp_math	-0.28	0.67	-3.66	0.19	-6.41	-0.26	-1.10	0.40	0.10	0.18
arch_enginr	0.09	1.04	-3.09	0.50	-5.74	-0.64	-0.60	0.78	0.55	0.59
sciences	-0.34	0.61	-3.57	0.05	-6.11	-0.48	-0.29	0.30	-0.14	0.20
social_serv	-	0.32	-	-	-	-0.19	-	-	-0.81	0.00
legal	-	-	-3.97	0.31	-	-0.22	-0.87	0.18	-0.04	0.02
education	-	-	-	-	-	-0.84	-1.35	0.15	-0.26	0.00
entertain	-	0.52	-2.97	0.15	-6.10	-0.07	-1.11	0.11	-0.08	0.15
health_prac	-0.57	0.37	-1.92	-0.20	-5.79	-1.21	-0.98	0.00	-0.75	0.04
health_sup	-	-	-	-	-	-	0.66	-	1.30	1.54
protective	-	1.76	0.13	1.21	-4.32	0.14	0.60	1.71	1.34	1.52
food_service	-	1.76	-	1.26	-	1.40	0.25	1.44	1.30	1.57
build_maint	0.83	1.76	-0.09	1.24	-5.08	0.52	0.56	1.61	1.31	1.46
pers_care	-	-	-3.75	1.50	-	1.40	1.20	1.62	1.65	1.58
sales	0.83	1.76	-2.14	1.28	-4.71	0.88	0.47	1.61	1.32	1.39
admin_supp	0.83	1.76	-1.98	1.23	-4.84	0.71	0.51	1.60	1.45	1.44
farm_occup	-0.70	1.14	-0.33	1.33	-	-0.13	0.85	1.35	1.33	1.37
constructn	0.83	1.76	-0.16	1.16	-4.32	0.20	0.92	1.62	1.48	1.46
maint_repr	0.83	1.76	-0.04	1.22	-5.14	0.39	0.70	1.63	1.44	1.47
production	0.83	1.76	-1.40	1.20	-4.92	0.47	0.55	1.52	1.33	1.40
transport	0.83	1.76	-0.25	1.23	-5.00	0.41	0.90	1.61	1.68	1.40

Source: Authors' calculations based on simulation results.

Table 11. Changes in Real factor returns or Employment due to TPP scenario with unemployment

	Real Returns and Wage under unemployment assumption	Change in Supply under unemployment assumption
Land	0.28	n.a.
Capital	0.91	n.a.
NatRes	-11.62	n.a.
management	0.63	n.a.
bus_finance	0.68	n.a.
comp_math	0.64	n.a.
arch_enginr	0.48	n.a.
sciences	0.67	n.a.
social_serv	0.80	n.a.
legal	0.71	n.a.
education	0.80	n.a.
Entertain	0.71	n.a.
health_prac	0.78	n.a.
health_sup	n.a.	1.54
Protective	n.a.	1.51
food_service	n.a.	1.37
build_maint	n.a.	1.41
pers_care	n.a.	1.60
sales	n.a.	1.28
admin_supp	n.a.	1.35
farm_occup	n.a.	0.53
Construct	n.a.	1.52
maint_repr	n.a.	1.25
Production	n.a.	0.49
Transport	n.a.	1.37

Source: Author's calculations based on simulation results.

* n.a. indicates that the variable is fixed and therefore does not change in this closure.

Farming occupations exhibit the second lowest unemployment reduction of 0.53 percent. According to the GTAP Data Base, thirty percent of farming workers are used in Grains and Crops, the majority of which are used in the vegetables and fruit sector. As we know from Figure 4, the vegetable and fruit sector declines by approximately 2 percent. While production of other crops sectors rises, it is not sufficient to offset the decline in demand for farm workers. Nonetheless, there is an increase in demand from other sectors, which is why labor supply of farm workers does slightly increase. Personal care workers, on the other hand, mainly work in the services

sectors, which expand due to the lower cost of imported inputs and the general rise in income and demand in the U.S., accounting for the high increase in supply.

Finally, the MyGTAP model extension also allow us to link these changes in factor incomes back to the real incomes of the 13 households in the U.S., so as to determine the effect of the TPP trade agreement on low versus high income households. Table 12 illustrates the changes in real incomes for the 13 household types examined.

