What is the effect of the Korea-US Free Trade Agreement on Global Value Chains?

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Abstract

This paper finds that the Korea-US Free Trade Agreement (FTA) increased US auto imports from Korea on average by $4.8 billion per year and decreased US agriculture exports to Korea by $0.7 billion per year using synthetic controls to estimate the treatment effect. However, when evaluating the treatment effect on the share of trade that is part of a global value chain (GVC), I find that for US auto imports from Korea, the FTA increased the share of both GVC and non-GVC trade by 0.3 percentage points. For US agriculture exports to Korea, it decreased the share of GVC trade by 3.3 percentage points and increased the share of non-GVC trade by 2.2 percentage points. Interestingly for both sectors, after the FTA the trend of the share of GVC trade in exports changed from an upward trend to a downward trend suggesting that the FTA changed the nature of the trade to more non-GVC intensive and less GVC intensive. These findings suggest that evaluating the effects of an FTA on only exports and imports completely misses the effects FTAs have on trade that is involved in global value chains.

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1 Introduction

While the contributions of Global Value Chains (GVC) to trade efficiency and economic development are widely recognized, little is known about how policy changes affect GVCs. This paper examines one major policy change, the Korea-US Free Trade Agreement (KORUS FTA). While market opening measures like KORUS should generally stimulate GVCs, the paper's results are unexpectedly mixed. Interestingly, this FTA made some trade more intensive in non-GVC (primarily final) goods, and less intensive in GVC (primary intermediate) goods. These findings suggest that some FTAs, possibly by design, simplify trade and reduce the importance of GVCs, rather than increase the complexity of trade and the importance of GVCs.

This is an important empirical question for two reasons. First, the KORUS FTA is the second-largest US FTA by trade flows meaning that it is a significant FTA. Second, GVCs allow countries to transfer technology or "know-how" and enable developing countries to benefit by allowing them to participate in trade that they otherwise would not have been able to (Bank, 2019; WTO, 2019). Additionally, GVC trade generates more productive jobs as production becomes more efficient as countries are able to take advantage of their comparative advantage (Constantinescu et al., 2019; Xing et al., 2021).

An FTA can affect GVC trade for two reasons. First, FTAs serve to reduce these border barriers through lower tariff rates and non-tariff barriers such as more transparent customs and regulations. Since GVC trade encounters multiple border barriers, a reduction in these barriers could have a large impact (Miroudot et al., 2013; Blanchard et al., 2016). Second, FTAs provide stable trade environments through long-term commitments agreed in the pro- visions encouraging firms to invest in long-term relationships (Baccini et al., 2021; Ruta, 2017; Laget et al., 2020). GVCs require such stable trade environments since they involve several firms across several countries. On the other hand, FTAs could increase non-GVC trade simply due to lower tariffs and non-tariff barriers between the US and Korea (Cavallo et al., 2021; Amiti et al., 2019). Lower tariffs translate to lower prices which increase demand for that product (Edwards, 1993; Wacziarg and Welch, 2008; Dornbusch, 1992). If an FTA privileges final goods, it makes value chains that were based on protection no longer nec- essary. Final goods liberalization may cut off intermediate goods trade that jumped tariffs before liberalization. Thus GVC trade can be hurt or helped depending on where the liber- alization takes place. Many studies have examined the relationship between FTAs and GVC trade. However, few have empirically estimated the effects on

GVC trade. The contribution of this paper is to provide an empirical estimate of the effect of the KORUS FTA on GVC trade between the US and Korea.

To assess how GVC trade was affected by the KORUS FTA, I evaluate using value-added accounting versus traditional trade statistics since trade statistics double count the same value-added when global value chains are involved (Hummels et al., 2001; Johnson and Noguera, 2012; Koopman et al., 2014; OECD, 2012). Using value-added accounting gross exports can be broken down into GVC trade and non-GVC trade. When gross exports in- crease it could be due to non-GVC trade increasing, GVC trade increasing, or a combination of both (Borin and Mancini, 2015; Antràs and Chor, 2021). Thus it is an empirical question of how an FTA affects GVC trade.

2 KORUS FTA Institutional Details

US-Korea trade is asymmetric with the US running a trade deficit with Korea, and US negotiators were especially interested in gaining market access where they thought US exports could perform better. After lengthy negotiations and political debates in both countries, the KORUS FTA entered into force in March 2012 (Williams et al., 2014). [1] Given US interests, the FTA's focus was primarily on the agriculture and auto sectors. However, the FTA also reduced and eliminated both tariff and non-tariff barriers and made regulations more transparent across several sectors (USITC, 2007; Cooper et al., 2011). This paper focuses on autos, agriculture, and electronics because they are important quantitatively and also qualitatively to the negotiators.

The US' goal for the FTA was to remove barriers to the South Korean auto and agriculture markets. South Korea's agricultural market was known to be the most closed among the OECD members. Korea also used regulation and standard-setting to discriminate against foreign firms in the auto sector. On the flip side, Korea sought to increase its national competitiveness by opening up its closed markets and gain greater access to US markets in autos and other manufactured goods schott2010korus.

[1] The agreement was first signed in 2007, but the US Congress failed to ratify its original form. A revised agreement was then signed in 2011.

2.1 Economic Setting of KORUS FTA

Table 1 lists the top 10 export and import partners for the US in 2012. It shows that South Korea is the 8th largest export partner and 6th largest import partner with a 2.7% and 2.6% of export and import share respectively. This shows that South Korea is an important trading partner for the US aside from its fellow NAFTA members, Canada and Mexico.

Table 1: US Export and Import Partners 2012

Rank	Export Partner	Export	Export Share (%)	Import Partner	Import	Import Share (%)
	World	1545	100	World	2274	100
1	Canada	293	18.9	China	426	18.7
2	Mexico	216	14.0	Canada	323	14.2
3	China	111	7.2	Mexico	278	12.2
4	Japan	70	4.5	Japan	146	6.4
5	United Kingdom	55	3.6	Germany	109	4.8
6	Germany	48	3.1	**Korea, Rep.**	59	2.6
7	Brazil	44	2.8	Saudi Arabia	56	2.5
8	**Korea, Rep.**	42	2.7	United Kingdom	55	2.4
9	Netherlands	41	2.6	France	42	1.8
10	Hong Kong	37	2.4	India	41	1.8

Export and Imports in billions of $

Source: WITS

Table 2 shows Korea's top 10 export and import partners. The US is its 2nd largest export partner and 3rd largest import partner with a 10.7% and 8.4% of export and import share respectively. This shows that Korea is much more dependent on the US. Notably, for both the US and Korea, China is the largest import partner.

Table 2: Korea Export and Import Partners

Rank	Export Partner	Export	Export Share (%)	Import Partner	Import	Import Share (%)
	World	548	100	World	520	100
1	China	134	24.5	China	81	15.6
2	**United States**	59	10.7	Japan	64	12.4
3	Japan	39	7.1	**United States**	44	8.4
4	Hong Kong	33	6.0	Saudi Arabia	40	7.6
5	Singapore	23	4.2	Qatar	26	4.9
6	Vietnam	16	2.9	Australia	23	4.4
7	Indonesia	14	2.6	Kuwait	18	3.5
8	India	12	2.2	Germany	18	3.4
9	Russia	11	2.0	Indonesia	16	3.0
10	Brazil	10	1.9	UAE	15	2.9

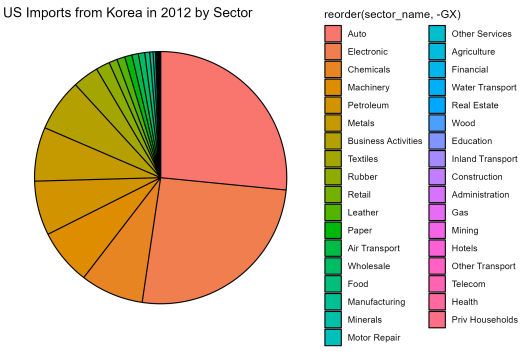
Export and Imports in billions of $

Source: WITS

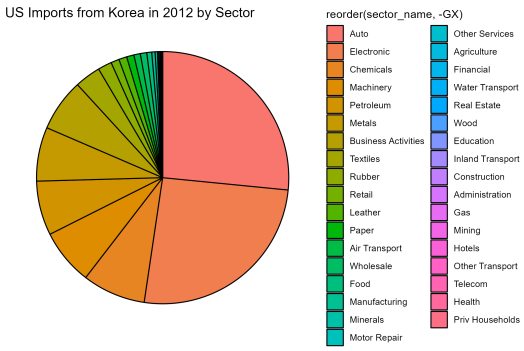
Figure 1a shows the US' main export sectors to Korea. Business Activity is number one primarily involving lending of aircrafts to Korea. Although I only consider manufacturing sectors in this paper, it is worth noting that service sectors are also affected by the FTA and a topic for a separate paper. The next largest export sectors are chemicals, electronics, and autos. This is why I choose to focus on electronics and autos. I also focus on the agriculture sector because the FTA focused on the agriculture sector. Figure 1b shows US' main import sectors from Korea. Again, autos and electronics are two of the largest sectors.

