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TRADE AND WELFARE EFFECTS OF A POTENTIAL FREE TRADE AGREEMENT BETWEEN JAPAN AND THE UNITED STATES

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Abstract

This paper deals with the trade and welfare effects of a potential bilateral trade agreement between the US and Japan. A possible agreement is currently being discussed between Washington and Tokyo, although, there is also the alternative for the US government joining Trans-Pacific Partnership (TPP). Based on the theoretical model of Caliendo and Parro (2015) I analyse the welfare gains of such a bilateral free trade agreement (FTA) in the style of Aichele et al. (2014). In particular, I simulate three scenarios with different levels of integration: The reduction of tariffs only, the scenario of a shallow FTA, and a deep FTA. In addition, the paper compares the trade and welfare changes of a deep FTA to the welfare effects of TPP. The findings are that Japan has the highest welfare gains with a FTA (0.085%), whilst the United States benefits the most from TPP with a welfare gain of 0.05%.

Keywords: Trade agreements, Gravity model, Counterfactual equilibrium, Intermediate goods, Input-output linkages, Japan, United States

JEL Classification Codes: F13, F14, F17

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1. Introduction

In the last decade, the value of US exports have grown strongly from 1.3 trillion US$ in 2005 to over 2.2 trillion US$ in 2015.[1] Hereby, trade agreements play a significant role as they open up foreign markets for US companies and products. In 2015, 47% of the US exports went to countries with an established US trade agreement.[2] Remarkably, Japan as the third largest global economy is the most important trading partner of the United States without a trade agreement in place. To adress this the multilateral Trans-Pacific Partnership (TPP) was sought to structure the trade relationship between both countries. But TPP also involves other countries such as Australia, Canada, Chile, and Mexico. It is expected to bring additional economic growth to the TPP member countries including the United States. However, after the US Election in 2016 one of the first steps of the new administration was to put the negotiations on TPP on a hold. The newest trade strategy for the Trump administration is now to focus on bilateral free trade agreements (FTA) in order to have a higher bargaining power. According to the US Commerce Secretary Wilbur Ross a bilateral agreement between two of the world's largest economies has "a very high priority" and is considered to be a forth runner for further bilateral trade agreements.[3] However, there are also tendencies from the White House to restart the negotiations on TPP, particularly, to strengthen the exports of the US agriculture sector. The aim of this paper is to evaluate the trade and welfare gains of a FTA between Japan and the United States and to compare these results to the potential trade effects of TPP.

Surprisingly, not much research has been done on the welfare effects of this particular trade agreement. Research has been conducted on a potential FTA between the EU and Japan (Benz and Yalcin (2013) and Felbermayr et al. (2017b)). But for a bilateral FTA between the United States and Japan there are only reports, investigating the FTA from a geopolitical and advisory perspective but not from the economic side (Scissors and Blumenthal (2017) and Cooper (2014)). With this paper I fill this gap, by analyzing the potential welfare gains of the FTA using the theoretical model of Caliendo and Parro (2015)[4], which builds on assumptions adopted from the

[1] In current US$. Data source: World Bank (2018)
[2] International Trade Administration (2018)
[3] US Commerce Secretary Wilbur Ross in The Diplomat (2017)
[4] For the analysis of this paper I rely on the codes and data files thankfully provided by Caliendo and Parro (2015).

new quantitative trade theory[5]. Applying the Caliendo and Parro (2015) model provides several advantages: First, following the theoretical model of Eaton and Kortum (2002), Caliendo and Parro (2015) allow producers to purchase goods from the lowest cost supplier in the economy. This assumption paves the way to use the gravity equation, which explains the trade flows between countries and is comfortable to apply. Secondly, the model solves for a counterfactual equilibrium in relative changes through which structural parameters that are difficult to identify cancel out and do not have to be estimated empirically. Caliendo and Parro (2015) borrow this approach from Dekle et al. (2008). Thirdly, their model is a multi-sector multi-country model with intermediate goods. This is particularly useful for the investigation of the FTA between Japan and the United States, as the impact of trade agreements does not only depend on the degree of policy changes but also on the interrelation between industries. Hereby, the input-output analysis (Leontief (1951)) plays an important role. The international economy can be seen as an interlinked production network where the output of one sector can become the input for another. An impulse of trade policy can be passed on and impact other sectors as well. A difference between this paper and Caliendo and Parro (2015) is that this paper tries to predict the effect of the potential FTA ex-ante while Caliendo and Parro (2015) estimate the effect of NAFTA ex-post.

To solve for the welfare gains I borrow the empirical strategy from Aichele et al. (2014). The approach is useful as it takes not only tariffs but also the non-tariff measures (NTM) into account. In general, trade agreements can take on different intensity levels to remove trade impediments. These can vary from reducing tariffs to deeper integration, where NTMs are minimized. The reduction of NTMs can include the standardization of regulatory legislation and industry standards as well as the opening of markets to foreign investments. The details of the potential FTA between the US and Japan are not known, as the negotiations have not officially started yet, even though it is commonly assumed that the FTA will lead to deeper integration. To estimate the impact of NTMs, I therefore apply the top-down method and use past trade agreements as a benchmark to quantify the possible welfare impact of the FTA.[6]

This paper contributes in two ways to the literature. It is not only one of the first on the welfare effects of the potential FTA between Japan and the US, but it also simulates different scenarios by conducting a counterfactual analysis. In the first scenario, all of the tariffs are cut,

[5] See Costinot and Rodriguez-Clare (2014) for more details.

[6] In order to estimate the impact of the NTMs I use the necessary dummy variables from Aichele et al. (2014).

while the second scenario cuts the tariffs to zero and additionally reduces the NTMs slightly (shallow FTA). The third scenario decreases all bilateral tariffs are cut to zero and reduces the NTMs strongly (deep FTA). In addition, I compare the trade and welfare changes of the deep FTA to the case if the Trans-Pacific Partnership (including the United States) is established. To exercise the counterfactual simulation, I use the most recent World Input-Output Database (WIOD) (Release 2016) as well as the UNCTAD's TRAINS database for the tariffs as the main data sources. The WIOD contains only data of six TPP countries, namely Japan, United States, Canada, Mexico, Chile and Australia.[7] However, those countries are responsible for 96% of the TPP members' GDP, through which valid interpretations are possible.

The key findings are that Japan has the largest welfare gains in the case of a deep FTA (0.085%), when comparing the three counterfactual trade scenarios. This is not surprising as the more trade costs are reduced the higher the welfare gains will be. More unexpected is that the United States gets its highest welfare gains in the first scenario where all tariffs are cut (0.003%). In the shallow and deep scenario, the welfare effects are for the United States even negative, with -0.001% and -0.007% respectively. In addition, I find that the United States should prefer TPP by comparing the FTA scenarios with TPP, as it leads to the largest welfare gains (0.05%). Japan will still favor a deep FTA as its welfare gains with TPP will only be 0.05%. It is important to note that this paper looks at the welfare changes not from a dynamic but from a static level. Starting point is the status quo from which I siumlate the trade and welfare effects triggered by a change in trade policy. Obviously, the impact of the trade policies cannot be seen instantly, it is much more an economic process and the changes can take up to a decade to adopt, as Baier and Bergstrand (2007) show.

The structure of the paper is as follows. Section 2 elaborates the stylized facts, while section 3 presents the gravity model of Caliendo and Parro (2015). Section 4 displays the strategy to determine the change in trade costs as well as the parameter identification. Section 5 presents the research findings. Finally, section 6 concludes.

[7]The other TPP countries not included in the input-output table are Brunei, New Zealand, Peru, Singapore, Vietnam and Malaysia.

2. Stylized Facts

The import values from Japan to the United States are constantly larger than the exports to Japan from the United States, as Figure 2.1. displays. For the year 2014, the United States has a trade deficit to Japan of approximately 58 billion US$. As the US government is eager to reduce its overall trade deficit a potential FTA could help to cut the trade deficit with Japan. The graph shows that the trade flows between the two countries were strongly hit during the financial crisis in 2008. Imports to the United States from Japan were much more affected than exports from United States to Japan. One of the reason for this was the decrease of the domestic demand in the United States. As the global economic situation stabilized, trade between the United States and Japan reached the pre-crisis level.

Figure 2.1.: US Imports & Exports in current values (Data: WIOD 2016)

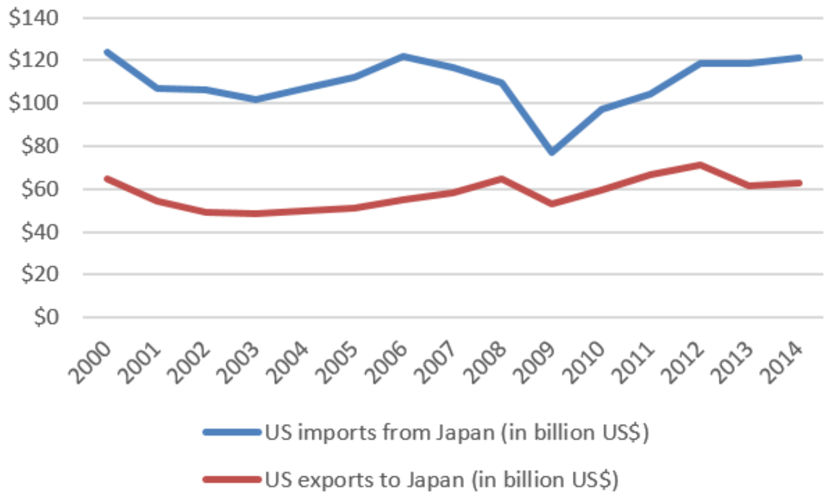
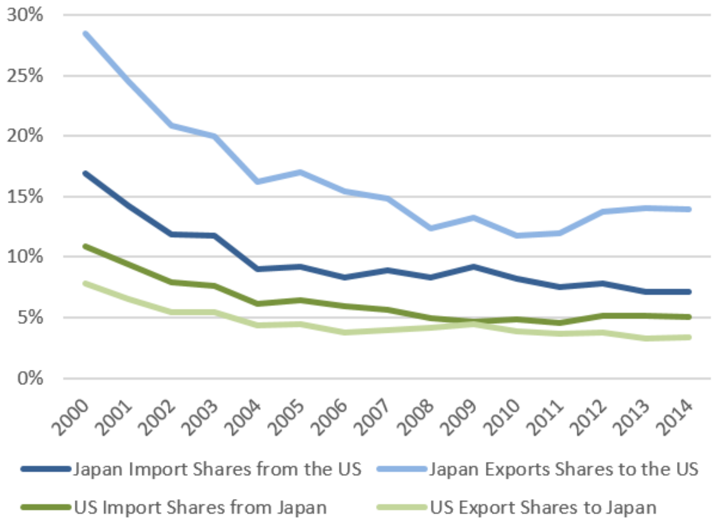


Figure 2.2. indicates, the importance of the bilateral trade relationship for Japan. It presents the import and export shares for both countries of the last two decades.[8] Hereby, both shares are significant larger for Japan. However, the import and export shares decreased for Japan by almost 50%, e.g. the import share for Japan declined from 2000 to 2014 from 28% to 14%. Note,

[8]The export shares are defined as US exports to Japan relative to all US exports, same holds for import shares.

that the largest reduction for both shares was between 2000 and 2004. Regarding the United States, the import and export shares decreased less than those of Japan and reached an import share level of 5% and an export share level of 3% in 2014. A bilateral FTA between the United States and Japan could have the potential to increase the import and export shares for both countries.