Table 12. Changes in Real income by household under the unemployment assumption

Household	Top source/s of factor income	% change in Income	% Change in consumption prices (CPI based on their basket)	% change in real Income
	I	II	III	IV
hhless5	Food service occupations (36%) and personal care (24%)	1.07	-0.27	1.34
hh5	Food service occupations (36%) and personal care (24%)	1.07	-0.27	1.34
hh10	Food service occupations (36%) and personal care (24%)	1.07	-0.22	1.29
hh15	Food service occupations (66%) and building maintenance (10%)	1.06	-0.21	1.26
hh20	Building maintenance occupations (61%)	1.06	-0.18	1.24
hh30	Food service occupations (23%) and personal care (23%)	1.09	-0.23	1.32
hh40	Administrative support occupations (32%), production (18%) and sales (17%)	0.91	-0.20	1.11
hh50	Administrative support occupations (22%), production (12%)	0.90	-0.19	1.09
hh70	Business and finance occupations (13%) and health practitioners (11%)	0.82	-0.17	0.99
hh80	Business and finance occupations (12%) and health practitioners (11%)	0.74	-0.19	0.93
hh100	Management occupations (24%) and Business and finance (9%)	0.63	-0.18	0.81
hh120	Management occupations (21%) and Business and finance (8%)	0.67	-0.14	0.82
hh150m	Management occupations (20%) and Business and finance (8%)	0.68	-0.14	0.83

Source: Author's calculations based on simulation results.

The impact of TPP on real household incomes stems from two effects. First, *the income effect*: Households earn income from their ownership of factors of production. High income households tend to earn income from capital and skilled labor, while low income households earn income from unskilled labor. As mentioned above, the TPP has differential impacts on the wages and

employment of the various factors depending on what happens to the sectors in which they are employed. The changes in wages and employment therefore flow through into changes in the incomes of households. Those with rising wages or employment will see incomes rise, while those with falling wages or rising unemployment will experience a decline in their incomes. The results show that low income households tend to benefit more from the TPP than high income households in terms of factor incomes (column II, Table 12). This is somewhat surprising since above we noted that farm and production workers experienced relatively low increases in employment, relative to other sectors. The reason for this is that the low income households are employed mostly as food service and personal care workers (column I, Table 12), not farm workers. Since services increase (Figures 3 and 4), so too does demand for service workers in these sectors, and, hence, lower income households. Note that this analysis is based on our own estimates of ownership of factors by households and would be further improved with the availability of this data.

Second, *the price effect*: Households also gain real income as a result of changes in prices of the goods that of which they consume the highest quantity. For instance, low income households tend to purchase more food and clothing, while higher income households may purchase more luxury items and services, and they may save more. Under the TPP, the prices of all goods decline, however, the prices of food and clothing tend to decline more giving lower income households an even larger boost in their real incomes.

Overall, both effects work in the same direction to raise the real incomes of the lower households more than those of the high income households, although all households gain.

6 SENSITIVITY ANALYSIS

Table 13 shows the results of other alternative scenarios that were considered in this study with and without unemployment. Our results are most sensitive to our assumptions regarding unemployment and the use of preferences to model NTBs.

6.1 NTBs as Tariff Equivalents

As discussed above, the reduction of NTBs were modelled as improved facilitation of trade, rather than as tariff equivalents. In this section, we compare our results against the scenario where NTBs are modelled as tariff equivalents (tms shock). In order to do this, we first need to include the NTB as part of the import tariffs in the GTAP database using an Altertax simulation (Malcom, 1998). Once the tariff equivalents have been included, the NTB reduction can then be simulated within the MyGTAP model as a 25 percent reduction in the portion of the tariff that corresponds

to the NTB.[15] One of the concerns about this methodology is that in MyGTAP, the tariff revenue is received by the government and hence its loss, lowers government income, whereas in reality rents from these NTBs may accrue to firms and eventually to households. This is not an issue in the GTAP model since the regional household collects all the income, and it is allocated equally to private and government consumption according to a Cobb-Douglas utility function. However, the question of who loses income earned from NTBs after reduction, becomes of greater importance with the inclusion of multiple households and a separated government in MyGTAP.[16]

Table 13. Impact of TPP under Alternative Assumptions

	Original results		NTBs modelled as TMS shock		Alternative Labor structure	
	Unemployment	Full	Unemployment	Full	Unemployment	Full
Real GDP	0.86	0.36	0.27	0.09	0.83	0.36
Exports	2.32	2.62	2.02	2.14	2.76	2.70
Imports	2.78	2.12	1.73	1.48	2.56	2.12
Trade Balance	-29,551	-11,047	-10,876	-3,862	-20,507	-10,973
Terms of Trade	-0.21	-0.24	0.02	0.01	-0.31	-0.28
Real Investment	1.56	0.61	0.51	0.16	1.19	0.61
Real Government Expenditure	0.43	-0.06	0.04	-0.13	0.37	-0.06
Consumer Prices	-0.18	-0.26	0.15	0.11	-0.27	-0.27

Source: Author's calculations based on simulation results.

