Dynamic Impact of Trade Liberalization: Evidence from U.S.-Korea FTA*

Soo Kyung Woo†

This Draft: May 2024
Click here for the most recent version

Abstract

This paper studies the dynamic effect of trade liberalization on output and on the labor market, exploiting cross-region variation within the United States at the state level after its Free Trade Agreement with Korea. A key feature is a theoretically sound measurement of a regional exposure, which considers the elasticity of substitution across products. Employing these measures with the Local Projection Method, I find that improved access to export markets is associated with a positive responses, whereas the reduced protection from foreign competition exhibits a delayed and negative effect. For instance, by the 12th quarter, GDP responds by 0.37 and -0.48 percentage points to a one percentage point reduction in Export Barrier and Protective Barrier, respectively. I further find that these changes are primarily driven by the expansion of the labor force and population, rather than by changes in the employment rate.

JEL Classification: E21, E24, F13, F14, F42, F62

Keywords: Trade Liberalizations, Tariffs, Trade Dynamics

*I am grateful to George Alessandria for his invaluable feedback and continued support. I also thank Yan Bai, Mark Bils, Gaston Chaumont, Chengyuan He, Shafaat Khan, Armen Khederlarian, Roman Merga, Walter Steingress, Kai-Jie Wu, Kei-Mu Yi, and the conference and seminar participants at National Tsing Hua University, the EGSC 2021 at Washington University in St. Louis, and University of Rochester for their helpful comments.

†sookyung.woo@sejong.ac.kr, Department of Economics, Sejong University

1 Introduction

Does trade liberalization make the U.S. better off? The recent call for protectionism has reignited the long-standing debate over the gains and the losses of free trade. While free trade allows the U.S. to benefit from opportunities to reach new markets abroad and import cheaper inputs, it comes at the expense of facing competition with foreign firms in the domestic market.

This paper provides empirical evidence on the dynamic effects of a Free Trade Agreement (FTA) on income and consumption. Using the episode of the U.S.-Korea FTA, I first introduce a measure of regional exposures to three channels of the trade liberalization: easier exporting, cheaper imported inputs, and a higher degree of local competition with foreign firms. Then I correlate the cross-state variation in the exposure measures with those in output and labor market variables over different time horizons using the Local Projection Method (Jordà, 2005).

The immediate challenge to this analysis is measuring the exposures to the changes in trade barriers. Although the FTA is a well-defined policy experiment, tariff rates on imports are set at a detailed product level (10-digit HS code) and cover thousands of products, making summarization in one measure not straightforward. Indeed, measures of the trade barrier used in the literature are often vaguely defined and lack economic interpretation (Rodriguez and Rodrik, 2000; Kee et al., 2008). For example, the most common measure of the barrier is the import-weighted average tariff rate, which can be readily calculated by the tariff revenue divided by the total value of imports. However, this measure is likely to be downward biased because products with excessively high tariff rates are not imported and are thus assigned too small weights, despite their strong prohibitive power. Shift-share type measures using the average tariff across sectors are sometimes employed, where the sectoral average is again import-weighted (Topalova, 2010; Kovak, 2013). Nonetheless, such an approach is subject to downward bias for a similar reason.

I tackle this challenge by introducing a measure of trade barriers that exploits demand structure of Armington trade theory, which is the basis of almost all trade models. In particular, I build on Anderson and Neary (1994, 1996) and Kee et al. (2008, 2009) to aggregate tariff rates across products. A novel feature of my measure is that it covers all three channels of tariff impact, namely, barriers to i) exporting output, ii) local competition with foreign firms, and iii) importing inputs. Each barrier measure is defined as an answer to each of three different, but similarly formulated, questions: what is the uniform tariff rate that, if applied to all products instead of the current tariff structure, would induce the same level of i) *aggregate export*, ii) *domestic sales*, or iii) *imported inputs*?

The new measure of trade barriers is not only well-grounded in trade theory, but it can also distinguish between the positive and negative channels of import tariffs, unlike the import-weighted average tariff, which can only indicate the overall combined impact. Moreover, it delivers more precise results regarding tariff impacts compared to the trade-weighted average measure. Estimations using the new measures have smaller standard errors. Still, it takes the format of a simple ad-valorem rate, making it convenient and intuitive to interpret.

When using this measure to estimate the impact of FTA, I focus on the dynamics along the transition. The literature on trade liberalization tend to study only the long-run impact and are rarely explicit about the transitional effect. However, it is well known that trade tends to respond gradually (Hooper et al., 2000; Mac Mullen and Woo, 2023). Also it is crucial to consider the transitional dynamics when evaluating welfare gains after a reform (Alessandria et al., 2014). Indeed, considering the transitions would help understand better the tension between new opportunities and potential threats of trade liberalization because different channels of the tariff may unfold at different timing. Moreover, it may provide suggestive evidence for spatial spillovers or mobility of resources.

The trade liberalization episode studied in this paper is the U.S.-Korea FTA, which went into force in 2012. It was the largest trade deal for the U.S. after North American Free Trade Agreement (NAFTA) in 1993. It progressively eliminated customs duties on almost all the products traded between the two countries. Within five years of the implementation, over 95 percent of the products were to become duty-free. After its implementation, Korea became the sixth largest trading partner of the U.S., taking 3.5 percent of total U.S. trade as of 2021.

I find that with lower barriers to exporting, GDP and employment increase. In specific, one percentage point lower Export Barrier leads to 0.10 percentage point larger GDP on impact, which grows to 0.36 percentage points after 12 quarters. Employment also grows by

0.32 percentage points by the 12th quarter. On the import side, increased competition with foreign firms, or lower Protective Barrier, has a delayed but larger impact: GDP and employment gradually decline by 0.48 and 0.81 percentage points, respectively, by the 12th quarter. However, access to cheaper inputs has a positive but insignificant impact on GDP and employment. I further find that these shifts in the production and labor market are primarily driven by changes in the overall size of the labor force and population, rather than by fluctuations in the labor force participation rate or the unemployment rate.

This paper is related to a strand of literature that studies the regional impact of trade. Taking regions as a unit of analysis provides a complementary understanding to the strand of literature that takes industrial sectors as a unit of analysis (Trefler, 2004; Flaaen and Pierce, 2019). In particular, the approach makes it possible to capture impacts on geographically defined variables such as labor participation unemployment. However, studies on regional variations within the U.S. have mainly focused on manufacturing response to the China Shock or the recent dispute between the U.S. and China (Autor et al., 2013; Benguria and Saffie, 2020; Waugh, 2019). This paper is close to Hakobyan and McLaren (2016) who study the distributional effects of NAFTA at the industry and geographic level. I add to this literature by analyzing the dynamics at a higher time frequency and using the less-studied but an important episode of trade liberalization.

This paper is also a part of the growing literature that studies the impact of trade through the global value chain. The role of tariffs on inputs has been mostly studied in relation to production in developing countries (Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Kasahara and Rodrigue, 2008; Halpern et al., 2015). Amiti and Konings (2007), for example, show that in the case of Indonesia, the tariff impact through access to cheaper inputs has a larger impact on firm-level productivity than the impact through the international competition effect. A case for the U.S. has been studied by Handley et al. (2020), who show that producers subject to input tariff shocks during the 2018 Trade War experienced a decrease in their export.

The remainder of this paper is structured as follows. Section 2 introduces the new measures of the trade barrier, and then discusses their magnitude across the states after the FTA. Section 3 uses these measures to estimate the dynamic responses, discusses the results, and compares them with the conventional import-weighted average tariff. Section 4 discusses the robustness. Section 5 concludes.

2 Measures of Trade Barriers

This section describes the measures that quantify the regional trade barriers imposed by tariffs. I introduce the definition of the measures and the data used, and then document the changes in the barrier measures due to the U.S.-Korea FTA.

2.1 Construction of the Measures

A trade barrier is commonly measured by the average tariff rates, where the weight is given by the trade flow of each product. This measure, often used to summarize diverse tariff rates across numerous products, can be easily calculated by dividing tariff revenue by total import value. Despite its simplicity, however, this method lacks a solid theoretical foundation and tends to exhibit a downward bias. This bias arises because excessively high tariffs can diminish trade in the affected products, leading to small trade flows and thus their underrepresentation in terms of their actual prohibitive impact.

To overcome these limitations, I resort to the import demand structure of the Armington model. As the foundation of almost all trade models with more than one good, the Armington model provides a useful framework for quantifying trade barriers. Using its standard demand structure, I derive a uniform rate that, if uniformly applied to imported products instead of the current tariff structure, would yield the same outcome as the actual data. This approach extends the Trade Restrictiveness Index (Anderson and Neary, 1994, 1996; Kee et al., 2008, 2009) into all aspects of tariff impact.

I consider three different channels of tariff impact: barriers on i) exports, ii) foreign competitors entering the U.S. market, and iii) imports of intermediate inputs. I define each barrier measure as the uniform tariff rate that yields the current level of i) aggregate export, ii) local firms' domestic sales, or iii) imported inputs. In the following, I refer to these barriers as Export Barrier, Protective Barrier, and Input Barrier.

Export Barrier

The Export Barrier quantifies the distortion in exports resulting from Korea's tariffs on U.S. products. It is defined as an answer to the following question: what is the uniform tariff rate that, if applied to all exported products instead of the current Korean tariff structure, would maintain the *aggregate export* at its current level?

