Free Trade Agreements and Import-import Substitution Effect Evidence from a CGE Analysis: The Case of EU-Korea and EU-Japan FTAs

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Taking account of both the impact of different Armington elasticities and different actionability of non-tariff measures (NTMs), I use a computable general equilibrium model to simulate different scenarios for the implementation of the European Union-Korea FTA and European Union-Japan FTA. The results show that Korea's decision to sign an FTA with the EU before Japan could support Korea's exports to the EU in the first scenario (I), where only the EU-Korea FTA is in force, and safeguard its exports from the effects of enforcing the EU-Japan FTA in the second scenario (II).

INTRODUCTION

Since the failure of the Doha Round, we have observed an increase in Free Trade Agreements (FTAs). These FTAs modify the market access conditions not only for the signatory countries' companies, but also indirectly for companies of third parties to the agreement, since their exports become more expensive vis-à-vis their competitors' benefitting from the FTA. This change could be especially heavy for small and medium enterprises (SMEs) that, because of more severe financial and human resource constraints, could hardly change their pattern of production and exporting to offset the preferential access of competitors in the trading partner's market. Therefore, a third-party state could also decide to implement an FTA with the trading partner to obtain the same preferential access for its domestic companies in the trading partner's market.

This paper's main objective is to use a computable general equilibrium (CGE) model to assess the import-import substitution effect of FTAs in a trading partner's market between two competitors due to the entry into force of FTAs. First, I will examine the effect of the entry into force of an FTA on the signatory country's exports and on a third country's export to the common trading partner that is signatory to an FTA. Second, I will investigate whether the trading partner will offset the imports from the signatory to a subsequent FTA, given the preferential access provided to the signatory to an earlier FTA. Then, I will elaborate on a "what if" scenario assessing the import-import substitution effect in the case of a second country signing an FTA with its trading partner earlier than its competitor. I will apply this analysis to the case of the EU-Korea FTA and the EU-Japan FTA. The Republic of Korea (hereinafter Korea) and Japan are competitors in many industries, share similar "gravity factors" vis-à-vis the EU, such as almost the same distance, language barriers, and lack of historical ties, but pursued different trade policy strategies through FTAs. Moreover, both consider the EU an important market. For this reason, concerned about the impact of the EU-Korea FTA on Japanese companies, the Keidanren (the Japan

Business Federation) viewed the EU-Korea FTA as a "big shock", pushing the Japanese government to negotiate its own FTA with the EU.

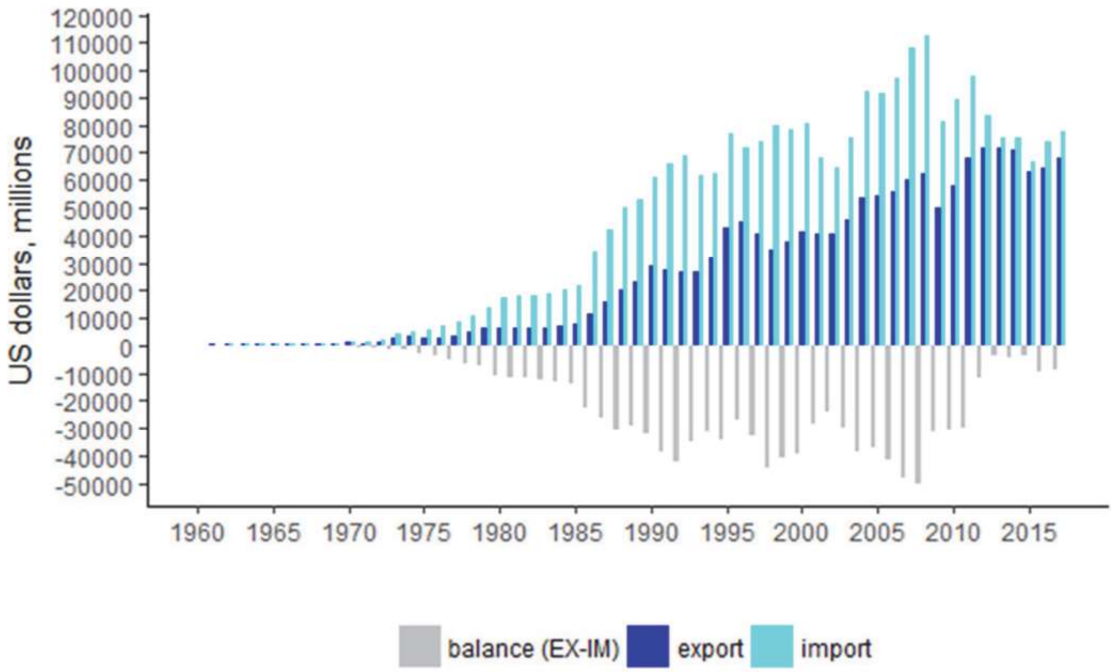
The paper will be organised as follows. First, I will outline the trade relations of Japan and Korea with the EU and compare the trend of their exports to the EU in the period 2004-2017. Second, I will derive a nested three-country two-tier Armington model with uniform and discriminatory tariffs to account for the importance of trade elasticities in trade policy models and the discriminatory role of tariffs on trading partners. This model will represent the underlying theoretical model of the CGE simulation. Finally, I will structure the analysis through the Global Trade Analysis Project (GTAP) model in the following steps. First, I will build an initial equilibrium scenario that will include the *ad valorem equivalent* (AVE) of bilateral non-tariff measures (NTMs) of the EU on Korea, Japan, and Rest of World (ROW) exports. Second, I will remove the EU tariffs and reduce AVEs only on Korean exports to the EU. Third, based on the outcomes of the previous scenario, I will remove the EU tariffs and reduce AVEs on Japanese exports to the EU. Finally, I will build a "what if" scenario assuming that Japan executed an FTA with the EU before Korea. Each scenario will be structured into three experiments, i.e. i) only import tariff removal; ii) only AVEs reduction; and iii) both import tariff and AVEs reduction. I will compare the results of each experiment to assess how EU imports from Korea and Japan are affected by the change in scenarios of FTAs.

JAPAN AND KOREA TRADE RELATIONS WITH THE EU

After World War II Japan was the first Asian country to restore robust economic relations with European countries. The European Community (EC) and Japan entered a phase of tough economic confrontation due to Japan's growing trade surpluses since the 1970s and European complaints about difficulty accessing the Japanese market. The difficulties in signing a trade agreement with Japan urged European countries to adopt some protectionist measures, such as antidumping, quotas, and demanding voluntary export restraint (VER) on Japan, with the goal of curbing Japanese exports. These measures had a side effect, i.e., an increase in Japanese foreign direct investment (FDI) in Europe. In fact, Japanese firms set up assembling plants in Europe to circumvent European restrictions. To this end, in 1987, Willy de Clercq, Vice-President of the European Commission, observed that "whenever the Community opens an anti-dumping inquiry or imposes antidumping duties on a product, plants for assembling the product which is subject of the inquiry or anti-dumping duty miraculously spring up in abundance in the Community" (Ishikawa, 1992, p. 84). On the other hand, the EC continued to demand the liberalisation of the Japanese market through the elimination of non-tariff barriers, considered by the European Community to be the main hurdle against European penetration into Japan. The EU-Japan relations entered a phase of normalisation in the 1990s. The effects of the Soviet Union's collapse, the transformation of the EC into the European Union (EU), the difficulties of the Japanese economy due to its financial bubble collapse, and the emergence of new players on the international stage, such as China and India, all contributed to modifying global political and economic frameworks. The willingness of the EU and Japan to strengthen their political and economic relations was embodied in The Hague Declaration in 1991, which established a framework of regular, high-level summits not only in the economic and political spheres, but also in new subjects, such as industrial cooperation, competition policy, security, international aid, and so on. Improvement in relations overall did not lead to a reduction of trade imbalances characterised by a large Japanese surplus until 2008. Since 2009, we have observed a decreasing Japanese surplus, mainly due to lower Japanese exports to the EU, rather than a strong increase in EU exports to Japan (figure 1).