Table 13 compares the results of three alternative scenarios under two employment assumptions (unemployment and full employment). The first scenario is our base case, modelling NTBs as trade facilitation (shock to ams). The second scenario models NTBs as tariff reduction (tms shock). It also includes modelling NTBs as trade facilitation under an alternative value added structure that we discuss in the next section.

It is evident from these results that modelling the NTBs as tariffs significantly reduces the impact of the TPP on growth and raises prices relative to the original scenario in which NTB reductions were modelled as preference shifts by the AMS variable/preference shift. Moreover, as expected the use of tariff equivalents significantly reduces the income, and, hence expenditures of governments as reductions in NTBs reduce tariff revenue. While the technology shift used in the original scenario does not have an implication on revenue, it does affect the price (or effective

[15] The part that correspond to the initial tariff will be eliminated in the simulation, to be able to establish a correct comparison against the original simulation.

[16] Changes in the model could be made to include rents which would then be allocated to households, although an additional assumption about how they should be allocated across the 13 households would also need to be made.

price), in a similar way to a tariff (see equation DPRICEIMP in model tablo code), additionally, the technology shift impacts demand for imports directly (see equation IMPORTDEMAND in model code). It is this efficiency type gain on quantity that results in larger increases to real GDP.

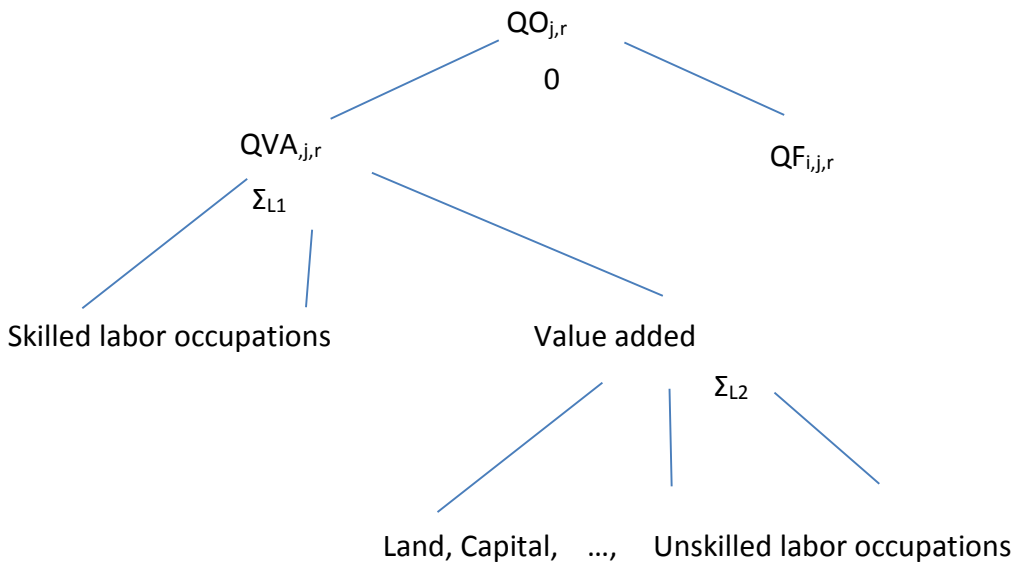
6.2 Impact of Full employment closure

Each alternative scenario was run under a full employment and unemployment closures. As expected, the impact on real GDP growth of the TPP agreement is much less under the full employment closure than with unemployment. The positive impact of the TPP raises demand for factors and the previously unemployed workers rejoin the labor force, which causes real GDP to rise further. With full employment there are no more resources that can be called upon to meet increased demand and factor prices merely rise, raising incomes, but not real GDP to the same extent as in the unemployment scenario.

6.3 Structure of Value Added

To test the robustness of our results, we modify the structure of value added to that proposed by Carrico and Tsigas (2014) where skilled workers substitute with composite value added while unskilled workers substitute directly with capital, land and natural resources (see Figure 5). Carrico and Tsigas (2014) argue that unskilled workers tend to be more substitutable with capital and land, than skilled workers are. The results obtained using the alternative value added structure are fairly consistent with the original value added specification. However, in the unemployment case, increased substitution between land and capital with unskilled labor, (which has access to a pool of unemployed workers), means prices and factors prices fall slightly more than in the base case. Relative to the original case, this results in lower returns to capital and hence lower investment, as well as a rise in exports rise and the trade balance.