Approximately, 30% of US exports is represented by autos, agriculture, and electronics. For Korean exports, more than 50% of trade is represented by these three sectors. Note that the US agriculture import from Korea is negligible and thus omitted from the analysis. These trade patterns had a large impact on the agenda for the KORUS agreement for the US as the dominant trade partner but also for Korea which is highly dependent on the US for its exports.

Figure 1: Major Sectors of US-Korea Trade



(a) US Exports to Korea



(b) US Imports from Korea

2.2 Sectoral Provisions of KORUS FTA

The KORUS provision on autos included measures that directly affect both GVC and non-GVC trade. The FTA eliminated duties on virtually all auto parts. For US imports from Korea, the 2.5% tariff was set to be eliminated in 2016 while the 25% tariff on light trucks was to be phased out from 2019-2022. These provisions were later revised by President Trump in 2019. For US exports to Korea, the 8% tariff was reduced to 4% and eliminated in 2016 and the 10% tariff on trucks was eliminated. In addition to the tariff provisions, the FTA made Korean regulations more transparent and harmonized safety and environmental standards. It also allowed 25,000 cars per automaker to be self-certified by US federal safety standards and bypass Korean safety standards. Finally, it reduced the engine displacement tax which discriminated against larger US engines, and created the Automotive Working Group which could discuss further issues relating to regulation and safety standards. These provisions did not affect the 700,000 Korean cars that were assembled each year in Hyundai and Kia plants in the US.

As the largest market for US oranges and 5th largest market overall for US agriculture with a value of $5 billion, South Korea agreed to grant duty-free status to two-thirds of current US agricultural exports as part of the agreement. Tariffs and import quotas on the

remaining agricultural goods will also be phased out within 10 years. Additionally, South Korea will eliminate its 40% tariff on beef imported from the US over a 15 year period and phase out its 25% tariff on frozen pork in 2016.

The FTA did not have much on tariffs on electronic products because the Multilateral Information Technology Agreement already eliminated tariffs on most electronic products before the FTA. However, it did provide some improvements on non-tariff measures such as intellectual property protection, government procurement, and competition policy.

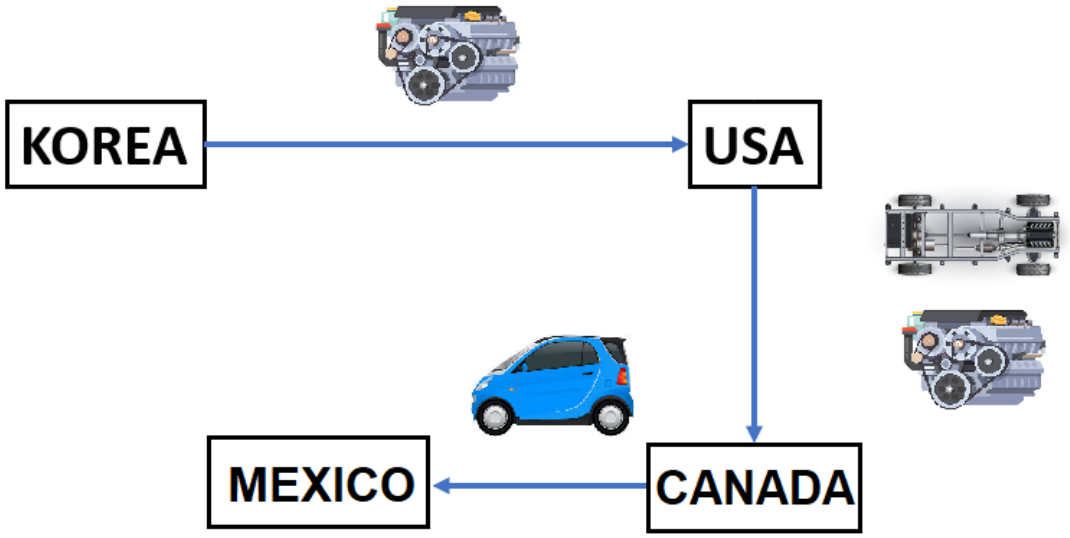
My results show that these provisions had significant effects for the auto and agriculture sector but not the electronics sector. The agreement appears to have temporarily increased US auto exports to Korea as well as increased US auto imports from Korea. Interestingly, the provisions for US agriculture seem to have decreased gross exports to Korea when the intended effect was to increase exports. It appears, that despite the more favorable conditions for US agricultural exports to Korea, Korean consumers still did not choose to consume US agricultural products as this was a highly contentious point for the Korean public not wanting US beef due to mad cow disease.

3 Global Value Chains

3.1 What is GVC trade?

In a global value chain, countries do not produce the whole product but production is fragmented across several countries. For example, Figure 2 shows Korea exporting a car engine. The US produces a car chassis, adds the engine from Korea, and exports them to Canada. Canada takes that and finishes the car and exports the finished car to Mexico. So no one country produces the car by itself but participates in a specific task. In this example, the Korea, US, and Canada trade are all GVC trade.

Figure 2: Global Value Chain Diagram



Bank (2019)

3.2 How do we measure GVC trade?

The measure used most widely in the literature defines GVC trade as trade in products with components that have crossed at least 2 borders (Borin and Mancini, 2015, 2019). Note that in the example above there were multiple border crossings before the car was finished. Although it is not the most precise measure, it does provide tractability and an intuitive approach to measuring GVC trade in the data.

In Figure 3, the green trade flows that cross two borders are considered GVC trade. At the bottom of the figure, Korea imports value-added from other countries and re-exports it to the US which then goes to the rest of the world (ROW). This value-added is already counted as GVC trade since it has already crossed two borders. Directly absorbed value-added export (DAVAX) is non-GVC trade and is shown by the orange line. It is the value-added that originates from Korea and is exported to the US and remains in the US. Since this trade crosses only one border it is counted as non-GVC trade. However, if the US takes the value-added from Korea and re-exports it to the rest of the world (ROW), then it is considered GVC trade. The total value-added that is embedded in Korea's exports

is defined as value-added in export (VAX) and contains both non-GVC and GVC exports that originate from Korea. Gross exports (GX) is the sum of all the trade flows out of Korea that crosses the US border and is also the sum of GVC and DAVAX. In practice, GVC is calculated by subtracting DAVAX from GX.

