# Measuring Trade Barriers and their Dynamic Impact: Evidence from Regional Exposure to US-Korea FTA*

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**Abstract**

This paper studies the dynamic impact of trade barriers, using regional variations in exposure to the U.S.-Korea Free Trade Agreement. A key contribution is the introduction of theoretically robust measures of trade barriers, which account for demand responses and incorporates multiple channels through which tariffs affect trade. I find the conventional measures understate the true extent of trade barriers. Applying the new measure, I find that lower barriers to exporting lead to increases in GDP and employment, while greater competition with foreign firms has a delayed negative effect. Access to cheaper inputs has a negative impact, especially on employment.

**JEL Classification:** F13, F14, F62

**Keywords:** Trade Liberalizations, Tariffs, Trade Dynamics

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# 1 Introduction

Protectionist trade policies are back in the spotlight, with recent U.S. administrations pursuing tariffs and erecting trade barriers. In the past, trade liberalization was promoted as a path to economic growth and improved consumer welfare. As the U.S. shifts away from its previous commitment to free trade, it is crucial to evaluate it is essential to examine both the advantages and adverse effects of trade policy. This study seeks to provide an answer to this question.

In this paper, I study a less-explored episode of trade liberalization: the U.S.-Korea Free Trade Agreement (FTA). The agreement, which went into force in 2012, was the largest trade deal for the U.S. after the North American Free Trade Agreement (NAFTA) in 1993. Also, its proximity to China, in terms of both distance and market structure, makes the FTA with Korea a particularly relevant case for understanding the recent reversion of trade policies in the US. The agreement progressively eliminated tariffs on almost all the products traded between the two countries. Within five years of the implementation, over 90 percent of the products were to become duty-free in both countries. After its implementation, Korea became the sixth largest trading partner of the U.S., with its share in U.S. gross trade rising from 2.5 percent to nearly 4 percent in 2023.

While the agreement allows the U.S. to benefit from expanding to Korean market and importing Korean inputs with lower tax, it comes at the expense of facing more competition with Korean firms in the domestic market. For the anlaysis I first introduce a measure of regional exposures to these three channels of trade liberalization: easier exporting, a higher degree of local competition with foreign firms, and cheaper imported inputs. 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 is measuring exposure to trade barriers.[1] Measures of the trade barrier used in the literature are often vaguely defined and lack economic interpretation (Ro-

[1] Although the FTA offers a well-defined policy setting, tariffs are set at a highly detailed level–8 or 10-digit HS codes–across thousands of products, complicating attempts to summarize them in a single measure.

driguez and Rodrik, 2000; Kee et al., 2008). The most standard approach is to aggregate tariffs by taking averages with trade weights. However, this method tends to have a downward bias. For instance, the import value-weighted average tariff rate can underestimate the impact of excessively high tariffs, as products with high tariffs end up not imported enough and therefore assigned too little weight, despite their strong prohibitive power. That is, trade weighting functions more as an ex-post approach and cannot fully capturing the distortions tariffs impose. Shift-share type measures using the average tariff across sectors are sometimes employed (Topalova, 2010; Kovak, 2013). However, the sectoral averages are again import-weighted and are also subject to downward bias for a similar reason. I find that countries do impose higher tariffs on products with higher demand elasticity so that average tariffs tend to be smaller than the actual barrier sizes.

I tackle this challenge by introducing a measure of trade barriers that exploits the demand structure of the 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 considering three different 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*? It is important to consider all channels simultaneously, especially in the context of bilateral trade agreement that changes both inward and outward trade barriers.

The new measure of trade barriers, well-grounded in trade theory, deviates from conventional measures. I find that these measures often yield higher values than the conventional ones, indicating that the simple average tariff understates the true extent of trade barriers. This occurs because countries, including the U.S., tend to impose higher tariffs on products with greater demand elasticity. Therefore, it is crucial to account for the demand response when measuring trade barriers. Another advantage of this measure is its ability to distinguish between the negative effects of tariffs cuts on imports that the firms compete with and the positive effects on those used as intermediates. In contrast, the import-weighted average tariff only captures the overall combined impact of import tariffs. Despite these improvements, the measure retains the simple form of ad-valorem rate, making it convenient and intuitive to interpret. When applied to regression analysis, it delivers more precise estimates of tariff impacts, with smaller standard errors compared to the conventional measures.