Figure 5. Alternative Structure for Value Added



Source: Carrico and Tsigas (2014)

6.4 Elasticities

In order to test the sensitivity of the results to the assumed elasticities, we doubled the value of the elasticity on the first level of the value added structure in the original scenario. This elasticity controls the substitutability between other endowments and the labor groupings of skilled and unskilled. We also run a second sensitivity simulation, doubling the parameters on the second level of the original simulation. This is the elasticity within both labor groupings that determines how substitutable skilled and unskilled occupations are with respect to each other.

As expected, these versions of the model become more responsive to the TPP agreement, due to the fact that skilled and unskilled occupations become more substitutable with other factors. This allows firms to more easily substitute capital for previously unemployed unskilled workers, which facilitates the improvement of their factor mix. This results in larger increases in employment and hence real GDP as can be seen in Table 14.

Table 14. Sensitivity analysis of macroeconomic results with respect to parameters

	Default parameters	Increased substitutability in L1	Increased substitutability in L2
Real GDP	0.86	0.93	1.05
Exports	2.32	2.93	2.26
Imports	2.78	2.61	2.99
Trade Balance	-29,551	-20,346	-35,380
Terms of Trade	-0.21	-0.36	-0.21
Investment	1.56	1.21	1.85
Government Income/Expenditure	0.64	0.61	0.85
Private Consumption	0.81	0.74	1.03
Consumer Prices (relative to numeraire)	-0.18	-0.30	-0.15

Source: Author's calculations based on simulation results.

7 CONCLUSIONS

The analysis in this paper employed the new MyGTAP framework to highlight distributional consequences of the TPP trade agreement. A richer description of the households and factors within the U.S. economy allows us to examine policy impacts, which would be impossible under the single regional household assumption.

As in other studies, we found that the TPP, and in particular the reduction in NTBs, has a positive impact on growth amongst the TPP member countries. Moreover, the NTBs tend to be most beneficial to those countries that reduced the NTB, hence non-TPP member economies did not gain as a result of the TPP agreement despite the reduction in NTBs against them.

Trade between the TPP members, and to a lesser extent with other countries, increased as a result of the TPP. There was a strong substitution towards imports due to the removal of NTBs and textile tariffs in the U.S. and increased exports due to the removal of tariffs by TPP member

countries. Changes in sectoral production were mixed, depending on whether the reduction in NTBs was sufficient to reduce the costs of production and hence increase demand, or if reductions in tariffs or NTBs elsewhere were sufficient to raise export demand for U.S. goods.

The new features of the MyGTAP-US model also permitted for improved analysis of household incomes and factor demands in the U.S. economy by showing the clear link between changes in sectoral production, factor demands, and private households' income. In general, we find that the low income households benefit the most as a result of the TPP. The reasons for this were: i) the TPP lowers prices in the U.S., particularly on food and clothing – the main components of the lower income households' consumption budgets; and ii) because the majority of workers that compose these households work in the services sector which expanded as a result of the TPP.

Overall, the results demonstrate that the MyGTAP framework is a very powerful tool for policy analysis. The linkage that the model specifies between sectors that benefit, their labor requirements and how labor in turn affects household income allows for much richer interpretation of the results of a given policy. This, however, is contingent on the quality of the underlying data; here, improvements are needed to specify the ownership of factors by households. Other developments that could be undertaken to improve this analysis are: firstly, better data on NTBs; the inclusion of rents in the model, which act in the same manner as tariffs, but where income accrues to the households; and, lastly, improvements in the modelling of changes in the supply of labor that would allow for movement between household types.

8 APPENDIX

Table A1. GTAP Sectors

No	Description	GTAP code
1	Paddy rice	PDR
2	Wheat	WHT
3	Cereal grains nec	GRO
4	Vegetables, fruit, nuts	V_F
5	Oil seeds	OSD
6	Sugar cane, sugar beet	C_B
7	Plant-based fibers	PFB
8	Crops nec	OCR
9	Bovine cattle, sheep and goats, horses	CTL
10	Animal products nec	OAP
11	Raw milk	RMK
12	Wool, silk-worm cocoons	WOL
13	Forestry	FRS
14	Fishing	FSH
15	Coal	COA
16	Oil	OIL
17	Gas	GAS
18	Minerals nec	OMN
19	Bovine meat products	CMT
20	Meat products nec	OMT
21	Vegetable oils and fats	VOL
22	Dairy products	MIL
23	Processed rice	PCR
24	Sugar	SGR
25	Food products nec	OFD
26	Beverages and tobacco products	B_T
27	Textiles	TEX
28	Wearing apparel	WAP
29	Leather products	LEA
30	Wood products	LUM
31	Paper products, publishing	PPP
32	Petroleum, coal products	P_C
33	Chemical, rubber, plastic products	CRP
34	Mineral products nec	NMM
35	Ferrous metals	I_S
36	Metals nec	NFM

