A study of the effects of the Korea-China free-trade agreement*

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Abstract

This paper uses a 53-country 15-industry computable general equilibrium model of trade to forecast the effects of the Korea-China free trade agreement on the manufacturing sector. The model uses the Eaton-Kortum methodology to explain intra-industry trade instead of the usual Armington assumption. The model predicts that the Korea-China FTA will increase Korea-China manufacturing trade by 56%, manufacturing employment in Korea by 5.7% and China by 0.55%. The model also predicts significant reallocation of employment across industries with the Food industry in Korea loosing jobs and other industries there gaining jobs, with the Medical equipment industry gaining the most. There will be some trade diversion from the ASEAN countries, as well as Japan and the United States.

JEL codes: F1

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1 Introduction

In recent years, Korea has successfully signed free-trade agreements (FTA) with a number of partners including the U.S., EU and ASEAN. Korea and China officially launched FTA negotiations in May 2012 and a major breakthrough happened in the seventh round of negotiations in September 2013, when the two parties agreed on a set of basic guidelines (i.e. modality) that included the level of overall market opening. Under the agreement, the two countries will remove their import duties on 90 percent of all products. The FTA negotiations, however, have progressed slowly since then as the countries failed to come up with a list of items to be liberalized or protected under the proposed FTA. The latest, 10th, round of negotiations took place in March, 2014, with the focus on goods, service and investment trade, rules of origin, technical barriers to trade, intellectual property right, etc.

The FTA between Korea and China can have a significant impact on the Korean economy because of the close economic relationship between the two countries. Korea is the world's 12th largest economy with $1.6 trillion GDP and 49 million consumers while China is the world's 2nd largest economy with $12.6 trillion GDP and 1,350 million consumers.[1] The Korea-China bilateral

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[1] Data are from the World Bank's WDI database and the U.S. CIA's The World Factbook. GDP is converted to USD using PPP exchange rates.

trade in 2012 was about $256 billion.[2] China is Korea's biggest trading partner, while Korea is China's third-largest export market and its second-largest source of imports.

Free trade agreements (FTAs) have a potential to significantly affect the economies of participating countries. They can increase the volume of trade and significantly affect the pattern of specialization and trade. Some industries, which do not have competitive advantage, may be negatively affected, while competitive industries may expand dramatically. The employment in those industries would be significantly affected as well. A free trade agreement may also affect countries other than those signing the agreement. For example, if Korea and China sign an FTA, some goods that were previously imported to Korea from Singapore may now be imported from China instead. This phenomenon is called trade diversion.

The Korea-China FTA can give several advantages to Korea. First, since the US and EU already have FTAs with Korea but not with China, the Korea-China FTA can give Korea a strong advantage in penetrating Chinese markets before the EU and US. Korea can play a "Hub" country role in connecting trades between China and the West through FTAs. Second, the Korea-China FTA can provide institutional framework in China to protect Korean firms and people working in China. It is believed that more than 22,000 Korean firms are currently operating in China. Third, using the already-implemented FTA with ASEAN, Korea can play a crucial role in leading potential Asian economic cooperation including East Asia and ASEAN.

This paper examines the potential effects of the Korea-China FTA on the Korean economy, in particular industry structure and employment, using a computable general equilibrium (CGE) model of the world economy. The model is based on solid economic theory and has been tested and evaluated in previous studies. Specifically, the model has been found to accurately predict the effects of NAFTA (Shikher, 2012a). Our forecast predicts which Korean industries would grow as the result of the FTA. In those industries, existing firms would increase sales and new firms would enter business. Our forecast can also predict which Korean industries would experience a decline in sales and, therefore, employment.

The model in this paper covers 53 countries and 15 industries. Trade in the model is affected by technology, trade costs, cross-industry supply of intermediate goods, and tastes. For each industry and country, the model can predict changes in trade, output, employment, prices, costs of production, wages, and welfare. We also plan to quantify the magnitude of the trade diversion that would occur as the result of the FTA.

As in the Ricardian model, countries in our model have different technologies and trade with each other to exploit their comparative advantages. As in the gravity model, trade costs in our model are an obstacle to international trade and create a wedge between goods prices in different countries (Eaton and Kortum, 2012). Intermediate goods play a large role in the model. Countries trade both final and intermediate goods. Trade in intermediate goods also occurs domestically since industries supply each other with intermediate goods. This creates linkages that transmit economic shocks to the upstream and downstream industries.

Compared to other models of trade, the major innovation of our model is how it explains intra-industry trade. Other models use the Armington (1969) assumption, while our model is based on the methodology of Eaton and Kortum (2002). In our mythology, each industry is populated by a multitude of producers making a variety of goods, with each producer wanting to be the least-cost supplier in the market. The model explicitly incorporates trade costs and uses them to explain

[2] About 11.7% of this trade was between Korea and Hong Kong SAR. The rest was between Korea and mainland China. Trade data are from the IMF DOT database.

the home bias in consumption and cross-country price differentials. Therefore, it is well suited to study the effects of changes in trade costs, such as trade wars or trade liberalizations (Costinot and Rodríguez-Clare, 2013). The model was previously used to study the effects of NAFTA and KORUS FTA (Shikher, 2012a; Yaylaci and Shikher, 2014).

The model that we propose to use to study the effects of Korea-China FTA has been extensively tested and evaluated. The model shows an extremely close fit to the data used to parametrize it, with the correlation of 0.99. More challenging evaluations of the model in Shikher (2011) and Shikher (2012a) looked at the model's ability to make accurate predictions outside of the sample used to parametrize it. The first paper evaluated the ability of the model to forecast changes in specialization that occurred during 1975-95. The second paper asked the model to forecast the effects of NAFTA from the point of view of 1989. It found the correlation between the actual and predicted changes in trade to be 0.95. Therefore, we have considerable confidence that the model would be able to accurately forecast the effects of Korea-China FTA.

2 Model

The model includes N countries and J industries. We use subscripts i and n to denote countries and j and m to denote industries. The focus on the empirical application of this model is on the manufacturing industries. The first $J-1$ industries produce manufacturing products, while the last industry produces nonmanufactures.

Labor is the only factor of production, as in the Ricardian and Eaton-Kortum models. The stock of labor is fixed for each country, while labor is mobile across industries within a country. Each industry has its own Cobb-Douglas cost function:

$$c_{ij} = w_i^{\beta_j} \rho_{ij}^{1-\beta_j}, \tag{1}$$

where w_i is the wage, ρ_{ij} is the price of the intermediate goods, and β_j is the share of labor. The bundle of intermediate goods is a Cobb-Douglas composite of goods from all industries, so the price of inputs ρ_{ij} is a Cobb-Douglas function of industry prices:

$$\rho_{ij} = \prod_{m=1}^{J} p_{im}^{\eta_{jm}} = \prod_{m=1}^{J-1} p_{im}^{\eta_{jm}}, \tag{2}$$

where η_{jm} is the share of industry m goods in the input of industry j, such that $\sum_{m=1}^{J} \eta_{jm} = 1$, $\forall j$. The second equality in equation (2) holds because following Eaton and Kortum (2002) we assume that (at least some of) nonmanufacturing output can be traded costlessly and use it as the numeraire: $p_{iJ} \equiv 1$. Note that industries that make manufacturing goods can use nonmanufacturing intermediate goods.[3]

We use the framework of Eaton and Kortum (2002) to model intra-industry production, trade, and prices. Each industry $j < J$ has a continuum of goods indexed by $l \in [0, 1]$ and produced with its own productivity $z_{nj}(l)$. These productivities are the result of the R&D process and probabilistic, drawn independently from the Fréchet distribution with parameters $T_{ij} > 0$ and

[3] The assumption of tradability of the nonmanufacturing output means that the wages w_n in each country are given by the productivity in nonmanufacturing and the (numeraire) price of the nonmanufacturing good deflated by the price of the bundle of intermediates used in producing this good.

$\theta > 1$. The cdf of this distribution is $F_{ij}(z) = e^{-T_{ij}z^{-\theta}}$.[4] Consumers have CES preferences over the continuum of goods within an industry with the elasticity of substitution $\sigma > 0$.