To answer this question within a theoretical framework, I start with a demand system of the Armington Model with constant elasticity of substitution (CES). Under the CES structure, export X^i_{SK} from state S to Korea of product i is given by:

$$X^i_{SK}(\tau^i_K) = \left(\frac{p^i_S(1+\tau^i_K)}{P^i_K} \right)^{-\varepsilon^i_K} Y^i_K$$

$$P^i_K = \left[\sum_L \left(p^i_L(1+\tau^i_{LK}) \right)^{\varepsilon^i_K} \right]^{1/\varepsilon^i_K}$$

where p^i_S is the price of product i from state S, P^i_K is the price index for product i in Korea, τ^i_K is tariff rate imposed by the Korean government on product i from the U.S., ε^i_K is demand elasticity for product i in Korea, and Y^i_K is the total expenditure on product i in Korea. The equation highlights that export X^i_{SK} is a function of the tariff rate τ^i_K, as the tariff raises the price of the product from p^i_S to $p^i_S(1+\tau^i_K)$ and shifts the demand.

Now consider all products that are exported from state S to Korea. By summing them up, the aggregate export from state S to Korea can be expressed as $\sum_i X^i_{SK}(\tau^i_K)$. Then, the Export Barrier of state S is implicitly defined as B^{Export}_S such that:

$$\sum_i X^i_{SK}(B^{Export}_S) = \sum_i X^i_{SK}(\tau^i_K).$$

That is, B^{Export}_S is the uniform rate at which the aggregate exports under the rate and that under the current tariff structure are equated.

Totally differentiating in a partial equilibrium setup,

$$\sum_i dX^i_{SK} \cdot B^{Export}_S = \sum_i dX^i_{SK} \cdot \tau^i_K,$$

and solving for B_S^{Export}, we get

$$B_S^{Export} = \frac{\sum_i X_{SK}^i \left(1 - X_{SK}^i / Y_K^i\right) \ \varepsilon_K^i \ \tau_K^i}{\sum_i X_{SK}^i \left(1 - X_{SK}^i / Y_K^i\right) \ \varepsilon_K^i}. \tag{1}$$

Thus, the Export Barrier is a weighted sum of tariff rates, where the weights reflect the composition of an export value and the demand elasticity of each product.

In particular, the weight is increasing in the export value for most of the products.[1] Moreover, it is also increasing in the demand elasticity: if a demand of a product is highly elastic, then the tariff on that product is given a larger weight as it would limit the imports more than a low elasticity product.

To construct the measure for each state in each year, data are drawn from multiple sources. The classification of the product is at the 6-digit level of HS code, which is the finest level of the code that is internationally standardized. Korea's tariff schedule for U.S. products consists of around five thousand 6-digit lines and comes from the Korea Ministry of Trade. In cases that the schedule is segmented into a finer level into the 10-digit HS code, I calculate the rate by taking a simple average within the same 6-digit products. Export flows of each state to Korea of the corresponding products are from the Census. For the demand elasticity of Korea, I take the value estimated by Kee et al. (2008).

On the other hand, data on the total expenditure Y_K^i in Korea at the 6-digit HS code level is not readily available. Instead, I decompose the share X_{SK}^i / Y_K^i into three parts:

$$\frac{X_{SK}^i}{Y_K^i} = \underbrace{\frac{X_{SK}^i}{X_{US,K}^i}}_{(a)} \cdot \underbrace{\frac{X_{US,K}^i}{X_{World,K}^i}}_{(b)} \cdot \underbrace{\frac{X_{World,K}^i}{Y_K^i}}_{(c)}$$

where $X_{US,K}^i$ is Korea's import from the U.S. of product i, and $X_{World,K}^i$ is Korea's total import from the world of product i. The term (a) can be obtained using the state's share in the U.S. of exports to Korea of product i, which is available from the Census. The term (b) is the U.S.'s share in the world of imports from Korea of product i and is collected from the UN

[1] For each i, $w_s^i = X_{SK}^i \left(1 - X_{SK}^i / Y_K^i\right)$ is increasing in X_{SK}^i if and only if $X_{SK}^i \leq 0.5 Y_K^i$, which means that state S takes less than a half of the product i's market share in Korea.

Comtrade database.[2] Finally, the term (c) is the import's share in total use of the corresponding sector, classified with an IO code. Data on the share is collected from Korea Statistics. The correspondence between IO and HS codes is also from Korea Statistics.

Protective Barrier

The U.S. tariff on its imports protects a state from the competition with Korean firms and thus distorts domestic production and sales. Protective Barrier measures such distortion. It is defined as the uniform tariff rate that, if applied to imports instead of the current U.S. tariff schedule, would induce the same *sales in the U.S.* as its current level.[3]

Similar to the derivation of the Export Barrier, I start with a CES demand of the U.S. for product i from state S:

$$X^i_{S,US}(\tau^i_{US}) = \left(\frac{p^i_S}{P^i_{US}}\right)^{-\varepsilon^i_{US}} Y^i_{US}$$

where $X^i_{K,US}$ is the U.S. import from Korea of product i, τ^i_{US} is tariff rate imposed by the U.S. government on product i from Korea, p^i_S is the price of product i from state S, ε^i_{US} is the demand elasticity for product i in the U.S., Y^i_{US} is the total expenditure on product i in the U.S., and P^i_{US} is the price index for product i in the U.S.,

$$P^i_{US} = \left[\sum_L \left(p^i_L(1+\tau^i_{L,US})\right)^{\varepsilon^i_S}\right]^{1/\varepsilon^i_s},$$

where L denotes all countries that the U.S. is purchasing product i from.

The Protective Barrier is B^{Prot}_S such that:

$$\sum_i X^i_{S,US}(B^{Prot}_S) = \sum_i X^i_{S,US}(\tau^i_{US}).$$

[2]Multiplication of two shares $(a) \times (b) = X^i_{SK}/X^i_{World,K}$ can be obtained directly by using data of X^i_{SK} and $X^i_{World,K}$. However, since two variables come from separate data sources, I choose to use two shares, each of which comes consistently from one source, in order to keep the consistency and minimize a measurement error.

[3]Note that it takes into account sales not only within the state itself but also to the entire U.S. market. This means that foreign competition captured by the barrier measure may not necessarily be within the state, and it encompasses competition occurring in other states as well. Furthermore, all types of products, including both consumer and intermediate goods, are of interest as long as they constitute a firm's output.

Totally differentiating

$$\sum_i dX^i_{S,US} \cdot B^{Prot}_S = \sum_i dX^i_{S,US} \cdot \tau^i_{US}$$

and solving for B^{Prot}_S, we get

$$B^{Prot}_S = \frac{\sum_i (X^i_{K,US} X^i_{S,US}/Y^i_{US})\, \varepsilon^i_{US}\, \tau^i_{US}}{\sum_i (X^i_{K,US} X^i_{S,US}/Y^i_{US})\, \varepsilon^i_{US}}. \tag{2}$$

Thus, the Protective Barrier is a weighted sum of the U.S. tariff rates, where the weights reflect the composition of U.S. consumption of state S products, that of Korean products, and the demand elasticity.

Data used to construct Protective Barrier also classifies the product at the 6-digit HS code level. The tariff schedule of the U.S. on imports from Korea is drawn from USITC.[4] Import flow from Korea is from the Census, and demand elasticity of the U.S. is again from Kee et al. (2008).

Data on the expenditures $X^i_{S,US}$ and Y^i_{US} in the U.S. at the 6-digit HS code level are not available. Instead, I construct the share $X^i_{S,US}/Y^i_{US}$ indirectly by:

$$\frac{X^i_{S,US}}{Y^i_{US}} = \frac{GDP^i_S - X^i_{S,World}}{\sum_S (GDP^i_S - X^i_{S,World} + X^i_{World,S})}$$

where GDP^i_S is GDP of product i in state S, $X^i_{S,World}$ is the total export of product i from state S to the world, and $X^i_{World,S}$ is the total import of product i from the world to state S. That is, I calculate the domestic absorption by the output minus what is exported out of the country, and the U.S. expenditure by the sum of all states' output net of trade. Meanwhile, GDP by the state is only available at the sector level, classified with the NAICS code. The data is provided by BEA. Thus, I calculate the share at the 4-digit NAICS level using GDP data from BEA and trade data from the Census and then link it to each product using the concordance between HS and NAICS codes from BEA.

[4] Specific tariff rates are omitted, which accounts for 4.90% of total tariff lines. As a robustness test, I show that the result is robust to using the product level applied tariff to get the ad-valorem equivalent rates. See Section 4.1 for details.

Input Barrier

Input Barrier summarizes the distortion on the use of imported intermediate inputs that arises due to the U.S. tariff on imports from Korea. The measure is am answer to: what is the uniform tariff rate that, if imposed on all imports instead of the current U.S. tariff structure, would leave the *intermediate imports from Korea* at their current level?

Unlike the other measures, here we only consider products that are classified as an intermediate good, assuming that all imports of any intermediate good are to be used as an input for production in that state. The CES demand for intermediate good i from Korea in state S is given by:

$$m^i_{KS}(\tau^i_{US}) = \left(\frac{p^i_K(1+\tau^i_{US})}{P^i_S} \right)^{-\varepsilon^i_S} M^i_S$$

where m^i_{KS} is the import from Korea to state S of intermediate product i, p^i_K is the price for product i from Korea, $\tau^i_{K,US}$ is a tariff rate imposed by the U.S. on imports of product i from Korea, ε^i_S is the demand elasticity of product i in state S, M^i_S is the total use of intermediate product i in state S, and P^i_S is the price index for product i in state S written as

$$P^i_S = \left[\sum_L \left(p^i_L(1+\tau^i_{LS}) \right)^{\varepsilon^i_S} \right]^{1/\varepsilon^i_s}$$

where L denotes any country that state S is purchasing product i from.