By 1963, although Korea had established diplomatic relations with both individual European countries and with the EC, the wide economic gap between the two sides (as Korea was then a poor country), prevented any significant relationship with Europe in the 1960s. As the Korean economy rapidly grew, however, and came to be named as one of the "Four Asian Tigers", trade between the EC and Korea began growing exponentially. The EC encountered similar difficulties with Korea as it had found with Japan, including discrimination against European exporters in the Korean market and increasing trade deficits. In this regard, Willy de Clercq declared that “Korea should not give in the temptation to become a second Japan” (European Commission, 1986). Korea, mostly in the electronics industry, was also targeted by EC antidumping measures. Interestingly, Doo Jin Kim (2003) showed the strong connection between the EC/EU antidumping measures and Korean FDI in Europe.

FIGURE 1
EU TRADE WITH JAPAN, 1960 – 2017



Note: own calculation
Source: Direction of Trade Statistics, IMF

In the 1990s relations moved to a higher level, marked by the conclusion of the Framework Agreement on Trade and Cooperation in 1996. In the years following that agreement, the EU and Korea strengthened their cooperation in several areas other than trade, paving the way for negotiations of the free trade agreement. In September 2003, the Korean government drew an FTA Road Map, in which it announced its interest in negotiating an FTA with the EU. Korea considered FTAs a tool for opening up foreign markets, reducing export costs for Korean companies, attracting investments in Korea, and revitalizing the domestic market and competitiveness through new regulatory reforms. The EU’s initial cold response to an FTA with Korea turned into a proactive initiative in 2006 with the EU’s new trade policy, *Global Europe: Competing in the World*. With this new trade policy strategy, the EU acknowledged that comprehensive FTAs can promote openness and integration. Korea was identified as a priority partner because of its market potential and high levels of protection against EU exports. Furthermore, the EU accounted for Korea’s negotiations with the US and concluded that a US-Korea FTA could endanger European interests in the Korean market.

After eight rounds of negotiations starting in 2007, the European Union and Korea signed their FTA in October 2010. Upon the consent of the European Parliament and the ratification bill of the Korean Parliament, respectively in February and May 2011, the FTA was provisionally applied in July 2011. It was formally adopted and enforced in December 2015, after ratification by EU member states. The EU-Korea FTA has been considered the most ambitious FTA ever negotiated by the EU, both for its scope and for the speed at which trade barriers were removed. Most of import duties on industrial goods were removed when the FTA was provisionally applied in 2011, while the remaining duties were removed by the end of the transitional period in July 2016. For some sensitive products in the agriculture and fishery industries, the FTA scheduled a longer transitional period. With respect to other FTAs, the EU-Korea FTA significantly tackles non-tariff barriers, in particular in the automotive, pharmaceuticals, medical devices, and electronics sectors. The significant tackling of trade-related issues other than import duties – such as trade in services, establishment, and electronic commerce; payments and capital movements; government procurement; intellectual property; geographical indications; competition; and transparency – distinguishes this agreement from other previous FTAs, making it a benchmark for future FTAs.

In some ways, the EU-Korea FTA exceeds the obligations of the WTO. This occurs, for example, in Technical barriers to Trade (TBT), Sanitary and Phytosanitary Measures (SPS), and customs trade facilitation. Chapter 13 of the agreement, Trade and Sustainable Development, is considered one of the most innovative aspects of this trade deal. The EU-Korea FTA has also been considered a success for the Korean government that made Korea the first Asian country to sign a free trade agreement with the European Union.

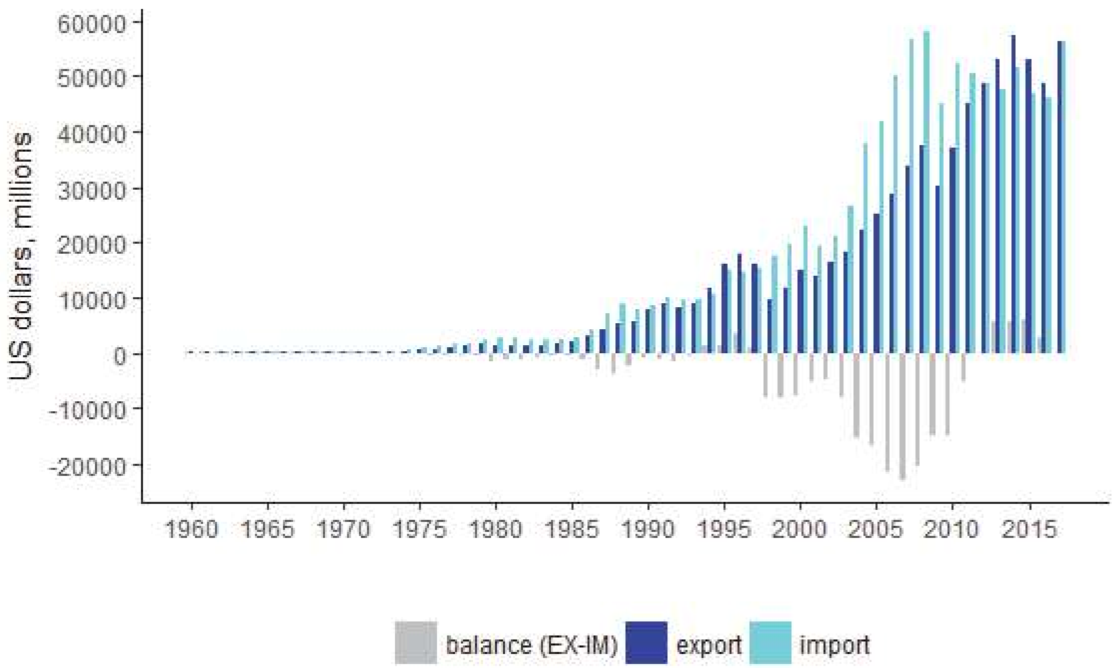
One of the first reactions to the EU–Korea FTA came from the Japanese Business Federation (Nippon Keidanren). During the negotiations, it had already raised its concerns about the effects of this deal on Japanese business. The Keidanren urged the Japanese Government to reach a similar pact with the EU (The Japan Times, 2009). In 2012, the chairman of Keidanren, Hiromasa Yonekura, wrote to European political and business leaders, calling for negotiations on an EU–Japan FTA/EPA to start as soon as possible (Keidanren, 2012). After the EU–Korea FTA was applied, Japanese automakers complained of being disadvantaged by the EU's FTA with Korea, because Korean competitors like Hyundai benefited from the removal of barriers (The Diplomat, 2013). The EU reported that, during the first year of the FTA, the EU imports of Korean cars increased by 20% (663 million) in value and 12% (+45,000 vehicles) in volume, partly at the expense of imports from other partners (European Commission, 2013, p. 3). A similar position was taken by the Japanese electronics industry. For example, Arnaud Brunet, Sony's director of European external relations, stated that most competition within Europe was coming from Korea, making the Korean deal a kind of "electro-shock" for Japanese companies (Euractiv, 2011).

Despite pressure from Japanese businesses, the Japanese Government seemed to postpone a hard commitment to negotiations with the EU because of contemporaneous negotiations on the Trans-Pacific Partnership (TPP). Hence, the negotiations with the EU were officially launched only in March 2013. After 18 rounds, the negotiations for the FTA were finalized on 8 December 2017. On 17 July 2018, the EU and Japan signed the agreement in Tokyo. The FTA, renamed the Economic Partnership Agreement (EPA), creating the world's largest open economic area covering 600 million people and approximately 30% of the world GDP, embodied the willingness of the European Union and Japan to reject any protectionist drift in world trade. On entry into force, Japan will liberalize 91% of its imports from the EU, and, at the end of the staging period, it will liberalize 99% of its imports from the EU while the remaining 1% will partly be liberalized through quotas and tariff reductions (in agriculture). On the other hand, the EU will liberalize 75% of its imports from Japan on entry into force while the remainder will be liberalized over a period of 15 years up to nearly 100%. The EPA significantly tackles non-tariff barriers and covers key issues such as government procurement, intellectual property, geographical indications, competition, subsidies, and state-owned enterprises (SOEs). The EPA is expected to take effect in late 2019.

The EU-Japan FTA should rebalance the advantages of the EU-Korea FTA for Korean companies in the EU market. In the first six years of the agreement, the EU-Korea FTA had a clear positive effect on European companies exporting to Korea. In fact, the EU turned a substantial and constant trade deficit with Korea into a surplus from 2013 to 2016 (figure 2).