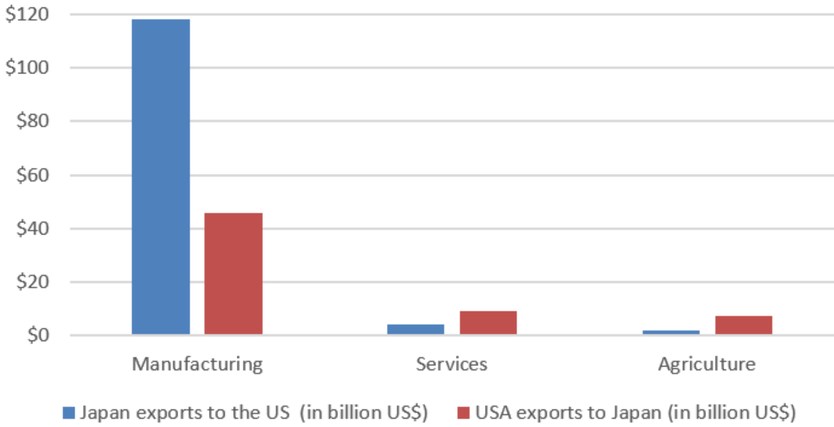
Figure 2.2.: Import & Export Shares (Data: WIOD 2016)



In Figure 2.3. I display the bilateral exports consisting of the aggregated sectors manufacturing, services, and agriculture. Particularly the manufacturing sector stands out. In 2014, Japan exported around 120 billion US$ of manufacturing goods to the United States. Hereby, the car industry is the largest export industry, followed by the computer & electronics and, the chemical industry. The aggregated manufacturing sector is the largest export sector to Japan of the US with roughly 45 billion US$. Amongst the US manufacturing sector, the manufacturers of food products, transport equipment, and chemicals are the largest exporters to Japan. The other aggregated sectors play a minor role: For Japan, expenditure in services account for 3 billion US$ and 300 million US$ for the agriculture sectors, whereas the US is exporting around 9.1 billion US$ in services and 7.6 billion US$ in agriculture products to Japan.

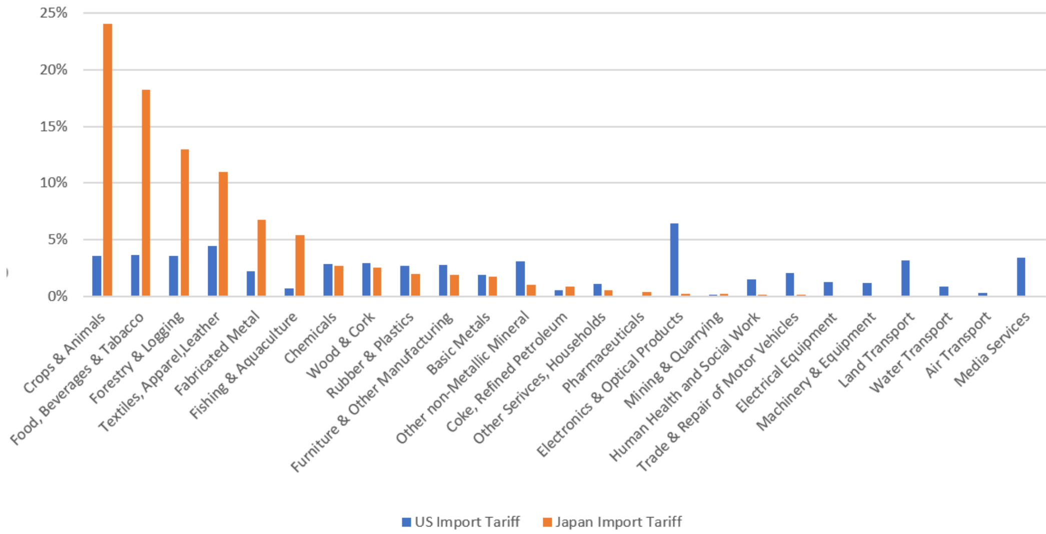
The average import tariff of the United States for Japanese products is with 4% already low and was fairly constant over the last 15 years, whereas the import tariffs on the Japanese side are higher on average. However, the tariff decreased from around 10% in 2001 to around 8% in 2014. Therefore, it can be said that Japan runs a more protective bilateral trade policy in terms of tariffs than its US counterpart. Looking at the tariffs in more detail, Figure 2.4.

Figure 2.3.: Bilateral Sector Exports in 2014, current values (Data: WIOD 2016)



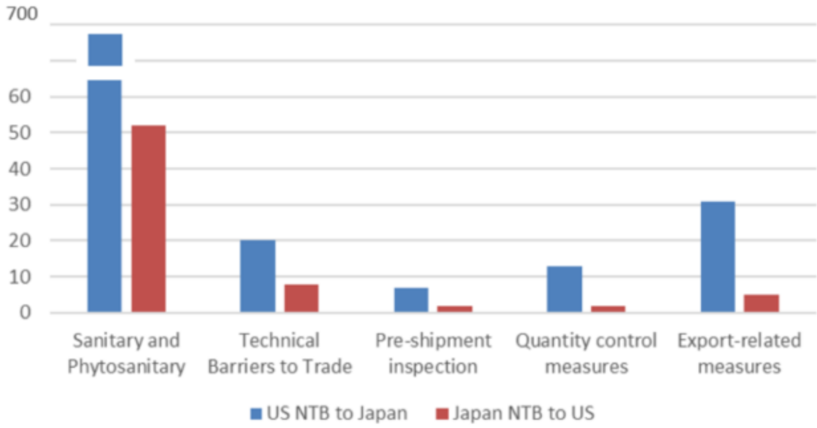
displays that especially Japan is shielding its agriculture sectors from US imports. The largest import tariffs being (on average) in the Corps & Animals, Food, Beverages & Tabaco industry. However, as Felbermayr et al. (2017b) point out there is a large tariff heterogeneity in Japans' agriculture sectors. On the one hand Japan particularly protects its rice industry (consisting out of many small farms) with tariffs, quotas and subsides. On the other hand, Japan is also depending on other imports in the food sector. This heterogeneity is also reflected in the trade policy: According to Felbermayr et al. (2017b), 25% of the tariffs in agriculture is duty free whereas other agriculture products are charged with tariffs up to 300%. On the US side tariffs are smoother across sectors. The largest tariffs are charged on average on electronics (6%) as well as on textile (4.4%) and food products (3.6%).

Figure 2.4.: Sectoral Import Tariffs in 2014 (Data: UNCTAD TRAINS 2014)



However, trade costs do not only depend on tariffs but also involve non-tariff measures. Figure 2.5. shows the number of non-tariff measures active between the United States and Japan in 2018. As the quality of the NTMs are in general harder to measure, the quantity of the NTMs I present in Figure 2.5 can give an indication about the costs of the trade barriers. Clearly, the United States has more non-tariff measures in place than Japan. Especially US regulations in the area of sanitary and phytosanitary outweighs Japan's regulation by far: 644 NTMs of the United States compared to 50 NTMs of Japan. Also, in the area of export-related measures and technical barriers to trade the number of barriers is much larger from the American side.

Figure 2.5.: Total Non-Traiff Measures in 2018 (Data: UNCTAD NTB 2018)



To conclude, Japan and the United States have a significant economic relationship, however over the last decade the trade shares have slightly decreased between both countries. This is due to the stronger Japanese trade relationship with China and other Asian countries, as well as the growing trade of the US with Mexico and China.[9] The trade deficits of the United States with Japan is mainly caused by trade deficits of the manufacturing sectors. On average, the US import tariffs on Japanese goods and services are 4% points lower than vice versa. Furthermore, Japan is protective of its agriculture sector, particularly the corps and animal sector, which includes the rice industries. Also, the Japanese car industry is less open to foreign car makers. As Cooper (2014) points out, only 6.7% of all cars in Japan are from foreign car companies. I discuss the impact of a potential trade agreement in form of either a bilateral or multilateral agreement in section 5.

[9]The United States has 20 FTAs with various countries in place, covering 25% of the total US exports, whilst Japan has 16 active trade agreements that is 7% of its total exports. Note, that the calculation is based on the WIOD 2016.

3. The Model

The model of Caliendo and Parro (2015) builds on the well-known Eaton and Kortum (2002) mulit-country and multi-sector Ricardian model. It also considers the input-output linkages between tradable and non-tradable sectors. The setup of the model includes intermediate goods, composite intermediate goods and heterogeneity in sectoral productivity. It involves the following assumptions: There are $n = 1, .., N$ countries which are referred to as n and i; and include $j = 1, .., J$ sectors indicated by j and k. The only factor of the country that counts into production is labor L_n. Labor is mobile across sectors, but it is not mobile across countries. It is assumed that all markets are perfectly competitive, so that price equals marginal cost.

3.1. Households

In each country n there are L_n representative households with Cobb-Douglas preferences. The households buy final goods in amount of C_n^j for the price of P_n, hence the consumer maximization problem becomes:

$$\max_{C_n^j} U(C_n) = \prod_{j=1}^{J} \left(C_n^j\right)^{\alpha_n^j} \quad s.t. \quad \sum_{j=1}^{J} P_n^j C_n^j = I_n \tag{3.1}$$

Here, α_n^j is the share of demand for the final good in sector j of country n. It is an exogenous parameter and it holds $\sum_{j=1}^{J} \alpha_n^j = 1$ as well as $\alpha_n^j \geq 0$. I_n is the income of the household of country n and includes labor income, tariff revenue and trade surplus. The solution of the price index of the final good is given by $P_n = \prod_{j=1}^{J} \left(P_n^j / \alpha_n^j\right)^{\alpha_n^j}$ and the equilibrium condition is defined as $P_n^j C_n^j = \alpha_n^j I_n$. The household uses a share of its income represented by α_n^j to purchase final goods in the amount of C_n^j.

3.2. Composite Intermediate Goods

Composite intermediate goods (materials) are produced by intermediate goods from the same sector. Composite intermediate goods (q_n^j) are used for the production of sector-specific final goods C_n^j and intermediate goods $q_n^j(x_n^j)$. They can be tradable, then the input can come from a variety of countries, or they can be non-tradable. In the case of tradable goods Ricardian motives of trade are introduced.[10] It is assumed that the access to technology varies by sector and country, which leads to different efficiency levels in intermediate good production. Therefore, the level of total factor productivity, also often interpreted as "costs" for each intermediate good, can vary. The inverse total factor productivities are modeled as random and independent variables with a common density of Φ^j. The common density Φ^j is exponential and has the parameter of λ_n^j : $x_n^j \sim \exp(\lambda_n^j)$. The scale parameter λ_n^j can be seen as the state of technologies in sector j of country n, which determines the absolute advantage in trade. Each intermediate good has its own cost draw $x_n^j > 0$ and is independent from the other intermediate good. Note, that the vector of technology draws of a particular sector j with N countries can be written as $x^j = (x_1^j, \ldots, x_N^j)$, then the joint density of x^j is defined in the following way $\Phi^j(x^j) = \left(\prod_{i=1}^N \lambda_n^j\right) \exp\left\{-\sum_{i=1}^N \lambda_n^j x_n^j\right\}$. Thus, the production function of the composite intermediate good is given by $q_n^j = \left[\int q_n^j(x^j)^{(1-1)/\eta^j} \Phi^j(x^j) dx^j\right]^{\eta^j/(\eta^j-1)}$ where η^j is the constant elasticity of substitution and varies across sectors.

Producers of the composite intermediate good purchase the sector specific intermediate good from that country which offers the lowest price for the intermediate good. Therefore, the minimization problem of the composite intermediate good aggregate is:

$$\begin{aligned} P_n^j q_n^j = \min_{q_n^j(x_n^j)} \int p_n^j(x^j) q_n^j(x^j) \Phi^j(x^j) dx^j \\ s.t. \left[\int q_n^j(x^j)^{(1-1/\eta^j)} \Phi^j(x^j) dx^j\right]^{\eta^j(\eta^j-1)} \geq q_n^j \end{aligned} \tag{3.2}$$

Here $P_n^j q_n^j$ is the total expenditure on composite tradable goods in sector j of country n. The solution of the minimization problem leads to the intermediate good demand function of $q_n^j(x^j) = \left(\frac{p_n^j(x^j)}{P_n^j}\right)^{-\eta^j} q_n^j$ with P_n^j as the price of the material $P_n^j = \left[\int p_n^j(x^j)^{(1-\eta^j)} \Phi^j(x^j) dx^j\right]^{1/(1-\eta^j)}$ and $p_n^j(x^j)$ as the lowest price for the sector specific intermediate good x^j across all countries. Hence, a change in tariffs affects the aggregated price index of intermediate goods, which in turn influences the material price as well. This is a key mechanism in the model.