No	Description	GTAP code
37	Metal products	FMP
38	Motor vehicles and parts	MVH
39	Transport equipment nec	OTN
40	Electronic equipment	ELE
41	Machinery and equipment nec	OME
42	Manufactures nec	OMF
43	Electricity	ELY
44	Gas manufacture, distribution	GDT
45	Water	WTR
46	Construction	CNS
47	Trade	TRD
48	Transport nec	OTP
49	Water transport	WTP
50	Air transport	ATP
51	Communication	CMN
52	Financial services nec	OFI
53	Insurance	ISR
54	Business services nec	OBS
55	Recreational and other services	ROS
56	Public Administration, Defense, Education, Health	OSG
57	Dwellings	DWE

Table A2. Region Aggregation

United States	United States
Canada	Canada
Mexico	Mexico
Chile	Chile
Peru	Peru
Australia	Australia
New Zealand	New Zealand
China	China
India	India
Japan	Japan
Russia	Russia
Malaysia	Malaysia
Singapore	Singapore
Vietnam	Vietnam
Central and Rest of South America	Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Caribbean, Rest of North America
Europe	Austria, Belgium, Cyprus, Czech Rep, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Switzerland, Norway, Rest of EFTA, Albania, Bulgaria, Belarus, Croatia, Romania, Ukraine, Rest of Eastern Europe, Rest of Europe
Middle East	Armenia, Azerbaijan, Georgia, Bahrain, Iran, Israel, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Rest of Western Asia
Rest of South East Asia	Cambodia, Indonesia, Lao People's Democratic Republic, Philippines, Thailand, Rest of Southeast Asia
Rest of Asia	Korea Rep., Mongolia, Taiwan, Rest of East Asia, Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia, Kazakhstan, Kyrgyzstan, Rest of Former Soviet Union
Africa	Egypt, Morocco, Tunisia, Rest of North Africa, Benin, Burkina Faso, Cameroon, Cote d'Ivore, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South Africa Customs Union
Oceania	Rest of Oceania
Rest of the World	Rest of the World, Hong Kong

Table A3. Sector Aggregation

Aggregate Sector	GTAP Sector Code
Grains and Crops	PDR, WHT, GRO, V_F, OSD, C_B, PFB, OCR, PCR
Meat and Livestock	CTL, OAP, RMK, WOL, CMT, OMT
Extraction	FRS, FSH, COA, OIL, GAS, OMN
Processed Food	VOL, MIL, SGR, OFD, B_T
Textiles and Wearing apparel	TEX, WAP
Light Manufactures	LEA, LUM, PPP, FMP, MVH, OTN, OMF
Heavy Manufactures	P_C, CRP, NMM, I_S, NFM, ELE, OME
Utilities and construction	ELY, GDT, WTR, CNS
Transport and Communication	TRD, OTP, WTP, ATP, CMN
Other Services	OFI, ISR, OBS, ROS, OSG, DWE

Table A4. Occupations, Skill type, and Education[17]

Name	Code	Skilled / Unskilled	% of Occupation with: Bachelor's degree	Master's degree	Doctoral or professional degree
Management Occupations	management	Skilled	32.8	18.2	4.9
Business and Financial Operations Occupations	bus_finance	Skilled	38.8	12.4	2.2
Computer and Mathematical Occupations	comp_math	Skilled	41.8	22.7	9.1
Architecture and Engineering Occupations	arch_enginr	Skilled	38.6	14.8	3.3
Life, Physical and Social Science Occupations	Sciences	Skilled	33.6	25.2	21.1
Community and Social Service Occupations	social_serv	Skilled	33.2	31.7	4.0
Legal Occupations	legal	Skilled	16.5	4.6	45.0
Education, Training and Library Occupations	education	Skilled	33.2	35.5	6.2
Arts, Design, Entertainment, Sports, and Media Occupations	entertain	Skilled	40.7	10.6	2.0
Healthcare Practitioners and Technical Occupations	health_prac	Skilled	20.7	11.5	25.7
Healthcare Support Occupations	health_sup	Unskilled	10.5	1.8	1.3
Protective Service Occupations	protective	Unskilled	20.9	4.3	0.7
Food Preparation and Serving Related Occupations	food_service	Unskilled	6.9	1.0	0.3
Building and Grounds Cleaning and Maintenance	build_maint	Unskilled	6.8	1.0	0.3
Personal Care and Service Occupations	pers_care	Unskilled	16.7	3.7	1.0
Sales and Related Occupations	sales	Unskilled	27.5	5.9	0.9
Office and Administrative Support Occupations	admin_supp	Unskilled	16.4	2.9	0.5

[17] We assigned skilled to those occupations where 50% or more at least a Bachelor degree have. The education percentages are the (simple) average of the education measurement by detailed occupation.