When using this measure to estimate the impact of the trade liberalization, I focus on the dynamics along the transition. The literature on trade liberalization tends to study only the long-run impact and is rarely explicit about the transitional effect. However, it is well known that trade tends to respond gradually (Hooper et al., 2000; Baier and Bergstrand, 2001; Ruhl, 2008), and it is crucial to consider the transitional dynamics when evaluating welfare gains after a reform (Alessandria et al., 2021). Moreover, the impact of trade on the labor market largely depends on labor mobility. Given the sluggish response of the U.S. labor market (Topel, 1986; Glaeser and Gyourko, 2005; Caliendo et al., 2019), these effects are expected to last over the medium to long run. However, the precise timing and duration of these effects remain unclear. Different channels of the tariff may unfold at different timing, and explicitly studying the dynamics of trade impact would help understand better the tension between potential opportunities and threats of a trade liberalization.

I find that with lower barriers to exporting, GDP and employment increase. These estimates, derived from the new barrier measures, are larger than those obtained using conventional measures. In specific, a percentage point lower Export Barrier leads to 0.80 percentage point larger GDP by the 12 quarters. Employment also grows by 0.41 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 0.61 and 0.14 percentage points, respectively, by the 12th quarter.[2] Interestingly, access to cheaper

[2] As will be discussed in Section 3.2, the result of the Protective Barrier cut on employment, as well as labor force, transfer benefits, and wages are qualitatively similar to those of Autor et al. (2013), who study the impact of Chinese import penetration.

inputs has a negative impact especially on 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 changes 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 and unemployment (Chiquiar, 2008; Topalova, 2010; Kovak, 2013). More recently, studies using regional variations within the U.S. have mainly focused on the impact of trade with China, namely the China shock or the trade war (Autor et al., 2013; Benguria and Saffie, 2020; Waugh, 2019). For example, Autor et al. (2013) use variations at the commuting zone level, while they focus on the effect of Chinese import penetration rather than the tariff changes. This paper is close to Hakobyan and McLaren (2016) who study the distributional effects of NAFTA in that I study the impact of tariffs against a major trading partner at the geographic level. I add to this literature by analyzing the dynamics at a higher time frequency and using a less-studied, yet 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 concerning 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 exports.

The remainder of this paper is structured as follows. Section 2 introduces the new measures, describes data, and discusses their magnitude across the states after the FTA. I also compare the new barrier measures with the conventional average tariff. Section 3 uses these measures to estimate the dynamic responses, discusses the results, and compares them with those using the conventional measures. Section 4 discusses the robustness of the results. Section 5 concludes.

# 2 Measures of Trade Barriers

This section describes the measures that quantify the regional trade barriers related to tariffs. I describe the data used, introduce the barrier measures, document the changes in the barrier measures due to the trade agreement, and then compare them with conventional measures.

## 2.1 Construction of the Measures

A common method for summarizing diverse tariff rates across numerous products is to calculate the weighted average of rates, using trade value as the weight for each product.[3] Despite its simplicity and widespread usage, this method lacks a solid theoretical foundation and often exhibits a downward bias. This bias arises because excessively high tariffs suppress trade for the affected products, leading to smaller trade flows and underrepresenting their prohibitive impact in the weighted average.

To address these limitations, I introduce measures that leverage the import demand structure of the Armington model. The Armington model, which serves as the foundation for nearly all trade models involving more than one good, provides a useful framework for quantifying trade barriers. This approach extends the Trade Restrictiveness Index, a measure that evaluates the overall welfare impact of tariffs, based on the theoretical framework of Anderson and Neary (1994, 1996) and the empirical methodology first developed by Kee et al. (2008, 2009), to capture different channels of tariff impacts.

[3] This can also be calculated as the ratio of tariff revenue to total import value.

Specifically, using the Armington demand structure, I derive a uniform tariff rate that, if applied uniformly across all imported products, would replicate the same outcomes as the observed tariff structure in the data across three distinct aspects. These aspects represent different channels of tariff impacts: barriers to i) exports to the foreign market, 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 sustains the current level of i) aggregate exports, ii) local firms' domestic sales, or iii) imported inputs. In the following, I refer to these barriers as the Export Barrier, Protective Barrier, and Input Barrier.

Beyond being firmly rooted in trade theory, another advantage of the new measures is that they can measure the regional exposure for any pair of trading partners. This means that both national and subnational measures can be obtained directly, without relying on Bartik-style indirect methods, as long as trade and elasticity data for the two partners are available. Additionally, the resulting tariff rates are expressed as ad-valorem equivalents, making its interpretation straightforward.