[10]The case of composite intermediate goods of non-tradeable sectors is displayed in the appendix A.1. The calculation of the tradebale and the non-tradeable are based on Caliendo and Parro (2012).

3.3. Intermediate Goods

Labor and composite intermediate goods from all sectors, tradable and non-tradable, are used as inputs to produce the intermediate good x_n^j. Hereby, the production function is defined as:

$$q_n^j(x_n^j) = [x_n^j]^{-\theta^j} [l_n^j(x_n^j)]^{\beta_n^j} \left[\prod_{k=1}^{J} q_{mn}^k(x_n^j)^{\gamma_n^{k,j}} \right]^{1-\beta_n^j} \tag{3.3}$$

where $l_n^j(x_n^j)$ is the labor demand. The efficiency of producing the intermediate good in sector j in country n is given by $[x_n^j]^{-\theta^j}$. The parameter θ^j captures the dispersion of productivity and intensifies the productivity draws.[11] The amount of materials from sector k used in the production of the intermediate good x_n^j is given by $q_{mn}^k(x_n^j)$. The share of composite intermediate goods from sector k used to create the intermediate good x_n^j in sector j is given by $\gamma_n^{k,j} \geq 0$. It holds $\sum_{k=1}^J \gamma_n^{k,j} = 1 - \beta_n^j$, where β_n^j is the share of value added in sector j of country n.[12] Producers of the tradable intermediate goods x_n^j maximize profits in the following way:

$$p_n^j(x_n^j) q_n^j(x_n^j) = \min_{l_n^j(x_n^j), \left\{q_{mn}^k(x_n^j)\right\}_{k=1}^J} \sum_{k=1}^{J} P_n^k q_{mn}^k(x_n^j) + l_n^j(x_n^j) w_n$$

$$\text{s.t.} [x_n^j]^{-\theta^j} [l_n^j(x_n^j)]^{\beta_n^j} \left[\prod_{k=1}^{J} q_{mn}^k(x_n^j)^{\gamma_n^{k,j}} \right]^{1-\beta_n^j} \geq q_n^j(x_n^j) \tag{3.4}$$

The solution for labor demand is given by $l_n^j(x_n^j) = \beta_n^j \frac{p_n^j(x_n^j) q_n^j(x_n^j)}{w_n}$ and the demand for composite intermediate goods by $q_{mn}^k(x_n^j) = \gamma_n^{k,j}(1-\beta_n^j) \frac{p_n^j(x_n^j) q_n^j(x_n^j)}{P_n^k}$. The price of an intermediate good is then given by $p_n^j(x_n^j) = \frac{B^j}{[x_n^j]^{-\theta^j}} c_n^j$ where B^j is a constant. The cost of the input bundle, c_n^j, is described by the equation $c_n^j = w_n^{\beta_n^j} \left(\prod_{k=1}^J (P_n^k)^{\gamma_n^{k,j}} \right)^{1-\beta_n^j}$. The equation is crucial, because through this equation the different sectors are connected. The equation shows that the cost of the intermediate goods depends on the one hand on wages of sector j in country n and on the other hand on the prices of all composite intermediate goods from tradable and non-tradable

[11] There are different notations for the dispersion parameter of productivity in Eaton and Kortum (2002) and Alvarez and Lucas (2007), $(1/\theta)_{EK} = \theta_{AL}$. For Eaton and Kortum (2002) θ is inversely related to the variation of the distribution. Aichele et al. (2014) follow Eaton and Kortum (2002), while Caliendo and Parro (2015) use the notation of Alvarez and Lucas (2007) to amplify the cost draws. Further Caliendo and Parro (2015) allow the parameter θ^j to be sector-specific but common across countries. In this paper the notation of Caliendo and Parro (2015) is followed.

[12] The closer β_n^j gets to 1 the less interactions between sector j of country n and other sectors take place. Note that in the extreme case of $\beta_n^j = 1$ there will be no interrelations between sectors. Also in the case of $\gamma_n^{j,j} = 1$, all materials of sector j are used for production in the same sector. The good is entirely produced by input of the same sector, and there is no interrelation between other sectors.

sectors. In particular, the last part of the cost equation is essential $\prod_{k=1}^{J}(P_n^k)^{\gamma_n^{k,j}}$. It represents the inputs from all sectors and is responsible for the interrelation of the sectors in the economy. Here P_n^k is the price of material in sector k. A price change in this particular sector, e.g. through a change in tariff, impacts all other sectors indirectly through the input cost bundles.

3.4. Introduction of Trade Costs

Caliendo and Parro (2015) distinguish between two types of costs. The first type of costs is defined as ad valorem flat-rate tariff τ_{ni}^j, which arises as intermediate goods are imported into country n from country i. The second type of trade costs d_{ni}^j, is called "iceberg cost" and is the physical loss goods experience when traded between countries.[13] "Iceberg costs" can take on the form of a function including different variables such as bilateral distance or common border. In this paper I borrow the approach of Aichele et al. (2014) to estimate the effects of non-tariff measures. Aichele et al. (2014) use the top-down approach in order to estimate a realistic reduction of trade costs. This approach investigates past trade agreements and their impact on trade cost reductions. The results are then used as benchmarks to predict the impact of future trade agreements. In this context, Aichele et al. (2014) use two types of dummy variables PTA_{deep} and $PTA_{shallow}$. Combining the two types of international trade costs leads to $k_{ni}^j = \tilde{\tau}_{ni}^j d_{ni}^j$ with $\tilde{\tau}_{ni}^j = (1 + \tau_{ni}^j)$ and $d_{ni}^j = D_{ni}^{\rho^j} e^{(\delta_{shallow}^j PTA_{shallow,ni} + \delta_{deep}^j PTA_{deep,ni} + \zeta^j R_{ni})}$. Taking international trade costs into account, the price of the intermediate good depends not only on the cost of the input bundle and the efficiency of producing the intermediate good but also on the trade cost k_{ni}^j. The producers purchase goods from the lowest-cost supplier of the economy. Hence, the price of intermediate goods of sector j in country n becomes $p_n^j(x^j) = \min_i \left[\frac{B^j c_i^j}{[x_i^j]^{-\theta^j}} k_{ni}^j\right]$. Using the approach of Alvarez and Lucas (2007) the gravity equation can be identified, which displays the trade flow and the expenditure share of country n on goods from country i.

$$\pi_{ni}^j = \frac{\lambda_i^j [c_i^j k_{ni}^j]^{-1/\theta^j}}{\sum_{h=1}^{N} \lambda_h^j [c_h^j k_{nh}^j]^{-1/\theta^j}} \tag{3.5}$$

[13] Caliendo and Parro (2015) define it in technical terms in the following way: To get one unit from country i to country n, requires to produce $d_{ni}^j \geq 1$ of the unit in country i; with $d_{nn}^j = 1$. In addition, the triangle inequality must hold namely $d_{nk}^j d_{ki}^j \geq d_{ni}^j$ for all n, k, i, otherwise, it would be possible that goods are not necessarily bought from the cheapest supplier.

3.5. Counterfactual Equilibrium

In the context of sectoral input-output linkages, the equilibrium wages and prices are such that they maximize the consumer's utility and the profit of the firms for each sector in each country. In addition, good- and labor market clearing conditions must hold.[14] Empirically, it is challenging to estimate the total productivity λ_i^j and the iceberg costs d_{ni}^j for each sector and country. To avoid estimating those exogenous parameters and still being able to solve the equilibrium, Caliendo and Parro (2015) borrowed the method of relative changes from Dekle et al. (2008). Let x be the initial level of a variable and x' the variable under the counterfactual level. The relative change is then defined as $\hat{x} \equiv x'/x$. The equilibrium is found for the change in relative wages and price, by moving the tariff structure from τ to τ'.

Definition: Let (w, P, π, c, X) be an equilibrium under tariff structure τ and let (w', P', π', c', X') be an equilibrium under tariff structure $\hat{\tau}$. Then, define $(\hat{w}, \hat{P}, \hat{\pi}, \hat{c}, \hat{X})$ as an equilibrium under τ' relative to τ. The general equilibrium equations are solved for an equilibrium in relative changes:

Cost change of the input bundle:

$$\hat{c}_n^j = \hat{w}_n^{\beta_n^j} \left(\prod_{k=1}^{J} (\hat{P}_n^k)^{\gamma_n^{k,j}} \right)^{1-\beta_n^j} \tag{3.6}$$

Change in the price index of tradable materials:

$$\hat{P}_n^j = \left[\sum_i [\hat{k}_{ni}^j \hat{c}_i^j]^{(-1/\theta^j)} \pi_{ni}^j \right]^{-\theta^j} \tag{3.7}$$

Change of bilateral trade shares:

$$\hat{\pi}_{ni}^j = \left(\frac{\hat{c}_i^j \hat{k}_{ni}^j}{\hat{P}_n^j} \right)^{-1/\theta^j} \tag{3.8}$$

Trade expenditure in each sector j and country n:

$$X_n^{j\prime} = \sum_{k=1}^{J} \gamma_n^{j,k} (1 - \beta_n^j) \left(\sum_{i=1} \frac{\pi_{in}^{k\prime}}{(1 + \tau_{in}^{k\prime})} X_i^{k\prime} \right) + \alpha_n^{j\prime} I_n' \tag{3.9}$$

Trade balance:

$$\sum_{j=1}^{J} F_n^{j\prime} X_n^{j\prime} + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^{j\prime}}{(1 + \tau_{in}^{j\prime})} X_i^{j\prime} \tag{3.10}$$

[14]For more detail on the equilibrium conditions, see appendix A.2.

Let the income under the new trade policy be $I'_n = \left[\hat{w}_n w_n L_n + \sum_{j=1}^{J} X_n^{j'} \left[1 - F_n^{j'}\right] - S_n\right]$, where $\hat{w}_n = \frac{w'_n}{w_n}$ and $F_n^{j'} = \sum_{i=1}^{N} \frac{\pi_{ni}^{j'}}{(1+\tau_{ni}^{j'})}$. Note that for the general equilibrium in relative changes, the trade cost equation $\hat{k}_{ni}^j$ becomes:

$$\hat{k}_{ni}^j = \frac{(1+\tau_{ni}^{j'})}{(1+\tau_{ni}^j)} e^{\delta_{shallow}^j (PTA'_{(shallow,ni)} - PTA_{(shallow,ni)}) + \delta_{deep}^j (PTA'_{(deep,ni)} - PTA_{(deep,ni)})} \tag{3.11}$$

where the bilateral distance D_{ni} and R_{ni} as the vector which includes other possible trade costs cancel out.