The price of each good l of industry j produced in country i and delivered to country n is $p_{nij}(l) = c_{ij}d_{nij}/z_{ij}(l)$, where d_{nij} is the Samuelson's ("iceberg") transportation cost.[5] The distribution of prices p_{nij} is described by the following cdf: $G_{nij}(p) = 1 - F_{ij}\left(c_{ij}d_{nij}/p\right) = 1 - e^{-T_{ij}(c_{ij}d_{nij})^{-\theta}p^{\theta}}$.

Country n consumers buy from the lowest-cost supplier, so the price of good l in country n is $p_{nj}(l) = \min\{p_{nij}(l), i = 1, ..., N\}$. The distribution of p_{nj} is $G_{nj}(p) = 1 - \prod_{i=1}^{N}\left[1 - G_{nij}(p)\right] = 1 - e^{-\Phi_{nj}p^{\theta}}$, where $\Phi_{nj} = \sum_{i=1}^{N} T_{ij}\left(c_{ij}d_{nij}\right)^{-\theta}$ summarizes technology, input costs, and transport costs around the world.

The exact price index for the within-industry CES objective function is

$$p_{nj} = \gamma\left[\sum_{i=1}^{N} T_{ij}\left(d_{nij}c_{ij}\right)^{-\theta}\right]^{-1/\theta}, \tag{3}$$

where $\gamma \equiv \Gamma\left(\left(\theta + 1 - \sigma\right)/\theta\right)^{1/(1-\sigma)}$ is a constant.[6]

Parameter T_{ij} represents industry-level productivity and, therefore, determines the comparative advantage across industries. For example, country n has a comparative advantage in industry j if $T_{nj}/T_{nm} > T_{ij}/T_{im}$.[7] Parameter θ determines the comparative advantage across goods within an industry. Lower value of θ means more dispersion of productivities among producers, leading to stronger forces of within-industry comparative advantage.

We can now derive the expressions for the industry-level bilateral trade volumes. The probability that a producer from country i has the lowest price in country n for good l is $\pi_{nij} \equiv \Pr\left[p_{nij}(l) \leqslant \min\{p_{nsj}(l); s \neq i\}\right] = \int_0^{\infty}\prod_{s\neq i}\left[1 - G_{nsj}(p)\right]dG_{nij}(p) = T_{ij}\left(\gamma c_{ij}d_{nij}/p_{nj}\right)^{-\theta}$. Since there is a continuum of goods on the interval $[0, 1]$, this probability is also the fraction of industry j goods that country n buys from i. It is also the fraction of n's expenditure spent on industry j goods from i: X_{nij}/X_{nj}, where X_{nij} is the spending of country n on industry j goods produced in country i and X_{nj} is the total spending in country n on industry j goods.[8] Therefore,

$$\pi_{nij} \equiv \frac{X_{nij}}{X_{nj}} = T_{ij}\left(\frac{\gamma d_{nij}c_{ij}}{p_{nj}}\right)^{-\theta}. \tag{4}$$

[4] Kortum (1997) and Eaton and Kortum (1999) provide microfoundations for this approach. Parameter T_{ij} governs the mean of the distribution, while parameter θ, which is common to all countries and industries, governs the variance. The support of the Fréchet distribution is $(0, \infty)$.

[5] To receive \$1 of product in country n requires sending $d_{nij} \geqslant 1$ dollars of product from country i. By definition, domestic transport costs are set to one: $d_{nnj} \equiv 1$. Trade barriers result in $d_{nij} > 1$. Note that trade costs are not restricted to be symmetric (d_{nij} can be different from d_{inj}). Waugh (2007) studies the effects of the asymmetry of trade costs.

[6] It follows from $p_{nj} = \left[\int_0^1 p_{nj}(l)^{1-\sigma}dl\right]^{1/(1-\sigma)} = \left[\int_0^{\infty} p_{nj}^{1-\sigma}dG_{nj}(p)\right]^{1/(1-\sigma)} = E\left[P_{nj}^{1-\sigma}\right]^{1/(1-\sigma)} = \gamma\Phi_{nj}^{-1/\theta}$. The last equality follows from a known statistical result (see Eaton and Kortum (2002)).

[7] Note that parameter T is not the same as total factor productivity (TFP). T is an exogenous parameter of the Fréchet distribution. TFP, on the other hand, is endogenous and represents the average productivity of the firms actually operating in an industry.

[8] This is true because conditional on the fact that country i actually supplies a particular good, the distribution of the price of this good is the same regardless of the source i.

We complete the model by describing the market clearing conditions. We have $w_i L_{ij} = \beta_j Q_{ij} = \beta_j \sum_{n=1}^{N} X_{nij} = \beta_j \sum_{n=1}^{N} \pi_{nij} X_{nj} = \beta_j \sum_{n=1}^{N} \pi_{nij} \left(Z_{nj} + Y_{nj} \right)$, where Z_{nj} is the spending on intermediate goods and Y_{nj} is the spending on final goods made by industry j. Following EK, we assume that each country spends a constant proportion of its income on goods from each industry, $\alpha_j = Y_{nj}/Y_n$. We also have

$$Z_{nj} = \sum_m Z_{nmj} = \sum_m \eta_{mj} M_{nm} = \sum_m \frac{\eta_{mj}\left(1-\beta_m\right)}{\beta_m} w_n L_{nm},$$

where Z_{nmj} is the spending by industry m on intermediate goods made by industry j and M_{nm} is the amount that industry m spends on all intermediate inputs. Therefore, the market clearing equation is

$$w_i L_{ij} = \beta_j \sum_{n=1}^{N} \pi_{nij} \left(\left(\sum_{m=1}^{J-1} \frac{\eta_{mj}\left(1-\beta_m\right)}{\beta_m} w_n L_{nm} \right) + \alpha_j Y_n \right), \tag{5}$$

where the consumption of manufactures by the nonmanufacturing industry is treated as final rather than intermediate consumption.

The model is given by equations (1)-(5). In the model, β_j, η_{mj}, γ, θ, α_{nj}, w_i, d_{nij}, T_{ij}, and Y_n are the parameters, and p_{nj}, c_{nj}, π_{nij}, and L_{nj} are the endogenous variables.

In order to solve the model, we first need to solve for the production costs using equations (1), (2), and (3). Solving for costs requires solving a system of $N \times (J-1)$ equations. For example, in our case, there are 53 countries and 15 manufacturing industries, so there will be $53 \times 15 = 795$ equations with 795 unknowns.[9] Once costs are solved for, π_{nij} can be calculated from (4) and industry employments L_{ij} can be solved from (5).

Combining (1), (2), and (3), we obtain the equation for costs:

$$c_{ij} = w_i^{\beta_j} \prod_{m=1}^{J-1} \left[\gamma^{-\theta} \sum_{n=1}^{N} T_{nm} \left(d_{inm} c_{nm} \right)^{-\theta} \right]^{-\frac{\eta_{jm}\left(1-\beta_j\right)}{\theta}}. \tag{6}$$

Taking logs of this equation we obtain

$$\log c_{ij} = \beta_j \log w_i + \left(1-\beta_j\right) \log \gamma - \frac{1-\beta_j}{\theta} \sum_{m=1}^{J-1} \left(\eta_{jm} \log \sum_{n=1}^{N} T_{nm} d_{inm}^{-\theta} c_{nm}^{-\theta} \right), \tag{7}$$

which is easier to solve numerically than (6).

3 Obtaining model parameters

The model is parametrized following a procedure first described in Shikher (2012b). The parameters are obtained as follows. Labor shares β_j are obtained from output and value added data. Industry shares η_{im} are obtained from input-output tables. Demand parameters α_j are calculated from production and trade data, as explained in this section. Wages w_i and country incomes (GDPs)

[9] This system of equations is easily solved using numerical methods in Matlab.

Y_n are taken directly from data. The data sources are described in Section 4. Parameter θ is taken from EK, where it is estimated to be 8.28.[10]

Technology parameters T_{ij} and trade costs d_{nij} are estimated using methodology similar to Eaton and Kortum's, but modified to account for multiple industries. Specifically, the price of inputs ρ_{ij} is now an index of industry prices p_{ij} and cannot be substituted out in the manner used by EK.