Name	Code	Skilled / Unskilled	% of Occupation with: Bachelor's degree	Master's degree	Doctoral or professional degree
Farming, Fishing and Forestry Occupations	farm_occup	Unskilled	8.5	1.7	0.7
Construction and Extraction Occupations	constructn	Unskilled	4.0	0.5	0.2
Installation, Maintenance, and Repair Occupations	maint_repr	Unskilled	7.2	1.0	0.3
Production Occupations	production	Unskilled	6.0	0.9	0.3
Transportation and Material Moving Occupations	transport	Unskilled	11.2	1.7	0.3

Table A5. Basic Employment Statistics (based on Occupation Employment Survey, 2007)

List of Occupations	Total Employed (thousands)	Total Unemployed (thousands)	Estimated Wages* (2007 USD)
Management Occupations	15486	278	60,252
Business and Financial Operations Occupations	6091	151	104,533
Computer and Mathematical Occupations	3441	76	89,313
Architecture and Engineering Occupations	2932	47	83,920
Life, Physical and Social Science Occupations	1382	28	77,606
Community and Social Service Occupations	2265	53	41,325
Legal Occupations	1668	40	61,391
Education, Training and Library Occupations	8485	198	59,525
Arts, Design, Entertainment, Sports, and Media Occupations	2789	127	49,696
Healthcare Practitioners and Technical Occupations	7248	93	78,795
Healthcare Support Occupations	3138	147	37,981
Protective Service Occupations	3071	118	51,065
Food Preparation and Serving Related Occupations	7699	626	35,893
Building and Grounds Cleaning and Maintenance	5469	392	25,660
Personal Care and Service Occupations	4760	238	31,295
Sales and Related Occupations	16698	835	41,504
Office and Administrative Support Occupations	19513	804	57,218
Farming, Fishing and Forestry Occupations	960	89	21,690
Construction and Extraction Occupations	9535	781	53,440
Installation, Maintenance, and Repair Occupations	5245	182	61,170
Production Occupations	9395	564	66,620
Transportation and Material Moving Occupations	8776	564	49,563
No previous work experience		627	
Total	146046	7058	

* This is also based on the Value of Labor at market Prices (EVOM), from the GTAP 8.1L Database (Narayanan, Aguiar and McDougall (2012)).

Table A6. Average NTBs levied by TPP partners on disaggregated commodities from all sources

	Australia	New Zealand	Malaysia	Singapore	Vietnam	Canada	USA	Mexico	Chile	Peru
Paddy rice	4.95	4.68	113.64	129.99	0.00	0.94	20.25	5.82	53.95	10.79
Wheat	0.01	12.17	0.10	12.87	0.00	4.84	0.00	0.04	0.18	0.09
Cereal grains nec	24.76	28.71	27.88	35.21	0.00	24.13	22.99	34.22	13.56	37.92
Vegetables, fruit, nuts	37.86	34.74	41.07	54.68	0.00	36.81	34.73	30.09	24.74	30.15
Oil seeds	53.89	36.11	45.17	38.25	0.00	31.07	46.53	32.11	33.78	32.73
Sugar cane, sugar beet	20.85	57.34	130.95	87.91	0.00	0.00	0.00	28.79	43.74	116.08
Plant-based fibers	0.00	0.00	0.00	12.76	0.00	0.00	0.00	0.00	0.00	0.00
Crops nec	19.49	17.17	28.13	26.42	0.00	8.93	4.96	17.53	22.13	24.72
Bovine cattle, sheep and goats, horses	18.82	8.62	40.03	28.64	0.00	6.79	28.53	26.37	15.84	20.61
Animal products nec	32.03	35.65	38.95	43.13	0.00	19.57	21.56	34.25	17.85	29.00
Raw milk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wool, silk-worm cocoons	0.00	0.00	0.00	0.00	0.00	0.00	32.82	0.00	0.00	0.00
Forestry	16.00	26.26	19.81	28.27	0.00	16.22	4.16	19.17	15.55	21.68
Fishing	40.96	33.77	37.19	34.49	0.00	32.81	32.14	36.78	20.93	32.60
Coal	0.00	0.00	30.30	30.81	0.00	0.00	0.00	0.00	0.00	0.00
Oil	37.66	0.00	38.92	33.36	0.00	38.84	35.97	37.48	0.00	37.39
Gas	37.66	0.00	38.92	33.36	0.00	38.84	35.97	37.48	0.00	37.39
Minerals nec	1.66	3.45	35.59	42.78	0.00	0.00	0.00	1.66	2.36	1.66
Bovine meat products	46.94	33.94	46.94	41.37	0.00	26.32	34.04	34.27	28.30	39.62
Meat products nec	46.94	33.94	46.94	41.37	0.00	26.32	34.04	34.27	28.30	39.62
Vegetable oils and fats	50.19	34.87	47.39	46.91	0.00	17.40	4.91	38.95	42.00	48.22
Dairy products	71.84	57.71	73.83	73.65	0.00	44.08	63.67	54.70	45.41	45.79
Processed rice	50.19	34.87	47.39	46.91	0.00	17.40	4.91	38.95	42.00	48.22
Sugar	48.50	32.13	43.63	47.66	0.00	0.00	18.58	32.65	26.17	30.99
Food products nec	50.55	39.80	51.09	50.52	0.00	13.95	25.93	38.57	37.73	42.48