3.6. Solving the Model

Given those counterfactual equilibrium conditions, the system of equations can be solved through an algorithm, which reduces the system of equations to one equation per country with the wage as the only unknown parameter.[15] The first step is to calculate the trade cost change $\hat{k}_n^j$, given the trade policies of τ and τ'. To solve the algorithm, it is assumed that π_{in}^j, $\gamma_n^{j,k}$, β_n^j, α_n^j as well as the parameter of productivity θ^j are given for each sector. The next step is to guess a vector of wage changes $\hat{w} = (\hat{w}_1, \ldots, \hat{w}_n)$. Together with $\hat{k}_n^j$, π_{in}^j, $\gamma_n^{j,k}$, β_n^j, δ^j the wage vector $\hat{w}$ is used to solve for equilibrium input costs $\hat{c}_n^j(\hat{w})$ and prices $\hat{P}_n^j(\hat{w})$ in each sector and country. After that, the bilateral trade shares under the new trade policy $\pi_{ni}^{j'}(\hat{w})$ are calculated; using $\hat{c}_i^j(\hat{w})$, $\hat{P}_n^j(\hat{w})$ and $\hat{k}_{in}^j$ and θ^j via $\hat{\pi}_{ni}^j$. Given $\pi_{ni}^{j'}(\hat{w})$ and τ', the value of weighted tariffs $F_n^{j}{}'$ can be identified. After that solve for the total expenditure of each sector j of country n under the new trade policy, which is $X_n^{j'}(\hat{w})$. This is done by inserting α_n^j, β_n^j, $\gamma_n^{j,k}$, τ' , $F_n^{j}{}'$ and $\pi_{in}^{j'}(\hat{w})$ into equation 3.10 and converting it into $X_n^{j'}(\hat{w})$, which is consistent with the wage vector. This is then inserted together with $\pi_{in}^{j'}(\hat{w})$, S_n, τ' into equation 3.10, which leads to the trade balance conditions of $\sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})} X_n^{j'}(\hat{w}) + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^{j'}(\hat{w})}{(1+\tau_{in}^{j'})} X_i^{j'}(\hat{w})$. Through this mechanism the system of equations is reduced to one equation per country, containing the countries' wages as the only unknown parameter. The last step is to identify the correct vector of wage changes $\hat{w} = (\hat{w}_1, \ldots, \hat{w}_n)$. The correct vector is found if the the equilibrium equation is in balance. If the equations do not hold, the vector of wage changes have to be guessed again, and the process is repeated. The procedure continues, until the correct vector in wage changes $\hat{w}$ is found.

[15] The process to solve the model is based on Caliendo and Parro (2015), for a detailed step-by-step description see section A.3 in the appendix.

3.7. Decomposing Welfare Effects

Having the system solved the counterfactual change in real wages $\hat{W}_n = \hat{w}_n / \prod_j^J \hat{P}_n^{j\,\alpha_n^j}$ can be identified. However, the change in real wages is not equal to the welfare change, due to the fact that the income of households depends also on lump sum tariff revenue. Therefore the change in welfare can be determined by taking the total derivative of the real income $W_n = I_n/P_n$, holding iceberg costs and exogenous trade deffcits constant, leads to the following equation:

$$d\, lnW_n = \frac{1}{I_n}\sum_{j=1}^{J}\sum_{i=1}^{N}\underbrace{(E_{ni}^j d\, lnc_n^j - M_{ni}^j d\, lnc_i^j)}_{Terms\ of\ Trade} + \frac{1}{I_n}\sum_{j=1}^{J}\sum_{i=1}^{N}\underbrace{\tau_{ni}^j M_{ni}(d\, lnM_{ni}^j - d\, lnc_i^j)}_{Volume\ of\ Trade}$$

Hence two multilateral and multisectoral mechanisms affect the change of welfare in the model: Terms of trade and volume of trade. Terms of trade are also known as purchasing power of a country. It depends of the differences between exports (E) and imports (M) who are affected by the change in export and import prices. Volume of trade depends on the tarrifs and amount of imports and also on the change in imports weightetd by import prices.

4. Data

In this section I bring the data to the model and identify the parameters which are necessary to solve the model empirically, once the trade policy changes are implemented.[16] Due to the use of the general equilibrium in relative changes, I do not have to estimate the parameters λ_i^j, D_{ni} and R_{ni} empirically.

4.1. Strategy to determine changes in trade costs

The change in trade cost $\hat{k}_{ni}^j$ depends on the tariffs τ and the counterfactual tariffs τ', as well as the dummy variables $PTA_{shallow}$, $PTA'_{shallow}$, PTA_{deep}, PTA'_{deep} and their parameters δ^j, as seen in equation 3.11.

[16] Hence, the tariff changes from τ to τ' and/or the non-tariff barriers changes from PTA to PTA'.

I collect the tariff data from the UNCTAD Trade Analysis Information System (TRAINS) for the year 2014 at the HS-based tariff line level (HS 2-digit) and transform them to the International Standard Industrial Classification revision 4 (ISIC Rev. 4). For the computation of the analysis I set the counterfactual tariffs τ' in every scenario to zero.[17] Furthermore, to simulate the reduction of the NTMs, I use the dummy variables of the top-down method, borrowed from Aichele et al. (2014). For the classification of $PTA_{shallow}$ and PTA_{deep} Aichele et al. (2014) rely on the Design of Trade Agreements (DESTA) database of Dür et al. (2014). This database covers over 790 PTAs, which include different types of FTAs and customs unions for the time span between 1947 and 2010. The database ranks the PTAs according to their strength of NTM reductions. The index of the ranking ranges from 0 to 7.[18] Aichele et al. (2014) classify trade agreements that have an index between 0 and 4 as $PTA_{shallow}$. With values above 4 the trade agreements are considered as deep preferential trade agreements. The meaning of a $PTA_{shallow}$ dummy variable is that it captures the impact if the FTA reduces NTMs as in average past trade agreements. The PTA_{deep} captures the effect if the FTA goes beyond the average NTM reduction.[19] In addition, I adopt from Aichele et al. (2014) the parameters $\delta^j_{shallow}$ and δ^j_{deep}. Those parameters are based on the WIOD (Release 2013) for the year 2011, which I transform to fit according to the sectors of the WIOD (Release 2016) of the year 2014. After I have determined the parameters $\delta^j_{shallow}$ and δ^j_{deep} I can estimate the trade cost $\hat{k}^j_{ni}$.

4.2. Parameter Identification

I use the WIOD released in 2016 as the main data source. To conduct the counterfactual analysis I take the World Input-Output Table of the year 2014 as it is the most recent year available in the WIOD. It covers 43 countries as well as an aggregate for the rest of the world (ROW) and includes 56 sectors which are classified according to the ISIC Rev. 4. This dataset is usefull as it covers around 90% of the global GDP. To avoid calculation difficulties I apply the approach of Felbermayr et al. (2017a) and summarize the sectors with zero outputs. This is particularly the

[17] A detailed description and explanation of the three trade policies is found in section 5.

[18] Dür et al. (2014) present seven key provisions after which the depth of PTAs is ranked: The provision captures the basic preferential trade agreement, services trade, investments, standards, public procurement, competition and intellectual property rights. If the trade agreement capture only one provision, it is ranked with 1, and so on.

[19] According to Aichele et al. (2014) most trade agreements are shallow PTAs, as for example the ASEAN and MERCOSUR treaties, whereas only 10% of the PTAs are considered deep PTAs, e.g. the European Union.

case for some service sectors.[20] In addition, I use the approach of Costinot and Rodriguez-Clare (2014) to eliminate negative inventories. This is necessary because otherwise the final demand turns out to be negative when summing up over investments, changes in inventories, and the final consumption expenditure by households and government.[21]

I obtain several parameters directly from the World Input-Output Table. I calculate the share of value added β_n^j by dividing the value added VA_n^j over the gross output for each sector j of country n and identify the input-output coefficient by adding all intermediate inputs of sector i from all countries into sector j and then dividing it by the total intermediate costs of sector j. Further, I obtain the trade flows for each sector j and country n from the WIOD, whereas the elasticities of demand θ^j for the agriculture, mining and manufacture sectors I take from Felbermayr et al. (2017a).[22] Regarding the service sectors and non-tradable goods sectors Egger et al. (2012) estimate the elasticity of demand to be 5.959. In this paper I apply the elasticity of demand of Egger et al. (2012) for the service sectors.[23] Once the parameters above are identified I can calculate the share of the final demand good in sector j [24] and the bilateral trade share[25].

5. Simulation Results

In the following, I analyze the impact of different trade policy scenarios.[26] As shown before, the tariffs between the US and Japan are already small on average. In the first scenario (only) all bilateral tariffs are reduced to zero. It is considered as the weakest possible FTA.[27] The second

[20] An overview of the compiled sectors is displayed in the appendix A.4.

[21] The apporach is also used in other papers as for example in Krebs and Pflüger (2015).

[22] These particular elasticities of demand θ^j, which measures the dispersion of productivity for each sector, are used also in other papers, e.g. Felbermayr et al. (2017c).

[23] Other research work also relies on the elasticity of demand of Egger et al. (2012) as in Aichele and Heiland (2014).

[24] The share of the final demand good in sector j is given by $\alpha_n^j = (Y_n^j - S_n^j - \sum_k^J \gamma_n^{j,k}(1-\beta_n^j)Y_n^k)/I_n$.

[25] Bilateral trade share can be obtained by $\pi_{ni}^j = Z_{ni}^j/(Y_n^j - S_n^j)$. This is done first by calculating domestic sales Z_{nn}^j in each country, where $Z_{nn}^j = Y_n^j - \sum_{i=1,i\neq n}^I Z_{in}^j$. Domestic sales are defined as the difference between gross production in country n and its total exports. Secondly, by calculating the surplus (net export) for each country n and each sector j, $S_n^j = \sum_{i=1}^I Z_{in}^j - \sum_{i=1}^I Z_{ni}^j$.

[26] To conduct the simulation I adpot and adjust the codes provided by Caliendo and Parro (2015).

[27] In some sectors the tariffs are still high on average, which is particular the case for Japan. Here following sectors stand out: Crops Animals (24%), Food, Beverages Tabaco (18%), Forestry Logging (13%), Textiles, Apparel, Leather (11%). For simplicity reason it is assumed in this paper that tariffs of these sectors are also set to zero. However, the outcome of the negotiations might lead to a different result of the tariff reduction.

scenario targets a potential shallow agreement where all tariffs are cut and non-tariff barriers are scaled down moderately. The third scenario covers the implementation of a deep FTA where all tariffs are reduced to zero and the NTMs are profoundly scaled-down. It is assumed that the deep FTA is the most likely scenario, as the Japan administration is eager to reduce the US non-tariff measures in order to have better market access to the United States. Lastly, I compare the trade effects of TPP (including the US) and a deep bilateral trade agreement between Japan and the United States. Hereby, TPP is considered to be a deep multilateral trade agreement.

5.1. Trade policy scenarios

Table 5.1 presents the results for the three potential FTAs and their impact on bilateral imports between the United States and Japan.[28] The bilateral imports take account of intermediate and finals goods from all sectors, including the service sectors. In all scenarios, the US imports more goods and services from Japan as vice versa. Hence, the US bilateral trade deficit increases under every form of trade policy.[29]

Table 5.1.: Bilateral Imports between USA and Japan (in bn US$)

		USA	Japan
Tariff Reduction (Scenario 1)	Bilateral imports	126.6	69.2
	Absolute change	+4.5	+5.6
	Relative change	3.7%	8.9%
Shallow FTA (Scenario 2)	Bilateral imports	152.7	83.8
	Absolute change	+30.7	+20.2
	Relative change	25.2%	31.8%
Deep FTA (Scenario 3)	Bilateral imports	176.6	99.5
	Absolute change	+54.5	+35.8
	Relative change	44.7%	56.4%

In the first trade policy scenario, the import growth is greater in Japan than in the United States (in absolute and relative changes). This is not surprising as Japan charges on average 4% higher tariffs on US products. A reduction of all tariffs has therefore a stronger effect on the Japanese import growth. In the second and third scenario, with tariff cuts and an additional

[28] I conduct the results from the status quo, without a change in trade policies.

[29] The largest trade deficit occurs in the case of the deep FTA, where the United States imports goods and services worth 176.6 billion US$ from Japan and exports 99.5 billion US$.

reduction of the NTMs the import rates are even higher in both countries than in the first scenario (in absolute and relative changes). Also, in both scenarios the import of Japanese products to the US grows stronger than the US goods to Japan (in absolute changes). This can be explained by the fact, that the United States have more NTMs on Japanese products than vice versa, as shown in section 2. Thus, a NTM reduction leads to more imports on the US side. However, Japan also benefits from the NTMs reduction and has even higher growth rates than the US in relative changes: The United States experiences an import growth of 25.2% in the shallow and a growth of 44.7% in the deep case, whereas the Japanese import growth is larger with 31.8% in the first scenario and 56.4% in the latter scenario.