Input Barrier, the uniform rate at which that aggregate import of inputs is same as under the current tariff schedule, is B^{Input}_S such that:

$$\sum_i m^i_{KS}(B^{Input}_S) = \sum_i m^i_{KS}(\tau^i_{US}).$$

Taking total derivatives,

$$\sum_i dm^i_{KS} \cdot B^{Input}_S = \sum_i dm^i_{KS} \cdot \tau^i_{US},$$

and solving for the uniform tariff rate B_S^{Input}, we get

$$B_S^{Input} = \frac{\sum_i m_{KS}^i \left(1 - m_{KS}^i / M_S^i\right)\ \varepsilon_{US}^i\ \tau_{US}^i}{\sum_i m_{KS}^i \left(1 - m_{KS}^i / M_S^i\right)\ \varepsilon_S^i}. \tag{3}$$

Thus, Input Barrier is a weighted sum of the U.S. tariff rates, where the weights reflect the importance of Korea as a sourcing market and the product demand elasticity. It takes a similar form as Export Barrier but with the weights of different subscripts, specifying the opposite direction of trade flows, and is restricted to intermediate inputs.

Note that a state may be both a user and a producer of a product. For example, Michigan not only utilizes auto parts for automobile production but also manufactures auto parts. Three barrier measures capture these different channels. Specifically, the Input Barrier captures the distortion Michigan faces as a user of auto parts. On the other hand, Export and Protective Barriers take into account the distortion for Michigan as a producer of auto parts when selling its parts abroad, to other states in the U.S., and within Michigan itself.

To measure Input Barrier of different states, we use data from various sources. Product classification as an intermediate input is from the UN. Data on the U.S. tariff is from USITC. Import flow for all intermediate products from Korea is from the Census. For the import elasticity of each state, I use Kee et al. (2008)'s estimates of the U.S. import elasticity, assuming that the elasticity is the same across all states ($\varepsilon_S^i = \varepsilon_{US}^i\ \forall i\ \forall S$). On the other hand, data on intermediate product use M_S^i by the state at the detailed 6-digit HS code level is unavailable. Thus, I resort to the decomposition of the share

$$\frac{m_{KS}^i}{M_S^i} = \underbrace{\frac{m_{KS}^i}{m_{World,S}^i}}_{(a)} \cdot \underbrace{\frac{m_{World,S}^i}{M_S^i}}_{(b)}$$

where $m_{World,S}^i$ is the total import of intermediate product i from the world to the state S. The first term (a) can be obtained using trade data from the Census. For the second term (b), I make use of the Use and Supply Table from BEA to get the national data on the total use of input for each output. Then, I assume that a state's contribution to the national use of input is proportional to the state's GDP share of output so that

$$m^{i}_{World,S} = \sum_j m^{ij}_{World,S} \cdot \frac{GDP^j_S}{GDP^j_{US}}$$
$$M^i_S = \sum_j M^{ij}_{US} \cdot \frac{GDP^j_S}{GDP^j_{US}}$$

where $m^{ij}_{World,US}$ is the national imported use of i as an input of j, M^{ij}_{US} is the national total use of i as an input of j, GDP^j_S is the state S's GDP of j, and GDP^j_{US} is the national GDP of j. I calculate these terms at the 4-digit NAICS level, and then link them to term (b) for each product at the 6-digit HS level using the concordance between HS and NAICS.

2.2 State-level Trade Barriers during the U.S.-Korea FTA

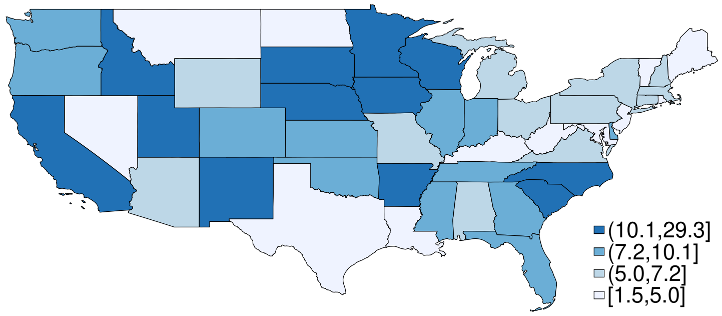
The FTA between the U.S. and Korea was initially signed in June 2007, followed by a renegotiated version signed in December 2010. The treaty went into force in March 2012. It required the tariffs between the two countries to be removed within 15 years, either immediately or through equal annual stages ranging from 2 to 15 years. A significant share of the products were subject to the immediate elimination of tariffs,[5] and over 95% of all tariff lines were to be duty-free within five years. Prior to the FTA, Korea was the 7th largest trading partner of the U.S., accounting for 2.7 percent of total U.S. trade. As of 2021, Korea became the 6th largest trading partner with a trade share of 3.4 percent.

Following the procedure described in Section 2.1, I quantify the barrier measures around the periods that the FTA was implemented. Table 1 documents the summary statistics of the barrier measures. The Export Barrier tends to be higher than the other two barriers, with mean, median maximum, and minimum being larger than the others. For example, the medians of the Export Barrier B^{Export}, the Protective Barrier B^{Prot}, and the Input Barrier B^{Input} are 7.1, 2.7, and 2.2 percent, respectively. This is because Korea's import tariff rates prior to 2012 are generally higher than the U.S. Moreover, there is a large variations in all three measures across states, standard deviation ranging from 1.9 to 4.7 percents. Figure 1 displays the variations

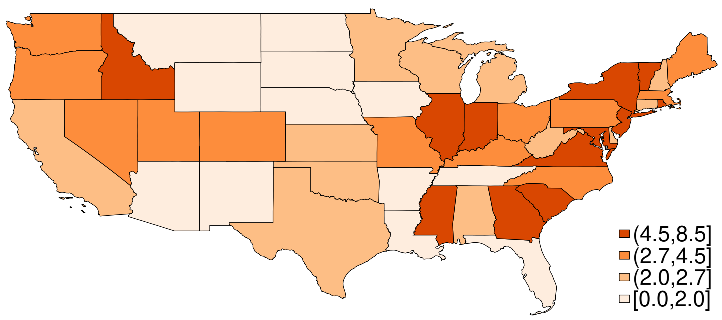
[5] Among the 5,087 tariff lines of Korea, 64% became duty-free on the date the treaty entered into force. In the U.S., 24% of 4,316 tariff lines became duty-free on impact.

Figure 1: Barrier measures prior to the FTA

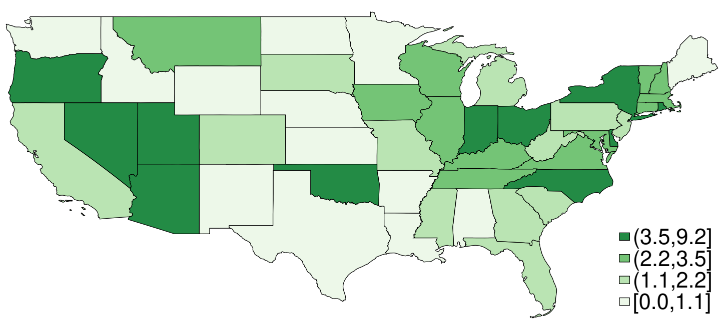
(a) Export Barrier



(b) Protective Barrier



(c) Input Barrier



Notes: The figure shows the measured sizes of three barriers of different states in 2011, in percents.

Table 1: Statistics prior to the FTA

	Mean	Median	St Dev	Min	Max
Export Barrier B^{Export}	7.9	7.1	4.7	1.5	29.3
Protective Barrier B^{Prot}	3.2	2.7	2.0	0.0	8.5
Input Barrier B^{Input}	2.5	2.2	1.9	0.0	9.2

Notes: The table shows the statistics of three barrier measures across states in 2011, in percents.

in the barrier sizes prior to the FTA across different states in the U.S. States with high the Export Barriers were mostly those exporting agricultural products to Korea, including Idaho, Arkansas and Iowa. Georgia has the highest Protective Barrier prior to the FTA, followed by Vermont and South Carolina. Input Barriers are highest in Nevada, Rhode Island, and North Carolina.

Table 2 shows the pairwise correlation of barrier measures. All three measures are not correlated with each other. In particular, it is rather surprising that the Protective Barrier and Input Barriers are not correlated. While both measures are averages of the common import tariffs, difference in the weights due to each state's industry structure yields largely heterogeneous exposure across different channels of import tariff.

Table 3 documents the distribution of the barrier measures before the FTA and their changes initiated by the FTA. The first column displays the barriers in 2011 before the FTA was implemented. The remaining columns display changes in the barrier measures realized in the

Table 2: Barrier correlations

	B^{Export}	B^{Prot}	B^{Input}
Export Barrier B^{Export}	1		
Protective Barrier B^{Prot}	-0.0571 (0.6908)	1	
Input Barrier B^{Input}	-0.2350 (0.0969)	0.0729 (0.6112)	1

Notes: The table shows the correlation of barrier measures using the 2011 data.