Figure 3: GVC vs DAVAX

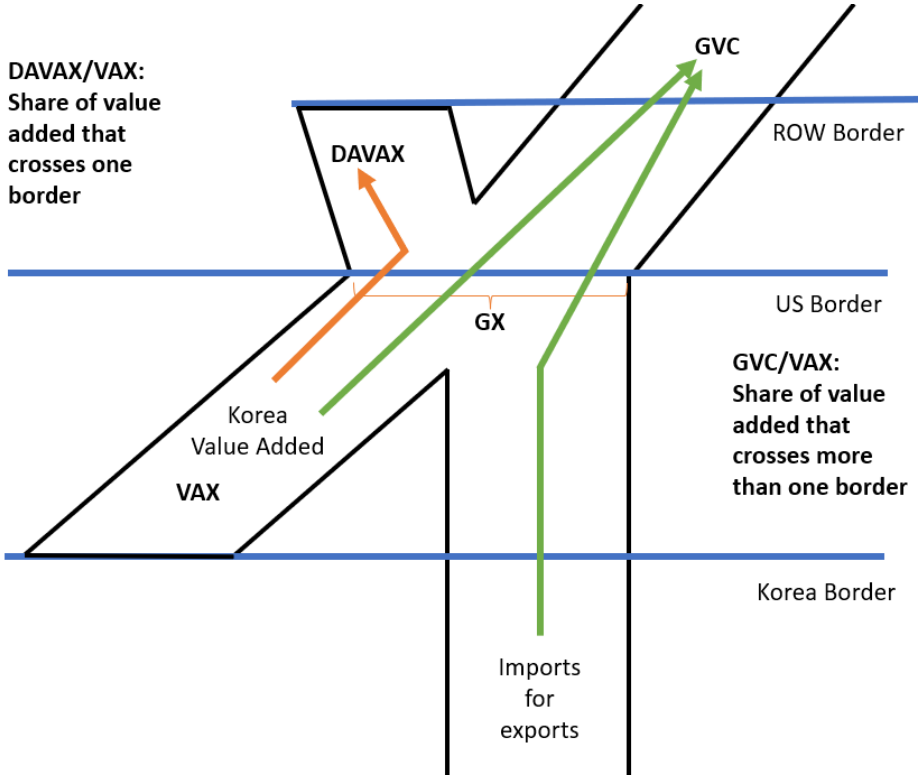
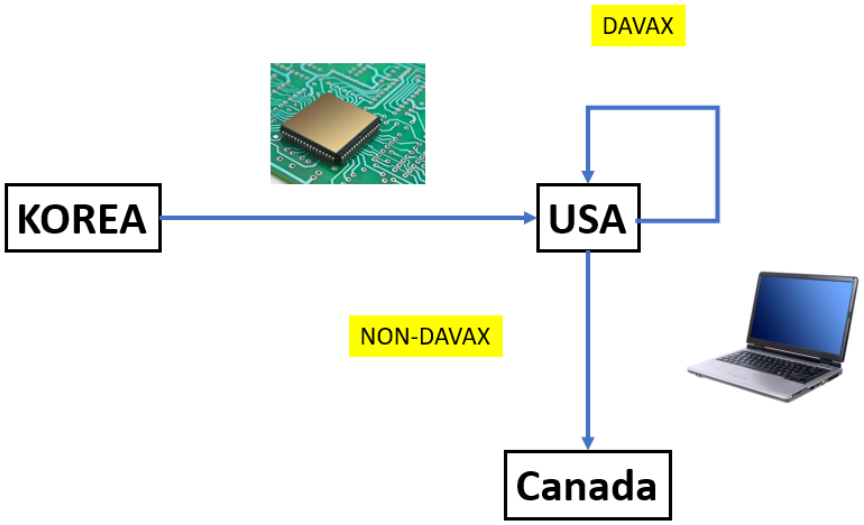


Figure 4 provides a real-world example of Figure 4. Korea exports a computer chip to the US. Suppose the US takes this computer chip to make a laptop and sells it to a domestic consumer. Then this value added is counted as DAVAX or non-GVC trade. If the US instead exports this laptop to Canada then the Korean value added from this computer chip is considered GVC trade.

Figure 4: DAVAX Example



4 Data

The data used to calculate the GVC measures come from Multi-Regional Input-Output (MRIO) tables which are built from Input-Output tables and international trade data by several organizations (Dietzenbacher et al., 2013; Timmer et al., 2015). I use the World Input-Output Database (WIOD) 2013 release for 1995-2006 and the Asian Development Bank (ADB) Multi-Region Input-Output (MRIO) tables for 2007-2018. I use two sources since the WIOD only goes up to 2014 while the ADB tables extend to 2021. The two sources are comparable since the ADB tables are constructed using the WIOD tables and extended to include more countries and years. Combining both datasets I have data from 40 countries and 35 industries from 1995-2018. I cut off my analysis in 2018 due to data issues and President Trump's renegotiations of the KORUS FTA in 2019.

Figure 5 shows an example of a two-country MRIO table. The unit of observation is a country-industry. Columns report the inputs used by country-industries while rows report inputs supplied by country-industries. For example, the first cell indicates that Korea's agriculture industry uses 10 units of input from Korea's agriculture industry. The cell below tells us that it uses 15 units of input from Korea's steel industry. Adding down

the column sums all the input uses from each country-industry and the value-added that Korea's agriculture sector uses and is equal to Korea's agriculture sector's total use of inputs. Adding across the row sums all the input supplied by Korea's agriculture sector and the final use by all country's households and is equal to Korea's agriculture sector's gross output. There are two identities. First, the total value of inputs is equal to the total value of gross output. This holds because any potential difference is accounted for as a profit or loss in value added. Second, gross output equals total use which holds because any difference is included as inventory accumulation or depreciation in the final use columns.

Figure 5: Input-Output Example

			Input Use						Final use		Total use
			Korea	Korea	Korea	USA	USA	USA	Korea	USA	
			Agri	Steel	Auto	Agri	Steel	Auto	Household	Household	
Inputs Supplied	Korea	Agri	10	0	10	5	0	30	20	20	95
	Korea	Steel	15	50	20	30	20	45	10	5	195
	Korea	Auto	0	0	40	5	10	40	30	25	150
	USA	Agri	10	0	0	20	0	0	20	40	90
	USA	Steel	20	30	10	10	20	40	20	10	160
	USA	Auto	0	5	55	10	30	60	10	55	225
	Value added		40	110	15	10	80	10			
	Gross output		95	195	150	90	160	225			

4.1 Calculation of GVC measures

In this section, calculations for gross exports, the share of GVC trade in exports, and the share of non-GVC trade in exports are shown using the two-country MRIO example above. Equations are drawn from Borin and Mancini (2019).

In Equation 1, GX_{KORUS}, the gross export from Korea to the US is a 3x1 vector since there are 3 sectors.

$$GX_{KORUS} = A_{KORUS}X_{US} + Y_{KORUS} \tag{1}$$

A_{KORUS} is the direct requirements coefficient matrix and is the dark blue matrix divided by the transpose of the yellow column vector, the total output of the US denoted by

X_{US}. So multiplying A_{KORUS} by X_{US} would give us the values in the dark blue matrix. For example, the first cell of the darker blue matrix divided by the first cell of the yellow vector is 5/90. This is the value of input from Korea-Agriculture that is used to produce $1 of output for US-Agriculture. Adding the final use columns, the darker green column vector, denoted by Y_{KORUS} to $A_{KORUS}X_{US}$ gives us the gross export from the US to Korea (GX_{KORUS}).

Equation 2 calculates $DAVAX_{KORUS}$, the non-GVC trade that only crosses one border.

$$\begin{aligned}\mathbf{DAVAX}_{KORUS} &= \mathbf{V}_{KOR}\left(\mathbf{I}-\mathbf{A}_{KORKOR}\right)^{-1}\mathbf{Y}_{KORUS} \\ &+ \mathbf{V}_{KOR}\left(\mathbf{I}-\mathbf{A}_{KORKOR}\right)^{-1}\mathbf{A}_{KORUS}\left(\mathbf{I}-\mathbf{A}_{USUS}\right)^{-1}\mathbf{Y}_{USUS}\end{aligned} \tag{2}$$

This is the orange trade flow in Figure 3. The first term captures the value-added that originates from Korea and is directly consumed in the US. V_{KOR} is the value-added that originates from Korea, the purple 1x3 vector. Multiplying this vector by $(I-A_{KORKOR})^{-1}$ allocates the value-added used to produce the final goods that are exported to Korea and immediately consumed. I is a 3x3 by identity matrix and A_{KORKOR} is the grey matrix. The second term does something similar except it is value-added that the US uses to produce final goods for its domestic consumers. This is still non-GVC trade because it does not leave the US and thus still crosses only one border.