Table 5.2.: Impact of trade policies on welfare

	Country	Total Welfare Effects	ToT	VoT
Tariff Reduction (Scenario 1)	Japan	-0.001%	*-0.004%*	*0.003%*
	USA	0.003%	*0.0008%*	*0.002%*
Shallow Integration (Scenario 2)	Japan	0.045%	*0.026%*	*0.019%*
	USA	-0.001%	*-0.013%*	*0.012%*
Deep Integration (Scenario 3)	Japan	0.085%	*0.054%*	*0.031%*
	USA	-0.007%	*-0.016%*	*0.009%*

Table 5.2 displays the impact on the welfare change by the three trade policies scenarios. In the first scenario, Japan is experiencing a negative effect on welfare (-0.001%). The negative effect is mainly driven by terms of trade (ToT) (-0.004%), which is larger than the volume of trade (VoT) (0.003%). As seen in section 3.7, the terms of trade are an indication for the purchasing power of a country and depend on the sectoral trade deficit, the sectoral change in import, and export prices. On the one hand, Japan has (on average) a sectoral trade deficit hence it imports more than it exports in the most sectors. One the other hand, the average sectoral export and import prices are decreasing with a relatively stronger reaction in export prices.[30] The effect of the sectoral weights are not as strong as the export and import price changes, which is the most dominantly effect. Henceforth the terms of trade turn out to be negative.[31] Regarding

[30] The export price depends on wage changes and the change of the prices for the intermediate goods, which are in turn influenced by the tariff reduction, see equation 3.6 and 3.7. The reduction of tariffs leads to a wage increase in by 0.01% and at the same time to a price index change of -0.02%, hence the change of export prices is negative.

[31] Japans imports are larger than its exports (174 billion US$ in imports and 173 billion US$ in exports), yet the average import price change is smaller than the export price change. Therefore, in total the

the shallow and deep scenario, the welfare impact for Japan is positive in both scenarios and becomes stronger as the FTA deepens. The story for the United States is different: In the first scenario the United States experiences welfare gains by a positive volume of trade and terms of trade. However, for a shallow and deep FTA the overall effects are negative. In both scenarios the negative impact on welfare is driven by the terms of trade: -0.013% in the case of a shallow FTA and -0.016% in the deep scenario, which are each larger than the positive effects of the volume of trade.

In the next step, I show the source of the welfare effects in more detail. Table 5.3 displays the welfare changes that derives either directly through the trade creation of the FTA or indirectly through the rest of the world (ROW). The results from Table 5.2 show that in the first scenario

Table 5.3.: Bilateral welfare effects of the FTA

		ToT		VoT	
	Country	FTA	ROW	FTA	ROW
Tariff Reduction	Japan	-0.001%	-0.003%	0.005%	-0.002%
(Scenario 1)	USA	0.0002%	0.0006%	0.002%	-4.3e-05%
Shallow Integration	Japan	0.004%	0.022%	0.011%	0.008%
(Scenario 2)	USA	-0.001%	-0.012%	0.004%	0.008%
Deep Integration	Japan	0.008%	0.046%	0.017%	0.014%
(Scenario 3)	USA	-0.002%	-0.014%	0.004%	0.005%

the terms of trade are in total negative for Japan. The decline in terms of trade is driven by the FTA (-0.001%) and even more by the ROW (-0.003%). This is because Japan's export prices fall relatively stronger than the import prices of the ROW. In addition, Japan is experiencing a negative impact through the ROW (-0.002%) in volume of trade, though this effect is outweighed by a positive volume of trade impact via the trade of the FTA (0.005%). These results can be explained by the concept of trade diversion where trading with the members within the FTA, driven by a new trade policy, becomes relatively cheaper than trading with the ROW. Hence, the volume of trade rises within the FTA and falls with the ROW.

In the case of a potential shallow FTA the largest driver of welfare comes from the ROW in terms of trade (0.022%). Regarding the volume of trade, the FTA and the ROW contribute similarly to the welfare growth, with 0.011% and 0.008% respectively. A potential deep FTA

export weighted by the change in export prices (-783 million US$) is smaller than the import weighted by the changes in import prices. That causes the terms of trade to be negative.

contributes the most to Japans welfare growth, especially through the ROW in terms of trade (0.046%), followed by the FTA (0.017%) and the ROW (0.014%) through the volume of trade.

As regards the United States, the tariff reduction has only a small effect on welfare in terms of trade. In scenario 1 the welfare is almost entirely driven by the FTA via the volume of trade, which comes from the increase of Japanese goods to the United States and the reduction of Japanese export prices. Interestingly, the shallow and deep agreement have a similar impact on the welfare change. In both scenarios the FTA and ROW have a negative impact on the welfare effect through the terms of trade. Considering the volume of trade, the growth rates through the FTA is the same in both cases and is even higher in the shallow scenario with 0.008% compared to the 0.005% in the deep scenario.

Keeping these results in mind, the United States should prefer a shallow agreement whilst Japan should favor a deep FTA. As mentioned in the introduction, a deep FTA is most likely to be established from a political standpoint. Therefore, I will focus in the following on the trade effects of a deep FTA.[32] Table 5.4 shows the sectoral contribution to the welfare change for the deep scenario in terms of trade and volume of trade. Remarkably, there are only a handful of sectors which drive welfare: First, consider the sectoral contribution in welfare by the volume of trade of the United States, displayed in column 4. Here, the Crops and Animals sector, the sector for Food, Beverages & Tobacco, and the sector for Fabricated Metal stand out. Together they contribute with 109.5% for the welfare gains in the volume of trade. Note, that the high contribution of the Crops and Animals sector (53.7%) is steered by the reduction of NTMs. Comparing it to the case where only the tariffs are reduced, the sector adds only 8% to the welfare gains and rises to 43.4% in the shallow scenario. There are also sectors which contribute negatively to the welfare change in volume of trade, particularly the Electronics & Optical Products, Motor Vehicles, Electrical Equipment as well as the Machinery & Equipment sector. Together they are responsible for 25.15% of the welfare losses.

In the case of a deep FTA, no sector contributes negatively for Japan in terms of volume of trade. Also, the sectors are less concentrated in their contribution to the welfare effect. The largest impact comes through the Electronics & Optical Products sector (19.6%), Food, Beverages & Tobacco (15.6%) and the sector of Crops & Animals (15.1%). Also the Motor Vehicles sector (11.9%) adds positively to the welfare effect through volume of trade.

[32] The sectoral results for the tariff and shallow scenario are displayed in the appendix A.5 and A.6.

Table 5.4.: Sectoral contribution to welfare effects in the case of a potential deep FTA

	Japan		USA	
Sector	(1) ToT	(2) VoT	(3) ToT	(4) VoT
Crops & Animals	0.50%	15.1%	2.17%	53.7%
Forestry & Logging	0.04%	0.31%	-0.02%	0.24%
Fishing & Aquaculture	0.04%	0.06%	-0.001%	0.45%
Mining & Quarrying	3.26%	1.38%	0.77%	-1.12%
Food, Beverages & Tobacco	1.59%	15.6%	2.99%	33.3%
Textiles, Apparel,Leather	1.47%	3.37%	-0.82%	3.91%
Wood & Cork	0.20%	0.60%	0.07%	0.05%
Paper	0.72%	0.03%	1.14%	-0.06%
Recorded Media Reproduction	0.07%	0.01%	0.14%	0.002%
Coke, Refined Petroleum	2.08%	1.10%	2.32%	0.19%
Chemicals	1.83%	5.46%	4.13%	4.42%
Pharmaceuticals	1.20%	0.74%	1.24%	1.42%
Rubber & Plastics	2.81%	2.34%	1.61%	0.30%
Other non-Metallic Mineral	1.59%	0.91%	0.54%	0.39%
Basic Metals	6.88%	5.38%	1.61%	-0.42%
Fabricated Metal	5.50%	3.21%	3.66%	22.5%
Electronics & Optical Products	10.5%	19.6%	3.85%	-14.5%
Electrical Equipment	6.04%	5.44%	2.80%	-3.07%
Machinery & Equipment	9.73%	1.39%	10.5%	-1.33%
Motor Vehicles	15.6%	11.9%	29.2%	-6.27%
Other Transport Equipment	-3.02%	0.03%	11.9%	0.01%
Furniture & Other Manufacturing	1.28%	1.88%	1.42%	6.00%
Aggregated Services	30.09%	4.16%	18.78%	-0.112%

The sectoral influence through the terms of trade is displayed in column 1 and 3 of Table 5.4. In terms of trade Japan has the highest contribution in the Motor Vehicles sector (15.6%), the sector for Electronics & Optical Products (10.5%) and Machinery (9.73%). Similar to Japan the main growth driver for the United States is the Motor Vehicles sector (29.2%), followed by Other Transport Equipment (11.9%) and Machinery (10.5%). Also service sectors have a positive impact on welfare gains through the terms of trade. This is due to the fact that the service sectors are also affected by the changes in export and import prices. Especially services can be impacted directly by the FTA foremost via the reduction of NTMs. Tariff can hardly be charged on services, only indirectly through the interrelations with non-services sectors, which are directly targeted by the trade policy.[33] In both countries the aggregated service sectors have a large impact on welfare growth, with 18.78% and 30.09% respectively.[34]

5.2. TPP vs a bilateral FTA

In this section, I present the results of the counterfactual simulation of the TPP and compare it with the trade and welfare effects of a deep FTA. Table 5.5 displays the results of TPP's trade effects in relative changes. The findings clearly indicate a strong increase in exports for all TPP countries. Japan exports goods to the United States with the value of 164 billion US$ in total. Compared to the status quo this is an increase of 34.8%, which is however smaller as through the deep FTA (44.7%). The United States export, 97 billion US$ to Japan - an export increase of 52.8%. This is slightly less when contrasted with the impact of the deep FTA (56.4%).[35] Canada, Mexico and the United States already have strong trade relationships with a large amount of exports. This is the case because they are geographically close to each other and well connected through NAFTA. Additionally, those three countries could intensify their trade through TPP. Explicitly, the high export growth rate between Canada and Mexico (85%) stands out. The reason for this is that the export from Canada to Mexico has been the lowest between the NAFTA members and therefore TPP's trade cost reduction leads to a relatively strong export enhancing effect. In addition, Australia's exports to Canada (61.6%) and to Japan (62.3%)[36] are strongly growing, and the exports to Mexico (154%) increase even more. The low

Table 5.5.: Trade effects from TPP

Importer \ Exporter	Japan	USA	Australia	Canada	Chile	Mexico
Japan		52.8%	62.3%	70.1%	57.4%	55%
USA	34.8%		40.6%	35.3%	44.7%	49.2%
Australia	41.7%	39.8%		52.6%	53.3%	40%
Canada	27.5%	39.3%	61.6%		48.4%	44.1%
Chile	41.1%	40%	50%	46.4%		47.4%
Mexico	50.6%	51.1%	154%	85%	65.2%	

[33] The contribution to welfare by volume of trade is small for the service sectors. This is because the volume of trade is stirred mainly by import of goods, which by nature services are not.
[34] The reason for the high shares is that the services are aggregated.
[35] In appendix A.7 I give an overview of absolute changes through TPP.
[36] TPP boosts Australia's exports to Japan from 47 billion US$ to 77 billion US$.

exports between Australia and Mexico before TPP are the reasons for this strong export growth. Within all TPP countries the exports from Australia to Mexico are the smallest (0.4 billon US$) and grow through the multilateral trade agreement by 0.7 billion US$, which leads to the high export growth in relative changes.

The changes of the export shares by the FTA and TPP are displayed in table 5.6. The 50 WIOD industries are aggregated into four main categories: Agriculture-, mining-, manufacturing- and service sector. Column 1 and 4 reflect the status quo, which are the export shares without any counterfactual trade policy adjustments.