Table 3: Barriers before and after the FTA

	B (%)	ΔB since FTA (%p)				
	2011	2012	2013	2014	2015	2016
Export Barrier B^{Export}						
25th percentile	10.1	-4.4	-1.2	-1.2	-0.5	-0.5
50th percentile	7.1	-3.6	-0.5	-0.5	-0.3	-0.3
75th percentile	4.9	-2.8	-0.3	-0.3	-0.1	-0.1
Protective Barrier B^{Prot}						
25th percentile	4.5	-2.4	-0.3	-0.3	-0.3	-0.3
50th percentile	2.7	-1.5	-0.2	-0.2	-0.2	-0.2
75th percentile	1.9	-1.1	-0.1	-0.1	-0.1	-0.1
Input Barrier B^{Input}						
25th percentile	3.6	-1.7	-0.4	-0.4	-0.3	-0.3
50th percentile	2.2	-1.0	-0.2	-0.2	-0.1	-0.1
75th percentile	1.0	-0.6	-0.1	-0.1	0.0	0.0

following years. Since the FTA requires the tariff rates eventually reach zero within a period of time, the changes in the next few years largely depends on the rates prior to the FTA. Indeed, as Export Barrier (ΔB^{Export}) is larger than the other barriers, its changes after the implimentation of the FTA tend to be larger than that of other measures.

Looking at the changes across time, the changes in the measures are largest in 2012, reflecting that most tariff concessions happened in the first year of the FTA. In the first year, the Export Barrier dropped by 3.6 percentage points for a median state. On the import side, median sizes of the Protective Barrier and Input Barrier drops were 1.5 percentage points and 1.0 percentage points, respectively. Also, there is a sizable dispersion in the drops. A state at the 25th percentile of barrier cuts experienced drops that were 4.4 percentage points (Export Barrier), 2.4 percentage points (Protective Barrier), and 1.7 percentage points (Input Barrier) larger than those faced by a state at the 75th percentile. The distributions of the barrier changes shift toward zero as time develops. By 2016, the barrier cuts are close to zero in most states.

3 Dynamic Responses to Barrier Changes

3.1 Estimation

Given the exposure to the FTA during the period of 2012-2016 in each state, I now estimate the dynamic response to these changes.[6] The response at time horizon h can be defined as a difference between the forecast path for the outcome variable and its counterfactual:

$$\beta_h = E(\Delta_h \ y_{S,t+h}|\Delta B_t = -1\%p, \mathcal{X}) - E(\Delta_h \ y_{S,t+h}|\Delta B_t = 0, \mathcal{X}) \tag{4}$$

where $\Delta_h \ y_{S,t+h} = y_{S,t+h} - y_{S,t-1}$ is growth in logged outcome variable y of state S between periods $t-1$ and $t+h$, $\Delta B_t = B_t - B_{t-1}$ is a change in the barrier measure at time t, and $\mathcal{X}$ is a vector of controls including lags of the outcome and all other barrier cuts during the sample period. In other words, β_h is the average cumulative response across states and across time of the outcome variable y at h periods ahead in response to 1 percentage point decrease in a barrier, conditional on the information available at the initial time t.

I estimate β_h using the Local Projection Method (Jordà, 2005). In particular, I estimate the following equation:[7]

$$\Delta_h \ y_{s,t+h} = \mu_s^h + \mu_{t+h}^h - \beta_h^{Export} \Delta B_{st}^{Export} - \beta_h^{Input} \Delta B_{st}^{Input} - \beta_h^{Prot} \Delta B_{st}^{Prot} + \sum_{k=-8}^{4} \omega_{t+k}^h \Delta B_{st+k} + \gamma^h \Delta_1 \ y_{s,t-1} + \varepsilon_{t+h}. \tag{5}$$

It is a set of estimations of direct forecasting model for each forecast horizon h. It provides with multi-step predictions and enables us to find the responses to a shock at h without reference to the data generating process.

Note that the regression includes all three barriers, which helps in identifying the role of each channel from the simultaneous effects of the common tariff lines within a state. This is

[6]The choice of the sample period is driven by the observation that the majority of tariff reductions occurred within the first five years. This can be seen also be seen in Table 3.

[7]The negative signs are used in front of the coefficients for the barriers in Equation 5. This is to interpret the estimates as the impact of liberalization, instead of pure changes in the barriers. Note that β_h is defined as a response to a tariff reduction in Equation 4.

especially advantageous since many states use products as inputs that are also their outputs. For example, Michigan serves as both a producer and consumer of auto parts. Also, I control for all future and past changes of the barriers, as the tariff rates were scheduled and announced publicly at the time that the treaty was signed.

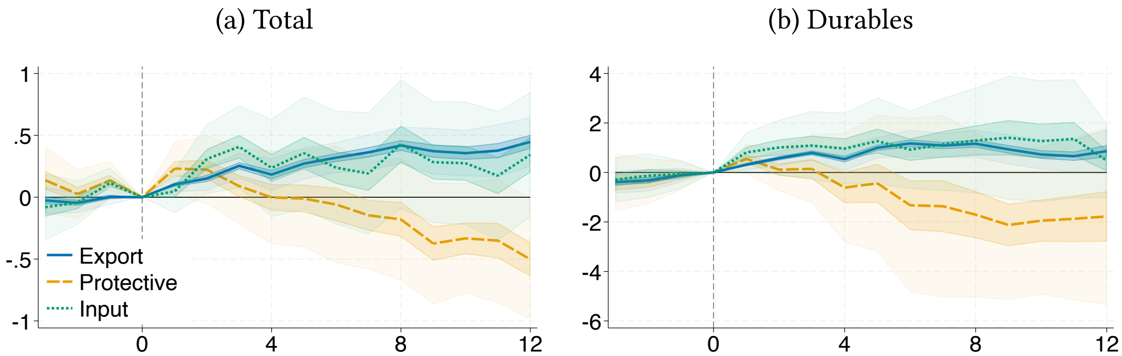
The horizon estimated ranges up to 12 quarters after a shock in trade barriers ($h = 0, 1, \cdots, 12$). I also check for the existence of any anticipatory movement by looking at the horizons before the shock ($h = -1, \cdots, -4$).

3.2 Results

Figure 2 presents the result of the estimation for the responses in GDP. Panel (a) shows the cumulative response in logged GDP to 1 percentage point cut in three trade barriers at time horizons $h = -4, \cdots, 12$. Before the tariff cut is realized ($h < 0$), there is not much movement in GDP. That is, the variables do not move in anticipation of the scheduled tariff changes. Once the policy is implemented ($h \geq 0$), the GDP moves in directions that we would intuitively expect: with easier access to export market, GDP gradually increases, reaching 0.5 percentage points by the 12th quarter (Export Barrier, blue). With lower protection from foreign firms, GDP slightly increases in the short run, but the impact turns negative over the longer horizon (Protective Barrier, yellow). Impact of lower barriers to cheaper inputs is realized in full sooner, around the second quarter, and stays stable over the long horizon (Input Barrier, green). Note that lower import tariff has two opposite effects: it restricts the GDP growth by increasing competitiveness in the local market, but promotes it by giving access to cheaper inputs. Similar patterns with larger sizes are found when we restrict the responses to only to the production of durable goods (Panel b).

I further study the labor market outcome. Figure 3 presents the results. Employment is hit the most by the reduced protection from foreign firms, with only minimal benefits observed from easier exports or cheaper inputs (Panel a). Specifically, a lower Protective Barrier reduces employment by 0.8 percentage points by the 12th quarter, while the cut in the Export Barrier gradually increases it by up to 0.3% in the same timeframe. On the other hand, the unemployment rate presents unexpected findings: although statistically insignificant, it tends