From these results, GVC trade can be calculated as gross exports (GX) net of DAVAX (Equation 3).

$$GVC_{KORUS} = GX_{KORUS} - DAVAX_{KORUS} \tag{3}$$

By subtracting DAVAX, what is left is the value-added that crosses at least two borders. Though related, the relationship between GVC and DAVAX is not fixed. GVC will not always decrease when DAVAX increases depending on what happens with GX. Suppose GX increases by more than the amount DAVAX increases, then GVC will also increase.

Finally, Equation 4 calculates value-added exports (VAX).

$$\mathbf{VAX}_{KORUS} = \mathbf{V}_{KOR}\left(\mathbf{I} - \mathbf{A}_{KORKOR}\right)^{-1}\Big[\mathbf{Y}_{KORUS} + \mathbf{A}_{KORUS}\left(\mathbf{I} - \mathbf{A}_{USUS}\right)^{-1}\mathbf{Y}_{USUS}$$
$$+ \mathbf{A}_{KORUS}\left(\mathbf{I} - \mathbf{A}_{USUS}\right)^{-1}\sum_{j\neq US,KOR}^{G}\mathbf{Y}_{USj}$$
$$+\mathbf{A}_{KORUS}\left(\mathbf{I} - \mathbf{A}_{USUS}\right)^{-1}\sum_{j\neq US}^{G}\mathbf{A}_{USj}\sum_{k}^{G}\sum_{l\neq KOR}^{G}\mathbf{B}_{jk}\mathbf{Y}_{kl}\Big] \tag{4}$$

The first two terms in the bracket are actually DAVAX when $V_{KOR}(1 - A_{KORKOR})^{-1}$ is distributed. This is because DAVAX is a subset of VAX. The two remaining terms take into account the value added from further re-exports by the US to other countries that are not Korea as well as whatever re-exports that those countries may do. I do not go into the details of this calculation since it is well outlined in Borin and Mancini (2019). Intuitively, as with Equation 2, Equation 4 assigns the value-added originating from Korea (V_{KOR}) to all its exports, and the sum is equal to VAX_{KORUS}. The share of GVC trade in exports is GVC/VAX and the share of non-GVC trade in exports is DAVAX/VAX.

5 Estimation Strategy

I use synthetic controls methodology to estimate the effects of the KORUS FTA (the treatment effect) on GVC and trade outcomes (Abadie et al., 2010; Arkhangelsky et al., 2019; Abadie, 2021). Using time series data of the three calculated outcomes, I assess how they evolve differently from bilateral trade flows that are not affected by the provisions of the KORUS FTA. The synthetic controls method is a variation of the difference in difference estimation technique. It creates a synthetic control that is most similar to the treated unit by taking a cleverly weighted average of variable in the control group or donor pool.

For US exports to South Korea, the donor pool of variables consists of US exports to partners that are not South Korean, and South Korean imports from partners that are not the US. For example, US exports to Mexico and South Korean imports from Japan would be in the donor pool. I limit the donor pool in this manner because I want to find bilateral trade pairs that resemble US exports to Korea the most. For US imports from Korea, the donor pool consists of US import partners that are not South Korean and Korean export

partners that are not the US. This setup holds all sectors. For both exports and imports, I exclude any country pairs that signed an FTA during this time period so that changes observed in the control group cannot be attributed to the signing of an FTA. [2]

$$\tau_{1t} = Y_{1t}^T - Y_{1t}^C \tag{5}$$

τ_{1t} is the treatment effect that I want to estimate. In an ideal setting, I would observe both the treated outcome of GVC trade between US and Korea Y_{1t}^T and the untreated outcome Y_{1t}^C and take the difference to get the treatment effect. However, I only observe the treated outcome. This is where the synthetic control comes in. The synthetic control provides the closest estimate of the unobserved untreated outcome, what would have happened to GVC trade in the absence of the FTA (Y_{1t}^C).

The synthetic control is constructed by choosing weights to minimize the difference between the pre-treatment attributes of the treated unit and pre-treatment attributes of the non-treated unit. The goal is to match the attributes of the treated unit using a weighted average of the non-treated units. The pre-treatment attributes I use are foreign value-added (FVA), domestic value-added (DVA), VAX, GDP, and several lags of the outcome variable. FVA is the value-added generated outside the exporting country and DVA is the value-added generated in the exporting country. I use FVA, DVA, and VAX so that the synthetic control has a similar size of value added in its GVC trade as the treated unit. GDP is included to match the size of the economy of the destination country. Formally, let X_1 be the kx1 vector of k pre-treatment attributes of the treated unit and X_0 be a kxJ matrix of k pre-treatment attributes of J non-treated units. Then a Jx1 vector of weights, W, is chosen to minimize

$$||X_1 - X_0 W|| \tag{6}$$

There are several ways to minimize this difference. The method I employ is from Abadie et al. (2010) and is similar to minimizing the sum of least squares. A separate set of weights, v_h, which captures the predictive power of each predictor is generated by data-driven methods to minimize the difference. The specific weights used are included in the appendix.

[2] The KORUS FTA may affect bilateral pairs in the donor pool and violate the independence assumption. However, the provisions of the KORUS FTA target very specific US-Korea bilateral flows and would not change trade with other partners significantly. I plan to do a gravity estimation as a robustness check.

$$\|\boldsymbol{X}_1 - \boldsymbol{X}_0\boldsymbol{W}\| = \left(\sum_{h=1}^{k} v_h \left(X_{h1} - w_2 X_{h2} - \cdots - w_{J+1} X_{hJ+1}\right)^2\right)^{1/2} \tag{7}$$

Using the weights w_j^* I am able to estimate $\hat{\tau_{1t}}$.

$$\hat{\tau_{1t}} = Y_{1t}^T - \sum_{j=2}^{J+1} w_j^* Y_{jt} \tag{8}$$

where Y_{1t}^T is the observed GVC outcomes of the treated unit and $\sum_{j=2}^{J+1} w_j^* Y_{jt}$ is weighted average of the control units that estimates Y_{1t}^C. The difference between the two is the estimated treatment effect of the KORUS FTA.

I estimate the treatment effect of the KORUS FTA on the following three measures for the auto, agriculture, and electronic sectors.

1. Gross Exports (GX)
2. Share of GVC trade in value-added exports (GVC/VAX)
3. Share of non-GVC trade in valued-added exports (DAVAX/VAX)

Inference for synthetic controls is done using a distribution obtained by iteratively assigning the treatment to units in the donor pool. For example, for US export to Korea, US export to China is one of the units in the donor pool. For one iteration, the same analysis is run as if the US-China bilateral flow received the treatment. The expectation is that it will not be that different from its synthetic control since it is not actually treated. For each iteration, a placebo treatment effect is calculated. This is repeated for each unit in the donor pool.

Compared to these placebo treatment effects, if the treatment effect of the true treated unit is extreme, then the treatment effect is considered significant. There are two ways to determine what is extreme. The first way is to plot the difference between the observed treated outcome and the synthetic control. If the difference post-treatment is much larger or smaller than the other placebos, then the treatment effect is extreme. Visually, this can be seen if the plot after the treatment is higher or lower than all the other plots. If the post-treatment difference is much larger or smaller than the placebos, I will consider the treatment effect significant. The second way is to calculate the ratio of the post-treatment mean squared predictive error (MSPE) over the pre-treatment MSPE for each iteration.

If the ratio is high relative to the placebos, it means that the post-treatment difference between the observed treated outcome and the synthetic control is large, and the treatment effect is extreme relative to the placebos. As a statistical test, the Fisher's exact p-value can be calculated. However, the standard 5% level of signifiance is not applicable. For all intensive purposes if the MSPE ratio for the treated unit ranks in the top 3, I will consider it significant.