	Australia	New Zealand	Malaysia	Singapore	Vietnam	Canada	USA	Mexico	Chile	Peru
Beverages and tobacco products	21.70	8.78	28.72	37.02	0.00	0.00	7.34	18.85	21.17	17.15
Textiles	0.79	2.79	35.52	44.13	0.00	0.12	21.00	30.52	0.99	0.98
Wearing apparel	0.00	0.00	17.02	31.29	0.00	0.00	26.64	12.72	0.00	0.00
Leather products	2.36	19.82	50.11	50.50	0.00	3.87	3.83	34.09	0.78	19.65
Wood products	0.00	11.27	40.99	49.91	0.00	5.31	15.10	10.58	15.05	41.84
Paper products, publishing	0.00	1.21	21.04	34.37	0.00	0.00	0.00	10.94	2.38	29.24
Petroleum, coal products	26.88	0.00	42.75	50.58	0.00	0.00	0.00	44.91	0.39	24.91
Chemical, rubber, plastic products	2.19	14.42	27.73	29.60	0.00	0.89	3.25	19.37	13.05	3.93
Mineral products nec	0.00	1.75	28.05	32.79	0.00	0.00	0.11	5.15	0.74	0.40
Ferrous metals	0.00	2.42	19.33	30.67	0.00	14.31	0.00	2.62	0.52	0.00
Metals nec	0.55	2.38	25.50	27.39	0.00	0.61	0.00	3.66	1.55	4.62
Metal products	1.35	2.54	27.39	31.84	0.00	2.85	3.00	16.55	0.66	0.76
Motor vehicles and parts	6.78	8.91	21.66	20.63	0.00	10.89	8.66	16.59	6.94	4.05
Transport equipment nec	0.00	0.12	38.16	35.77	0.00	6.82	13.46	8.31	7.99	1.20
Electronic equipment	21.06	29.24	28.39	33.89	0.00	0.00	6.26	15.21	6.17	6.01
Machinery and equipment nec	8.98	27.91	32.27	32.07	0.00	1.03	5.22	11.98	3.54	1.82
Manufactures nec	0.65	4.29	30.86	43.51	0.00	0.14	2.76	20.22	1.70	2.13

Table A7. Changes in U.S. Output, Exports and Imports by product, under unemployment assumption (Millions of 2007 US$)