Table 5.6.: Export shares by sectors and trade agreements

	Japan			USA		
	(1) Status Quo	(2) FTA	(3) TPP	(4) Status Quo	(5) FTA	(6) TPP
Agriculture	0.11%	0.12%	0.12%	2.82%	2.92%	2.93%
Mining	0.34%	0.34%	0.40%	2.33%	2.41%	4.00%
Manufacturing	81.54%	83.00%	82.94%	54.48%	54.69%	56.12%
Service	18.01%	16.54%	16.99%	40.37%	39.88%	36.95%
Normalized Herfindahl	0.076	0.081	0.078	0.025	0.025	0.024

The export shares from Japan and the United States take the exports to all countries into account. They do not just focus on the bilateral exports between Japan and the United States.

Column 1 shows that the Japanese manufacturing sector has the largest export share followed by the service sector - the other two sectors play a minor role.[37] The two trade agreements have only marginal effects on the change of the export shares. In both counterfactual scenarios the largest changes occur between the manufacturing and the service sector. Compared to TPP the bilateral FTA strengthens the export of the manufacturing sectors slightly more and has a moderately lower service export share. The export shares of the United States are more diversified. Focusing first on the baseline, the US agriculture, mining and service sector have higher shares than those of Japan, whereas the manufacturing sector is considerably smaller. Through the FTA and even more through TPP the mining and the manufacturing sectors get larger export shares, while the service sector loses. In addition, the normalized Herfindahl index (HHI) also reveals that Japan's export sectors are three times more specialized than those of the

[37] The three largest export industries reflect a similar structure: The Motor Vehicle industry (18.9%) as the largest and the Electronics & Optical Products (14%) as the second largest export industry are both part of the manufacturing sector. While the Wholesale Trade (9.42%) industry counts for the service sector.

United States, when comparing the HHI between Japan (0.076) and US (0.025) in the baseline case. The implementation of the FTA and TPP has small specification effects for Japan, as the HHI indicates. For the US the HHI shows a small diversion of the export shares in the case of TPP and no changes through an FTA.

Table 5.7.: Welfare effects of TPP

Country	Total	ToT	VoT
Japan	0.05%	*-0.01%*	*0.06%*
USA	0.05%	*-0.04%*	*0.09%*
Australia	0.122%	*0.12%*	*0.002%*
Canada	0.20%	*0.17%*	*0.03%*
Chile	0.35%	*0.34%*	*0.01%*
Mexico	0.56%	*0.46%*	*0.10%*

Table 5.7 presents the key findings for the welfare gains of the TPP countries. With 0.05% Japan and the US have the lowest welfare gains amongst the TPP members. In comparison to the potential bilateral FTA Japan experiences lower welfare gains, while the United States improves its welfare gains through TPP. In both countries the welfare gains are impacted by the negative effects of the terms of trade, as column 2 reflects. Interestingly, the cause of the negative impact in terms of trade differs for Japan and the United States. For Japan, the negative welfare effect in terms of trade can be explained by the larger reduction of average export prices (-0.25%) relative to the average import prices (-0.23%). On the other side, the negative terms of trade of the US are driven by large sectoral trade deficits. It turns out that the United States experiences large amounts of sectoral trade deficits especially with TPP countries. Hence, the TPP members contribute with -0.03% negatively to the of terms of trade (-0.04% in total).[38] Japan and the United States mainly benefit from TPP through the welfare gains in volume of trade, with 0.06% and 0.09% respectively. Worth mentioning is that for both countries the welfare effects in volumes of trade come predominantly from TPP countries. But at the same time both are negatively impacted by the trade with the ROW in volume of trade.[39] The argument is again that through the implementation of TPP trade diversion occurs. TPP's trade cost reduction makes trade within the TPP group relatively cheaper than with Non-TPP countries. This in

[38] I show the origin of the bilateral welfare effects by TPP in the appendix A.8.

[39] Through the trade with TPP members Japan welfare grows by 0.063% in volume of trade. While the trade with the ROW contributes negatively to the welfare change in volume of trade (-0.008%). The US benefits from the TPP countries in volume of trade by 0.11% and experiences welfare loses via the ROW by -0.024%.

turn leads to import growth amongst TPP member states, whilst imports from other countries decline. Hence, TPP impacts the welfare change in volume of trade positively for TPP members and negatively for ROW. As I have mentioned above all other TPP countries have higher welfare

Table 5.8.: Countries and Welfare effects of a deep FTA and TPP

	Deep FTA	TPP
Australia	0.004%	0.122%
Brazil	0.001%	0.009%
Canada	0.024%	0.201%
Chile	0.029%	0.353%
China	-0.005%	-0.030%
EU*	-0.002%	-0.016%
France	-0.001%	-0.002%
Germany	-0.016%	-0.087%
Indonesia	-0.016%	-0.075%
India	-0.0007%	-0.002%
Italy	-0.004%	-0.025%
Japan	0.085%	0.042%
South Korea	-0.028%	-0.139%
Mexico	0.094%	0.561%
Norway	-0.003%	-0.018%
Russia	0.0002%	-0.004%
Spain	-0.001%	-0.015%
Turkey	-0.002%	-0.010%
Taiwan	-0.025%	-0.131%
UK	-0.0004%	-0.0008%
USA	-0.006%	0.049%
ROW	0.004%	0.030%

∗ Note, that the welfare effects of the EU are averages and do not include the UK.

gains than Japan and the United States: Australia has a 0.122%, Canada a 0.20%, Chile a 0.35% and Mexico a 0.56% increase in welfare. For all of those countries welfare grows mainly through contribution of the terms of trade.[40] Especially Chile and Mexico have large amounts of sectoral trade surplus which add positively to their welfare gains in terms of trade.[41]

For a sample of countries, table 5.8 compares the total welfare effects of a deep FTA to the welfare changes driven by TPP. Not surprisingly the TPP members (other than Japan and the US) are all better off when TPP is in place, due to the direct reduction of trade costs. For countries who are already negatively impacted by the deep FTA as for example China, Indonesia or South Korea the trade liberalization of TPP will increase the negative effects on welfare. For most countries the impact on welfare loses is caused by terms of trade. Only marginal effects are caused by volume of trade, as small amounts of imports are directly created for other countries. However, other countries benefit from the FTA and even more from TPP as for example Brazil, which increase also mainly due to higher terms of trade. Russia benefits slightly from the deep FTA (0.0002%), which is caused by a higher volume of trade (0.0004%) compared to the negative terms of trade (-0.0002%). However, the discussed welfare changes are small and the results can therefore change easily through a change in trade policy. This is also the case if TPP is implemented: The total welfare is negative with -0.004%, caused by a larger negative impact of the terms of trade (-0.005%) compared to a small welfare change in volume of trade (0.001%).

6. Conclusion

Although Japan and the United States are responsible of roughly 30% of the global GDP, they are not connected via a trade agreement. As I show in this paper, the export shares from the United States to Japan have decreased over the last decade, as vice versa. A potential trade agreement has not only the potential to increase the bilateral export shares but also to raise the welfare gains of both countries. In this context, two potential trade agreements between Japan and the United States are currently discussed: A bilateral free trade agreement and the multilateral TPP. This paper provides insides for political discussion. One argument of the US administration of rejoining the negations of TPP is, that through TPP the American agriculture

[40] The weak contribution to welfare by volume of trade is again caused by trade diversion. The welfare growth by TPP countries is diluted by the welfare loses of the ROW. This is in particular true for Australia and Canada.

[41] Note that Mexico is a supplier of intermediate goods mainly to TPP members. Hence, the largest amount of Mexico's sectoral trade surpluses comes from within the TPP group. While Chile's trade surplus is generate primarily by ROW countries.

sector will benefit by more exporting. This paper confirms that the agriculture export share of the United States will increase (compared to the baseline (2.82%)) through the FTA (2.92%) and slightly more through TPP (2.93%). A major finding is that the United States is indeed better of when joining TPP. The total welfare gains are with 0.05% the highest in the case of TPP compared with any of the three other FTA scenarios. However, Japan is expected to prefer a deep bilateral FTA as it leads to the largest welfare gains of 0.085%. From the perspective of the EU it would be preferred if a bilateral FTA is established, as the welfare losses would be smaller (-0.002%) than in the case of TPP (-0.016%).

To conduct the counterfactual analysis I rely in this paper on the theoretical foundation of Caliendo and Parro (2015), which is part of the new quantitative trade theory. I then apply the Caliendo and Parro (2015) model empirically using the approach of Aichele et al. (2014). Hereby, the most recent WIOD (released 2016) is used for the year 2014, includes 50 sectors and 43 countries plus the rest of the world. The degree of trade barriers reduction for the trade agreement is not yet known, as a workaround, I apply the top-down method by Aichele et al. (2014) to simulate the trade barriers reduction. The top-down method uses past trade agreements as a benchmark to quantify the possible welfare impact of TPP and the FTA. However, the results will be much more precise once the outcomes of the negotiation of either a FTA or TPP are made public. Thus, the reduction of tariffs and NTMs do not have to be estimated anymore.

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A. Appendix

A.1. Composite Intermediate Goods in Non-Tradeable Sectors

In the case of the non-tradable sector, it is always cheaper to produce the intermediate good domestically. The production function of the composite good is the same as in the case of the tradable sector:

$$q_n^j = \left[\int q_n^j(x^j)^{(1-1)/\eta^j} \Phi^j(x^j) dx^j \right]^{\eta^j/(\eta^j-1)} \tag{A.1}$$

However, the density function is different:

$$\Phi^j(x^j) = (\lambda_n^j) \exp\left\{ -\lambda_n^j x_n^j \right\} \tag{A.2}$$

Solving the minimization problem leads to the following result: $p_n^j(x^j) = p_n^j(x_n^j)$. This result is similar to the definition of the non-tradable sector. The lowest intermediate good price of sector j is the price of the intermediate good of country n.

A.2. General Equilibrium

In the context of sectoral input-output linkages, the equilibrium wages and prices are such that they maximize the consumer's utility and the profit of the firms for each sector in each country. In addition, good- and labor market clearing conditions must hold. Caliendo and Parro (2012, p.15) specify the general equilibrium in the following way:

Definition 1: Given L_n, S_n, λ_i^j and d_{ni}^j, an equilibrium under trade policy of τ is a wage vector $w \in R_{++}^N$ and P_n^j that solves equilibrium conditions for all J and N:

Cost of the input bundle of country n in sector j:

$$c_n^j = w_n^{\beta_n^j} \left(\prod_{k=1}^{J} (P_n^k)^{\gamma_n^{k,j}} \right)^{1-\beta_n^j} \tag{A.3}$$

Price of the composite intermediate good in country n of sector j:

$$P_n^j = A^j B^j \left[\sum_i [k_{ni}^j c_i^j]^{(-1/\theta^j)} \lambda_i^j \right]^{-\theta^j} \tag{A.4}$$

Bilateral trade share of country i with respect to country n in sector j:

$$\pi_{ni}^j = (A^j B^j)^{-1/\theta^j} \left(\frac{c_i^j k_{ni}^j}{P_n^j} \right)^{-1/\theta^j} \lambda_i^j \tag{A.5}$$

Spending on trade in sector j of country n:

$$X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} (1 - \beta_n^j) \left(\sum_{i=1} \frac{\pi_{in}^k}{(1+\tau_{in}^k)} X_i^k \right) + \alpha_n^j I_n \tag{A.6}$$

Trade balance:

$$\sum_{j=1}^{J} F_n^j X_n^j + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^j}{(1+\tau_{in}^j)} X_i^j \tag{A.7}$$

A.3. Equilibrium in Relative Changes

To solve the equilibrium model, the steps below have to be followed, which are based on Caliendo and Parro (2015).

Step 1: Calculate π_{in}^j, $\gamma_n^{j,k}$, β_n^j, α_n^j, for all j and n

Bilateral trade share: $\pi_{in}^j = (Z_{in}^j)/(Y_n^j - S_i^j)$

Share that sector k spends on goods of sector j: $\gamma_n^{j,k} = h_n^{j,k} / \sum_j h_n^{j,k}$

Share of the value added: $\beta_n^j = VA_n^j / Y_n^j$

Share of the final demand good in sector j: $\alpha_n^j = \frac{Y_n^j - S_n^j - \sum_k^J \gamma_n^{j,k}(1-\beta_n^j)\gamma_n^k}{I_n}$

Step 2: Estimate productivity θ^j and the parameters $\delta_{shallow}$ and δ_{deep}.