6 Results

Table 3 summarizes the average treatment effect and significance on all outcomes based on the first criteria mentioned above. It shows that the KORUS FTA had a significant effect on US auto imports and US agriculture exports, but no significant effects on the other trade flows we examined. US auto imports increased by $4.8 billion and was a result of both the share of GVC and non-GVC trade increasing. So in this case, the FTA had a positive effect for both types of trade. Curiously, the overall effect of the FTA was to decrease gross exports of US agriculture products by $0.7 billion. Despite the 2.2 percentage point increase in the share of non-GVC trade, the share of GVC trade decreased even more by 3.3 percentage points. The FTA did not have a significant impact on US auto exports, agriculture imports, and electronics exports and imports.

Across the US exports and imports of the three sectors, three different effects of FTA can be observed. For US auto imports, the FTA had a positive treatment effect on both GVC and non-GVC trade. For US auto exports, the FTA had a positive effect on GVC trade but a negative effect on non-GVC trade. For US agriculture exports, the FTA had a negative effect on GVC trade but a positive effect on non-GVC trade. This goes to show that the effect of FTA is dependent on the sector that is affected as well as the provisions. The next sections will dive deeper into the auto, agriculture, and electronic sectors looking at both US exports to Korea and US imports from Korea for each sector.

Table 3: Table of KORUS FTA Treatment Effects

		US Exports to Korea		**US Imports from Korea**	
Sector	**Outcome**	**Treatment Effect**	**Significant**	**Treatment Effect**	**Significant**
Autos	GX	-$0.3 billion	N	$4.8 billion	Y
	GVC	5.6 pp	N	0.3 pp	Y
	DAVAX	-10.4 pp	Y	0.3 pp	N
Agri	GX	-$0.7 billion	Y		
	GVC	-3.3 pp	Y		
	DAVAX	2.2 pp	Y		
Elec	GX	$0.4 billion	N	-$1.3 billion	N
	GVC	-1.2 pp	N	0.3 pp	N
	DAVAX	1.9 pp	N	0.3 pp	N

pp stands for percentage points

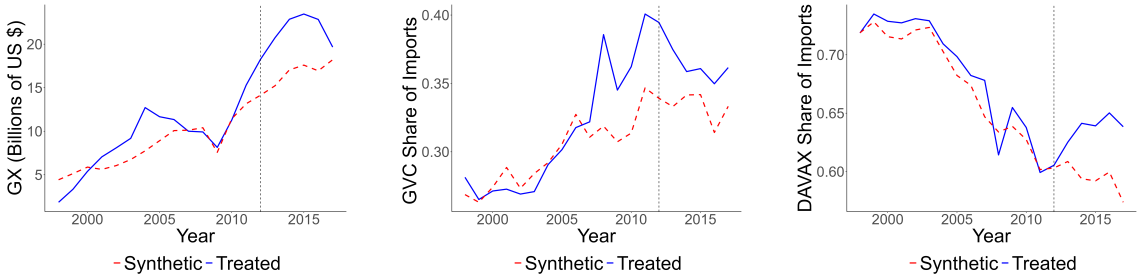
6.1 Autos

Figure 6 compares the three measures of interest for the treated unit, US Auto imports from Korea (blue line) with the constructed synthetic controls for this variable (red dotted line) from 1998-2017. Going from left to right, the measures are US Gross Auto Imports from Korea, the GVC share of these imports, and the non-GVC share of these imports. The vertical line in 2012 is the year of the treatment, the year when the KORUS FTA went into effect.

Figure 6a shows that starting from 2009 gross imports from Korea in autos increases from $8.1 billion to $23.5 billion in 2015. This seems to show some anticipatory effects and continuing effects of the FTA. As mentioned, the treatment effect, the gap between the grey observed outcome of the treated unit and the pink synthetic control, is on average a $4.8 increase for years after 2012. Figures 6b and 6c both show a 0.3 percentage point increase in the GVC share and non-GVC share of US auto imports after the FTA suggesting that the FTA had a positive effect on both types of trade.

However, looking at the trend of Figures 6b and 6c reveals an interesting story. Figure 6b shows an upward trend in the share of GVC trade prior to 2012. However, that trend shifts to a downward trend in 2012. The opposite is true for the non-GVC share of trade in Figure 6c. This shows that although the FTA increased both the share of GVC trade and non-GVC trade, it also seems to have changed the composition of the trade from becoming steadily more GVC-focused to becoming less GVC-focused.

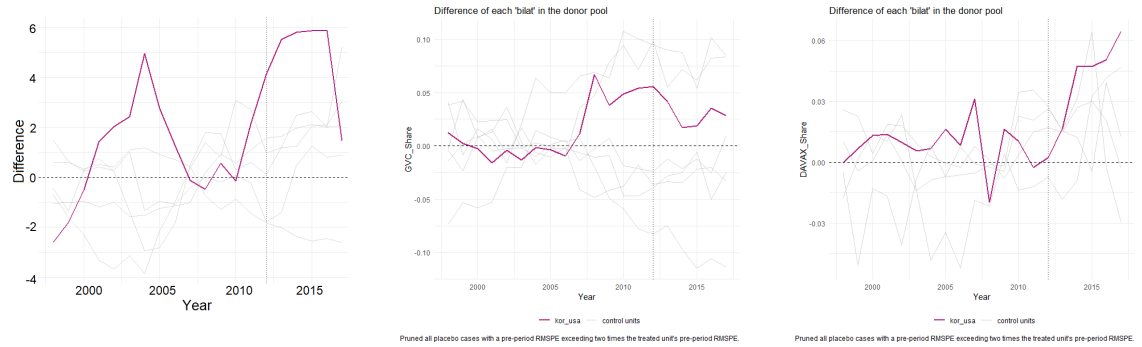
Figure 6: US Auto Imports from Korea vs Synthetic Control



(a) (b) (c)

Figures 7a and 7b show large positive differences for gross imports and the GVC share of trade relative to the placebos. This shows that the treatment effects on gross imports and the share of GVC trade are significant. However, the results for the GVC share of trade could be driven by the general collapse in trade in 2008-2009. Lastly, I do not find a significant difference from the placebos for the non-GVC share of trade (7c).

Figure 7: Placebo Test: US Auto Imports from Korea



(a) GX (Billions of $) (b) GVC (c) DAVAX

Table 4 shows that US auto imports from Korea had the second-highest MSPE ratio for gross imports providing more evidence that the treatment effect is significant.

Table 4: Significance Table: US Auto Gross Imports from Korea

Trade Flow	MSPE Ratio	Rank
Sweden-US	6.35	1
Korea-US	5.19	2
Taiwan-US	3.06	3
France-US	1.97	4
China-US	1.64	5
UK-US	1.39	6
Japan-US	0.37	7
Canada-US	0.06	8

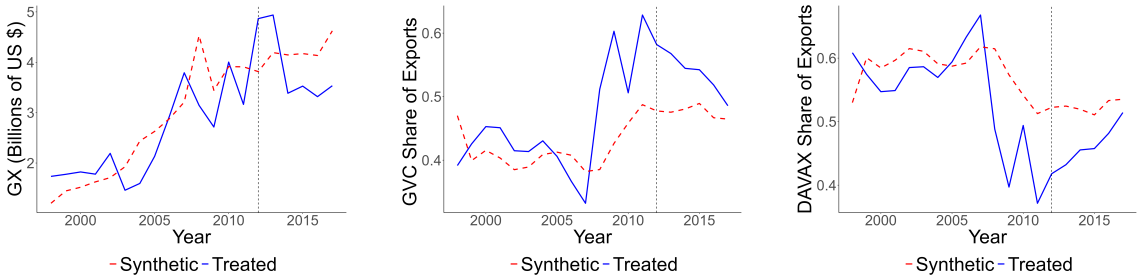
Consider next US exports of autos to Korea. Figure 8a shows that initially, gross exports increases from $3.1 billion in 2011 to $4.9 billion in 2012 and 2013. However, gross exports go back down to $3.4 billion in 2014. Although the average treatment effect on gross exports is -$0.3 billion in 2012 and 2013 the treatment effect was $1.1 billion and $0.7 billion respectively. The FTA has a much larger effect of 5.6 percentage point increase on the GVC share of trade. Different from US auto imports, the FTA has a large negative effect on the non-GVC share of trade of 10.4 percentage points. In the case of US auto exports, the FTA seems to have increased GVC trade but decreased non-GVC trade. This seems to provide evidence for the hypothesis that the FTA benefited GVC trade more than non-GVC trade.