On the other hand, the results did not meet Korean expectations in the first years of the FTA's application. In 2011, EU imports from Korea decreased by 8.2% compared with the previous year. However, it should be noted that the global financial crisis and the sovereign debt crisis felt by some members of the Eurozone hit the economies of the EU members in those years, causing a weak European demand. It should be further noted that legal enforcement of the FTA does not imply that all Korean goods (or European goods to Korea) automatically benefit from the FTA. Some conditions need to be met to benefit from preferential treatment. In this regard, the provisions included in the Protocol on Rules of Origin are relevant.[1] Thus, companies could not have adequately prepared for its provisions, since its enforcement was more rapid than expected, especially compared with the implementation time required by the US-Korea FTA.

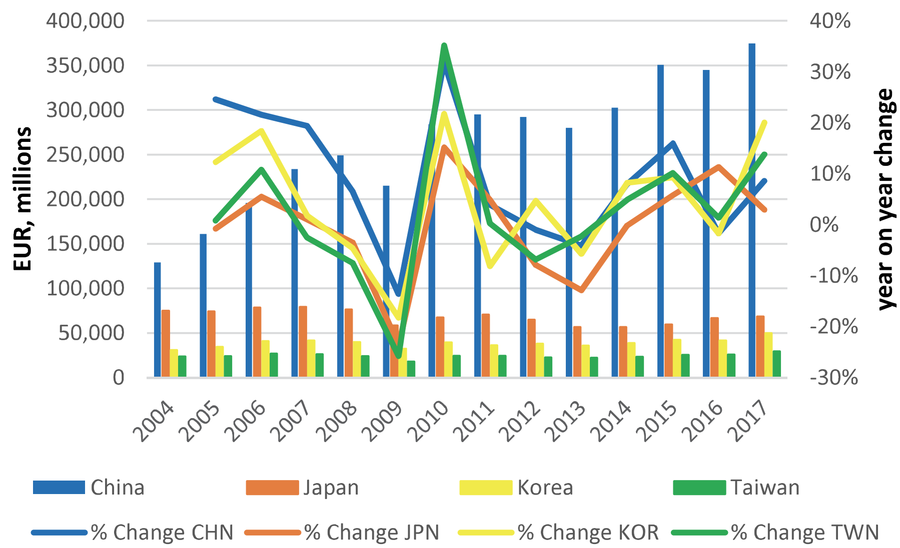
FIGURE 2
EU TRADE WITH KOREA, 1960 – 2017



Note: own calculation
Source: Direction of Trade Statistics, IMF

To evaluate the effects of the FTA on Korean exports in the EU, we compared the trend of EU imports from China, Japan, Korea, and Taiwan. In this regard, figure 3 shows the European total imports from China, Japan, Korea, and Taiwan from 2004 to 2017. The general trend was similar with the exception seen in 2012 when the EU imports only increased from Korea, while imports from the other partners decreased. Compared with only Japan, we observed that since the FTA's application, the performance gap on EU markets has grown in favour of Korea, with the exception of 2016. In 2017, imports from Korea reached €50 billion while they totalled €68.5 billion from Japan. Compared with 2011, this resulted in +38% of imports from Korea and -3% of imports from Japan. Overall, the compound annual growth rate (CAGR) for the EU imports from these partners was -0.7% from Japan, 3.8% from Korea, 8.5% from China, and 1.6% from Taiwan for the years 2004-2017.[2] If we divide the total period into two parts to account for the application of the EU-Korea FTA, we observe that the EU imports changed by -1.8% CAGR from Japan, 4.2% CAGR from Korea, 14% CAGR from China, and 0.2% CAGR from Taiwan between 2004-2010, while by -0.5% CAGR from Japan, 5.5% CAGR from Korea, 4.1% CAGR from China, and 3.3% CAGR from Taiwan between 2011-2017.

FIGURE 3
EU TOTAL IMPORTS (SITC06) FROM CHINA, JAPAN, KOREA, TAIWAN 2004 – 2017



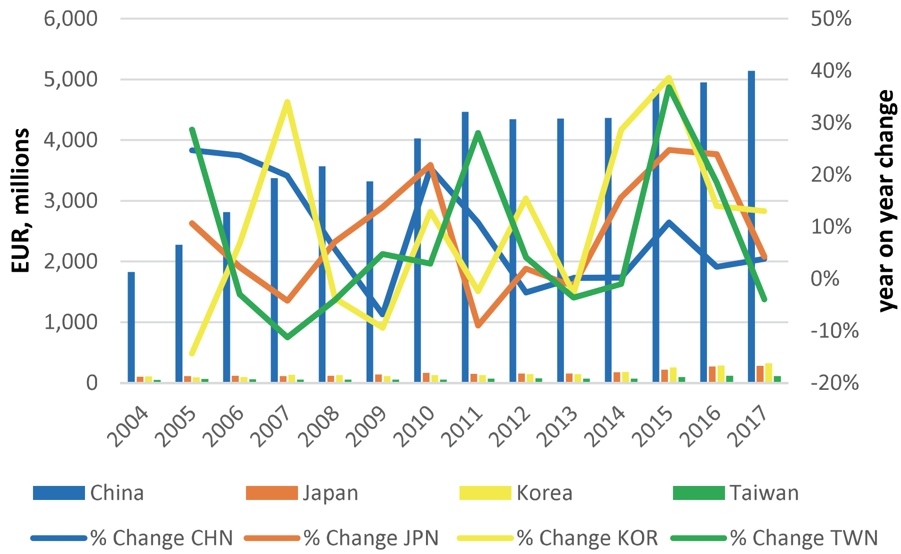
Note: own calculation
Source: Eurostat

Figures 4, 5, and 6 show the EU imports from these partners respectively in Food, Drinks and Tobacco, Machinery and Transport Equipment, and Chemicals. In Food, Drinks, and Tobacco, Korea, Japan, and Taiwan export very low quantities to the EU. Notwithstanding, the EU has increased its imports from these partners since 2014. Compared with 2011, the EU imports increased in 2017 by 158% from Korea and by 88% from Japan. If we considered CAGR we observed that for the overall period 2004-2017 the EU imports increased by 8% CAGR from Japan and China, 9% CAGR from Korea, and 7% CAGR from Taiwan. In 2004-2010, the increase was 8% CAGR for Japan, 3% CAGR for Korea, 14% CAGR for China, and 2% CAGR for Taiwan. If we considered 2011-2017, Korea recorded the largest increase, 17% CAGR, while China, Japan, and Taiwan saw 2% CAGR, 11% CAGR, and 8% CAGR, respectively.

All these countries export the bulk of their goods to the EU in the Machinery and Transport Equipment sectors. Since 2012, Korean exports have performed better than Japanese exports in the EU market, apart from 2016. In 2017, EU imports from Korea recorded a larger increase (+24.7%) for a value of €31 billion (+€8 billion compared with 2011). After the decreases in 2012 and 2013, EU imports from Japan increased yearly, but insufficiently to reach in 2017 the value of 2011, (€45.7 billion in 2017, -€400 million compared with 2011). This resulted in +34% increase of imports from Korea and -1% decrease from Japan in 2017, compared with 2011. Imports grew by 1.7% CAGR from Korea, 9% CAGR from China, 0.6% CAGR from Taiwan, and decreased by -1.6% CAGR from Japan in 2004- 2017. Before the application of the EU-Korea FTA, EU imports grew by 15% CAGR from China and by 2.5% CAGR from Korea, while they decreased by -3.9% CAGR from Japan and -1.2% CAGR from Taiwan. After FTA application, they grew by 5.1% CAGR from Korea, 5% CAGR from China, and 3.3% CAGR from Taiwan, while still decreasing from Japan (-0.1% CAGR).