**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:

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

where $p_S^i$ is the price of product $i$ from state $S$, $P_K^i$ is the price index for product $i$ in Korea, $\tau_K^i$ is tariff rate imposed by the Korean government on product $i$ from the U.S., $\varepsilon_K^i$ is demand elasticity for product $i$ in Korea, and $Y_K^i$ is the total expenditure on product $i$ in Korea. The equation highlights that export $X_{SK}^i$ is a function of the tariff rate $\tau_K^i$, as the tariff raises the price of the product from $p_S^i$ to $p_S^i(1+\tau_K^i)$ 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 $\sum_i X_{SK}^i(\tau_K^i)$. Then, the Export Barrier of state $S$ is implicitly defined as $B_S^{Export}$ such that:

$$\sum_i X_{SK}^i(B_S^{Export}) = \sum_i X_{SK}^i(\tau_K^i).$$

That is, $B_S^{Export}$ is the uniform rate at which the aggregate exports under the rate and those under the current tariff structure are equated.

Totally differentiating in a partial equilibrium setup,

$$\sum_i dX_{SK}^i \cdot B_S^{Export} = \sum_i dX_{SK}^i \cdot \tau_K^i,$$

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.[4] Moreover, it is also increasing in the demand elasticity: if the demand for a product is highly elastic, then the tariff on that product is given a larger weight as it would limit the imports more than

[4]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 $X_{SK}^i \leq 0.5Y_K^i$, which means that state $S$ takes less than a half of the product $i$'s market share in Korea.

a low elasticity product.

### Protective Barrier

The U.S. tariff on imports protects a state from competition with Korean firms, helping the state maintain its levels of domestic production and sales. The Protective Barrier quantifies the distortions caused by these protections. It is defined as the uniform tariff rate that, if applied to imports instead of the current U.S. tariff schedule, would result in the same *sales in the U.S.* as observed under the current tariff structure.[5]"

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 $i$, $\tau^i_{US}$ 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 $S$, $\varepsilon^i_{US}$ 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:

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

[5]This measure accounts for sales not only within the state itself but across the entire U.S. market. As a result, it captures foreign competition faced by a firm in a state, even if such competition originates in other states. Unlike the Input Barrier discussed below, this measure includes all types of products, including intermediate goods. Specifically, intermediate goods are considered here as long as they constitute a firm's output and are subject to foreign competition.

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.

**Input Barrier**

The Input Barrier summarizes the distortion in the use of imported intermediate inputs that arises due to the U.S. tariff on imports from Korea. The measure is an 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, $\varepsilon^i_S$ 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 $P_S^i$ is the price index for product $i$ in state $S$ written as

$$P_S^i = \left[ \sum_L \left( p_L^i (1 + \tau_{LS}^i) \right)^{\varepsilon_S^i} \right]^{1/\varepsilon_s^i}$$

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 the same as under the current tariff schedule, is $B_S^{Input}$ such that:

$$\sum_i m_{KS}^i (B_S^{Input}) = \sum_i m_{KS}^i (\tau_{US}^i).$$

Taking total derivatives,

$$\sum_i dm_{KS}^i \cdot B_S^{Input} = \sum_i dm_{KS}^i \cdot \tau_{US}^i,$$

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, the 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 the 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.

Table 1: Base rate statistics

| | N | Mean | Std. | Min | p25 | Median | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| US | 9,486 | 4.20 | 11.18 | 0.00 | 0.00 | 2.70 | 6.00 | 350.00 |
| Korea | 10,976 | 13.09 | 52.63 | 0.00 | 5.50 | 8.00 | 8.00 | 887.40 |

*Notes:* The table presents statistics for base rates, which correspond to the tariff rates scheduled for imports before the agreement was enacted in 2012. U.S. tariff lines are defined at the HTS8 (8-digit HS) level, while Korea's are defined at the HSK (10-digit HS) level.