However, once again as with US auto imports the trends in Figures 8b and 8c shift in 2012. The share of GVC trade decreases steadily from 0.79 to 0.67 while the share of non-GVC trade increases steadily from 0.57 to 0.71 after 2012. It appears that the provisions for final goods had a positive effect while the provisions for intermediate goods did not. Due to this reversal in trend, by 2017 the treatment effect is close to 0. One thing to note is that the big change in 2009 most likely influenced by the Global Trade Collapse is not tracked well by the synthetic control. If the match by the synthetic control during this period leading up to 2012 were better, the treatment effect could have been negative for the share of GVC trade and positive for the share of non-GVC trade.

The US does not appear to have succeeded in expanding into the South Korean auto market as a result of the KORUS FTA, despite some temporary success in 2012-2013. What the FTA did seem to accomplish was to reverse the trend of US exports to Korea from

becoming more GVC trade to becoming more non-GVC trade oriented. This is similar to our observations in the case of US auto imports.

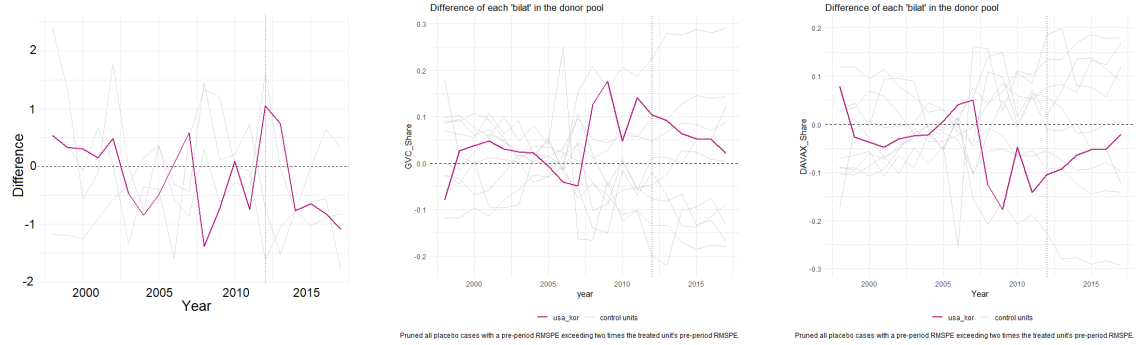
Figure 8: US Auto Exports to Korea vs Synthetic Control



(a) GX (Billions of $) (b) GVC (c) DAVAX

Figure 9 shows that only the share of non-GVC trade has a large negative difference relative to the placebos while the treatment effects of the FTA on gross exports and the share of GVC trade do not seem to be significant relative to the placebos.

Figure 9: Placebo Test: US Auto Exports to Korea



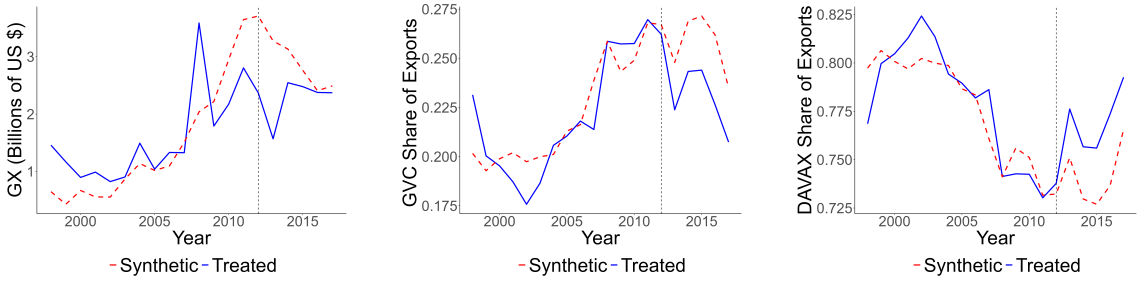
(a) GX (Billions of $) (b) GVC (c) DAVAX

6.1.1 Agriculture

As Figure 10 shows, the analysis of US exports to Agriculture to Korea shows a decrease in gross exports, a decrease in the share of GVC trade, and an increase in the share of non-GVC trade. Contrary to expectation, the FTA had a negative treatment effect of $0.7 billion on gross exports. Since the provisions of the FTA on agricultural products focused

on final goods and agricultural products are typically directly consumed rather than being re-exported, I expected the treatment effect on the share of GVC trade to be negative and the treatment effect on the share of non-GVC trade to be positive. Compared to auto exports, the share of GVC trade in agriculture exports is much lower, 0.3 vs 0.8 in 2012. Consistent with expectation, the FTA had a negative treatment effect on the share of GVC trade of 3.3 percentage points and a positive treatment effect on the share of non-GVC trade of 2.2 percentage points. As with autos, the FTA causes trade to become less GVC focused and more non-GVC focused.

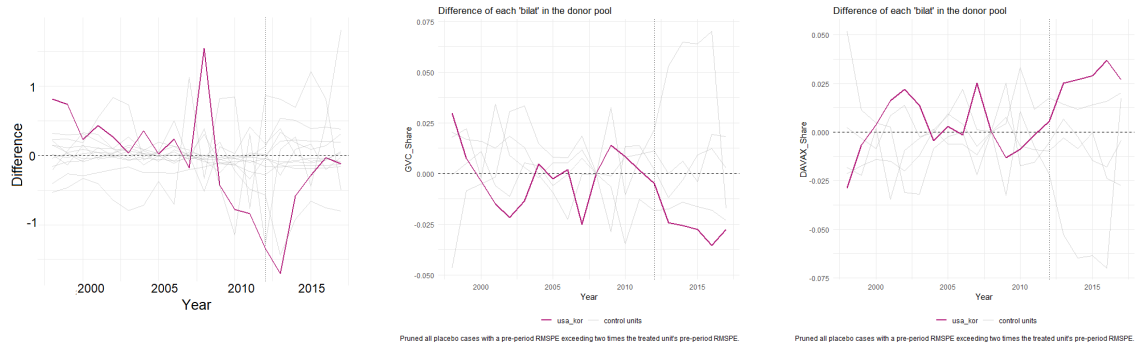
Figure 10: US Agriculture Exports to Korea vs Synthetic Control



(a) GX (Billions of $) (b) GVC (c) DAVAX

Figure 11 shows big difference for all three outcomes relative to their placebos suggesting that the treatment effects are all significant. Table 5 also shows that the US agriculture exports to Korea had the highest MSPE ratio.

Figure 11: Placebo Test: US Agriculture Exports to Korea



(a) GX (Billions of $) (b) GVC (c) DAVAX

I omit a discussion of US imports from Korea because it is such an insignificant trade flow.

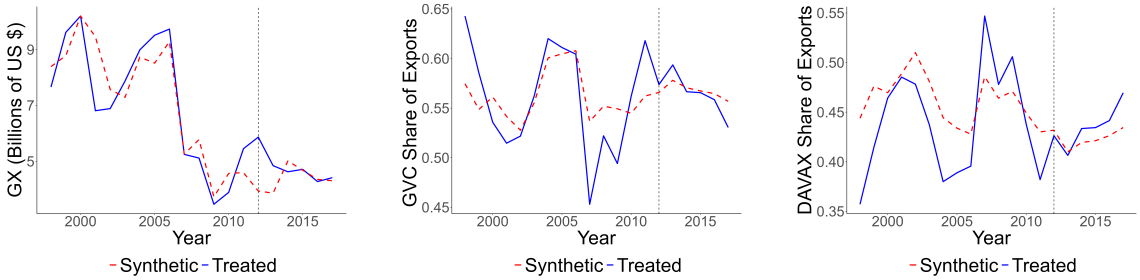
Table 5: Significance Test: US Agricultural Exports to Korea

Trade Flow	MSPE Ratio	Rank
US-Korea	5.43	1
US-France	2.71	2
US-UK	2.44	3
US-Mexico	2.00	4
US-Spain	1.32	5
US-Italy	1.21	6
US-Turkey	1.15	7
US-Taiwan	0.96	8
US-Indonesia	0.82	9

6.1.2 Electronics

Table 3 shows that there are no significant treatment effects in the electronics sector. This is expected because even before the FTA many trade barriers in electronics had been removed. Figure 12 shows that after 2012 the synthetic control tracks the actual observed outcomes of the treated unit for all three outcomes. This shows that the treatment effect is close to 0. The results provide a limited, though useful check of the synthetic control methodology; the method shows no evidence of treatment effects when indeed there is no reason to expect one. The same is true for US electronic imports. The figures and placebo tests for the electronic sector are all in the appendix.