Figure 2: GDP



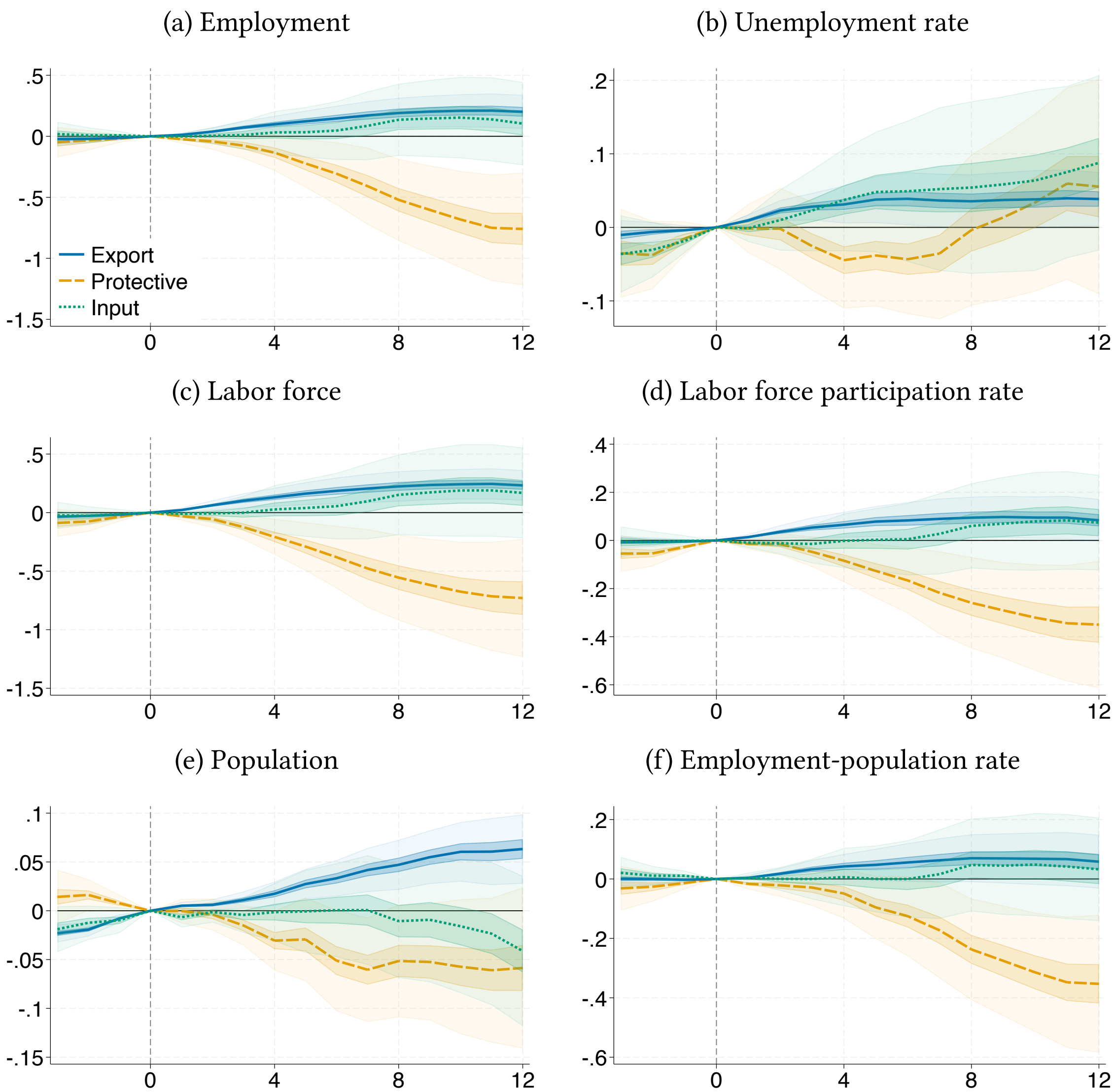
Notes: The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of β_h^{Export}, β_h^{Prot}, and β_h^{Input} over the horizon of $h = -4, \cdots, 12$. The light and dark shaded areas display 90% and 68% confidence intervals, respectively. All dependent variables are logged and multiplied by 100.

to rise with reductions in the Export and Input Barriers, while temporarily decreasing with the cut in the Protective barrier (Panel b).

To understand this result, I examine the responses in the labor force. Interestingly, the pattern of the labor force's response closely mirrors that of employment, both in timing and magnitude (Figure 3, Panel c). Some of these changes are related to the changes in population: the Export Barrier cut triggers gradual population growth, while the Protective Barrier cut induces a reduction (Panel e). However, despite changes in population sizes, the labor force as a share of the population also moves in tandem (Panel d). These findings together implies the impact of liberalization on employment is associated with individuals entering or exiting the labor force, part of it coming from the migration in and out of the state. Indeed, most of the changes in employment is due to the overall labor force adjustments, rather than shifts in the proportion of employed individuals within the labor force.

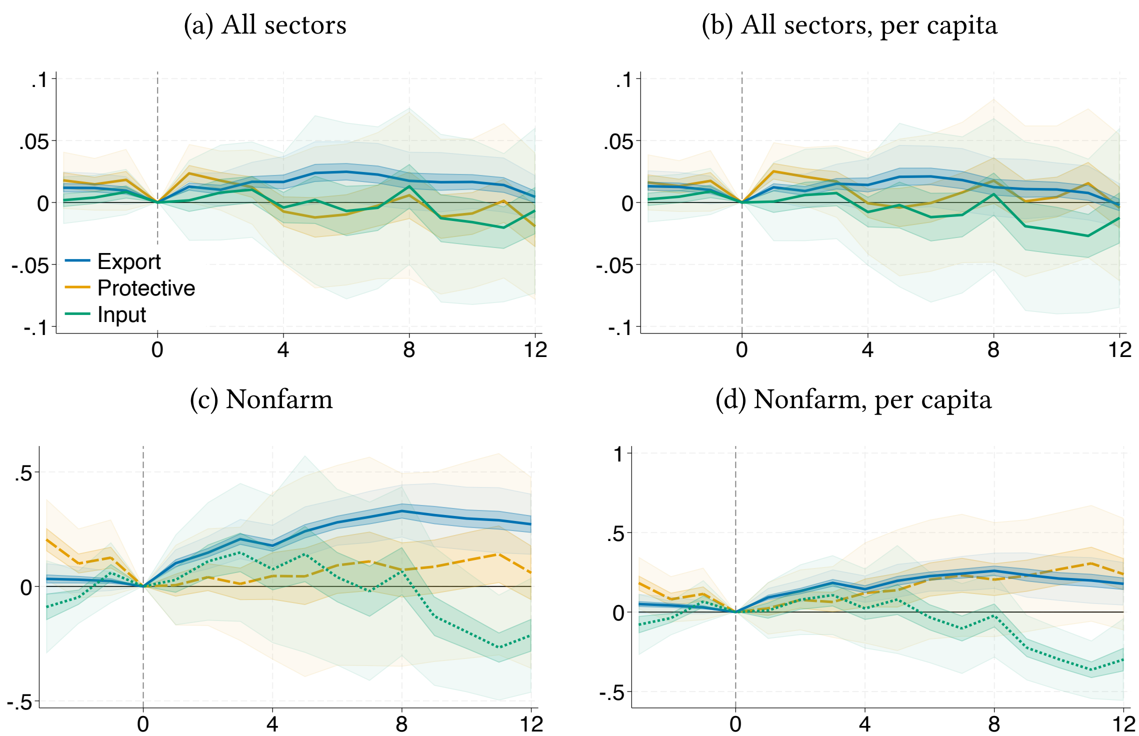
While the labor market sees significant adjustments with barrier changes, the impact on personal income appears minor. Figure 4 displays the responses in personal income. Income from all sectors, both measured as a whole and per capita, shows statistically and economically insignificant estimates (Panels a and b). If anything, appears to be a positive impact from the Export Barrier cut. However, the impact dissipates by the 12th quarter, unlike the responses observed in the labor market. On the other hand, when focusing on the nonfarm sector, the

Figure 3: Labor market responses



Notes: The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of β_h^{Export}, β_h^{Prot}, and β_h^{Input} over the horizon of $h = -4, \cdots, 12$. The shaded areas display 90% and 68% confidence intervals. Dependent variables in (a)-(d) are logged and multiplied by 100.

Figure 4: Personal income



Notes: The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of β_h^{Export}, β_h^{Prot}, and β_h^{Input} over the horizon of $h = -4, \cdots, 12$. The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

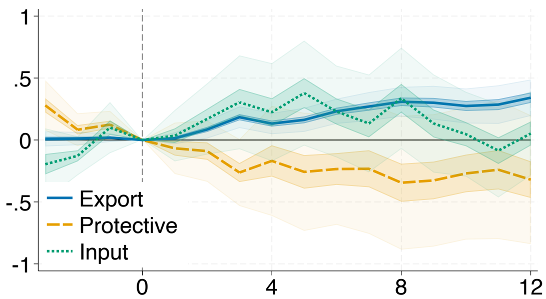
Export Barrier cut induces substantial and persistent increases in personal income (Panels c and d). Given that there were substantial tariffs changes in the farming sector as well, this result suggests that the farming sector behaves differently from other sectors, and considering both farming and nonfarming together could potentially dilute the income changes that are concentrated in the nonfarm sector.

To explore this further, I decompose the personal income by its source and analyze the responses in each of them.[8] Figure 5 displays responses in each component of personal income. Interestingly, wages and salaries shows a clear pattern that is very similar to what is found in Figure 2: positive and gradual impact of the Export Barrier cut, persistently negative impact of the Protective barrier cut, and temporarily positive impact of the Input Barrier cut (Panel a). Dividends, interest, and rent decrease on impact with the Protective Barrier cut, but

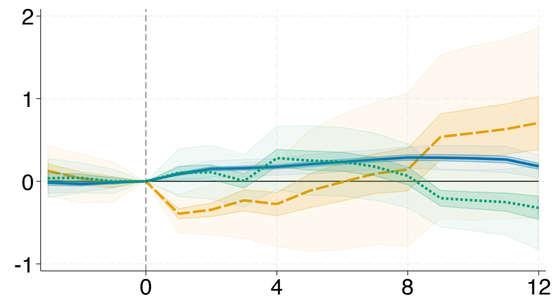
[8]Personal income consists of the following: Wages and salary 50%, Dividends, interest, and rent 20%, Proprietors' income 10%, and Transfer 17%. The shares are based on the 2012-2016 average.

Figure 5: Income by source

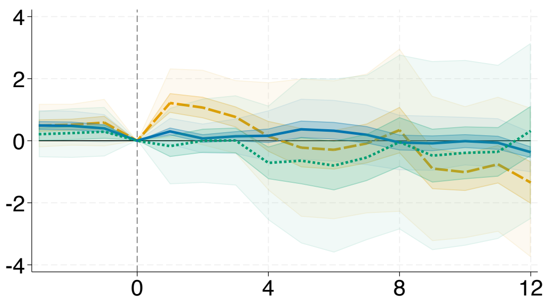
(a) Wage and salary



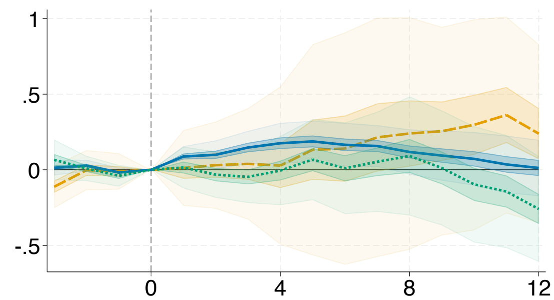
(b) Dividends, interest, and rent



(c) Proprietors' income



(d) Transfer



Notes: The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of β_h^{Export}, β_h^{Prot}, and β_h^{Input} over the horizon of $h = -4, \cdots, 12$. The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

soon becomes insignificant (Panel b). Proprietors' income responds with a much larger magnitude, but it is not very significant (Panel c). Thus, while other types of income may fluctuate differently, it is mainly through wages and salaries that U.S. residents' income is affected.