## 2.2 Data

To calculate the measure for each state over time, data are sourced from multiple datasets. Tariff rates for both countries are obtained from the official FTA document provided by the Korea Ministry of Trade. The document provides the base tariff rate prior to the FTA for each product. Korea's tariff schedule is defined at the 10-digit HS level, while the U.S. uses the 8-digit level. The analysis, however, uses products at the 6-digit level of the HS code, the finest level of the code that is internationally standardized. For cases where tariff schedules vary within a 6-digit code, I calculate the rate by taking a simple average across the products within the same 6-digit code.[6]

Table 1 presents the base rate statistics for tariffs of the U.S. and Korea. Korea's average tariff rate is substantially higher at 13.1% compared to 4.2% in the U.S. Additionally, the variability in Korea's tariff rates is much greater, with a standard deviation of 52.6% versus 11.2% for the U.S. This difference is further highlighted by the maximum tariff rates: Korea's peak rate reaches 887.40%, while the U.S. maximum is 350%.[7] The median tariff in Korea (8.0%) is also higher than in the U.S. (2.7%). The interquartile range for the U.S. spans from 0% to 6%, whereas Korea's range is narrower, from 5.5% to 8%. These statistics indicate that while Korea generally has higher tariff levels, U.S. tariffs are more dispersed.

The official FTA document also provides the staging category for different products, that

[6] Ideally, tariffs below the 6-digit level would be aggregated using the same method discussed above. However, the data required to construct the weights–such as import elasticity and consumption–are often unavailable at such a detailed level and are subject to potential measurement errors.

[7] There are 126 products with tariffs exceeding 100% in Korea, most of which are agricultural goods. Excluding these high-tariff products for the construction of barrier measures gives very similar results as the baseline.

indicates the timeline by which tariff reductions are implemented under the FTA. Each product is assigned to a specific category that determines how and when its tariff rate will be reduced, ranging from immediate elimination to phased reductions over a number of years. For example, products in a "Category A" staging schedule become duty-free immediately upon implementation of the agreement, while other categories phase out tariffs over longer periods.

Table 2 shows the distribution of products across staging categories. Products in Category A that became duty-free immediately upon the policy's implementation make up the largest share in both countries: 67% for the U.S. and 45% for Korea. The second-largest category is Category K, also in both countries, covering products that were already duty-free before the agreement took place. Taking these two categories together with categories B, C, D, and Q, over 90% of the products were to be duty-free in both countries within five years of the implementation. In contrast, other products had tariffs phased out over specific periods, varying from 2 years to 20 years.[8]

For the import demand elasticity, I take the value estimated by Kee et al. (2008) each for U.S. and Korea.[9] Here I assume that that the import elasticity is common across all states in the U.S. Data on export and import flows to Korea of the corresponding products, used for the construction of Export Barrier, is from the U.S. Census Bureau.[10] Products are categorized as intermediate inputs according to the Stages of Processing (SoP) classification of United Nations.

As shown in Equation (1), constructing the Export Barrier requires data on the share of

[8] Among 10,992 products, Korea imposes quotas on 48 (0.44%). However, quota requirements are excluded in my calculation of tariff barrier measures. Also, products in Categories V and W are subject to different tariff rules at different times of the year, although there is only one product in each of these categories. I applied the reduction rule that is mentioned first in the document.

[9] Details on the elasticity estimates are provided in Section 4.1. In that section I compare these elasticity estimates with the those of Soderbery (2015) and Soderbery (2018). I also show the robustness checks using these alternative estimates.

[10] A potential concern with using state-level trade data is that it may not fully capture the actual destinations and sources of U.S. trade. For the Export Barrier measure, the relative size of trade across products within a state is the key factor. If there is significant variation across products in these discrepancies within a state, it could generate noises in the barrier measures. This limitation, however, is not unique to the new measure and is also a challenge inherent in the construction of average tariff measures.