Figure 12: US Electronic Exports to Korea vs Synthetic Control



(a) GX (Billions of $) (b) GVC (c) DAVAX

7 Conclusion

Theory suggests that FTAs affect both GVC and non-GVC trade depending on the provisions. If liberalization happens primarily for final goods, non-GVC trade will be positively impacted, but GVC trade may contract. However, if the liberalization is primarily for intermediate goods, GVC trade will be impacted positively relative to non-GVC trade. FTAs provide stability and incentive for firms to invest in long-term relationships that are crucial for developing GVC trade. However, I do not observe this in my results arguably because a longer time horizon and firm level data may be needed in order to see such slower acting effects.

The main goal of this paper is to show empirically the effect of the KORUS FTA on GVC and non-GVC trade. This paper finds that the Korea-Us Free Trade Agreement (FTA) increased US auto imports on average by $4.8 billion per year and decreased US agriculture exports by $0.7 billion per year. For US auto imports the FTA increased the share of both Global Value Chain (GVC) and non-GVC trade by 0.3 percentage points. For US agriculture exports it decreased the share of GVC trade by 3.3 percentage points and increased the share of non-GVC trade by 2.2 percentage points. In both sectors, after the FTA trade became more non-GVC intensive and less GVC intensive.

I observe changes in GVC trade in sectors that were explicitly targeted by negotiators, auto and agriculture, but not in areas that were not targeted by them, like electronics. The trend for the share of GVC trade in exports was decreasing after the agreement in most sectors. The results do not show effects for either exports or imports in sectors that might benefit from and FTA generally (say through coordination of regulations among

FTA members) but are not tied to early, targeted interventions.

The trade agreement was partially successful for the US. Initially, US exports of autos increased but after two years dropped back to pre-agreement levels. Interestingly, US agricultural exports actually decreased slightly. Although the US was the big partner in this agreement, having more power in choosing the terms and the sectors that were affected by the agreement, South Korean exports seem to have benefitted more initially. Most significantly, Korea expanded its auto exports to the US. Furthermore, Korea was able to maintain its important political relationship with the US that had been forged since the Korean War.

The paper needs additional robustness results to support its conclusions. For example, the interdependence of trade and potential trade diversion have not been fully taken into account. In order to address this, I plan to estimate the effect of the KORUS FTA using a gravity model which will capture interdependence among global trade flows. Another shortcoming is the poor fit of the synthetic control in some sectors. I am also planning to use an augmented synthetic control to improve the fit as a further robustness check (Ben-Michael et al., 2021).

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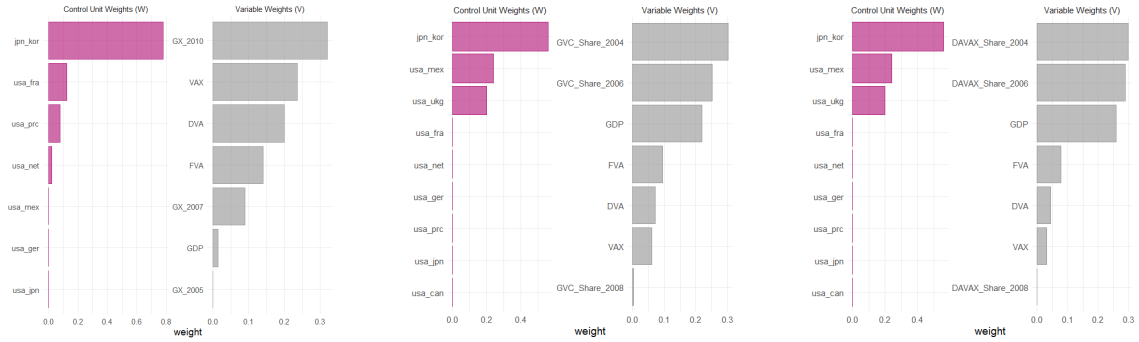
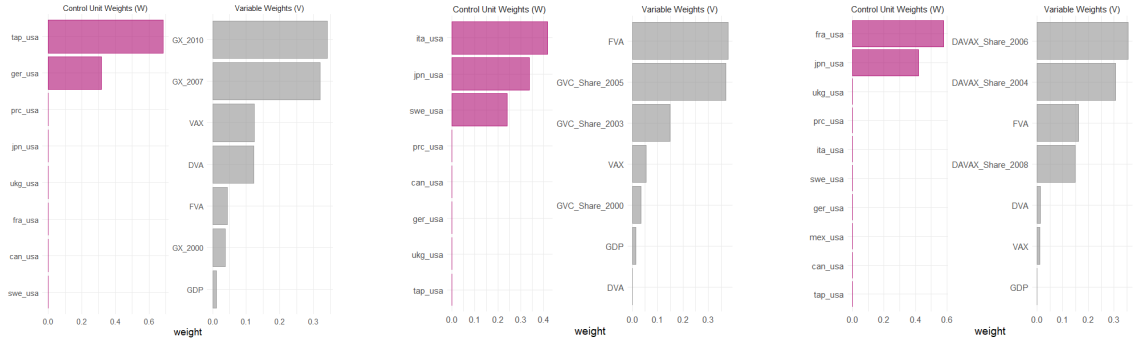
Appendix

Figure 13: Weights used to construct Synthetic Control for US Auto Exports to Korea



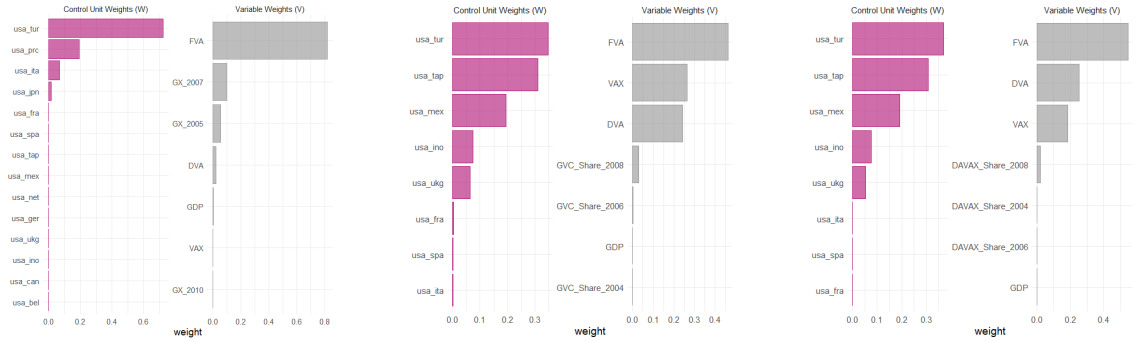
(a) GX (b) GVC (c) DAVAX

Figure 14: Weights used to construct Synthetic Control for US Auto Imports from Korea