Using the estimates of the above graphs and those presented in Tables 4 and 5, we can quantify the impact of trade liberalization from a state's perspective. For example, consider the barrier changes in 2012 when the FTA was first implemented. Comparing two states, one at the 75th percentile of the Export Barrier change and the other at the 25th percentile, the state with the larger barrier cut would be expected to experience a 0.43 percentage point larger increase in GDP[9] and a 0.19 percentage point larger increase in employment in the 4th quarter.

[9]Noting that the interquartile range in the state-level Export Barrier changes in 2012 is (-2.8)-(-4.4)=1.6 percentage points (Table 3 column 2), the differential change between states at the upper and lower quartile of the barrier change is expected to be $1.6 \times 0.27 = 0.43$ (Table 4). The rest of the discussion is obtained in a similar way using the two tables.

Table 4: GDP

	Quarter 0	Quarter 4	Quarter 8	Quarter 12
ΔB^{Export}	0.10***	0.27***	0.37***	0.36***
	(0.04)	(0.08)	(0.11)	(0.12)
ΔB^{Prot}	0.23*	-0.01	-0.37	-0.48*
	(0.13)	(0.24)	(0.30)	(0.26)
ΔB^{Input}	0.05	0.36	0.28	0.29
	(0.11)	(0.28)	(0.30)	(0.31)
Time FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES
R^2	0.338	0.554	0.627	0.789
Observations	293	293	293	293

Notes: See Equation (5) in the text. Robust standard errors in parentheses. Clustered at the state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Employment

	Quarter 0	Quarter 4	Quarter 8	Quarter 12
ΔB^{Export}	0.01	0.12**	0.20**	0.32**
	(0.01)	(0.05)	(0.08)	(0.12)
ΔB^{Prot}	-0.02	-0.22*	-0.60***	-0.81***
	(0.02)	(0.12)	(0.22)	(0.28)
ΔB^{Input}	-0.00	0.03	0.15	-0.08
	(0.02)	(0.13)	(0.19)	(0.22)
Time FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES
R^2	0.775	0.661	0.706	0.832
Observations	293	293	293	245

Notes: See Equation (5) in the text. Robust standard errors in parentheses. Clustered at the state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The magnitude of the impacts continues to grow by the 8th quarter.

In the case of the Protective Barrier cut, a state at the 75th percentile would be expected to experience a 0.13 percentage point larger decline in GDP and a 0.29 percentage point larger decline in employment in the 4th quarter. The magnitude of the impacts continues to build up until the 12th quarter, especially in employment: there is a larger decline in employment of 0.78 and 1.05 percentage points in the 8th and the 12th quarter, respectively. An interquartile move of the Input Barrier change yields a modest increase in GDP and employment, but it is statistically insignificant over all horizons.

3.3 Link to the Conventional Measures

Due to the parallel structure in which they are defined and derived, the three measures share a similar closed form. We can leverage this similarity to conduct further analysis of the measures and draw a connection to the conventional import-weighted average tariff.

Recall that all three measures take the form of a weighted average, although the weight of each measure differs from each other. That is, all three measures derived in Equations (1), (2), and (3) can be rewritten as $B_S = \frac{\sum_i w_S^i \ \varepsilon^i \ \tau^i}{\sum_i w_S^i \ \varepsilon^i}$ where the weights differ as:[10]

$$w_S^i = \begin{cases} \frac{X_{SK}^i \left(1 - X_{SK}^i / Y_K^i\right)}{\sum_i X_{SK}^i \left(1 - X_{SK}^i / Y_K^i\right)} & \text{for } B_S^{Export} \\ \\ \frac{X_{K,US}^i X_{S,US}^i / Y_{US}^i}{\sum_i X_{K,US}^i X_{S,US}^i / Y_{US}^i} & \text{for } B_S^{Prot} \\ \\ \frac{m_{KS}^i \left(1 - m_{KS}^i / M_S^i\right)}{\sum_i m_{KS}^i \left(1 - m_{KS}^i / M_S^i\right)} & \text{for } B_S^{Input}. \end{cases} \tag{6}$$

Let the barred variables $\bar{x}$ denote the weighted average of x^i where the weight is given by w^i and the hatted $\hat{x}^i$ be x rescaled by $\bar{x}$. That is, $\bar{\tau}_S = \sum_i w_S^i \tau^i$, $\bar{\varepsilon}_S = \sum_i w_S^i \varepsilon^i$, and $\hat{\varepsilon}_S^i = \varepsilon_S^i / \bar{\varepsilon}_S$.

[10] Subscripts of ε^i and τ^i are dropped for simplicity. More precisely, B_S^{Export} is with ε_K^i and τ_K^i; B_S^{Prot} is with ε_{US}^i and τ_{US}^i; B_S^{Input} is with ε_S^i and τ_{US}^i.

Using these notations, it can be shown that

$$B_S = \sum_i w_S^i \ \hat{\varepsilon}_S^i \ \tau^i$$
$$= \underbrace{\sum_i w_S^i \ \tau^i}_{\bar{\tau}_S} + \underbrace{\sum_i w_S^i (\tau^i - \bar{\tau}_S)(\hat{\varepsilon}^i - \bar{\varepsilon}_S)}_{cov_S(\tau^i, \hat{\varepsilon}^i)} . \tag{7}$$

The first equality follows from the definition of $\hat{\varepsilon}^i$, and the second uses the equation $\sum_i w_S^i \hat{\varepsilon}^i = 1$, which is again evident from the definition of $\hat{\varepsilon}^i$.

This shows that any barrier measure B_S can be decomposed into two parts: weighted average $\bar{\tau}_S$ of tariff and weighted covariance $cov_S(\tau^i, \hat{\varepsilon}^i)$ of tariff and demand elasticity, with both the average and covariance being assigned a weight w^i.

Now consider the conventional measure of trade-weighted average tariff. The average tariff on exports and imports is formally written as:

$$T_S = \underbrace{\sum_i \omega_S^i \ \tau^i}_{\bar{\tau}_S} \tag{8}$$

$$\omega_S^i = \begin{cases} \frac{X_{SK}^i}{\sum_i X_{SK}^i} & \text{for } T_S^{Export} \\ \frac{X_{KS}^i}{\sum_i X_{KS}^i} & \text{for } T_S^{Import} \end{cases} \tag{9}$$

where X_{SK} is the export from state S to Korea, and X_{KS} is the import from Korea to state S.[11]

Comparing Equations (7) and (8), the new barrier measure B_S differs from the conventional tariff measure T_S in two key aspects. First, while both measures share the average term $\bar{\tau}_S$, only B_S includes an additional covariance term $cov_S(\tau^i, \hat{\varepsilon}^i)$ that is absent in T_S. This difference arises from the consideration of demand response based on the CES structure. Unless this covariance term is zero, B_S would deviate from T_S. A zero covariance term occurs when all products are subjected to identical tariff rates or when the elasticities for all products are equalized, a scenario that is highly uncommon. This divergence underscores how the new measure rectifies the bias in the conventional measure.

[11]Subscripts of τ^i are dropped for simplicity. More precisely, T_S^{Export} is with τ_K^i; T_S^{Import} is with τ_{US}^i.

Second, the weights are defined differently, as shown in Equations (6) and (9). The weights used in the new measures B_S deliberately reflect the distinct channels through which the tariff affects the local economy, while the weights used in the conventional measures T_S are simply trade flows. Also, in the case of the new measures, there are two separate types of weights to collectively explain channels on the import side: B_S^{Prot} and B_S^{Input}. On the other hand, in the case of the conventional measures, only one type of weight is used on the import side to construct T_S^{Import}, and it cannot separate the tariff impact on competing products from the tariff impact on input products.

To compare two measures in the data, Figure 6 shows their correlations. As depicted in Panel (a), the export-side measures exhibit a high correlation (0.82). However, Panels (b) and (c) demonstrate that import-side measures display larger variations (0.19 and 0.34, respectively). This indicates that the actual impact to the import tariff of a product differs from what is measured by the import value, emphasizing the necessity to consider different channels separately.

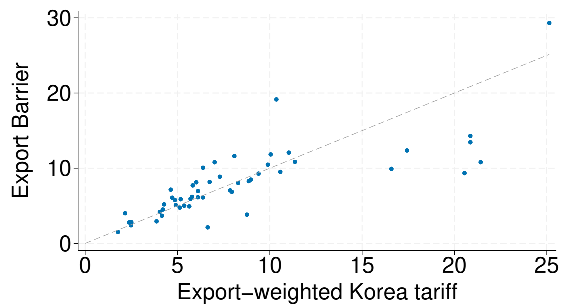
In order to highlight the use of the new barrier measures, I provide the results estimated with the conventional tariff measures of Equation (8). Figure 7 compares the result with that of the new measures. The panels in the left column (a) and right column (b) represent separate regressions, where the red dotted lines show the estimates when regressed on the conventional average tariff, while blue, yellow, and green solid lines are estimates of the new measures that have been displayed in Figure 2.