Table 2: Staging categories

| Category | Staging | Korea | | US | |
|---|---|---|---|---|---|
| | | Count | Share | Count | Share |
| A | Duty-free immediately | 7,392 | 67.25 | 4,761 | 44.72 |
| B | 2 equal stages, duty-free year 2 | 6 | 0.05 | 10 | 0.09 |
| C | 3 equal stages, duty-free year 3 | 752 | 6.84 | 360 | 3.38 |
| D | 5 equal stages, duty-free year 5 | 509 | 4.63 | 746 | 7.01 |
| E | 6 equal stages, duty-free year 6 | 2 | 0.02 | 1 | 0.01 |
| F | 7 equal stages, duty-free year 7 | 41 | 0.37 | 91 | 0.85 |
| G | 10 equal stages, duty-free year 10 | 636 | 5.79 | 575 | 5.40 |
| H | 15 equal stages, duty-free year 15 | 108 | 0.98 | 65 | 0.61 |
| I | Variable reductions, duty-free year 10 | 24 | 0.22 | 12 | 0.11 |
| J | No change 8 years, then 4 equal stages, duty-free year 12 | 3 | 0.03 | 17 | 0.16 |
| K | Always duty-free | 1,408 | 12.81 | 3,990 | 37.48 |
| L | 9 equal stages, duty-free year 9 | 1 | 0.01 | 0 | 0.00 |
| M | 12 equal stages, duty-free year 12 | 40 | 0.36 | 0 | 0.00 |
| N | Reduced to 30% in 15 equal stages, duty-free year 16 | 2 | 0.02 | 0 | 0.00 |
| O | 18 equal stages, duty-free year 18 | 7 | 0.06 | 0 | 0.00 |
| P | 20 equal stages, duty-free year 20 | 1 | 0.01 | 0 | 0.00 |
| Q | Annual stages, duty-free 2014 | 21 | 0.19 | 0 | 0.00 |
| R | Full article value duty, then duty-free year 10 | 0 | 0.00 | 1 | 0.01 |
| S | Duty-free immediately, selected items duty-free without bond | 0 | 0.00 | 17 | 0.16 |
| T | No change 10 years, then 5 equal stages, duty-free year 15 | 1 | 0.01 | 0 | 0.00 |
| V | Seasonal reductions, 17 or 4 equal stages, duty-free years 5 or 17 | 1 | 0.01 | 0 | 0.00 |
| W | Seasonal 30% reduction, then 6 equal stages, duty-free year 7 | 1 | 0.01 | 0 | 0.00 |
| X | No change | 13 | 0.12 | 0 | 0.00 |
| Y | No FTA obligations; WTO commitments apply | 16 | 0.15 | 0 | 0.00 |
| Z | Reduced to 20%, then 9 equal stages, duty-free year 10 | 7 | 0.06 | 0 | 0.00 |
| Total | | 10,992 | 100 | 10,646 | 100 |

*Notes:* Category G includes 26 products that are duty-free within a quota, with Category G rules applying once this limit is exceeded.

state $S$ exports to Korea in Korea's total expenditure, $X^i_{SK}/Y^i_K$. However, data on the total expenditure $Y^i_K$ in Korea at the 6-digit HS code level is not readily available. To address this data limitation, I decompose the share $X^i_{SK}/Y^i_K$ into three parts:

$$\frac{X^i_{SK}}{Y^i_K} = \underbrace{\frac{X^i_{SK}}{X^i_{US,K}}}_{(a)} \cdot \underbrace{\frac{X^i_{US,K}}{X^i_{World,K}}}_{(b)} \cdot \underbrace{\frac{X^i_{World,K}}{Y^i_K}}_{(c)}$$

where $X^i_{US,K}$ is Korea's import from the U.S. of product $i$, and $X^i_{World,K}$ 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 of imports from Korea of product $i$ and is collected from the UN Comtrade database.[11] 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. This approach allows us to construct an estimate of the share $X^i_{SK}/Y^i_K$ using available aggregate data while maintaining consistency with the theoretical framework.

Similarly, for Protective Barriers, data on the state $S$ sales to the U.S., $X^i_{S,US}$, and U.S. expenditure, $Y^i_{US}$, in the U.S. at the 6-digit HS code level are not available (see Equation (2)). 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

[11] 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.

state is only available at the sector level, classified with the NAICS code. 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.

For Input Barriers, data on intermediate product use, $M_S^i$, of state $S$ at the 6-digit HS code level is unavailable. To get the share $m_{KS}^i / M_S^i$ of Equation (3), I resort to its decomposition

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

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

$$m_{World,S}^i = \sum_j m_{World,S}^{ij} \cdot \frac{GDP_S^j}{GDP_{US}^j}$$
$$M_S^i = \sum_j M_{US}^{ij} \cdot \frac{GDP_S^j}{GDP_{US}^j}$$

where $m_{World,US}^{ij}$ is the national imported use of $i$ as an input of $j$, $M_{US}^{ij}$ is the national total use of $i$ as an input of $j$, $GDP_S^j$ is the state $S$'s GDP of $j$, and $GDP_{US}^j$ 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.