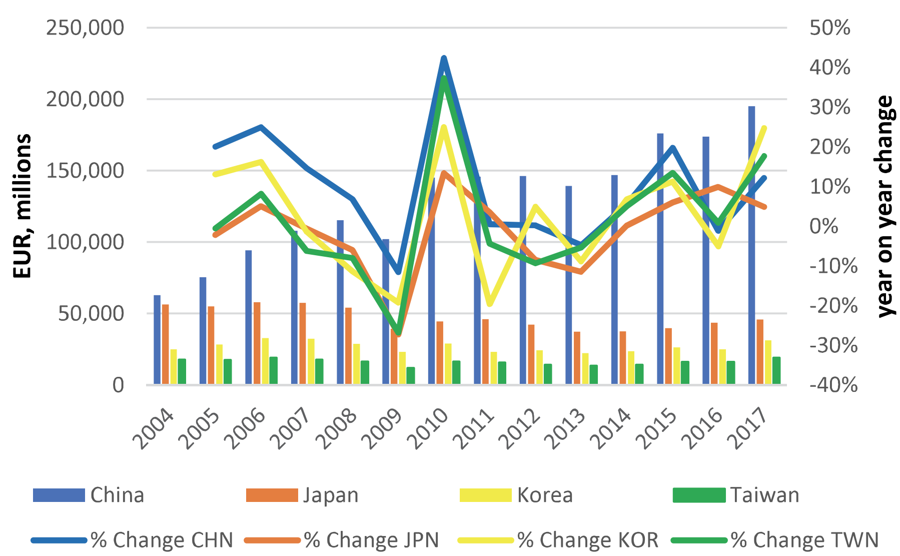
The Chemicals sector is another important export sector for Korea, Japan, and China. Figure 6 shows the impressive growth of Korean chemical products on the EU market since 2004. We can observe that this growth started with the implementation of the FTA. In fact, in 2010 the imports from Korea grew by "only" 73% compared with €1 billion in 2004. Instead, in 2017 they grew by 207% compared with 2011, reaching €6.9 billion and exceeding imports from Japan that stalled at €6.8 billion. The CAGR for 2004-2017 was 16% for Korea, 12% for China, 9% for Taiwan, and only 1% for Japan. In 2004-2010, imports from China marked the largest CAGR (18%), followed by Taiwan (11%) and Korea (10%). Imports from Japan grew by only 2% CAGR. After the implementation of the EU-Korea FTA, we observed that the CAGR for Korea was 21%, much larger than China (6%) and Taiwan (5%). In 2011-2017 Japan recorded a -0.1% CAGR.

FIGURE 4
EU IMPORTS IN FOOD, DRINKS AND TOBACCO (SITC06) FROM CHINA, JAPAN, KOREA, TAIWAN 2004 – 2017



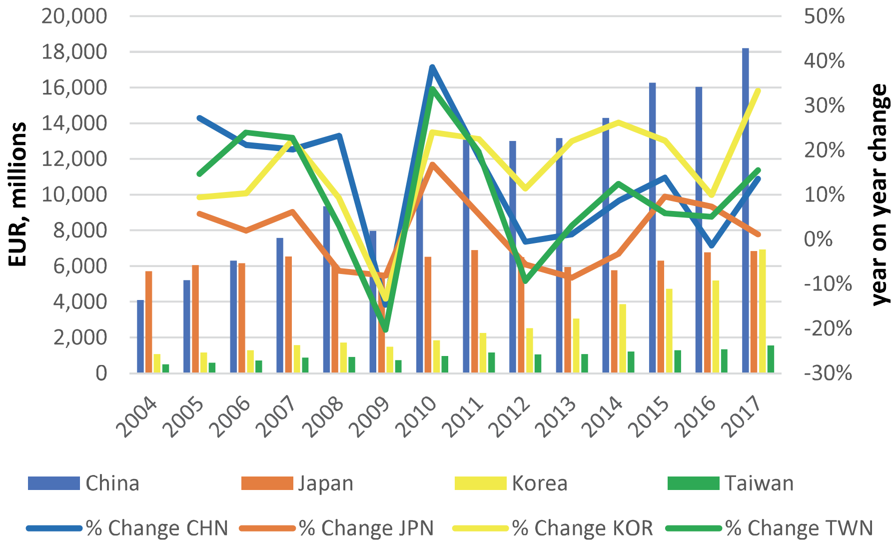
Note: own calculation
Source: Eurostat

FIGURE 5
EU IMPORTS IN MACHINERY AND TRANSPORT EQUIPMENT (SITC06) FROM CHINA, JAPAN, KOREA, TAIWAN 2004 – 2017



Note: own calculation
Source: Eurostat

FIGURE 6
EU IMPORTS IN CHEMICALS (SITC06) FROM CHINA, JAPAN, KOREA, TAIWAN 2004 – 2017



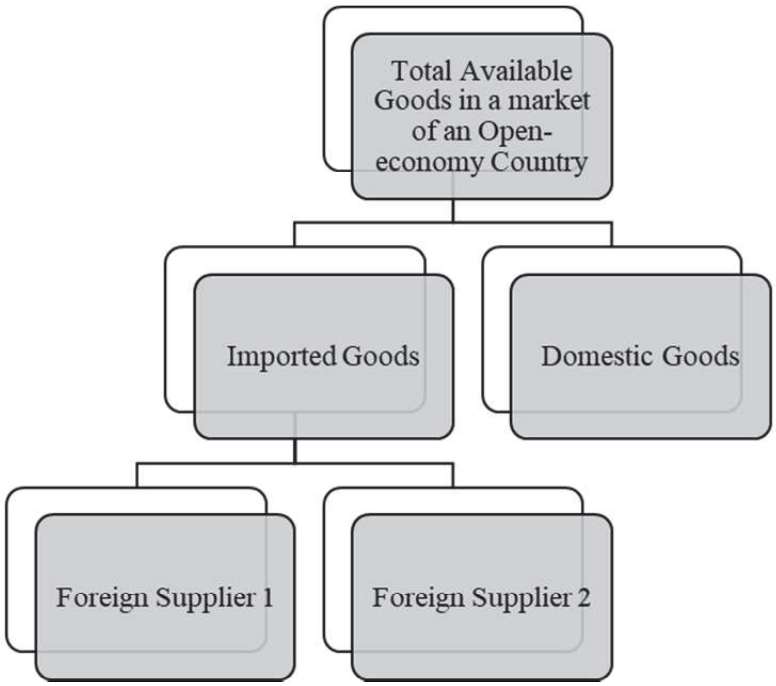
Note: own calculation
Source: Eurostat

After the initial disappointing years of the EU-Korea FTA for Korea, the agreement seemed to produce positive effects on Korean exports to the EU, marked also by the balance in trade reached in 2017 after four years of trade deficits with the EU. The improvements of the last years could be due to progressively ending the transitional period for tariff elimination, which concluded in 2016, improved knowledge of the FTA's provisions by businesses, and a possible reorganisation of Korean production and export patterns, taking into account the requirement of the rule of origin, and, of course, the recovery of the EU economies. Since the EU-Japan FTA will require still some time to enforce, Korean exports on the EU market could continue to maintain a certain margin of advantage provided by the EU-Korea FTA.

NESTED THREE-COUNTRY TWO-TIER ARMINGTON MODEL WITH UNIFORM AND DISCRIMINATORY TARIFFS

Before detailing the model setup and results, it should be noted that the quantitative results of a computable general equilibrium (CGE) model – and, consequently, the policy orientation that policymakers could adopt based upon it – depend heavily on the choice of the magnitude of the model's behavioral parameters. Models aiming at assessing trade policy, such as the impact of preferential trade agreements, are very sensitive to the so-called Armington elasticity. In his seminal paper "A Theory of Demand for Products Distinguished by Place of Production" (1969), Armington departs from the classical assumption of perfect-substitutability between domestic and imported goods of the same kind, assuming that goods are imperfect substitutes in demand because they are distinguished by their kind and by their place of production. Thus, the Armington trade elasticity parameter determines the degree of substitutability between domestic and imported goods (in the first tier) and among imported goods from different countries of origin (in the second tier), due to changes in the relative price of those pairs of goods in the same market (figure 7).

FIGURE 7
TWO-TIER ARMINGTON MODEL



Empirically, the Armington elasticity parameter is mainly estimated through time series, cross-sectional analysis, and gravity-type models. The literature provide no unquestionable magnitudes from estimation, but sets forth the following generally accepted findings as summarised by McDaniel & Balistreri (2002): (1) more disaggregate analyses find higher elasticities (see also Gallaway, McDaniel, & Rivera, 2003); (2) the estimated long-run elasticities are higher than the estimated short-run elasticities (see also Gallaway, McDaniel, & Rivera, 2003; Németh, Szabó, & Ciscar, 2011); and (3) time series analyses generally find lower elasticities relative to cross-sectional studies. Furthermore, it can be added that (4) the elasticity between home and import goods is smaller than the elasticity between foreign sources of imports (see Németh, Szabó, & Ciscar, 2011; Feenstra, Obstfeld, Luck, & Russ, 2014). A study related to the former literature is that of Blonigen & Wilson (1999) who showed how some determinants, that they regrouped into product, industry, political, and "home bias", contributed to explaining variation in substitution elasticities across sectors. They found that for the US industrial sectors, the Armington trade elasticities between domestic and imported goods were strongly affected by the presence of foreign-owned affiliates in the domestic country that increased the elasticity of substitution while, to a lesser extent, unions and entry barriers in the domestic country lowered the elasticity of substitution.