First, the new barrier measures give a much more precise estimate than the conventional measures. In all of the graphs, the estimate with the new measures (solid lines) has a much narrower confidence interval than that with the conventional measures (dotted red). This is especially true in the case of the Export Barrier and export tariff: GDP and employment are significant only when estimated with the barrier measure, even though the sizes of the estimates are close to each other.

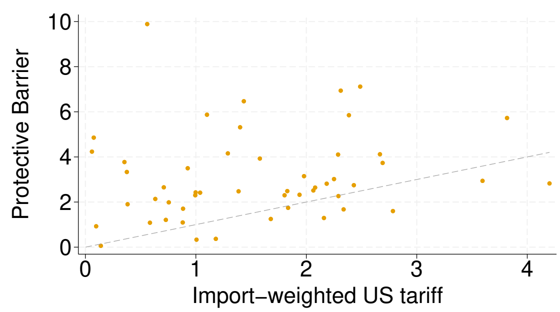
Second, the new barrier measures allow us to disentangle two opposite forces of import tariffs. If we use the conventional measures, we only see a combined effect of lower import tariffs on output and input, which is estimated to be positive (red dotted line in the second or

Figure 6: Barrier measures vs. trade-weighted average tariff

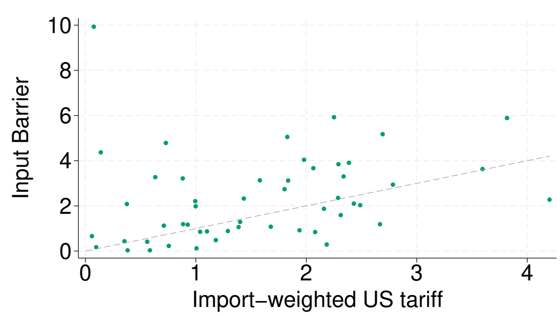
(a)



(b)

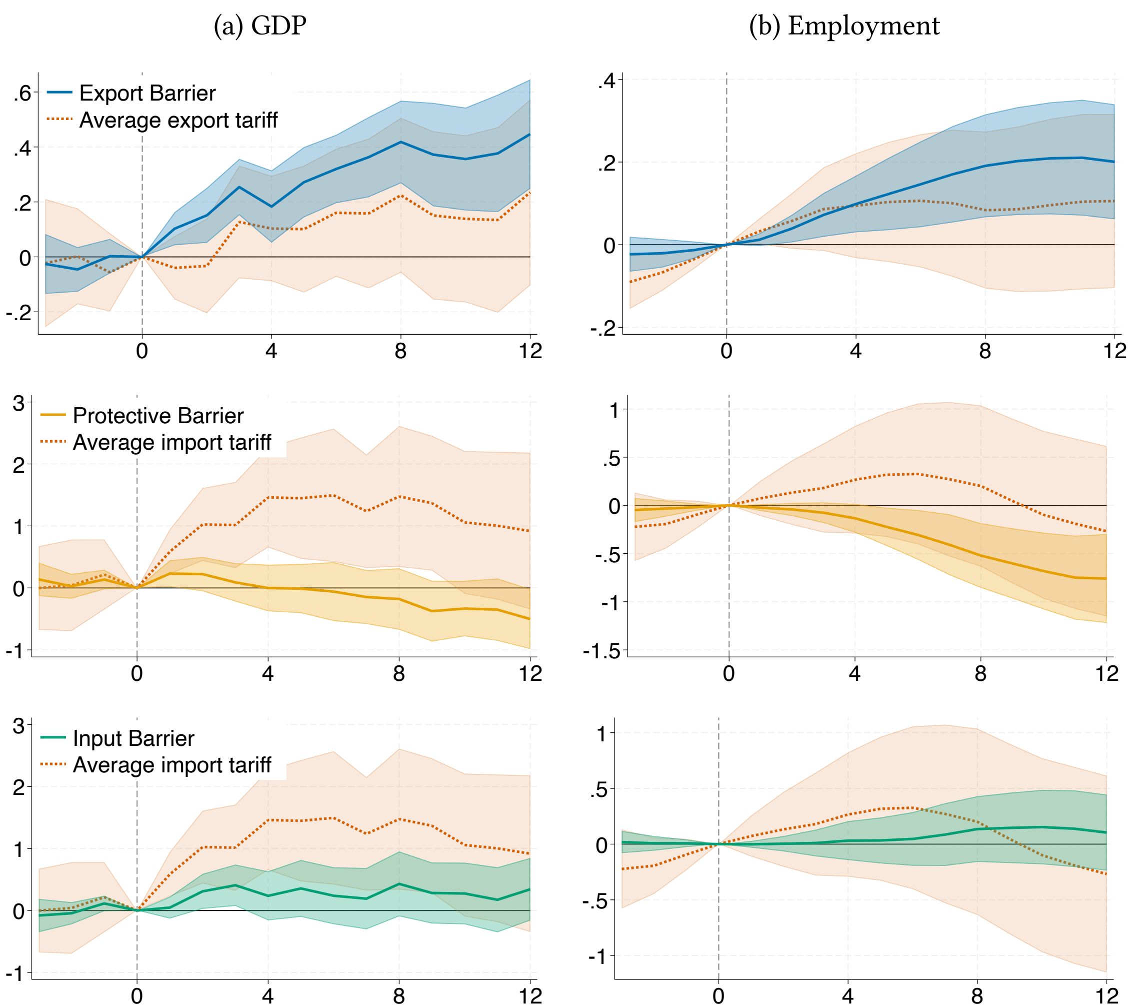


(c)



Notes: The dashed line displays the 45 degree line.

Figure 7: Estimation with different measures



Notes: Each of two columns is from a separate regression. The solid blue, yellow, and green lines are reproduction of those in Figure 4 Panel (a) and Figure 2 Panel (d). Red dotted lines labeled as T Export and T Import denote estimates for the conventional measures defined in Equations (8) and (9). The shaded areas display 90% confidence intervals. All dependent variables are logged and multiplied by 100.

the third rows). However, by using the new measures, we can disentangle the negative impact of lower import tariff on output (Protective Barrier cut, yellow solid lines) and the positive impact of lower import tariff on input (Input Barrier cut, green solid lines).

4 Robustness

In this section, I discuss a few alternative specifications to test the robustness of the result. First, I consider using applied tariff instead of scheduled tariff. Second, I redo the analysis with a different numbers of lags in the Local Projection Method.

4.1 Applied Tariff

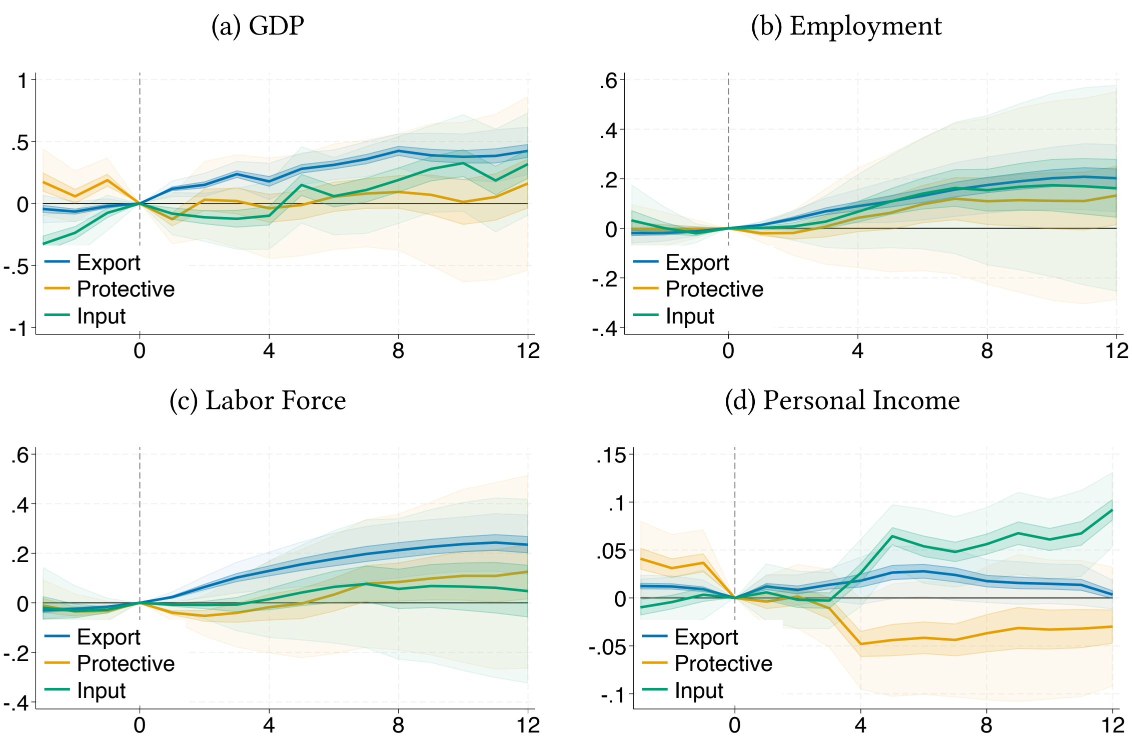
The barrier measures in the benchmark exercise are based on the tariff rates that have been scheduled when the policy was signed. Instead in this section, I consider employing the applied tariff rates at the time of importation. The applied rates are calculated by total duty divided by customs value at the HS6 level, both denominated in USD. Rates at the top and bottom one percentiles are truncated. The result of the estimation is presented in Figure 8.