From (4):

$$\frac{\pi_{nij}}{\pi_{nnj}} = \frac{X_{nij}}{X_{nnj}} = \frac{T_{ij}}{T_{nj}} d_{nij}^{-\theta} \left(\frac{c_{ij}}{c_{nj}} \right)^{-\theta}. \tag{8}$$

Let's define $S_{ij} \equiv T_{ij} c_{ij}^{-\theta}$ as a measure of international competitiveness of industry j of country i. Taking logs of (8) and using the definition of S_{ij} we get

$$\log \frac{X_{nij}}{X_{nnj}} = -\theta \log d_{nij} + \log S_{ij} - \log S_{nj}. \tag{9}$$

As in EK, trade costs are proxied by

$$\log d_{nij} = d_{kj} + b_j + l_j + f_j + m_{nj} + \delta_{nij}, \tag{10}$$

where d_{kj} $(k = 1, ..., 6)$ is the effect of distance lying in the kth interval, b_j is the effect of common border, l_j is the effect of common language, f_j is the effect of belonging to the same free trade area, m_{nj} is the overall destination effect, and δ_{nij} is the sum of geographic barriers that are due to all other factors. Note that all trade costs are industry-specific. Also note that by definition $\log d_{iij} \equiv 0$.

As in EK, equations (9) and (10) are combined to obtain the estimating equation for S_{ij} and trade costs:

$$\log \frac{X_{nij}}{X_{nnj}} = -\theta d_{kj} - \theta b_j - \theta l_j - \theta f_j + D_{ij}^{exp} + D_{nj}^{imp} - \theta \delta_{nij}, \tag{11}$$

where $D_{ij}^{exp} = \log S_{ij}$ is the exporter dummy and $D_{nj}^{imp} = -\theta m_{nj} - \log S_{nj}$ is the importer dummy. The overall destination effect is calculated as $m_{nj} = -(1/\theta) \left(D_{nj}^{exp} + D_{nj}^{imp} \right)$. When estimating (11) the following normalization is used: $D_{us,j}^{exp} = D_{us,j}^{imp} = 0$. Consequently, the estimation produces the relative competitiveness measures $S_{ij}/S_{us,j}$.

Taking logs of the definition of the (relative) competitiveness measure S_{ij} we have

$$\log \frac{S_{ij}}{S_{us,j}} = \log \frac{T_{ij}}{T_{us,j}} - \theta \log \frac{c_{ij}}{c_{us,j}}. \tag{12}$$

Note that to get technology parameters T_{ij} from S_{ij}, it is necessary to strip both wages and prices from S_{ij} (unlike the EK where only wages needed to be stripped). From (4), we have

$$\frac{X_{iij}}{X_{ij}} = T_{ij} \left(\frac{\gamma c_{ij}}{p_{ij}} \right)^{-\theta}$$

[10] They also obtain a second estimate of 3.6, but 8.28 is their preferred estimate since $\theta = 3.6$ results in unreasonably high trade costs.

from which we get

$$\log\frac{X_{iij}/X_{ij}}{X_{us,us,j}/X_{us,j}}=\log\frac{T_{ij}}{T_{us,j}}-\theta\log\frac{c_{ij}}{c_{us,j}}+\theta\log\frac{p_{ij}}{p_{us,j}}. \tag{13}$$

Subtracting (12) from (13), we obtain the expression for industry prices. We then combine that expression with (2) to get the expression for input prices:

$$\log\frac{\rho_{ij}}{\rho_{us,j}}=\frac{1}{\theta}\sum_{m=1}^{J-1}\eta_{jm}\left(\log\frac{X_{iim}/X_{im}}{X_{us,us,m}/X_{us,m}}-\log\frac{S_{im}}{S_{us,m}}\right).$$

Finally, combining equations (12) and (1) with the above equation and rearranging, we get the expression for the technology parameters:

$$\log\frac{T_{ij}}{T_{us,j}}=\log\frac{S_{ij}}{S_{us,j}}+\theta\beta_j\log\frac{w_i}{w_{us}}+\left(1-\beta_j\right)\sum_{m=1}^{J-1}\eta_{jm}\left(\log\frac{X_{iim}/X_{im}}{X_{us,us,m}/X_{us,m}}-\log\frac{S_{im}}{S_{us,m}}\right). \tag{14}$$

This suggests a two-step procedure for estimating the technology parameters. First, the gravity equation (11) is estimated to obtain exporter dummies $S_{ij}/S_{us,j}$. Then these estimates are used to calculate technology parameters $T_{ij}/T_{us,j}$ according to (14).

The demand share parameters α_m are calculated from the production and trade data as follows. By definition, $Z_{nm}+Y_{nm}=X_{nm}$. In addition, $X_{nm}=Q_{nm}-EX_{nm}+IM_{nm}$ and $Z_{nm}=\sum_j p_{nm}M_{njm}=\sum_j \rho_{nj}M_{nj}\eta_{jm}=\sum_j \eta_{jm}\left(1-\beta_j\right)Q_{nj}$. Therefore, α_{nm} are calculated as

$$\alpha_{nm}=\frac{1}{Y_n}\left(Q_{nm}-EX_{nm}+IM_{nm}-\sum_{j=1}^{J-1}\eta_{jm}\left(1-\beta_j\right)Q_{nj}\right) \tag{15}$$

Then, α_m are calculated as the averages of α_{nm} across the countries in the dataset.

4 Estimated trade costs and technology parameters

The model is parametrized using 2005 data for 15 industries and 53 countries. The industries are based on the 2-digit ISIC rev. 3 classification and are described in Table 1. The countries included in the dataset can be seen in Table 2.

The data necessary to estimate the gravity equation (11) was presented in Yaylaci (2013). That paper shows the evolution of trade cost between a large number of countries over a span of several decades. The data sources are as follows.

Sectoral output data comes from the United Nation's Industrial Statistics database (INDSTAT2-2010, Rev.3). The corresponding bilateral trade data is obtained from the COMTRADE database of the UN which uses the 4-digit SITC (Rev. 1) classification. Using a concordance, the 4-digit SITC Revision 1 trade data was aggregated to the 2-digit ISIC data. Missing data was filled from nearby years. The gravity data (distance, common border, common language, currency union, regional trade agreements) comes from the Gravity Database compiled by CEPII. The distance is divided into 6 intervals, as in EK: [0,375), [375,750), [750,1500), [1500,3000), [3000,6000), and [6000,maximum). Data on the existing tariffs between the U.S. and Korea come from WITS online database of the World Bank.

Imports from home X_{iij} are calculated as output minus exports, and spending X_{ij} is calculated as output minus exports plus imports. Labor's share in output, β_j, is calculated as the average of the labor shares of the countries in our dataset. Parameters α_j and β_j are presented in Table 1. The data for industry shares η_{jm} is obtained from the OECD input-output tables. The values of η_{jm} used in the model and shown in Table A1 of the Appendix are the averages of η_{jm}'s of the countries in the OECD dataset (they are very similar).[11] Table A1 shows the forward and backward linkages between industries.

Table 1: Countries included in the dataset.

Australia	Ecuador	Iran	Mauritius	Slovakia	Uruguay
Austria	Ethiopia	Ireland	Mexico	Slovenia	USA
Brazil	Finland	Israel	Netherlands	South Africa	Vietnam
Bulgaria	France	Italy	New Zealand	Spain	
Chile	Germany	Japan	Norway	Sweden	
China	Greece	Jordan	Peru	Tanzania	
Colombia	Hungary	Kazakhstan	Philippines	Trinidad and Tobago	
Costa Rica	Iceland	Kenya	Poland	Turkey	
Czech Rep.	India	Korea	Portugal	UK	
Denmark	Indonesia	Malaysia	Russia	Ukraine	

The trade costs d_{ni} and technology parameters T_{ij} are estimated following the methodology described in Section 3. The average estimated trade costs (averaged across country pairs and industries) is 2.84, which is equivalent to 184% ad-valorem tariff.[12] The average (across country pairs) trade costs in each industry are listed in Table 1. The smallest average trade costs are in the machinery and textile industries and the largest are in the petroleum, paper, and wood industries.

The mean productivity draws, measured by $T_{ij}^{1/\theta}$, are estimated for each industry j and country i. The results are presented in Table 3 for selected countries and selected industries. The mean productivity draws are measured relative to the United States. Table 4 shows the rankings of the countries in these selected industries according to their mean productivity draw (i.e. "state of technology"). The U.S. has the highest or second-highest state of technology in all industries. Other developed countries have top rankings as well while the least developed countries are at the bottom of the rankings. Korea has the 7th place according to the cross-industry average of presented industry rankings (shown in the last column of Table 4). It is ahead of such countries as Spain, Australia, and Sweden. The numbers shown in Tables 3 and 4 show the absolute advantages of each country in different industries.