Step 3: Construct $\hat{k}_n^j$:

For the model of Caliendo and Parro (2012) use $\hat{k}_{in}^j = \frac{1+\tau_{in}^{j'}}{1+\tau_{in}^j}$, with tariff structures τ and $\hat{\tau}'$.

For the model of Aichele et al. (2014) use τ and $\hat{\tau}'$ and $\delta_{shallow}$ and δ_{deep} to get $\hat{k}_{in}^j = \hat{\tau}_{in}^j e^{\delta_{shallow}^j(PTA'_{(shallow,in)} - PTA_{(shallow,in)}) + \delta_{deep}^j(PTA'_{(deep,in)} - PTA_{(deep,in)})}$.

Step 4: Guess a vector of wage changes $\hat{w} = (\hat{w}_1, \therefore, \hat{w}_n)$.

Step 5: Use $\hat{w}$, $\hat{k}_n^j$, π_{in}^j, $\gamma_n^{j,k}$, β_n^j, δ^j to solve for equilibrium input costs $\hat{c}_n^j(\hat{w})$ and prices $\hat{P}_n^j(\hat{w})$ for each sector and each country, which are consistent with the vector of wages $\hat{w}$.

Step 6: Use $\hat{c}_n^j(\hat{w})$ and prices $\hat{P}_n^j(\hat{w})$, together with $\hat{k}_{in}^j$ and θ^j to calculate the bilateral trade shares $\pi_{ni}^{j'}(\hat{w})$ under the trade policy of τ', this is done by using $\hat{\pi}_{ni}^j$.

Step 7: Given $\pi_{ni}^{j'}(\hat{w})$ from step 6, and the tariff vector τ' the value of weighted tariffs $F_n^{j'} = \sum_{i=1}^N \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})}$ can be calculated. Further, $X_n^{j'}(\hat{w})$ consists with the vector of wages $(\hat{w})$ in the following way:

$$X_n^j = \sum_{k=1}^J \gamma_n^{j,k}(1-\beta_n^j)\left(\sum_{i=1} \frac{\pi_{in}^k(\hat{w})}{(1+\tau_{in}^k)} X_i^k\right) + \alpha_n^j\left[w_n L_n + \sum_{n=1}^J X_n^j\left[1-F_n^j\right] - S_n\right] \tag{A.8}$$

From equation A.8, the counterfactual equation can be derived:

$$X_n^{j'} = \sum_{k=1}^J \gamma_n^{j,k}(1-\beta_n^j)\left(\sum_{i=1} \frac{\pi_{in}^{k'}(\hat{w})}{(1+\tau_{in}^{k'})} X_i^{k'}\right) + \alpha_n^j\left[\hat{w}_n w_n L_n + \sum_{n=1}^J X_n^{j'}\left[1-F_n^{j'}\right] - S_n\right] \tag{A.9}$$

The equation can also be expressed in a matrix form, because it consists as a system of $J \times N$ in $J \times N$.

$$\boldsymbol{\Omega}(\hat{\boldsymbol{w}})\boldsymbol{X} = \boldsymbol{\Delta}(\hat{\boldsymbol{w}}) \tag{A.10}$$

Here, $\Delta(\hat{w})$ is a vector which involves the shares for each sector and country of the sum of nominal income minus the surplus for each country. Vector X includes the expenditure levels for each sector and country. Those vectors are defined in the following way:

$$\Delta(\hat{w}) = \begin{bmatrix} \alpha_1^1 \left(\hat{w}_n w_n L_n - S_n^{'}\right) \\ \vdots \\ \alpha_1^J \left(\hat{w}_n w_n L_n - S_n^{'}\right) \\ \vdots \\ \alpha_N^1 \left(\hat{w}_n w_n L_n - S_n^{'}\right) \\ \vdots \\ \alpha_N^J \left(\hat{w}_n w_n L_n - S_n^{'}\right) \end{bmatrix}_{JN\times 1} \quad ; \quad X = \begin{bmatrix} X_1^{1'} \\ \vdots \\ X_1^{J'} \\ \vdots \\ X_n^{1'} \\ \vdots \\ X_N^{J'} \end{bmatrix}_{JN\times 1} \tag{A.11}$$

$\Omega(\hat{w})$ is a matrix which consists out of three parts, $\Omega(\hat{w}) = I - F(\hat{w}) - \hat{H}(\hat{w})$. Hereby, I is the identity matrix and $F(\hat{w})$ is defined as:

$$F(\hat{w}) = \begin{bmatrix} A_1 \otimes \tilde{F}_1'(\hat{w}) & \dots & 0_{J\times J} & \dots & 0_{J\times J} & \dots & 0_{J\times J} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0_{J\times J} & \dots & A_2 \otimes \tilde{F}_2'(\hat{w}) & \dots & 0_{J\times J} & \dots & 0_{J\times J} \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0_{J\times J} & \dots & 0_{J\times J} & \dots & A_{N-1} \otimes \tilde{F}_{N-1}'(\hat{w}) & \dots & 0_{J\times J} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0_{J\times J} & \dots & 0_{J\times J} & \dots & 0_{J\times J} & \dots & A_N \otimes \tilde{F}_N'(\hat{w}) \end{bmatrix}_{JN\times JN} \tag{A.12}$$

Note that $F(\hat{w})$ involves the vectors:

$$A_n = \begin{bmatrix} \alpha_n^1 \\ \vdots \\ \alpha_n^J \end{bmatrix}_{JN\times 1} , \tilde{F}_n'(\hat{w}) = \left((1 - F_n^{1'}(\hat{w})) \dots (1 - F_n^{1'}(\hat{w}))\right)_{1\times J} \tag{A.13}$$

with $F_n^{j'}(\hat{w}) = \sum_{i=1}^{N} \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})}$.

$\tilde{H}(\hat{w})$ is defined in the following way, which includes $\tilde{\pi}_{in}^{k'}(\hat{w}) = \frac{\pi_{in}^{k'}(\hat{w})}{1+\tau_{in}^{k'}}$:

$$H(\hat{w}) = \begin{bmatrix} \gamma_1^{1,1}(1-\beta_1^1)\tilde{\pi}_{1,1}^{1'}(\hat{w}) & \dots & \gamma_1^{1,J}(1-\beta_1^J)\tilde{\pi}_{1,1}^{J'}(\hat{w}) & \dots & \gamma_1^{1,1}(1-\beta_1^1)\tilde{\pi}_{N,1}^{1'}(\hat{w}) & \dots & \gamma_1^{1,J}(1-\beta_1^J)\tilde{\pi}_{N,1}^{J'}(\hat{w}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \gamma_1^{J,1}(1-\beta_1^1)\tilde{\pi}_{1,1}^{1'}(\hat{w}) & \dots & \gamma_1^{J,J}(1-\beta_1^J)\tilde{\pi}_{1,1}^{J'}(\hat{w}) & \dots & \gamma_1^{J,1}(1-\beta_1^1)\tilde{\pi}_{N,1}^{1'}(\hat{w}) & \dots & \gamma_1^{J,J}(1-\beta_1^J)\tilde{\pi}_{N,1}^{J'}(\hat{w}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \gamma_N^{1,1}(1-\beta_N^1)\tilde{\pi}_{1,N}^{1'}(\hat{w}) & \dots & \gamma_N^{1,J}(1-\beta_N^J)\tilde{\pi}_{1,N}^{J'}(\hat{w}) & \dots & \gamma_N^{1,1}(1-\beta_N^1)\tilde{\pi}_{N,N}^{1'}(\hat{w}) & \dots & \gamma_N^{1,J}(1-\beta_N^J)\tilde{\pi}_{N,N}^{J'}(\hat{w}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \gamma_N^{J,1}(1-\beta_N^1)\tilde{\pi}_{1,N}^{1'}(\hat{w}) & \dots & \gamma_N^{J,J}(1-\beta_N^J)\tilde{\pi}_{1,N}^{J'}(\hat{w}) & \dots & \gamma_N^{J,1}(1-\beta_N^1)\tilde{\pi}_{N,N}^{1'}(\hat{w}) & \dots & \gamma_N^{J,J}(1-\beta_N^J)\tilde{\pi}_{N,N}^{J'}(\hat{w}) \end{bmatrix}_{JN \times JN} \tag{A.14}$$

$\Omega_n(\hat{w})$ is important, because it describes how a change of tariffs in a particular sector is affecting all other sectors. Let there be no tariffs and no other composite goods from other sectors be used in the production of sector j, $\gamma_n^{j,j} = 1$, then there is no linkage between sectors, and the matrix $\Omega_n(\hat{w})$ is a diagonal. Solving the system of equation for $X(\hat{w})$ (total expenditure of country n) leads to the following solution if $\Omega_n(\hat{w})$ is invertible:

$$\boldsymbol{X(\hat{w}) = \Omega^{-1}(\hat{w})\Delta(\hat{w})} \tag{A.15}$$

Let $X_n^{j'}(\hat{w})$ be the total expenditure of the material in sector j of country n. Combining the trade balance condition with the good market clearing condition, the trade balance condition can be re-conducted, now including the wage vector of unknowns, $\hat{w}$.

Step 8: Insert $\pi_{in}^{j'}(\hat{w})$, $X(\hat{w})$, τ' and S'_n to obtain:

$$\sum_{j=1}^{J} F_n^{j\prime} X_n^{j\prime} + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{in}^{j'}(\hat{w})}{(1+\tau_{in}^{j'})} X_i^{j\prime} \tag{A.16}$$

Which leads to:

$$\boldsymbol{\sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{ni}^{j'}(\hat{w})}{(1+\tau_{ni}^{j'})} X_n^{j'}(\hat{w}) + S_n = \sum_{j=1}^{J}\sum_{i=1}^{N} \frac{\pi_{in}^{j'}(\hat{w})}{(1+\tau_{in}^{j'})} X_i^{j'}(\hat{w})} \tag{A.17}$$

The last step is to identify the correct vector of wage changes $\hat{w} = (\hat{w}_1, \dots, \hat{w}_n)$. The correct vector is found if the the equilibrium equation A.17 is in balance. If the equation does not hold, the vector of wage changes has to be guessed again, and the algorithm is repeated. The process continues until the correct vector in wage changes $\hat{w}$ is found.