In Panel (a) of Figure 8, the result for the GDP is presented. The responses to the Export and Input Barriers are similar to the benchmark case, both in terms of signs and sizes: the barrier cuts is correlated with the increase in GDP by 0.5 percentage points. However, the response to the Protective Barrier cut is small and insignificant when using the applied tariff. In employment and labor force, similar results are found. While the Export Barrier and Input Barrier show positive results as in the benchmark case, the result of the Protective Barrier is insignificant in this case. Meanwhile, larger responses are found in the personal income.

4.2 Number of Lags

I run estimation using different number of lags in the response variable. The results are almost unchanged, particularly in terms of signs and significance. Specifically, the response to the Export Barrier cut is nearly identical to the benchmark case. Furthermore, the Protective Barrier cut also shows very similar results, with the response being positive on impact and

Figure 8: Using Applied Tariff



Notes: The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of β_h^{Export}, β_h^{Prot}, and β_h^{Input} over the horizon of $h = -4, \cdots, 12$. The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

becoming significantly negative by the 12th quarter. Finally, the Input Barrier cut does not seem to have a significant impact as in the benchmark case, either in the cases of 2 or 4 lags.

Table 6: GDP, lags

	$L = 2$				$L = 4$			
	Quarter 0	Quarter 4	Quarter 8	Quarter 12	Quarter 0	Quarter 4	Quarter 8	Quarter 12
ΔB^{Export}	0.09**	0.26***	0.36***	0.36***	0.10**	0.29***	0.36***	0.36***
	(0.04)	(0.08)	(0.11)	(0.12)	(0.04)	(0.08)	(0.12)	(0.12)
ΔB^{Prot}	0.22*	-0.02	-0.38	-0.48*	0.22*	-0.00	-0.38	-0.49*
	(0.12)	(0.24)	(0.29)	(0.25)	(0.13)	(0.23)	(0.29)	(0.26)
ΔB^{Input}	-0.00	0.33	0.25	0.30	-0.00	0.31	0.25	0.33
	(0.09)	(0.23)	(0.29)	(0.35)	(0.10)	(0.24)	(0.30)	(0.35)
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
State FE	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.354	0.556	0.628	0.789	0.366	0.566	0.628	0.793
Observations	293	293	293	293	293	293	293	293

Notes: See Equation (5) in the text. Robust standard errors in parentheses. Clustered at the state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5 Conclusion

This paper examines the effect of tariff cuts that accompanied the U.S.-Korea FTA in GDP and labor market along the transitional path. I first introduce a procedure to aggregate Korean tariffs on U.S. exports, U.S. tariffs on Korean exports, or U.S. tariffs on imported inputs in order to quantify the sizes of to Export Barrier, Protective Barrier, or Input Barrier that each state faces with trading with Korea. Using differential changes in these measures across states in the U.S., I estimate the relationship between the barrier cuts and GDP, employment, and income over the time horizon that ranges from 4 quarters before to 12 quarters after a shock.

The new measures provide not only a theoretically sound quantification of trade barriers, but also a more precise results. Specifically, using the measures, we can disentangle the negative impact of Protective Barrier cut and the positive impact of the Input Barrier cut. Moreover, the impact of the Export Barrier cut is more clearly estimated with a smaller standard error.

Also, the estimates of dynamic impact along the transitional path enable a richer understanding of how trade liberalization shapes the local economy. I find that each barrier impact differs in terms of not only the magnitude and the direction but also its gradualness and persistence. Protective Barrier cut tends to affect the economy for a longer time horizon at least for 12 quarters, while the response to the Input Barrier cut 8 quarters after the shock overshoots its longer-run estimates. One might find it surprising that GDP and the labor market do not move much in anticipation of barrier changes. This might be specific to the episode studied or to the identification procedure. More careful analysis of the anticipatory effect is left as future research.

Finally, the results have implications for evaluating the effects of import tariffs. One argument from proponents of free trade is that it promotes not only exports but also domestic production through the supply channel effect with better imports. However, the findings of this paper suggest that the positive impact of such a policy is not significant in the case of the U.S. In fact, any positive effects seem to be outweighed by the negative impact, particularly in the long run.

References

Alessandria, George, Horag Choi, and Kim Ruhl, "Trade Adjustment Dynamics and the Welfare Gains from Trade," Working Paper 20663, National Bureau of Economic Research November 2014.

Amiti, Mary and Jozef Konings, "Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia," *American Economic Review*, 2007, *97* (5), 1611–1638.

Anderson, James E. and J. Peter Neary, "Measuring the Restrictiveness of Trade Policy," *The World Bank Economic Review*, 1994, *8* (2), 151–169.

__ **and** __ , "A New Approach to Evaluating Trade Policy," *The Review of Economic Studies*, 1996, *63* (1), 107–125.

Autor, David H., David Dorn, and Gordon H. Hanson, "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, October 2013, *103* (6), 2121–68.

Benguria, Felipe and Felipe Saffie, "The Impact of the 2018-2019 Trade War on US Local Labor Markets," *Available at SSRN*, 2020.

Flaaen, Aaron and Justin R Pierce, "Disentangling the Effects of the 2018-2019 Tariffs on a Globally Connected US Manufacturing Sector," 2019.

Hakobyan, Shushanik and John McLaren, "Looking for local labor market effects of NAFTA," *Review of Economics and Statistics*, 2016, *98* (4), 728–741.

Halpern, László, Miklós Koren, and Adam Szeidl, "Imported inputs and productivity," *American Economic Review*, 2015, *105* (12), 3660–3703.

Handley, Kyle, Fariha Kamal, and Ryan Monarch, "Rising import tariffs, falling export growth: When modern supply chains meet old-style protectionism," Technical Report, National Bureau of Economic Research 2020.

Hooper, Peter, Karen Johnson, and Jaime R Marquez, "Trade elasticities for the G-7 countries," 2000.

Kasahara, Hiroyuki and Joel Rodrigue, "Does the use of imported intermediates increase productivity? Plant-level evidence," *Journal of development economics*, 2008, *87* (1), 106–118.

Kee, Hiau Looi, Alessandro Nicita, and Marcelo Olarreaga, "Import demand elasticities and trade distortions," *The Review of Economics and Statistics*, 2008, *90* (4), 666–682.

__ **,** __ **, and** __ , "Estimating Trade Restrictiveness Indices," *The Economic Journal*, 2009, *119* (534), 172–199.

Kovak, Brian K, "Regional effects of trade reform: What is the correct measure of liberalization?," *American Economic Review*, 2013, *103* (5), 1960–76.

Mullen, Marcos Mac and Soo Kyung Woo, "Real Exchange Rate and Net Trade Dynamics: Financial and Trade Shocks," 2023.

Rodriguez, Francisco and Dani Rodrik, "Trade policy and economic growth: a skeptic's guide to the cross-national evidence," *NBER macroeconomics annual*, 2000, *15*, 261–325.

Topalova, Petia, "Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India," *American Economic Journal: Applied Economics*, October 2010, *2* (4), 1–41.

— **and Amit Khandelwal**, "Trade liberalization and firm productivity: The case of India," *Review of economics and statistics*, 2011, *93* (3), 995–1009.

Trefler, Daniel, "The long and short of the Canada-US free trade agreement," *American Economic Review*, 2004, *94* (4), 870–895.

Waugh, Michael E, "The Consumption Response to Trade Shocks: Evidence from the US-China Trade War," Working Paper 26353, National Bureau of Economic Research October 2019.

Òscar Jordà, "Estimation and Inference of Impulse Responses by Local Projections," *The American Economic Review*, 2005, *95* (1), 161–182.

Data Appendix

- Products: The product is defined at HS-6 level. Although the tariff rates are defined at the finer level of HS-10 in both countries, HS-10 are not harmonized across countries, making it hard to link the tariffs to trade flows and other variables. In fact in most of the cases, the tariff rates do not differ within HS-6 level. In a few cases that the schedule is segmented into a finer level into the 10-digit HS code, I calculate the rate by taking a simple average within the same 6-digit products. The correspondence between the product code HS and IO is taken from Korea Statistics, while the correspondence between HS and NAICS is from BEA.

- Tariff rates: The tariff schedules of both the U.S. and Korea are digitized from the Chapter 2 of the official Agreement, downloaded from Korea Ministry of Trade. The tariff revenue of the U.S. on imports from Korea is drawn from USITC. The tariff lines with rates over 300% are excluded. Tariff cut on these products does not fully reflect the changes in protection for these products, because these are mostly agricultural products that are protected by quotas or safeguards even after the FTA. These products account for 0.5% of the total number of tariff lines.

- Trade flows: Bilateral export and import of each state to Korea of the corresponding products are from the Census. Korea's aggregate import from the U.S. and the world is collected from the UN Comtrade. Data on use of imports in each sector in Korea is collected from Korea Statistics.

- Income and labor market variables: State level GDP, income, and expenditure are from BEA. Employment and wages are from QCEW. Labor participation related variables are from BLS.

- Input share: I use Use and Supply Table from BEA.

- Demand elasticity: The product level elasticity of both the U.S. and Korea are estimated values from Kee et al. (2008).