Comparing mean productivity draws across industries tells us the comparative advantages of countries. The comparative advantages in turn affect the pattern of trade between countries. Since in this paper we are analyzing the trade between China and Korea, we will compare mean productivity draws of China and Korea across industries.

[11] In the data, in addition to intermediate and final goods, there are also investment goods. Since there is no investment in the model, investment goods are treated as intermediate goods.

[12] Anderson and van Wincoop (2004) roughly estimate the average international trade cost between rich OECD countries to be around 1.7 (excluding local distribution margins, see pp. 692-693). This is lower than the (non-weighted) average trade cost of 2.84 estimated in this paper. However, our dataset includes many less-developed countries that have much higher trade costs than the rich OECD countries. If these countries are excluded from the dataset, the average trade cost for the remaining rich OECD countries is 1.76, which is much closer to the number reported in Anderson and van Wincoop (2004).

Table 2: Description of industries, values of parameters α_j and β_j, and average estimated trade costs.

Num.	Name	Description	ISIC Rev.3	α_j	β_j	Average trade costs*
1	Food	Food products, beverages and tobacco	15+16	0.088	0.127	180%
2	Textile	Textiles, textile products, leather and footwear	17+18+19	0.026	0.211	165%
3	Wood	Wood and products of wood and cork	20	0.007	0.184	228%
4	Paper	Pulp, paper, paper products, printing and publishing	21+22	0.017	0.195	243%
5	Petroleum products	Coke, refined petroleum products and nuclear fuel	23	0.046	0.052	259%
6	Chemicals	Chemicals	24	0.020	0.139	146%
7	Rubber	Rubber & plastics products	25	0.016	0.193	186%
8	Nonmetals	Other non-metallic mineral products	26	0.018	0.203	224%
9	Metals	Basic metals	27	0.009	0.133	175%
10	Metal products	Fabricated metal products, except machinery & equip.	28	0.018	0.226	208%
11	Machinery, other	Office, accounting, computing, and other machinery	29+30	0.046	0.207	133%
12	Machinery, e&c	Electrical machinery, communication equipment	31+32	0.052	0.182	139%
13	Medical	Medical, precision & optical instruments	33	0.009	0.246	148%
14	Transport	Transport equipment	34+35	0.047	0.172	188%
15	Other	Other manufacturing (incl. furniture)	36+37	0.019	0.210	136%

* Average trade costs across all country pairs.

Table 3: Mean productivity draws for selected countries and industries,relative to the U.S., $T_{ij}^{1/\theta}$.

Country	Food	Textile	Wood	Paper	Chemicals	Rubber	Nonmetals	Metals	Metal products	Machinery, other	Machinery, e&c	Medical	Transport
Australia	0.862	0.829	0.779	0.763	0.809	0.719	0.734	0.921	0.746	0.754	0.760	0.764	0.738
Brazil	0.795	0.665	0.691	0.572	0.654	0.608	0.631	0.808	0.509	0.560	0.584	0.441	0.631
Chile	0.735	0.533	0.725	0.522	0.634	0.499	0.422	0.794	0.428	0.429	0.419	0.360	0.446
China	**0.610**	**0.684**	**0.648**	**0.522**	**0.606**	**0.527**	**0.617**	**0.703**	**0.531**	**0.506**	**0.594**	**0.422**	**0.522**
Colombia	0.610	0.531	0.407	0.434	0.474	0.443	0.444	0.615	0.345	0.352	0.390	0.288	0.370
Czech Rep.	0.518	0.538	0.537	0.530	0.550	0.532	0.609	0.649	0.542	0.533	0.558	0.443	0.585
France	0.872	0.921	0.881	0.850	0.891	0.848	0.911	0.895	0.837	0.830	0.879	0.817	0.907
Germany	0.874	0.948	0.972	0.946	0.915	0.932	1.001	0.975	0.967	0.959	0.960	0.938	0.974
Greece	0.675	0.715	0.541	0.588	0.608	0.588	0.605	0.708	0.607	0.549	0.596	0.466	0.515
India	0.554	0.577	0.460	0.406	0.576	0.478	0.484	0.640	0.420	0.387	0.443	0.315	0.462
Indonesia	0.577	0.538	0.548	0.446	0.461	0.443	0.441	0.499	0.355	0.368	0.453	0.278	0.394
Ireland	0.812	0.639	0.632	0.699	0.873	0.629	0.605	0.603	0.725	0.826	0.777	0.756	0.556
Israel	0.640	0.750	0.686	0.630	0.767	0.729	0.716	0.661	0.743	0.687	0.754	0.661	0.541
Italy	0.815	0.988	0.849	0.812	0.813	0.821	0.928	0.893	0.866	0.859	0.826	0.762	0.775
Japan	0.655	0.877	0.707	0.834	0.863	0.986	0.897	1.004	0.865	0.920	0.940	0.918	1.056
Korea	**0.633**	**0.956**	**0.640**	**0.781**	**0.770**	**0.989**	**0.815**	**0.933**	**0.807**	**0.799**	**0.932**	**0.708**	**0.936**
Malaysia	0.670	0.670	0.680	0.535	0.573	0.607	0.528	0.631	0.517	0.569	0.666	0.451	0.506
Mexico	0.569	0.572	0.464	0.491	0.621	0.511	0.523	0.619	0.523	0.529	0.573	0.458	0.543
New Zealand	0.827	0.684	0.654	0.634	0.627	0.565	0.542	0.698	0.679	0.632	0.642	0.592	0.574
Norway	0.711	0.753	0.702	0.780	0.768	0.696	0.657	0.818	0.752	0.739	0.773	0.740	0.718
Philippines	0.525	0.493	0.460	0.385	0.454	0.451	0.395	0.454	0.384	0.442	0.532	0.359	0.431
Portugal	0.571	0.699	0.776	0.577	0.573	0.569	0.606	0.549	0.609	0.547	0.592	0.419	0.532
Russia	0.522	0.454	0.555	0.466	0.596	0.415	0.418	0.769	0.356	0.389	0.412	0.336	0.482
South Africa	0.707	0.676	0.612	0.580	0.663	0.586	0.597	0.854	0.541	0.577	0.566	0.427	0.618
Spain	0.815	0.872	0.850	0.770	0.793	0.797	0.893	0.854	0.786	0.736	0.772	0.648	0.787
Sweden	0.676	0.710	0.815	0.882	0.767	0.770	0.728	0.854	0.809	0.794	0.847	0.731	0.819
Turkey	0.654	0.738	0.518	0.477	0.586	0.585	0.637	0.676	0.561	0.516	0.578	0.392	0.612
UK	0.850	0.906	0.793	0.866	0.861	0.821	0.860	0.893	0.846	0.837	0.836	0.833	0.848
USA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Vietnam	0.543	0.510	0.439	0.328	0.376	0.393	0.389	0.421	0.345	0.302	0.373	0.232	0.392

Note: Countries are selected based on their trade volumes with Korea. The results for all the countries in the dataset are in the Appendix.

Table 4: Rankings of selected countries in selected industries according to their technology parameters.