Furthermore, the tariff applied by the importing country contributes to increasing prices of those imported goods, affecting the substitution elasticity. This should lead to lower Armington elasticities when in presence of trade barriers and higher Armington elasticities when trade barriers are removed. Welsch (2006, p. 557) stated that "estimated Armington elasticities reflect not only incomplete substitutability due to differences in (perceived) product characteristics, but also *de facto* incomplete substitutability due to trade barriers".

On the other hand, the sensitivity of the results of a CGE model to the trade elasticities has been shown, for example, in Khan (1994) and more recently in McDaniel and Balistreri (2002). Khan (1994), applying a computable general equilibrium model to Bangladesh, showed that the trade gains from import liberalisation were lowest if the price elasticities of imports and exports were small and the greatest if they were large. McDaniel and Balistreri (2002) showed that the effects of unilateral trade liberalisation for Colombia in a three goods (aggregated agricultural products, aggregated manufactured products, and aggregated services) and four regions (Colombia, NAFTA members, other Latin American countries, and the rest of the world) CGE model would be harmful if Colombia had low trade elasticity (between 1 and 3) and beneficial if it had higher trade elasticity (5).

Given the recent proliferation of FTAs, it is possible to discern two main cases in the trade relations between importing country and exporting countries. The first case represents a situation where an importing country does not have any FTA in force so that the exports of its foreign suppliers are subject to a uniform tariff. We could think about this case as the application of Most Favoured Nation (MFN) regime to all its foreign suppliers. The second case represents a situation where at least one foreign supplier benefits from a better tariff condition – reduction or elimination of tariffs that could be the result of an FTA – while the other foreign suppliers are subject to a higher tariff. These situations can be represented in a nested three-country two-tier Armington model.

When we consider competing exporting countries in the Armington model, we are in the case of a two-tier Armington model where the budget is allocated in three stages: first among all goods without regards to their origin; second between national and imported goods; and third among competing imported goods. The second and third stages are affected by the magnitude of the parameter of the elasticity of substitution between domestic goods and imported goods, and among imported goods, respectively. These steps result in an optimisation problem.[3]

Following Zhang (2006), I first present the case where the domestic country, *D*, applies a uniform tariff, τ, on the imported goods from its suppliers, *J* and *K*. Secondly, I present the case where *D* applies a discriminatory tariff, τ_j, only on the imported goods from *J*. Equations (1) and (2) present the consumer's optimisation problem in country *D* in the first tier in the case of applying a uniform tariff to both foreign suppliers. Equation (3) is the first order condition of this problem.

$$\max Z = \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

$$\text{where } M = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta) J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}$$

$$subject\ to\ P_z Z = P_d D + (1+\tau_m) P_m M \tag{2}$$

$$\frac{M}{D} = \left(\frac{1-\alpha}{\alpha}\right)^{\sigma} \left(\frac{P_d}{(1+\tau_m)P_m}\right)^{\sigma} \tag{3}$$

In the second tier, the maximisation problem is given by equations (4) and (5). Equation (6) is the first order condition.

$$\max M = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta) J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \tag{4}$$

$$subject\ to\ (1+\tau_m) P_m M = (1+\tau_k) P_k K + (1+\tau_j) P_j J \tag{5}$$

$$\frac{J}{K} = \left(\frac{1-\beta}{\beta}\right)^{\theta} \left(\frac{(1+\tau_k)P_k}{(1+\tau_j)P_j}\right)^{\theta} \tag{6}$$

where:

- Z is a composite good made of domestic goods (D) and imported goods (M);
- M is a composite good made of imported goods from J and K;
- τ_i, with $i = \{m, k, j\}$ is the import tariff rate;
- P_i, with $i = \{z, d, m, k, j\}$ is the price of the respective composite good;
- α is a share parameter;
- β is a share parameter;
- σ is the Armington substitution elasticity between domestic goods and imported goods; and
- θ is the Armington substitution elasticity between J supplier's goods and K supplier's goods.

In the case of a discriminatory tariff, we will solve an optimisation problem in the first tier as given by equations (7) and (8). Equation (9) is the first order condition.

$$\max Z = \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{7}$$

$$subject\ to\ P_z Z = P_d D + (1+\tau_j) P_m M \tag{8}$$

where $(1+\tau_j)P_m M = P_k K + (1+\tau_j)P_j J$

$$\frac{M}{D} = \left(\frac{1-\alpha}{\alpha}\right)^{\sigma} \left(\frac{P_d}{(1+\tau_j)P_m}\right)^{\sigma} \tag{9}$$

The optimization problem for the second tier, as given by equations (10) and (11), will give the first order condition as in equation (12).

$$\max M = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta) J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \tag{10}$$

$$subject\ to\ (1+\tau_j)P_m M = P_k K + (1+\tau_j)P_j J \tag{11}$$

$$\frac{J}{K} = \left(\frac{1-\beta}{\beta}\right)^{\theta} \left(\frac{P_k}{(1+\tau_j)P_j}\right)^{\theta} \tag{11}$$

If country *D* maintains a uniform tariff on goods from both country *J* and country *K*, the consumers' demand in *D* will not discriminate between goods from *J* and *K* because of the tariff. However, if country *D*, because of an FTA, eliminates tariffs on imported goods from country *K*, while keeping tariffs on imported goods from country *J*, consumers in *D* will shift their foreign goods demand from *J* to *K* because the imported goods from the latter are now less expensive. The greater the substitutability between goods *K* and *J*, the larger the impact that the tariff elimination will have on goods *K*. This implies that trade between *D* and *K* will increase to the detriment of trade between *D* and *J*.[4] Thus, in this case country *K* will benefit from the FTA with country *D*, gaining an advantage over *J* in *D* market. These two Armington models form the basis of the following CGE model, where *D* represents the EU, *J* represents Japan and *K* represents Korea.

SIMULATION OF THE IMPACT OF EU-KOREA AND EU-JAPAN FTA ON EU IMPORTS

I will use a computable general equilibrium model, implemented through GTAP, version 8.1 base year 2007, to simulate the effects of the EU-Korea FTA and the EU-Japan FTA on European imports from Korea and Japan. The year 2007 is chosen to bring back the world economic structure to a time not affected by the effects of the EU-Korea FTA. The model is made up of 4 regions – including an aggregated EU 25, Japan, Korea, and the remaining countries aggregated as Rest of World (ROW) – and 10 sectors – Agriculture, Automotive/Motor Vehicles, Chemicals, Electronics, Machinery, Mining & Extraction, Processed Food (PcF), Labour-intensive Manufactures (LMnf), Capital-intensive Manufactures (CMnf), and Services. This analysis focuses on the Automotive/Motor Vehicles, Chemicals, and Electronics sectors, where most of Japanese and Korean exports to the EU are concentrated. The initial equilibrium (IE), which corresponds to the case of uniform tariffs presented in equations (1)-(6), is redefined to add the AVE of European NTMs to the base tariff rates on imports from Korea, Japan, and ROW in the Automotive/Motor Vehicles, Chemicals, and Electronics sectors. The base tariff rates are reported in table 1. Table 2 reports the AVE of EU NTMs in Automotive/Motor Vehicles, Chemicals, and Electronics sectors estimated in CEPII/ATLASS (2007) and Copenhagen Economics (2009) for, respectively, Korea and Japan and in ECORYS (2009) for the United States that have been used as an approximation for ROW.[5]

TABLE 1
BASE TARIFF RATES ON EU IMPORTS FROM JAPAN, SOUTH KOREA AND REST OF THE WORLD

	Japan	Korea	ROW
Agriculture	3,71	7,69	3,05
Services	0	0	0
Motor Vehicles	7,73	5,96	2,24
Electronics	1,94	1,86	1,27
Machinery	1,81	1,96	1,04
Chemicals	2,79	3,76	1,36
Mining & Extraction	1,56	0,49	0,03
Processed Food	8,81	10,03	11,57
Labour-intensive Manufactures	3,67	5,15	4,11
Capital-intensive Manufactures	1,75	0,92	0,54
Total	33,77	37,82	25,21

Source: GTAP, version 8.1 base year 2007

TABLE 2
AVE OF EU NTMS ON IMPORTS FROM JAPAN, SOUTH KOREA AND REST OF THE WORLD IN CHEMICALS, MOTOR VEHICLES AND ELECTRONICS SECTORS

	Japan*	Korea⊗	ROW⊕
Chemicals	32	43	24
Motor Vehicles	16	7	25
Electronics	16	26	7

* Copenhagen Economics (2009), p. 65.
⊗ CEPII/ATLASS (2007), p. 46.
⊕ The estimates are for the United States. ECORYS (2009), p. 24.