	Output		Exports		Imports	
	Output	%	Initial	%	Initial	%
Paddy rice	2,261	0.12%	505.5462	0.94%	47.87827	13.47%
Wheat	11,960	0.60%	8009.225	1.62%	558.7268	1.40%
Cereal grains nec	53,183	0.46%	11519.03	2.04%	866.1652	1.69%
Vegetables, fruit, nuts	62,895	-2.01%	8538.303	0.46%	15932.12	2.74%
Oil seeds	25,978	-0.41%	9602.248	-0.57%	806.0322	11.66%
Sugar cane, sugar beet	2,270	-1.96%	0.437314	3.04%	5.709547	-0.03%
Plant-based fibers	6,176	-0.25%	4644.021	1.38%	94.72103	-1.89%
Crops nec	17,140	3.03%	3760.334	21.59%	8135.462	2.56%
Bovine cattle, sheep and goats, horses	39,499	-0.64%	560.1245	1.72%	2693.34	5.49%
Animal products nec	44,185	1.98%	3382.492	2.81%	2059.994	1.32%
Raw milk	34,150	0.19%	0.271434	2.06%	48.03653	-1.26%
Wool, silk-worm cocoons	46	-1.61%	34.83228	7.38%	52.46294	-2.12%
Forestry	21,102	-0.15%	1700.817	3.29%	708.343	0.05%
Fishing	4,797	-0.38%	769.0477	2.96%	2318.914	-1.37%
Coal	48,173	0.40%	3619.101	-2.43%	2137.069	3.32%
Oil	127,832	-2.69%	451.0229	45.86%	247576.3	2.50%
Gas	24,824	-2.39%	7055.248	60.51%	34157.43	11.15%
Minerals nec	44,697	0.50%	7601.815	-0.19%	6739.705	0.53%
Bovine meat products	99,880	0.03%	3234.656	3.12%	4805.808	20.67%
Meat products nec	83,840	3.09%	9646.899	29.31%	3150.272	31.39%
Vegetable oils and fats	16,893	1.36%	4248.869	6.04%	3917.108	1.89%
Dairy products	91,229	0.16%	3415.624	25.00%	3577.566	32.57%
Processed rice	2,821	0.35%	767.5476	2.76%	466.2665	0.59%
Sugar	13,705	-2.13%	246.3993	1.01%	1449.982	18.40%
Food products nec	341,484	0.76%	22007.44	11.94%	36597.82	6.68%
Beverages and tobacco products	137,961	0.83%	5566.534	4.11%	18571.53	0.56%
Textiles	141,163	-4.75%	14044.8	5.74%	47335.06	5.54%
Wearing apparel	93,779	-6.36%	2965.933	7.81%	66584.59	8.66%
Leather products	14,620	-1.46%	2306.585	4.88%	27589.37	1.34%
Wood products	278,286	-0.51%	10133.98	4.27%	58902.05	3.63%
Paper products, publishing	456,918	0.58%	27061.06	1.85%	30274.66	0.01%
Petroleum, coal products	518,136	5.25%	60323.25	13.94%	74660.26	-5.77%
Chemical, rubber, plastic products	888,652	0.44%	184163.5	3.77%	190816.3	0.65%
Mineral products nec	137,753	0.91%	8985.275	3.01%	22345.41	-0.45%

	Output		Exports		Imports	
	Output	%	Initial	%	Initial	%
Ferrous metals	165,836	0.08%	18044.53	2.96%	34832.54	-0.63%
Metals nec	142,714	-0.08%	33929.6	2.19%	53423.66	-0.38%
Metal products	342,412	0.18%	23051.9	3.50%	42316.31	0.97%
Motor vehicles and parts	565,003	0.05%	104597.9	3.71%	235778.9	1.87%
Transport equipment nec	270,013	-0.78%	96342.24	2.73%	49026.3	5.15%
Electronic equipment	504,827	-1.46%	94386.45	3.48%	245526.2	1.96%
Machinery and equipment nec	1,007,022	-0.57%	225023.7	1.95%	310043.9	1.98%
Manufactures nec	96,720	0.29%	19436.11	4.11%	77297.34	0.70%
Electricity	387,983	0.73%	1268.488	1.54%	3126.444	-0.38%
Gas manufacture, distribution	111,429	0.63%	1299.806	1.46%	1444.938	-0.04%
Water	127,755	0.72%	456.8412	2.22%	296.6073	-0.83%
Construction	1,693,304	1.26%	6116.788	1.33%	2834.242	-0.41%
Trade	2,894,724	0.72%	16537.39	1.32%	23781.91	0.04%
Transport nec	599,537	1.28%	31045.92	5.08%	40492.19	-1.13%
Water transport	59,462	0.92%	1694.798	9.30%	1832.823	0.01%
Air transport	235,835	1.95%	28145.18	8.45%	32492.26	-2.13%
Communication	531,465	0.60%	11000.91	0.39%	10823.65	0.23%
Financial services nec	1,538,464	0.61%	45555.25	0.65%	32978.51	0.05%
Insurance	560,222	0.63%	17423.33	0.84%	32544.65	0.21%
Business services nec	2,165,546	0.51%	91926.4	0.76%	86575.99	0.00%
Recreational and other services	1,263,478	0.98%	28556.81	1.78%	11373.24	-0.44%
Public Administration, Defense, Education, Health	4,624,661	0.52%	64098.74	0.27%	35230.11	0.42%
Dwellings	1,418,502	0.36%	0.000001	0	0	0

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