Country	Food	Textile	Wood	Paper	Chem.	Rubber	Nonmet.	Metals	Metal products	Machinery, other	Machinery, e&c	Medical	Transport	Av of ranks
USA	1	1	1	1	1	1	2	2	1	1	1	1	2	1.27
Germany	3	4	2	2	2	4	1	3	2	2	2	2	3	2.60
France	4	5	3	7	3	6	4	6	7	7	6	6	5	5.73
Japan	21	8	15	8	5	3	5	1	4	3	3	3	1	5.93
UK	6	6	10	5	6	8	7	7	5	6	8	4	6	6.33
Italy	10	2	6	10	8	7	3	8	3	4	9	9	9	7.00
Korea	**24**	**3**	**22**	**11**	**11**	**2**	**10**	**4**	**9**	**10**	**4**	**15**	**4**	**10.47**
Spain	9	9	5	13	10	9	6	10	11	16	14	17	8	10.87
Australia	5	10	11	14	9	13	13	5	15	14	15	8	12	11.60
Sweden	17	18	9	4	14	10	14	11	8	11	7	12	7	11.87
Norway	15	13	16	12	12	14	16	14	14	15	13	11	13	13.80
Ireland	11	27	23	16	4	17	22	37	17	8	11	10	21	17.33
Israel	23	14	18	18	13	12	15	25	16	17	16	16	24	18.60
Brazil	12	25	17	22	19	18	18	16	31	22	25	26	16	20.87
New Zealand	8	20	20	17	22	25	27	22	18	19	20	18	20	20.87
South Africa	16	22	25	20	18	22	24	12	25	20	28	27	17	20.93
Greece	18	17	29	19	24	21	23	20	20	23	22	22	29	23.27
China	**25**	**21**	**21**	**27**	**25**	**28**	**19**	**21**	**26**	**31**	**23**	**29**	**28**	**23.60**
Malaysia	19	23	19	24	34	19	28	31	28	21	18	24	31	23.67
Turkey	22	15	32	31	28	23	17	23	23	28	26	31	18	24.27
Portugal	33	19	12	21	33	24	21	40	19	24	24	30	27	26.33
Mexico	34	29	36	29	23	31	29	33	27	27	27	23	23	28.33
Czech Rep.	41	33	30	25	35	27	20	28	24	26	31	25	19	28.87
Chile	13	35	14	28	21	32	36	17	33	35	38	34	35	29.40
Russia	40	44	27	34	26	41	38	18	38	36	39	37	32	33.07
India	35	28	38	37	31	33	31	30	34	37	36	38	34	33.73
Indonesia	32	34	28	35	42	38	35	42	39	39	35	44	38	36.20
Colombia	26	36	43	36	38	37	34	36	43	41	41	42	44	37.07
Philippines	39	41	37	39	43	36	39	47	36	32	33	35	36	38.07
Vietnam	37	40	41	44	50	44	40	50	42	47	43	49	39	42.93

Note: Countries are sorted by the cross-industry average rank shown in the last column.

Note: Countries are selected based on their trade volumes with Korea. The results for all the countries in the dataset are in the Appendix. The rankings in this table are based on the complete dataset of countries and industries.

Korea has absolute advantage in all industries except for the Wood industry in which China has a tiny absolute advantage. Korea has a much higher variability of mean productivities across industries than China. Korea's rankings vary from 2nd among all the countries in the dataset in the Rubber industry to 24th in the Food industry. China's rankings, on the other hand, are much more similar across industries. It's highest ranking is 19th in the Nonmetals industry and its lowest ranking is 29th in the Medical industry. Comparing the productivites in Korea and China across industries, we note that Korea has much higher productivity than China in the Medical, Transport, and Rubber industries. These are the industries in which Korea has comparative advantage. On the other hand, Korea's and China's productivities in the Food and Wood industries are very similar. These are the industries in which China has the comparative advantage.

5 Counterfactual simulations

We will now use the model described in the previous sections to predict the effects of a free-trade agreement between China and Korea. The exercise entails the removal of tariffs currently in place between the two countries. The model will be solved with the tariffs removed and the results will be compared to the baseline model, which has the tariffs in place. We will especially focus on the changes in trade and employment.

The values of currently existing tariffs in Korea and China in each industry are obtained from the World Bank's WITS database. The tariffs are shown in Table 5. The level of protection varies significantly across industries. By far, the most protected industry in both countries is the Food industry where the tariffs are 24% in China and 34% in Korea. The Transport and Nonmetals industries are protected in China while the Textile industry is protected in both countries.[13]

Table 5: Existing tariffs between China and Korea

Importer	Exporter	Food	Textile	Wood	Paper	Chemicals	Rubber	Nonmetals
China	Korea	23.8%	8.6%	2.2%	5.8%	5.1%	6.7%	11.3%
Korea	China	33.7%	9.0%	5.5%	0.0%	4.8%	6.6%	7.4%

Importer	Exporter	Metals	Metal products	Machinery, other	Machinery, e&c	Medical	Transport
China	Korea	4.3%	8.0%	3.3%	4.1%	6.8%	13.4%
Korea	China	1.2%	2.9%	2.7%	3.1%	5.0%	1.9%

Source: WITS

In order to simulate the China-Korea free-trade agreement, we will reduce the estimated trade costs d_{nij} between the two countries by the amount of tariffs shown in Table 5 and solve the model for industry employments, output, prices, and trade.

[13] It is also interesting to compare openness of different industries in China and Korea. Openness can be measured by a ratio of exports to output. This ratio tells us what fraction of output is exported. By this measure, the food industry is fairly closed. The openness ratio in the Food industry is 0.04 in Korea and 0.10 in China. By comparison, the openness ratio in the Medical industry is 0.89 in Korea and 0.71 in China. This is despite the fact that the Food industry has a higher share of intermediate goods than the Medical industry (see Table 1). The Transport industry is more open in Korea than China: the openness ratio is 0.35 in Korea and 0.09 in China. The openness ratio is typically higher in smaller countries.

Several factors will determine the magnitudes of trade changes. The size of the existing tariff, which is being removed, will affect trade changes. Removing bigger tariff will tend to produce bigger effects on trade. For example, since the food industry has large existing tariffs, we should expect trade to increase significantly if these tariffs are removed.

It is also important to look at the size of the tariff being removed in relation to the total trade cost in an industry. If the total trade costs are small, then removing a tariff will have a greater effect. On the other hand, if trade costs are large, then removing a tariff that only constitutes a small portion of all trade costs will not have a very large effect on trade.

The pattern of comparative advantages will also affect changes in trade. Reducing trade costs allows comparative advantages to play a bigger role in determining the pattern of trade. The pattern of comparative advantages will have an especially strong effect on employment due to trade liberalization. Generally, a country with the comparative advantage will gain employment while the other country will lose employment.

Finally, with trade liberalization there will be trade diversion. For example, let's consider three countries, A, B, and C, with A importing good X from C before liberalization. If A reduces tariffs on X coming from B, then B may become a cheaper source for X in A, so trade will divert from C to B. There can potentially be large trade diversion due to Korea-China free-trade agreement because China currently has a free-trade agreement with ASEAN countries. It means that ASEAN countries, such as Malaysia, Philippines, and Indonesia currently enjoy low trade barriers in China while Korean goods are covered by tariffs. With Korea-China FTA, Korean goods will compete on a level playing field with the ASEAN countries in China. So at least some of the goods that China currently sources from the ASEAN countries will be sourced from Korea once the FTA is implemented. In addition, with Korea-China FTA, some of the goods that China currently buys from the U.S., especially Machinery goods, may be sourced from Korea once the FTA is implemented, since Korea and the U.S. are close competitors in Machinery.

Table 6 shows the effects of the Korea-China FTA on the bilateral manufacturing trade between the two countries. The model predicts that, everything else equal, the Korea-China FTA would increase Korea's manufacturing exports to China by 61.6% and China's manufacturing exports to Korea by 48.4%. The greatest increase in trade would occur in the Food industry. This is because the Food industry had the highest level of tariffs before the FTA. The second-highest trade increases would occur in the Textile industry, which was also heavily protected by tariffs before the FTA.

Table 6: Percent change in Korea-China manufacturing trade

Importer	Exporter	Food	Textile	Wood	Paper	Chemicals	Rubber	Nonmetals
China	Korea	303.0%	96.8%	16.7%	37.3%	40.4%	44.7%	92.6%
Korea	China	258.3%	50.1%	32.9%	2.7%	31.3%	48.8%	36.4%

Importer	Exporter	Metals	Metal products	Machinery other	Machinery e&c	Medical	Transport	**All manuf.**
China	Korea	28.6%	65.2%	24.1%	32.2%	66.6%	78.8%	**61.6%**
Korea	China	12.5%	17.0%	17.2%	22.3%	39.7%	12.3%	**48.4%**

Tables 8 shows what happens to specialization, measured by industry shares in total manufacturing employment, and welfare as the result of the FTA. Table 7 shows the specialization before the FTA. Table 9 presents percent changes in industry employments.

Looking at Table 7, we note that the current pattern of specialization is different in Korea and China. In Korea, the Electrical and Communications Machinery industry has the greatest share of manufacturing workers, 20.9%. The largest industry in China by this measure is Textile.

Tables 8 and 9 show that industry-level changes that occur due to the FTA are also different in Korea and China. For example in Korea, the Food industry shrinks significantly, while the Medical industry expands. In China, the Food industry grows while the Medical industry shrinks.