I will examine three scenarios. The first scenario (I) takes into consideration the enforcement of the EU-Korea FTA. In this scenario the enforcement of the FTA modifies the tariff *status quo* as in IE scenario among competitors for the EU market access, resulting in a situation shown in equations (7)-(12), where the countries excluded by the FTA would face restricted access to the partner market compared with the competitor because of the existing tariffs. Scenario I becomes the new baseline scenario where I implement the second scenario (II), i.e. the effects of enforcing the EU-Japan FTA. In this scenario, Korean exports face zero tariffs and continue to benefit from improvement in trade efficiency. Hence, the EU-Japan FTA brings back Japan and Korea to tariff *uniformity* with respect to the EU market, as in equations (1)-(6). Finally, I work out a "what if" scenario (IF), where I consider the case where the EU-Japan FTA entered into force before the EU-Korea FTA. Each scenario is made of three experiments. In the first experiment (i) I eliminate only the EU import tariffs. In the second experiment (ii) I reduce only the NTMs in Automotive/Motor Vehicles, Chemicals, and Electronics sectors. In the last experiment (iii) I eliminate the EU import tariffs and reduce the NTMs in Automotive/Motor Vehicles, Chemicals, and Electronics sectors. The opportunity to initially distinguish between the effects of tariffs and NTMs it is useful to evaluate how each of them impact on trade.

When the analysis includes the effects of NTMs, a key decision concerns how much an AVE of NTMs should be reduced. In fact, it is not realistic to assume a full elimination of AVE of NTMs because not all the NTMs in force are adopted for protectionist purposes or to create unnecessary trade costs. In fact, NTMs can be adopted to pursue public policy objectives, such as the health and safety of consumers, which can indirectly affect trade (World Trade Organization, 2012). Therefore, we should consider the concept of "actionability" of NTMs, defined as the degree to which an NTM or regulatory divergence can potentially be reduced (ECORYS, 2009, p. 15). In this analysis I consider two different actionability scenarios: 25% as analysed in the ambitious scenario in Francois et al. (2013) and a higher actionability (67% for automobile, 63% for chemicals, and 64% for electronics), as reported in Copenhagen Economics (2009, p. 121). Another issue related to the reduction of NTMs is considering how to allocate its effects. In fact, the effects of NTMs can mainly result in increased costs of doing business (for example, firms need obtain a conformity certificate from the authority of the importing country) or in a restriction in market access, as in the case of import quotas. Hence, ECORYS (2009, p. XVIII) made a distinction between "cost", which can be raised by NTMs, and "rent", which can be generated as a consequence of market concentration and economic power of companies due to a restricted market access. ECORYS found that the price impact of NTMs for the EU was due to the increase in costs for 60% and to economic rent for 40%. I modelled these findings as an increase in 60% in trade efficiency (*ams*), 30% in importer rent (modelled as import tariff surcharges), and the remaining 10% in exporter rent (modelled as export tax surcharges) due to FTA enforcement.

Table 3 shows the results from scenario (I) with 25% actionability. As expected, the EU increased imports from Korea while reducing imports from Japan and ROW in all three experiments in Automotive/Motor Vehicles, Chemicals, and Electronics sectors. The largest increase was recorded in the Chemicals sector (+115%), mainly due to the reduction of the NTMs. Comparing experiments (i) and (ii) shows that Korean exports to the EU benefit more from reducing NTMs in the Chemicals and Electronics sectors than from removing tariffs.

In the second scenario (II), the Japanese exports to the EU benefitted from the EU-Japan FTA, re-balancing the advantage that Korean exports had from the EU-Korea FTA. In this scenario we observe that in experiment (i), where I considered only the elimination of EU tariffs on Japanese imports in a scenario built on zero tariffs and reduced NTMs on Korean imports, the EU increased imports from Japan and Korea. However, the Automotive/Motor Vehicles sector recorded the largest increase for Japan (+47%) and the smallest for Korea (+0.2%). Instead, in the Electronics and Chemicals sectors, EU imports from Korea (respectively +26% and +37%) increased more than from Japan (+8% and +13%). In experiment (ii), the EU imports from Japan increased more than in experiment (i) in the Chemicals (+52%) and Electronics (+28%) sectors, while they reduced in Automotive/Motor Vehicles; but they were still positive (+20%). This last result was due to the largest base tariff imposed by the EU on Japanese exports in Automotive/Motor Vehicles. The change in EU imports from Korea is positive and similar in magnitude to that in experiment (i) but with the largest increase in the Automotive/Motor Vehicles sector (+1.6%). The overall experiment (iii) shows the greatest increase in EU imports from Japan, +75% in Automotive/Motor Vehicles, +42% in Electronics, and +73% in Chemicals. In this experiment, the EU imports from Korea diminished sluggishly in Chemicals and Electronics compared with prior experiments. In Automotive/Motor Vehicles, instead, the EU recorded a reduction of its imports from Korea (-1.5%) (table 4).

However, in comparing the percentage change in EU imports from Japan and Korea, we should take into account that scenario (II) was built on scenario (I), where we recorded larger EU imports from Korea because of the EU-Korea FTA. As consequence of the EU-Korea FTA, EU imports from Korea increased consistently while EU imports from Japan decreased. These imports values were the baseline for scenario (II) implying that, even if the percentage change of EU imports from Japan was larger than those from Korea, the baseline value for imports was lower for Japan and much higher for Korea.

In the "what if" scenario (IF), where I hypothesised that the EU-Japan FTA had been enforced before the EU-Korea FTA, the EU imports grew only from Japan, while they decreased from Korea and ROW. Imports changes from Korea were negative in all three experiments, with the largest decrease in the Automotive/Motor Vehicles sector in experiment (iii) (-5%) (table 5). This implies that Korea's decision to sign an FTA with the EU before Japan could support its export to the EU in scenario (I) and safeguard its exports from the effects of the EU-Japan FTA in scenario (II).

TABLE 3
SCENARIO I: EFFECTS OF EU-KOREA FTA ON EU IMPORTS IN AUTOMOTIVE, ELECTRONIC AND CHEMICAL SECTOR (25% ACTIONABILITY) (% CHANGE)

	ROW			Japan			Korea		
Sectors	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction
Automotive	-1,17	-0,29	-1,53	-1,21	-0,37	-1,67	36,64	6,88	45,56
Electonics	-0,73	-3,19	-4,2	-0,74	-3,28	-4,32	11,8	57,47	75,18
Chemicals	-0,24	-0,51	-0,84	-0,3	-0,61	-1,02	20,61	78,96	115,05

Source: own calculation based on GTAP.

TABLE 4
SCENARIO II: EFFECTS OF THE EU-JAPAN FTA ON EU IMPORTS IN AUTOMOTIVE, ELECTRONIC AND CHEMICAL SECTOR BASED ON SCENARIO I (25% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction
Automotive	-2,92	-1,56	-4,69	46,85	19,59	75,22	0,24	1,65	-1,47
Electonics	-3,62	-4,48	-5,34	8,42	27,61	41,61	26,5	25,47	24,14
Chemicals	-1,04	-1,65	-2,3	13,33	52,15	73,01	37,48	36,7	35,72

Source: own calculation based on GTAP.

TABLE 5
SCENARIO IF: EFFECTS OF THE EU-JAPAN FTA ON EU IMPORTS IN AUTOMOTIVE, ELECTRONIC AND CHEMICAL BASED ON SCENARIO IE (25% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction
Automotive	-2,77	-1,37	-4,57	47,1	19,81	75,32	-2,77	-1,37	-4,58
Electonics	-0,81	-1,76	-2,72	11,58	31,23	45,38	-1,07	-1,95	-3,19
Chemicals	-0,52	-1,14	-1,81	13,96	52,97	73,79	-0,66	-1,24	-2,07

Source: own calculation based on GTAP.