A.4. Sector Overview & Delta

Figure A.1.: Sector Overview & Delta (Data: Aichele et al. (2014))

Merged sectors & ISIC Rev.4 sector description	Delta Shallow	Delta Deep	Merged sectors & ISIC Rev.4 sector description	Delta Shallow	Delta Deep
Crops & Animals A01	-0,00043441	-0,0520384	Construction F	-0,02836046	-0,0506796
Forestry & Logging A02	0,007090103	-0,0254062	Trade & Repair of Motor Vehicles G45	-0,02164793	-0,0973318
Fishing & Aquaculture A03	0,057667934	-0,0240811	Wholesale Trade G46	-0,02164793	-0,0973318
Mining & Quarrying B	-0,00105485	-0,0254043	Retail Trade G47	-0,02164793	-0,0973318
Food, Beverages & Tabacco C10-C12	-0,07526021	-0,1156926	Land Transport H49	-0,03054204	-0,0669575
Textiles, Apparel,Leather C13-C15	-0,02419767	-0,1959343	Water Transport H50	-0,00402752	-0,0693069
Wood & Cork C16	-0,02631579	-0,1715934	Air Transport H51	-0,02936734	-0,020641
Paper C17	-0,03108367	-0,1119864	Aux. Transportation Services H52	-0,02164793	-0,0973318
Recorded Media Reproduction C18	-0,03108367	-0,1119864	Postal and Courier H53	-0,03708676	-0,0493371
Coke, Refined Petroleum C19	-0,14772103	-0,1230093	Accomodation and Food I	-0,04480618	-0,0938077
Chemicals C20	-0,04237824	-0,0668353	Publishing J58	-0,03708676	-0,0493371
Pharmaceuticals C21	-0,04237824	-0,0668353	Media Services J59_J60	-0,03708676	-0,0493371
Rubber & Plastics C22	-0,04237824	-0,0668353	Telecommunications J61	-0,03708676	-0,0493371
Other non-Metallic Mineral C23	-0,0288873	-0,0559914	Computer & Information Services J62_J63	-0,03708676	-0,0493371
Basic Metals C24	-0,0288873	-0,0559914	Financial Services K64	-0,02685014	-0,0822286
Fabricated Metal C25	-0,16553779	-0,2037388	Insurance K65_K66	-0,02550764	-0,0567209
Electronics & Optical Products C26	-0,11398246	-0,1416705	Real Estate L68	-0,04480618	-0,0938077
Electrical Equipment C27	-0,21382784	-0,1108059	Legal and Accounting M69_M70	-0,04480618	-0,0938077
Machinery & Equipment C28,C33	-0,06161584	-0,0550141	Business Services M71,M73-M75	-0,04480618	-0,0938077
Motor Vehicles C29	-0,08065395	-0,2441417	Research and Development M72	-0,04480618	-0,0938077
Other Transport Equipment C30	-0,0587473	-0,1766739	Admin. & Support Services N	-0,0238295	-0,0399396
Furniture & Other Manufacturing C31_C32	-0,07428571	-0,1103297	Public & Social Services O84	-0,02987078	-0,0615875
Electricity & Gas D35	-0,02366169	-0,0652794	Education P85	-0,02987078	-0,0615875
Water Supply E36	-0,03842927	-0,0634167	Human Health and Social Work Q	-0,02987078	-0,0615875
Sewerage & Waste E37-E39	-0,03842927	-0,0634167	Other Serivces, Households R-U	-0,02987078	-0,0615875

A.5. Sectoral contribution to welfare - Tariff Reduction

Figure A.2.: Sectoral contribution to welfare - Tariff Reduction

	ToT	VoT	ToT	VoT		ToT	VoT	ToT	VoT
Crops & Animals A01	-0.132%	19.7%	1.08%	8.38%	Construction F	-0.0257%	0%	0.0701%	0%
Forestry & Logging A02	0.0019%	1.3%	0.389%	0.661%	Trade & Repair of Motor Vehicles G45	-0.0071%	0%	0.291%	0%
Fishing & Aquaculture A03	0.022%	-0.0275%	0.218%	0.542%	Wholesale Trade G46	-0.186%	0%	14.5%	0%
Mining & Quarrying B	-4.22%	2.4%	5.24%	1.82%	Retail Trade G47	-0.0648%	0%	0.454%	0%
Food, Beverages & Tabacco C10-C12	0.185%	13.4%	-0.0278%	37.8%	Land Transport H49	-0.0619%	3.43%	2.3%	0.0689%
Textiles, Apparel,Leather C13-C15	-0.703%	2.03%	4.76%	5.54%	Water Transport H50	2.66%	-0.0867%	0.51%	0.00341%
Wood & Cork C16	-0.144%	0.313%	0.169%	0.0607%	Air Transport H51	0.0409%	0.0442%	3.7%	0.149%
Paper C17	0.243%	0.011%	-0.027%	0.039%	Aux. Transportation Services H52	0.0701%	0%	0.789%	0%
Recorded Media Reproduction C18	-0.00539%	0.00259%	0.0417%	0.0016%	Postal and Courier H53	0.00277%	0%	0.521%	0%
Coke, Refined Petroleum C19	-0.383%	1.11%	6.47%	0.391%	Accomodation and Food I	0.608%	0%	0.065%	0%
Chemicals C20	*19.9%*	*14.9%*	*3.72%*	*10.4%*	Publishing J58	0.00365%	0%	2.9%	0%
Pharmaceuticals C21	-0.0321%	-0.0909%	-0.658%	0.039%	Media Services J59_J60	0.0237%	3.27%	1.45%	0.0447%
Rubber & Plastics C22	6.38%	0.989%	-0.801%	0.844%	Telecommunications J61	0.0123%	0%	0.764%	0%
Other non-Metallic Mineral C23	0.403%	0.947%	0.66%	0.152%	Computer & Information Services J62_J63	-0.0378%	0%	1.84%	0%
Basic Metals C24	3.57%	4.95%	0.16%	1.03%	Financial Services K64	-0.0156%	0%	4.19%	0%
Fabricated Metal C25	2.81%	2.94%	-2.71%	30.1%	Insurance K65_K66	-0.0417%	0%	5.64%	0%
Electronics & Optical Products C26	31.5%	26.4%	20.5%	2.06%	Real Estate L68	-0.00428%	0%	0.22%	0%
Electrical Equipment C27	9.95%	-0.95%	2.53%	0.077%	Legal and Accounting M69_M70	-0.0469%	0%	2.65%	0%
Machinery & Equipment C28,C33	7.14%	0.187%	-2.26%	0.0347%	Business Services M71,M73-M75	0.0234%	0%	4.05%	0%
Motor Vehicles C29	18.3%	1%	5.8%	-0.767%	Research and Development M72	0.00261%	0%	1.16%	0%
Other Transport Equipment C30	1.45%	0%	-3.91%	0%	Admin. & Support Services N	0.0234%	0%	6.23%	0%
Furniture & Other Manufacturing C31_C32	0.868%	1.79%	1.79%	0.408%	Public & Social Services O84	0.00186%	0%	1.05%	0%
Electricity & Gas D35	-0.012%	0%	0.217%	0%	Education P85	-0.0108%	0%	0.333%	0%
Water Supply E36	-0.001%	0%	0.0187%	0%	Human Health and Social Work Q	-0.001%	0.010%	0.20%	0.030%
Sewerage & Waste E37-E39	-0.01%	0%	0.498%	0%	Other Serivces, Households R-U	-0.087%	0.002%	0.274%	0.051%

A.6. Sectoral contribution to welfare - Shallow FTA

Figure A.3.: Sectoral contribution to welfare - Shallow FTA

	ToT	VoT	ToT	VoT		ToT	VoT	ToT	VoT
Crops & Animals A01	0.588%	18.8%	2.76%	43.4%	Construction F	0.0183%	0%	-0.0287%	0%
Forestry & Logging A02	0.046%	0.284%	0.038%	0.124%	Trade & Repair of Motor Vehicles G45	0.0214%	0%	-0.0532%	0%
Fishing & Aquaculture A03	0.057%	0.065%	0.044%	0.272%	Wholesale Trade G46	19.6%	0%	5.55%	0%
Mining & Quarrying B	3.21%	1.93%	3.97%	-0.814%	Retail Trade G47	1.1%	0%	0.713%	0%
Food, Beverages & Tabacco C10-C12	1.72%	17.1%	3.55%	25.7%	Land Transport H49	2.85%	2.28%	2.13%	-0.0237%
Textiles, Apparel,Leather C13-C15	1.7%	2.9%	0.055%	2.65%	Water Transport H50	2.99%	0.313%	0.579%	0.0117%
Wood & Cork C16	0.236%	0.48%	0.17%	0.0432%	Air Transport H51	0.698%	0.167%	0.994%	-0.026%
Paper C17	0.905%	0.0666%	1.16%	-0.0246%	Aux. Transportation Services H52	0.949%	0%	0.431%	0%
Recorded Media Reproduction C18	0.0837%	0.0184%	0.149%	0.00248%	Postal and Courier H53	0.0493%	0%	0.325%	0%
Coke, Refined Petroleum C19	2.32%	0.965%	2.65%	0.184%	Accomodation and Food I	0.842%	0%	-0.0309%	0%
Chemicals C20	-1.15%	5.76%	4.43%	2.78%	Publishing J58	0.0384%	0%	1%	0%
Pharmaceuticals C21	1.28%	0.998%	1.44%	1.2%	Media Services J59_J60	0.0509%	1.1%	0.678%	-0.0284%
Rubber & Plastics C22	2.41%	1.8%	1.85%	0.403%	Telecommunications J61	0.196%	0%	0.688%	0%
Other non-Metallic Mineral C23	1.7%	0.811%	0.721%	0.393%	Computer & Information Services J62_J63	0.451%	0%	0.47%	0%
Basic Metals C24	7.59%	4.96%	2.29%	-0.131%	Financial Services K64	0.721%	0%	1.26%	0%
Fabricated Metal C25	5.38%	3.44%	3.85%	17.1%	Insurance K65_K66	0.338%	0%	1.41%	0%
Electronics & Optical Products C26	5.56%	22.7%	4.89%	-9.31%	Real Estate L68	0.0414%	0%	0.06%	0%
Electrical Equipment C27	4.14%	3.24%	3.81%	-5.99%	Legal and Accounting M69_M70	0.0353%	0%	0.719%	0%
Machinery & Equipment C28,C33	8.92%	1.3%	10.6%	-0.873%	Business Services M71,M73-M75	1.87%	0%	1.27%	0%
Motor Vehicles C29	16.9%	5.94%	18.7%	17.9%	Research and Development M72	0.0369%	0%	0.431%	0%
Other Transport Equipment C30	0.711%	0%	9.69%	0%	Admin. & Support Services N	0.58%	0%	1.02%	0%
Furniture & Other Manufacturing C31_C32	1.36%	1.94%	2.09%	5.07%	Public & Social Services O84	0.167%	0%	0.469%	0%
Electricity & Gas D35	0.0428%	0%	0.00%	0%	Education P85	0.0819%	0%	0.0864%	0%
Water Supply E36	0.0467%	0%	-0.00%	0%	Human Health and Social Work Q	0.0147%	0.0169%	0.008%	-0.0161%
Sewerage & Waste E37-E39	0.017%	0%	0.83%	0%	Other Serivces, Households R-U	0.442%	0.545%	0.0775%	-0.0172%

A.7. TPP changes on Exports

Figure A.4.: TPP changes on exports (in million US$)

BASE	AUS	CAN	CHE	JPN	MEX	USA
AUS	$0	$2.703	$3.088	$15.081	$1.655	$27.015
CAN	$1.818	$0	$5.858	$11.700	$19.944	$296.399
CHE	$1.097	$1.253	$0	$2.537	$1.141	$13.598
JPN	$47.690	$14.205	$7.167	$0	$4.500	$63.610
MEX	$483	$8.384	$1.648	$15.420	$0	$182.353
USA	$10.168	$351.981	$33.228	$122.070	$268.283	$0

Simulation	AUS	CAN	CHE	JPN	MEX	USA
AUS	$0	$4.123	$4.735	$21.371	$2.318	$37.788
CAN	$2.941	$0	$8.694	$14.922	$28.750	$413.207
CHE	$1.645	$1.834	$0	$3.582	$1.682	$19.043
JPN	$77.409	$24.133	$11.272	$0	$6.978	$97.192
MEX	$1.223	$15.495	$2.721	$23.228	$0	$275.452
USA	$14.289	$475.640	$48.052	$164.556	$400.463	$0

abs. Change	AUS	CAN	CHE	JPN	MEX	USA
AUS	$0	$1.420	$1.647	$6.290	$663	$10.774
CAN	$1.124	$0	$2.837	$3.222	$8.805	$116.807
CHE	$548	$580	$0	$1.045	$541	$5.445
JPN	$29.719	$9.928	$4.105	$0	$2.478	$33.582
MEX	$740	$7.112	$1.073	$7.807	$0	$93.099
USA	$4.121	$123.658	$14.824	$42.486	$132.180	$0

A.8. Bilateral welfare effects of TPP

Table A.1.: Bilateral welfare effects of TPP

	ToT		VoT	
Country	TPP	ROW	TPP	ROW
Japan	-0.011%	-0.001%	0.063%	-0.008%
USA	-0.029%	-0.009%	0.11%	-0.024%
Australia	0.029%	0.09%	0.020%	-0.018%
Canada	0.071%	0.1%	0.066%	-0.036%
Chile	0.032%	0.307%	0.008%	0.004%
Mexico	0.310%	0.15%	0.053%	0.046%

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