To understand what happens in the Food industry, we need to look at Tables 3 and 4, which show comparative advantages, and Table 5, which shows existing (pre-FTA) tariffs. From Table 5, we know that the Food industry has high existing tariffs. Therefore, we should expect a lot of new trade after FTA is implemented. This is what we see in Table 6. Tables 3 and 4 tell us that China has comparative advantage in Food: the productivity in Chinese Food industry is just a bit below that of the Korean Food industry, while generally, China's productivity is much lower than Korea's. Since China has comparative advantage in Food, production shifts to China when trade is liberalized. The employment in Chinese Food industry grows together with its share in Chinese manufacturing. Korean Food industry shrinks in terms of absolute employment as well as share of manufacturing.

Now, let's take a look at the Textile industry. Both Korea and China have relatively high tariffs in this industry, so there is a significant post-FTA increase in trade. Table 3 and especially Table 4 tell us that Korea has a comparative advantage in the Textile industry, though the advantage is moderate. Therefore, post-FTA Korea increases its specialization in Textile and employment in that industry grows. China decreases its specialization in Textile, but not much. Despite the decline of the share of Textile in total Chinese manufacturing, the employment in China's Textile industry grows a little because of the growth of total manufacturing employment.

Korea's comparative advantage is much more pronounced in the Rubber industry, where its productivity is nearly twice as high as China's. As the results of the FTA, production in that industry shifts to Korea. On the producer level, the Eaton-Kortum model implies the following. Korean producers that were not competitive in China pre-FTA can now out-compete the Chinese firms that make the same products. These Korean producers are more productive than the Chinese firms that they drive out of business, but less productive than the Korean producers that were exporting to China even before the FTA. As the results of the FTA, Korean exports to China of Rubber products increase, but exports become a smaller fraction of output. The mirror image of this happens in China: there is less output in the Rubber industry, but a greater fraction of output is exported.

In the Medical industry, the current total cost of importing goods from Korea to China is lower than the cost of importing from China to Korea. At the same time, tariff reductions that occur with the FTA are similar in both countries. This means that the FTA reduces trade costs from Korea to China proportionally more than the trade costs from China to Korea. This is one reason why Korea's exports to China in this industry increase more than China's exports to Korea.

Korea has a comparative advantage in the Medical industry, so specialization in this industry increases in Korea and decreases in China as the result of the FTA. In fact, Medical industry in Korea benefits the most from the FTA - its employment grows 13.46%. There is also significant trade diversion in the Medical industry due to the Korea-China FTA. A big portion of the increase in Korean exports to China come at the expense of the exports of ASEAN countries and some developed countries, such as Japan. For example, the employment in the Medical industry in

Philippines declines 6.58% as the result of the Korea-China FTA. In Japan, the employment in this industry declines 3.4%, in the U.S. 0.64%.

The FTA has positive overall effects on the Korean and Chinese economies. The last column of Table 9 shows that the total manufacturing employment grows in both countries, but more so in Korea. This means that labor shifts from agriculture and services to manufacturing. The last column of Table 8 shows the welfare effects of the FTA. Prices of manufacturing goods fall as the result of the FTA in both countries and, therefore, welfare increases. As typical in FTA analyses, our model predicts moderate (but permanent) welfare effects of the FTA: 0.18% in China and 0.27% in Korea.[14]

In terms of the importance for the economies involved, the Korea-China FTA ranks above the Korea-U.S. FTA. The Korea-China FTA increases bilateral trade by 56% and increases manufacturing employment by 5.67% in Korea and 0.55% in China. The Korea-U.S. FTA is projected to increase bilateral Korea-U.S. trade by 31%, manufacturing employment in Korea by 0.97% and the U.S. by 0.26%. The Korea-China FTA may be compared to NAFTA, which increased U.S.-Mexico trade by about 60-70%.

6 Conclusion

Korea-China free-trade agreement can potentially have a very significant impact on the economies of Korea, China, and even other countries. In this paper, we use a computable general equilibrium (CGE) model of the world economy to predict the economic effects of this agreement. Our model includes 53 countries and 15 industries and, unlike most other CGE models, uses the Eaton-Kortum methodology to explain intra-industry trade instead of the Armington assumption. This means that our industries are populated by many different producers instead of the representative producer. Consumers choose to buy from a producer that can out-compete others, rather than basing their decisions on the national origin of the producers. Technology and trade costs play key roles in our model in determining the patter of trade and specialization. The model that we use to predict the effects of the Korea-China FTA has been previously evaluated in several historical simulations, including NAFTA, and found to make accurate predictions.

We simulate the effects of Korea-China FTA by removing all existing tariffs on manufactured goods between the two countries. The simulation results show that the bilateral trade in manufactures between Korea and China increases 56% as the result of the FTA. The largest trade increases occur in the Food industry, which is currently the most protected.

There are also significant changes in specialization and industry employment driven mostly by the pattern of comparative advantages. In Korea, the Food industry contracts the most. Textile, Chemicals, Rubber, and Medical equipment industries expand. There is also trade diversion in some industries, especially from the ASEAN countries, but also from Japan and the United States.

We find large effects on the Korea economy as the result of the FTA. Prices of traded goods decrease as the result of the FTA and welfare increases. Manufacturing employment increases by 5.7% and there is a large reallocation of workers across industries. The Food industry looses almost 12% of its workforce while Medical equipment industry increases its workforce by 13.5%. We find that the Korea-China FTA can have greater effects on trade and employment of Korea than the Korea-U.S. FTA.

[14] The welfare effects do not account for any costs associated with retraining workers who change industries or any public assistance that those workers may require.