Tables 6, 7 and 8 reproduce the same scenarios with a higher actionability for NTMs, with 67% for Automotive/Motor Vehicles, 63% for Chemicals, and 64% for Electronics, respectively. Overall, we observed similar results but with a larger magnitude of change because we accounted for a higher reduction of NTMs. Interestingly, if we compare the Electronics sector in both scenario (II) experiment (i), we observe that the tariff barrier removal in EU-Japan FTA could not lead to an increase in EU imports from Japan because of the advantage that Korean exports had benefitted from through a larger reduction of NTMs. Hence, the different degrees of NTMs reductions affected the overall results.

TABLE 6
SCENARIO I: EFFECTS OF EU-KOREA FTA ON EU IMPORTS IN AUTOMOTIVE, ELECTRONIC AND CHEMICAL SECTOR (60% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction
Automotive	-1,17	-0,8	-2,14	-1,21	-1,09	-2,51	36,64	16,92	58,06
Electonics	-0,73	-10,71	-12,24	-0,74	-11,02	-12,61	11,8	197,52	226,8
Chemicals	-0,24	-1,87	-2,45	-0,3	-2,23	-2,92	20,61	303,64	386,91

Source: own calculation based on GTAP.

TABLE 7
SCENARIO II: EFFECTS OF THE EU-JAPAN FTA ON EU IMPORTS IN AUTOMOTIVE, ELECTRONIC AND CHEMICAL SECTOR BASED ON SCENARIO I (60% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction
Automotive	-3,18	-4,48	-7,77	46,15	58,84	119,64	0,02	-0,69	-3,91
Electonics	-13,51	-16,57	-16,89	-2,96	71,49	75,73	60,98	55,93	55,22
Chemicals	-3,63	-6,58	-6,93	10,06	172,68	175,26	102,61	97,25	96,57

Source: own calculation based on GTAP.

TABLE 8
SCENARIO IF: EFFECTS OF THE EU-JAPAN FTA ON EU IMPORTS IN AUTOMOTIVE, ELECTRONIC AND CHEMICAL BASED ON SCENARIO IE (60% ACTIONABILITY) (%CHANGE)

Sectors	ROW			Japan			Korea		
	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction	(i) Tariff Removal Only	(ii) NTMs Reduction Only	(iii) Tariff Removal & NTMs Reduction
Automotive	-2,77	-4,08	-8,06	47,1	59,03	130,06	-2,77	-4,1	-8,09
Electonics	-0,81	-5,27	-6,43	11,58	93,83	111,6	-1,07	-5,84	-7,34
Chemicals	-0,52	-3,76	-4,73	13,96	180,37	216,08	-0,66	-4,08	-5,25

Source: own calculation based on GTAP.

Furthermore, as explained above, the results are also impacted by the magnitude of substitution elasticity. Hence, I repeated experiment (iii) for all the scenarios with 25% actionability with $\pm 50\%$ of the base substitution elasticity between domestic goods and imported goods and among imported goods, respectively σ and θ in the previous Armington model. Tables 9 and 10 show the base, smaller, and larger elasticity for σ and θ. The three scenarios' results are reported in tables 11, 12, and 13. As we observe, the results are highly affected by the magnitude of the elasticities. For example, in scenario (I) experiment (iii) (table 11) the EU imports in Chemicals increased from Korea between a minimum range of +42.02%, in the case of low estimation of both σ and θ, and a maximum of +222.37%, in the case of higher estimation of both σ and θ.

TABLE 9
SUBSTITUTION ELASTICITY BETWEEN DOMESTIC GOODS AND IMPORTED GOODS

	Base	-50%	50%
Agriculture	2,46	1,23	3,69
Services	1,94	0,97	2,91
Motor Vehicles	3,14	1,57	4,71
Electronics	4,4	2,2	6,6
Machinery	4	2	6
Chemicals	3,3	1,65	4,95
Mining & Extraction	5,12	2,56	7,68
Processed Food	2,48	1,24	3,72
Labour-intensive Manufactures	3,7	1,85	5,55
Capital-intensive Manufactures	2,76	1,38	4,14

Source: the base elasticity as reported in ESUBD, GTAP.

TABLE 10
SUBSTITUTION ELASTICITY AMONG IMPORTED GOODS

	Base	-50%	50%
Agriculture	4,92	2,46	7,38
Services	3,86	1,93	5,79
Motor Vehicles	6,25	3,12	9,37
Electronics	8,8	4,4	13,2
Machinery	8,03	4,01	12,04
Chemicals	6,6	3,3	9,9
Mining & Extraction	11,67	5,83	17,50
Processed Food	5,01	2,50	7,51
Labour-intensive Manufactures	7,42	3,71	11,13
Capital-intensive Manufactures	5,87	2,93	8,80

Source: the base elasticity as reported in ESUBM, GTAP.

TABLE 11
SCENARIO I, EXPERIMENT (III): RESULTS WITH DIFFERENT ELASTICITIES OF SUBSTITUTION (25% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	Base	-50%	+50%	Base	-50%	+50%	Base	-50%	+50%
Automotive	-1,53	-0,64	-2,55	-1,67	-0,7	-2,78	45,56	19,88	74,68
Electonics	-4,2	-1,76	-7,23	-4,32	-1,81	-7,45	75,18	30,04	132,1
Chemicals	-0,84	-0,31	-1,56	-1,02	-0,4	-1,86	115,05	42,02	222,37

Source: own calculation based on GTAP.

TABLE 12
SCENARIO II, EXPERIMENT (III): RESULTS WITH DIFFERENT ELASTICITIES OF SUBSTITUTION (25% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	Base	-50%	+50%	Base	-50%	+50%	Base	-50%	+50%
Automotive	-4,69	-1,92	-8,04	75,22	30,81	130,65	-1,47	-0,77	-2,97
Electonics	-5,34	-2,41	-8,52	41,61	17,31	68,31	24,14	9,64	39,8
Chemicals	-2,3	-0,93	-3,97	73,01	28,27	130,69	35,72	13,18	62

Source: own calculation based on GTAP.

TABLE 13
SCENARIO IF, EXPERIMENT (III): RESULTS WITH DIFFERENT ELASTICITIES OF SUBSTITUTION (25% ACTIONABILITY) (%CHANGE)

	ROW			Japan			Korea		
Sectors	Base	-50%	+50%	Base	-50%	+50%	Base	-50%	+50%
Automotive	-4,57	-1,88	-7,86	75,32	30,8	130,77	-4,58	-1,85	-7,91
Electonics	-2,72	-1,17	-4,46	45,38	18,71	75,41	-3,19	-1,41	-5,22
Chemicals	-1,81	-0,73	-3,17	73,79	28,49	132,39	-2,07	-0,85	-3,59

Source: own calculation based on GTAP.

CONCLUSION

The proliferation of FTAs opens an issue on whether a country can take advantage of an FTA in the partner market against its competitors. After disappointing results at first, the Korean exports to the EU increased in recent years, with the recovery of the EU economies. In the period 2011-2017, Korean exports to the EU recorded larger compound annual growth rates than Japan, China, and Taiwan. The largest growth has been recorded in the Chemicals sector, where in 2017 the EU imports from Korea overcame those from Japan. Hence, the EU-Korea FTA produced positive effects on Korean exports compared with those of Japan. Although simplistic because accounting only for static advantages, the model's results highlight the effects of changing baseline scenarios on EU imports from two competitors, Korea and Japan. We can observe that Korean exports to the EU gained greatly from the enforcement of the EU-Korea FTA compared with Japanese exports, and continue to gain or reduce losses with enforcement of the EU-Japan FTA. The alternative scenario, where I hypothesised that the EU-Japan FTA had been implemented before the EU-Korea FTA, is the only scenario where Korean exports decreased heavily in all sectors. Thus, the effects of the FTAs do not result only in increasing exports, but also in safeguarding against negative effects from other FTAs – for example, by restraining an eventual reduction of exports. Of note, all results were affected both by the magnitude of the Armington elasticity and the actionability of NTMs.