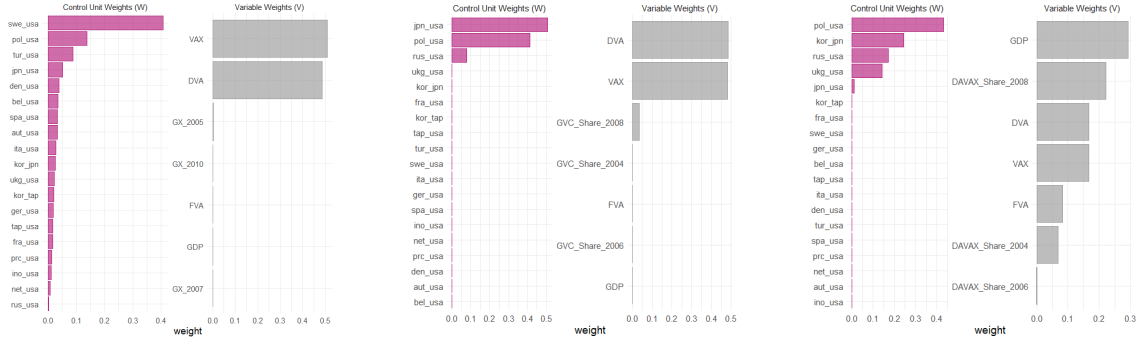
(a) GX (b) GVC (c) DAVAX

Figure 15: Weights used to construct Synthetic Control for US Agricultural Exports to Korea



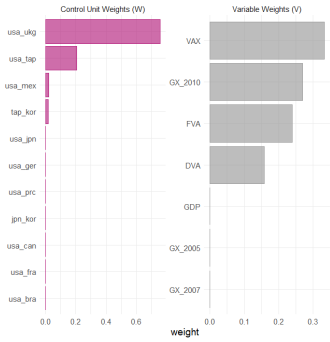
(a) GX (b) GVC (c) DAVAX

Figure 16: Weights used to construct Synthetic Control for US Agriculture Imports from Korea

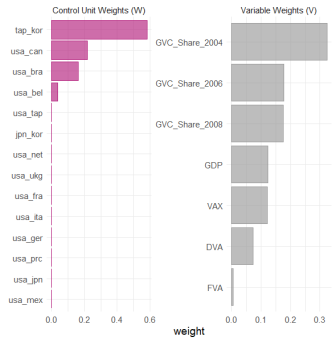


(a) GX (b) GVC (c) DAVAX

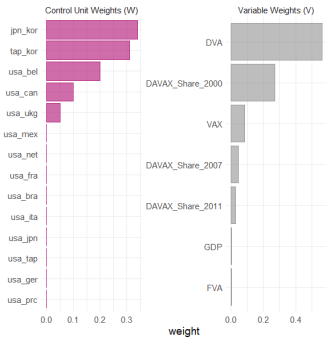
Figure 17: Weights used to construct Synthetic Control for US Electronic Exports to Korea



(a) GX

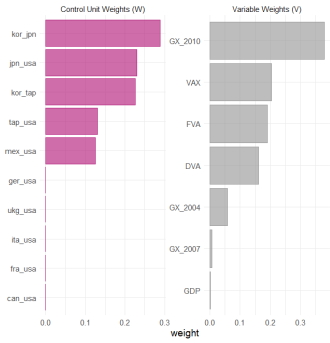


(b) GVC

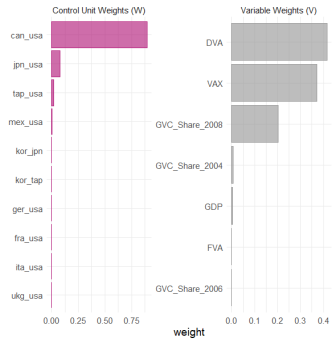


(c) DAVAX

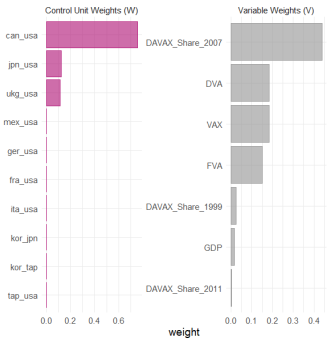
Figure 18: Weights used to construct Synthetic Control for US Electronic Imports from Korea



(a) GX

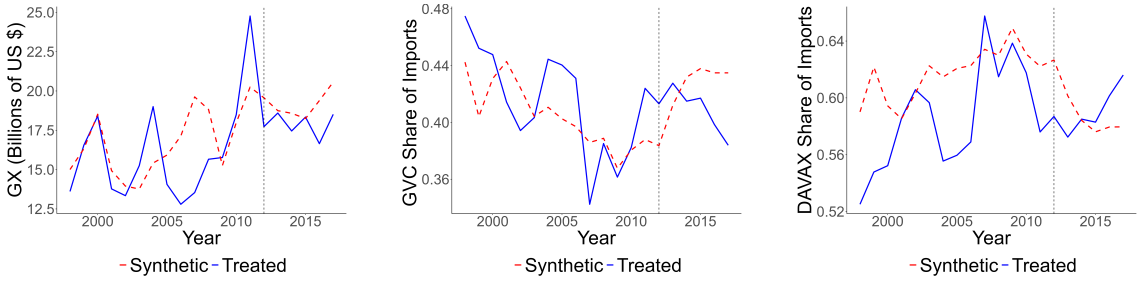


(b) GVC



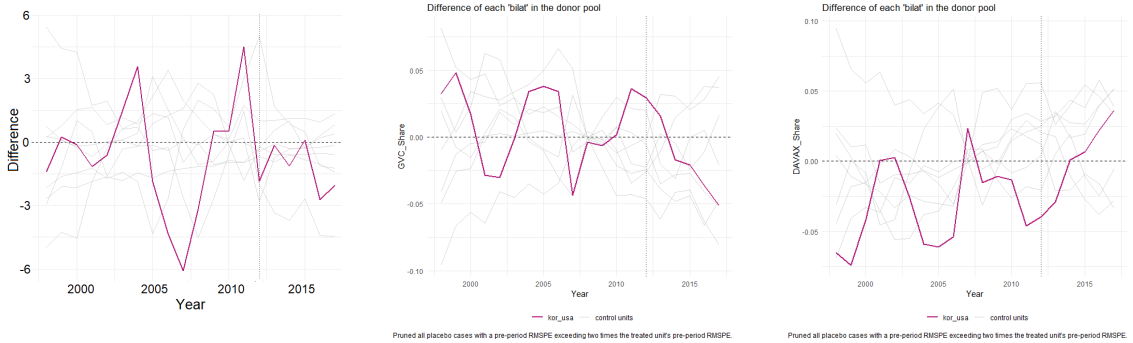
(c) DAVAX

Figure 19: US Electronic Imports from Korea vs Synthetic Controls



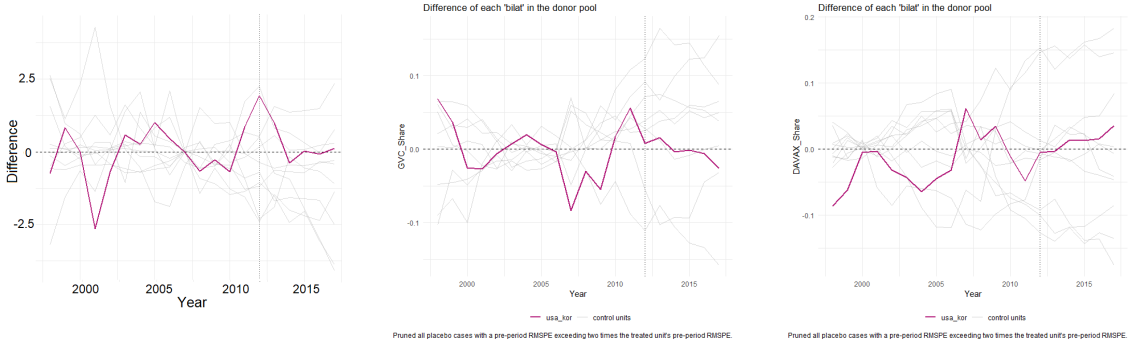
(a) GX (Billions of $) (b) GVC (c) DAVAX

Figure 20: Placebo Test: US Electronic Imports from Korea



(a) GX (Billions of $) (b) GVC (c) DAVAX

Figure 21: Placebo Test: US Electronic Exports to Korea



(a) GX (Billions of $) (b) GVC (c) DAVAX