Table 7: Specialization before FTA

	Food	Textile	Wood	Paper	Chemicals	Rubber	Nonmetals	Metals	Metal products	Machinery other	Machinery e&c	Medical	Transport
Australia	21.0%	5.3%	3.5%	8.2%	6.8%	5.0%	6.3%	11.4%	8.3%	4.9%	4.3%	1.4%	7.3%
Brazil	13.7%	8.9%	2.7%	6.3%	7.3%	4.8%	4.6%	9.6%	7.2%	9.2%	7.9%	1.3%	10.6%
Chile	22.5%	3.2%	4.6%	7.0%	9.2%	3.2%	3.9%	34.0%	5.4%	2.3%	0.6%	0.3%	1.4%
China	**5.9%**	**19.3%**	**2.3%**	**4.2%**	**6.6%**	**3.3%**	**3.2%**	**7.1%**	**7.0%**	**13.0%**	**12.6%**	**1.4%**	**4.7%**
Colombia	23.0%	13.1%	2.5%	8.5%	6.8%	5.6%	6.7%	5.7%	6.7%	3.8%	2.4%	0.4%	5.6%
Czech Rep.	7.3%	4.6%	2.5%	4.4%	4.6%	5.9%	4.8%	8.9%	8.4%	15.5%	13.2%	1.7%	12.4%
France	13.4%	5.0%	2.2%	6.5%	9.9%	6.2%	4.6%	5.5%	7.6%	8.4%	9.9%	2.8%	13.2%
Germany	8.9%	2.6%	1.8%	6.0%	7.3%	6.0%	3.9%	7.6%	8.3%	14.6%	11.2%	3.1%	14.4%
Greece	20.8%	10.2%	2.9%	8.8%	4.8%	4.5%	8.1%	8.6%	10.0%	5.6%	6.2%	0.9%	2.9%
India	11.4%	17.4%	2.1%	5.5%	8.8%	4.9%	4.2%	7.2%	6.9%	7.7%	7.8%	1.2%	8.5%
Indonesia	13.3%	20.7%	5.1%	7.3%	5.8%	5.4%	4.1%	5.2%	5.0%	3.7%	10.4%	0.6%	6.2%
Ireland	7.3%	0.6%	1.2%	4.9%	53.5%	3.5%	2.1%	0.8%	2.6%	10.2%	4.7%	3.1%	0.5%
Israel	8.2%	4.5%	1.6%	4.8%	13.7%	4.5%	28.4%	2.5%	6.2%	6.1%	9.4%	4.1%	2.9%
Italy	10.0%	12.9%	2.2%	5.9%	6.6%	5.1%	5.0%	6.6%	8.3%	13.8%	8.4%	2.2%	6.1%
Japan	8.4%	3.4%	1.6%	5.5%	7.2%	5.7%	3.9%	8.0%	8.0%	14.6%	13.7%	2.5%	12.3%
Korea	**6.1%**	**7.0%**	**1.4%**	**4.6%**	**6.6%**	**6.2%**	**3.0%**	**7.7%**	**7.3%**	**10.9%**	**20.9%**	**2.8%**	**10.9%**
Malaysia	1.7%	2.0%	1.4%	1.7%	3.5%	3.2%	1.5%	3.9%	4.4%	13.5%	58.3%	1.0%	1.3%
Mexico	14.1%	9.4%	0.8%	3.8%	6.4%	2.6%	4.9%	5.5%	2.9%	13.2%	16.3%	2.5%	7.6%
New Zeal.	31.1%	4.7%	3.6%	8.3%	6.1%	3.8%	4.4%	7.7%	7.3%	7.5%	7.6%	2.4%	2.4%
Norway	16.7%	2.0%	2.3%	7.3%	8.9%	2.4%	4.5%	11.9%	5.8%	7.1%	4.5%	2.4%	7.3%
Philippines	5.0%	7.0%	0.8%	2.4%	3.5%	2.4%	2.5%	4.0%	4.8%	16.6%	42.4%	2.3%	3.1%
Portugal	12.4%	18.3%	5.0%	7.5%	5.2%	5.1%	6.8%	3.1%	7.6%	6.5%	11.7%	1.1%	5.2%
Russia	10.5%	5.4%	2.4%	5.5%	8.8%	3.7%	5.2%	18.7%	6.3%	6.8%	4.2%	1.9%	5.9%
South Af.	13.0%	5.9%	3.1%	5.9%	6.9%	4.3%	7.1%	18.8%	7.1%	6.1%	5.3%	0.8%	8.9%
Spain	14.9%	7.4%	2.6%	7.0%	7.4%	5.8%	6.0%	7.0%	8.1%	7.7%	8.1%	1.2%	10.7%
Sweden	7.6%	1.3%	2.6%	10.5%	7.6%	3.9%	3.5%	10.5%	8.4%	12.9%	12.4%	2.7%	12.6%
Turkey	13.3%	25.5%	2.2%	5.2%	5.2%	4.1%	5.4%	5.9%	6.6%	6.1%	7.3%	0.6%	7.7%
UK	13.6%	4.1%	2.3%	7.9%	10.3%	6.3%	4.5%	5.8%	8.5%	9.6%	6.9%	3.0%	10.6%
USA	14.0%	4.3%	2.5%	7.5%	8.4%	6.2%	4.3%	6.0%	8.3%	10.4%	8.4%	3.5%	10.1%
Vietnam	13.0%	41.4%	2.7%	3.7%	4.3%	2.9%	3.1%	1.7%	4.4%	2.7%	4.6%	0.6%	3.9%

Note: These are percents of manufacturing labor employed in each industry. Petroleum Products and Other industries are omitted. Each row adds up to 100%.

Note: Countries are selected based on their trade volumes with Korea. The results for all the countries in the dataset are in the Appendix.

Table 8: Percent change in specialization and welfare

	Food	Textile	Wood	Paper	Chemicals	Rubber	Nonmet.	Metals	Metal products	Mach. other	Mach. e&c	Medical	Transport	Welfare
Australia	-0.12%	-0.43%	-0.03%	0.17%	0.02%	0.05%	0.24%	0.13%	0.16%	0.08%	0.01%	-0.34%	0.26%	0.01%
Brazil	0.09%	-0.20%	-0.02%	0.09%	0.02%	0.02%	0.10%	-0.01%	0.05%	0.01%	-0.12%	-0.40%	0.10%	0.00%
Chile	-0.01%	-0.45%	-0.19%	0.09%	0.12%	0.01%	0.11%	0.04%	0.02%	0.04%	-0.11%	-0.35%	0.09%	0.01%
China	**3.71%**	**-0.26%**	**0.17%**	**-0.21%**	**-1.18%**	**-2.23%**	**0.05%**	**-0.09%**	**-0.39%**	**0.29%**	**0.51%**	**-2.72%**	**-1.07%**	**0.18%**
Colombia	0.10%	-0.32%	0.05%	0.11%	0.03%	0.01%	0.12%	0.04%	0.04%	0.03%	-0.14%	-0.31%	0.08%	0.01%
Czech Rep.	0.23%	-0.27%	-0.15%	0.14%	0.06%	0.07%	0.16%	0.00%	0.06%	0.05%	-0.08%	-0.32%	0.18%	0.01%
France	0.17%	-0.31%	-0.05%	0.13%	0.06%	0.06%	0.15%	0.00%	0.08%	0.01%	-0.11%	-0.41%	0.12%	0.01%
Germany	0.25%	-0.24%	-0.15%	0.17%	0.11%	0.07%	0.18%	0.03%	0.09%	0.04%	-0.08%	-0.72%	0.19%	0.01%
Greece	0.09%	-0.28%	0.05%	0.10%	0.00%	0.04%	0.10%	-0.04%	0.06%	0.03%	-0.06%	-0.18%	0.01%	0.01%
India	0.24%	-0.31%	0.01%	0.17%	0.00%	0.02%	0.18%	0.03%	0.13%	0.09%	-0.02%	-0.12%	0.22%	0.01%
Indonesia	0.45%	-0.23%	0.35%	0.32%	0.09%	0.17%	0.39%	-0.01%	0.17%	0.14%	0.18%	-1.71%	0.47%	0.01%
Ireland	0.20%	-0.28%	-0.29%	0.10%	0.09%	0.05%	0.13%	-0.06%	0.02%	0.04%	-0.22%	-0.40%	0.19%	0.01%
Israel	0.26%	-0.32%	-0.14%	0.16%	0.09%	0.07%	0.20%	-0.01%	0.09%	0.04%	-0.08%	-1.09%	0.20%	0.01%
Italy	0.23%	-0.35%	-0.02%	0.16%	0.08%	0.10%	0.19%	0.02%	0.11%	0.08%	-0.02%	-0.28%	0.19%	0.00%
Japan	0.55%	-0.53%	-0.74%	0.37%	0.31%	0.21%	0.42%	0.18%	0.25%	0.31%	0.15%	-2.79%	0.53%	0.01%
Korea	**-15.15%**	**6.54%**	**8.86%**	**-0.91%**	**4.34%**	**4.22%**	**-2.76%**	**1.01%**	**0.87%**	**-1.31%**	**-0.18%**	**9.20%**	**-1.36%**	**0.27%**
Malaysia	0.30%	-0.36%	-0.04%	0.05%	0.00%	-0.13%	0.11%	-0.01%	0.05%	0.39%	0.08%	-1.72%	0.30%	0.01%
Mexico	0.20%	-0.39%	-0.02%	0.14%	0.07%	0.05%	0.15%	-0.01%	0.03%	0.06%	-0.06%	-0.05%	0.14%	0.01%
New Zeal.	-0.12%	-0.46%	-0.13%	0.16%	0.14%	0.07%	0.24%	0.08%	0.15%	0.12%	0.10%	0.09%	0.28%	0.01%
Norway	0.11%	-0.36%	-0.02%	0.09%	-0.02%	0.00%	0.10%	-0.08%	0.04%	0.01%	-0.13%	-0.29%	0.09%	0.01%
Philippines	0.42%	0.18%	-0.92%	0.38%	0.20%	0.10%	0.53%	0.19%	0.26%	0.62%	0.32%	-5.57%	0.87%	0.01%
Portugal	0.21%	-0.32%	0.05%	0.16%	0.06%	0.11%	0.18%	0.05%	0.12%	0.00%	-0.07%	-0.08%	0.17%	0.00%
Russia	0.05%	-0.20%	0.02%	0.10%	-0.04%	-0.02%	0.11%	-0.04%	0.04%	0.05%	-0.11%	-0.04%	0.10%	0.01%
South Af.	0.13%	-0.32%	-0.13%	0.12%	0.01%	0.03%	0.10%	-0.05%	0.05%	0.02%	-0.08%	-0.31%	0.14%	0.01%
Spain	0.12%	-0.28%	0.00%	0.10%	0.01%	0.02%	0.11%	-0.02%	0.06%	0.01%	-0.09%	-0.29%	0.10%	0.01%
Sweden	0.21%	-0.31%	-0.06%	0.13%	0.07%	0.06%	0.15%	0.00%	0.06%	0.01%	-0.14%	-0.41%	0.15%	0.01%
Turkey	0.22%	-0.30%	0.09%	0.17%	0.03%	0.11%	0.20%	0.06%	0.13%	0.10%	-0.01%	-0.20%	0.19%	0.01%
UK	0.15%	-0.31%	-0.02%	0.13%	0.05%	0.07%	0.13%	-0.01%	0.06%	-0.01%	-0.12%	-0.54%	0.15%	0.01%
USA	0.19%	-0.37%	-0.05%	0.16%	0.11%	0.07%	0.17%	0.01%	0.07%	0.01%	-0.13%	-0.40%	0.18%	0.01%
Vietnam	0.12%	-0.13%	0.17%	0.25%	-0.01%	-0.07%	0.49%	0.02%	0.30%	0.34%	0.26%	-0.52%	0.46%	0.01%

Note: Specialization is fraction of manufacturing workers employes in a particular industry. The numbers in the table above represent percent changes in these fractions. Petroleum Products and Other industries are omitted.