Considering that the transitional period for the EU-Korea FTA has already terminated, while the EU-Japan FTA still needs to be implemented, Korean goods on European markets will continue to benefit from the EU-Korea FTA in the coming years. Furthermore, in addition to these static advantages, Korean companies could consolidate their market share, offering better selling conditions to European buyers and, consequently, strengthening relationships with them. Thus, the Korean government's decision to sign an FTA with the EU before its competitors allowed Korean companies to strengthen their positions. This could be the right trade policy strategy to increase exports with a trading partner, and should be taken into consideration by competitive players in an increasingly competitive world.

ENDNOTES

1. In order to benefit from preferential treatment established by the EU-Korea FTA, goods must "originate" in Korea or EU, fulfill certain additional requirements, and be accompanied by an "origin declaration". For details refer to European Union, The EU-Korea Trade Agreement in practice (2011, p. 5-8).
2. The formula for CAGR is $\left(\frac{Ending\ value}{Beginning\ value}\right)^{\left(\frac{1}{\#\ of\ years}\right)} - 1$.
3. The derivation of the following optimisation problem is given in the Appendix.
4. For details about Armington elasticities and terms of trade read Zhang (2006).
5. CEPII/ATLASS (2007) estimates the AVE of NTMs using the methodology developed by Kee, H., A. Nicita, and M. Olarreaga. I took estimates of AVE of NTMs in Copenhagen Economics (2009) and ECORYS (2009) that use gravity-type models. The AVE of NTMs for Machinery has not been included because it was not statistically significant in Copenhagen Economics (2009) and ECORYS (2009).

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APPENDIX

Proof of the optimisation problem for the first-tier uniform tariff Armington model:

$$\max Z = \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$

$$\text{where } M = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta) J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \quad (1)$$

$$sujet\ to\ P_z Z = P_d D + (1+\tau_m) P_m M \quad (2)$$

$$\mathcal{L} = \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} - \lambda(P_z Z - P_d D - (1+\tau_m) P_m M)$$

$$\frac{\partial \mathcal{L}}{\partial D} = \frac{\sigma}{\sigma-1} \frac{\sigma-1}{\sigma} \alpha D^{\frac{\sigma-1}{\sigma}-1} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}-1} - \lambda P_d = 0$$

$$\alpha D^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}} = \lambda P_d$$

$$\lambda = \frac{\alpha D^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}}{P_d}$$

$$\frac{\partial \mathcal{L}}{\partial M} = \frac{\sigma}{\sigma-1} \frac{\sigma-1}{\sigma} (1-\alpha) M^{\frac{\sigma-1}{\sigma}-1} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}-1} - \lambda(1+\tau_m) P_m = 0$$

$$(1-\alpha) M^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}} = \lambda(1+\tau_m) P_m$$

$$\lambda = \frac{(1-\alpha) M^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}}{(1+\tau_m) P_m}$$

$$\frac{\alpha D^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}}{P_d} = \frac{(1-\alpha) M^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}}{(1+\tau_m) P_m}$$

$$\frac{\alpha D^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}}{(1-\alpha) M^{-\frac{1}{\sigma}} \left(\alpha D^{\frac{\sigma-1}{\sigma}} + (1-\alpha) M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}} = \frac{P_d}{(1+\tau_m) P_m}$$

$$\frac{\alpha D^{\frac{-1}{\sigma}}}{(1-\alpha) M^{\frac{-1}{\sigma}}} = \frac{P_d}{(1+\tau_m) P_m}$$

$$\left(\frac{D}{M}\right)^{\frac{-1}{\sigma}} = \frac{1-\alpha}{\alpha} \frac{P_d}{(1+\tau_m) P_m}$$

$$\left(\frac{M}{D}\right)^{\frac{1}{\sigma}} = \frac{1-\alpha}{\alpha} \frac{P_d}{(1+\tau_m) P_m}$$

$$\left(\frac{M}{D}\right)^{\frac{1}{\sigma}} = \frac{1-\alpha}{\alpha}\frac{P_d}{(1+\tau_m)P_m}$$

$$\frac{M}{D} = \left(\frac{1-\alpha}{\alpha}\right)^{\sigma}\left(\frac{P_d}{(1+\tau_m)P_m}\right)^{\sigma} \quad (3)$$

Proof of the optimisation problem for the second-tier uniform tariff Armington model:

$$\max M = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \quad (4)$$

$$subject\ to\ (1+\tau_m)P_m M = (1+\tau_k)P_k K + \left(1+\tau_j\right)P_j J \quad (5)$$

$$\mathcal{L} = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \lambda\left((1+\tau_m)P_m M - ((1+\tau_k)P_k K + \left(1+\tau_j\right)P_j J)\right)$$

$$\frac{\partial\mathcal{L}}{\partial K} = \frac{\theta}{\theta-1}\frac{\theta-1}{\theta}\beta K^{\frac{\theta-1}{\theta}-1}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}-1} - \lambda(1+\tau_k)P_k = 0$$

$$\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} = \lambda(1+\tau_k)P_k$$

$$\lambda = \frac{\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{(1+\tau_k)P_k}$$

$$\frac{\partial\mathcal{L}}{\partial J} = \frac{\theta}{\theta-1}\frac{\theta-1}{\theta}(1-\beta)J^{\frac{\theta-1}{\theta}-1}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}-1} - \lambda\left(1+\tau_j\right)P_j = 0$$

$$(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} = \lambda\left(1+\tau_j\right)P_j$$

$$\lambda = \frac{(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{\left(1+\tau_j\right)P_j}$$

$$\frac{\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{(1+\tau_k)P_k} = \frac{(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{\left(1+\tau_j\right)P_j}$$

$$\frac{\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}} = \frac{(1+\tau_k)P_k}{\left(1+\tau_j\right)P_j}$$

$$\frac{\beta K^{-\frac{1}{\theta}}}{(1-\beta)J^{-\frac{1}{\theta}}} = \frac{(1+\tau_k)P_k}{\left(1+\tau_j\right)P_j}$$

$$\left(\frac{J}{K}\right)^{\frac{1}{\theta}} = \frac{1-\beta}{\beta}\frac{(1+\tau_k)P_k}{\left(1+\tau_j\right)P_j}$$

$$\frac{J}{K} = \left(\frac{1-\beta}{\beta}\right)^{\theta} \left(\frac{(1+\tau_k)P_k}{(1+\tau_j)P_j}\right)^{\theta} \tag{6}$$

I will skip proof of the optimisation problem for the first-tier discriminatory tariff Armington model. Following the proof of the optimisation problem for the second-tier discriminatory tariff Armington model:

$$\max M = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \tag{10}$$

$$subject\ to\ (1+\tau_j)P_m M = P_k K + (1+\tau_j)P_j J \tag{11}$$

$$\mathcal{L} = \left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \lambda\left((1+\tau_j)P_m M - P_k K - (1+\tau_j)P_j J\right)$$

$$\frac{\partial \mathcal{L}}{\partial K} = \frac{\theta}{\theta-1}\frac{\theta-1}{\theta}\beta K^{\frac{\theta-1}{\theta}-1}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}-1} - \lambda P_k = 0$$

$$\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} = \lambda P_k$$

$$\lambda = \frac{\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{P_k}$$

$$\frac{\partial \mathcal{L}}{\partial J} = \frac{\theta}{\theta-1}\frac{\theta-1}{\theta}(1-\beta)J^{\frac{\theta-1}{\theta}-1}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}-1} - \lambda(1+\tau_j)P_j = 0$$

$$(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} = \lambda(1+\tau_j)P_j$$

$$\lambda = \frac{(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{(1+\tau_j)P_j}$$

$$\frac{\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{P_k} = \frac{(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{(1+\tau_j)P_j}$$

$$\frac{\beta K^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}}{(1-\beta)J^{-\frac{1}{\theta}}\left(\beta K^{\frac{\theta-1}{\theta}} + (1-\beta)J^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}}} = \frac{P_k}{(1+\tau_j)P_j}$$

$$\frac{\beta K^{-\frac{1}{\theta}}}{(1-\beta)J^{-\frac{1}{\theta}}} = \frac{P_k}{(1+\tau_j)P_j}$$

$$\frac{J}{K} = \left(\frac{1-\beta}{\beta}\right)^{\theta} \left(\frac{P_k}{(1+\tau_j)P_j}\right)^{\theta} \tag{12}$$