Note: Countries are selected based on their trade volumes with Korea. The results for all the countries in the dataset are in the Appendix.

Table 9: Percent change in industry employment

	Food	Textile	Wood	Paper	Chemicals	Rubber	Nonmet.	Metals	Metal products	Mach. other	Mach. e&c	Medical	Transport	All manuf.
Australia	-0.43%	-0.75%	-0.35%	-0.14%	-0.29%	-0.26%	-0.07%	-0.19%	-0.16%	-0.23%	-0.30%	-0.65%	-0.06%	-0.31%
Brazil	-0.06%	-0.35%	-0.17%	-0.06%	-0.13%	-0.12%	-0.05%	-0.15%	-0.10%	-0.14%	-0.27%	-0.54%	-0.05%	-0.15%
Chile	-0.19%	-0.63%	-0.36%	-0.08%	-0.06%	-0.16%	-0.06%	-0.14%	-0.15%	-0.13%	-0.29%	-0.53%	-0.08%	-0.18%
China	**4.28%**	**0.28%**	**0.72%**	**0.33%**	**-0.63%**	**-1.70%**	**0.60%**	**0.46%**	**0.16%**	**0.84%**	**1.06%**	**-2.19%**	**-0.53%**	**0.55%**
Colombia	-0.06%	-0.49%	-0.12%	-0.05%	-0.14%	-0.15%	-0.04%	-0.12%	-0.12%	-0.13%	-0.30%	-0.47%	-0.08%	-0.16%
Czech Rep.	-0.02%	-0.51%	-0.39%	-0.11%	-0.19%	-0.17%	-0.09%	-0.24%	-0.18%	-0.20%	-0.33%	-0.57%	-0.07%	-0.25%
France	-0.04%	-0.51%	-0.26%	-0.07%	-0.15%	-0.14%	-0.06%	-0.21%	-0.13%	-0.19%	-0.31%	-0.62%	-0.08%	-0.21%
Germany	-0.02%	-0.51%	-0.43%	-0.10%	-0.17%	-0.20%	-0.09%	-0.24%	-0.19%	-0.23%	-0.35%	-0.99%	-0.09%	-0.27%
Greece	-0.05%	-0.42%	-0.09%	-0.03%	-0.14%	-0.09%	-0.04%	-0.17%	-0.08%	-0.11%	-0.20%	-0.31%	-0.13%	-0.14%
India	-0.03%	-0.58%	-0.26%	-0.11%	-0.28%	-0.25%	-0.09%	-0.24%	-0.15%	-0.19%	-0.29%	-0.40%	-0.05%	-0.27%
Indonesia	-0.10%	-0.77%	-0.20%	-0.23%	-0.46%	-0.38%	-0.16%	-0.56%	-0.38%	-0.41%	-0.37%	-2.25%	-0.08%	-0.55%
Ireland	-0.06%	-0.54%	-0.54%	-0.15%	-0.16%	-0.20%	-0.13%	-0.32%	-0.24%	-0.21%	-0.47%	-0.65%	-0.07%	-0.25%
Israel	-0.03%	-0.61%	-0.42%	-0.12%	-0.19%	-0.21%	-0.08%	-0.29%	-0.20%	-0.24%	-0.37%	-1.37%	-0.08%	-0.28%
Italy	-0.03%	-0.61%	-0.28%	-0.09%	-0.18%	-0.16%	-0.07%	-0.24%	-0.15%	-0.18%	-0.28%	-0.54%	-0.06%	-0.26%
Japan	-0.07%	-1.15%	-1.35%	-0.26%	-0.31%	-0.41%	-0.20%	-0.44%	-0.37%	-0.31%	-0.47%	-3.40%	-0.09%	-0.62%
Korea	**-11.83%**	**10.71%**	**13.12%**	**2.97%**	**8.42%**	**8.29%**	**1.04%**	**4.96%**	**4.81%**	**2.55%**	**3.72%**	**13.46%**	**2.49%**	**5.67%**
Malaysia	-0.29%	-0.95%	-0.64%	-0.54%	-0.59%	-0.72%	-0.48%	-0.60%	-0.54%	-0.20%	-0.51%	-2.30%	-0.30%	-0.59%
Mexico	-0.02%	-0.61%	-0.24%	-0.08%	-0.15%	-0.17%	-0.07%	-0.24%	-0.19%	-0.16%	-0.28%	-0.27%	-0.08%	-0.22%
New Zeal.	-0.45%	-0.79%	-0.46%	-0.16%	-0.19%	-0.26%	-0.09%	-0.25%	-0.18%	-0.20%	-0.23%	-0.23%	-0.05%	-0.33%
Norway	-0.04%	-0.51%	-0.17%	-0.05%	-0.17%	-0.14%	-0.05%	-0.23%	-0.11%	-0.13%	-0.27%	-0.44%	-0.05%	-0.15%
Philippines	-0.66%	-0.90%	-1.98%	-0.70%	-0.88%	-0.97%	-0.55%	-0.88%	-0.81%	-0.45%	-0.75%	-6.58%	-0.21%	-1.07%
Portugal	-0.02%	-0.56%	-0.19%	-0.07%	-0.17%	-0.13%	-0.05%	-0.18%	-0.11%	-0.24%	-0.30%	-0.32%	-0.07%	-0.24%
Russia	-0.13%	-0.38%	-0.16%	-0.08%	-0.21%	-0.19%	-0.07%	-0.21%	-0.14%	-0.13%	-0.28%	-0.22%	-0.08%	-0.17%
South Af.	-0.06%	-0.50%	-0.32%	-0.07%	-0.17%	-0.15%	-0.09%	-0.24%	-0.13%	-0.17%	-0.26%	-0.50%	-0.05%	-0.19%
Spain	-0.05%	-0.44%	-0.17%	-0.06%	-0.15%	-0.14%	-0.05%	-0.19%	-0.10%	-0.15%	-0.25%	-0.45%	-0.06%	-0.16%
Sweden	-0.02%	-0.54%	-0.29%	-0.10%	-0.17%	-0.18%	-0.08%	-0.23%	-0.17%	-0.22%	-0.37%	-0.64%	-0.09%	-0.23%
Turkey	-0.04%	-0.55%	-0.17%	-0.09%	-0.23%	-0.15%	-0.06%	-0.20%	-0.13%	-0.16%	-0.27%	-0.46%	-0.07%	-0.26%
UK	-0.05%	-0.51%	-0.22%	-0.07%	-0.16%	-0.13%	-0.07%	-0.21%	-0.15%	-0.21%	-0.32%	-0.74%	-0.05%	-0.20%
USA	-0.05%	-0.61%	-0.29%	-0.09%	-0.13%	-0.17%	-0.07%	-0.23%	-0.18%	-0.23%	-0.37%	-0.64%	-0.06%	-0.24%
Vietnam	-0.55%	-0.80%	-0.50%	-0.42%	-0.67%	-0.74%	-0.18%	-0.65%	-0.36%	-0.33%	-0.41%	-1.18%	-0.21%	-0.67%

Note: Petroleum Products and Other industries are omitted.

Note: Countries are selected based on their trade volumes with Korea. The results for all the countries in the dataset are in the Appendix.

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