## 2.3 U.S.-Korea FTA and Trade Barriers

The negotiations for the U.S.-Korea FTA were first authorized by Congress in 2002, but it took several years of legislative processes and renegotiations until it finally went into effect in

Table 3: Barrier statistics

| | N | Mean | Std | Min | p25 | p50 | p75 | max |
|---|---|---|---|---|---|---|---|---|
| **Export Barrier** $B^{Export}$ | 49 | 8.02 | 5.11 | 1.89 | 4.88 | 6.19 | 10.64 | 30.04 |
| **Protective Barrier** $B^{Protective}$ | 49 | 2.58 | 1.49 | 0.00 | 1.70 | 2.26 | 2.92 | 7.19 |
| **Input Barrier** $B^{Input}$ | 49 | 2.70 | 1.60 | 0.05 | 1.60 | 2.84 | 3.63 | 6.42 |

*Notes:* The table shows the statistics of three barrier measures during 2011 prior to the FTA, in percents. p25, p50, and p75 denote 25th, 50th, and 75th percentile, repectively. It covers 49 states in the US, including the District of Columbia and excluding Alaska and Hawaii.

March 2012. It required the tariffs between the two countries to be removed within 15 years, either immediately or through equal annual reductions occurring at the start of each year. A significant share of the products were subject to the immediate elimination of tariffs, and most of the products were to be duty-free within five years.[12] Before the FTA, Korea was the 7th largest trading partner of the U.S., accounting for around 2.5 percent of gross U.S. trade. As of 2023, Korea became the 6th largest trading partner with almost 4 percent.[13]

Following the procedure described in Section 2.1 and using data from Section 2.2, I quantify the barrier measures around the periods that the FTA was implemented. Table 3 documents the summary statistics of the barrier measures. The Export Barrier tends to be higher than the other two barriers, with its mean, median, minimum, and maximum being larger than the others. For example, the medians of the Export Barrier, the Protective Barrier, and the Input Barrier are 7.15, 2.51, and 2.03 percent, respectively. This is because Korea's import tariff rates prior to 2012 were generally higher than the U.S. as discussed above.

Moreover, there are large variations in trade barriers across across different U.S. states. Table 3 shows that the standard deviation ranges from 1.71 (Protective Barrier) to 4.73 (Export Barrier) percent. Figure 1 displays the regional variations of three barrier measures. Export Barrier is highest for Idaho (29.31%), followed by Arkansas (19.15%), Iowa (14.30%), and South

[12] Among the 10,992 tariff lines of Korea, 67% became duty-free on the date the treaty entered into force. In the U.S., 45% of 10,646 tariff lines became duty-free on impact. For more details, see Table 2.

[13] There was a renegotiation of the U.S.-Korea FTA that started in July 2017, was signed in September 2018, and went into effect in January 2019. The amendments focused on the automobile sector, including the delays of tariff reductions on Korean trucks. In the analysis I focus on the period until 2017.

Dakota (13.45%). High trade barriers of these states stem from the high tariff on agricultural products including meat and grains. For example, tariff lines that contribute the most for the trade barriers against Idaho's exports include food products such as cheese,[14] whey,[15] and peas.[16] These products are subject to high tariffs over 30 percents, with relatively high demand elasticity.

Unlike the barriers to exports, Protective Barriers on the import side tend to be higher for states on the eastern states. Top four states are: South Carolina (7.12%), Georgia (6.95%), Vermont (6.47%), and Mississippi (5.87%). South Carolina and Georgia have significant automotive and electronics sectors that import components from Korea. South Carolina, for instance, has a large automotive industry, with manufacturers like BMW relying on Korean parts.

Input Barriers are highest in Oklahoma (5.05%) and Arizona (4.79%). The products contributing most to these high input barriers are primarily woven fabrics.[17] Among the intermediates imported by Oklahoma, plastic materials used in construction, piping, and packaging[18] face relatively high tariffs. In Arizona, aluminum products[19] exhibit high demand elasticity.

Table 4 shows the pairwise correlation of the three barriers. The observed correlation is generally low. It is rather surprising that Protective Barriers and Input Barriers are not correlated. While both measures are averages of the common import tariffs, the differences in weighting–driven by each state's unique industry structure–result in significantly heterogeneous exposure across the different channels of import tariffs. This pattern is also illustrated in Figure 1, where states benefiting from protection against imports do not align with those burdened by high intermediate tariffs.

Figure 2 presents the distribution of the barrier changes initiated by the FTA. Since the FTA

[14] Cheese, not elsewhere specified or included (HS 040690)

[15] Whey and modified whey, whether or not concentrated (HS 040410)

[16] Dried peas, shelled (HS 071310)

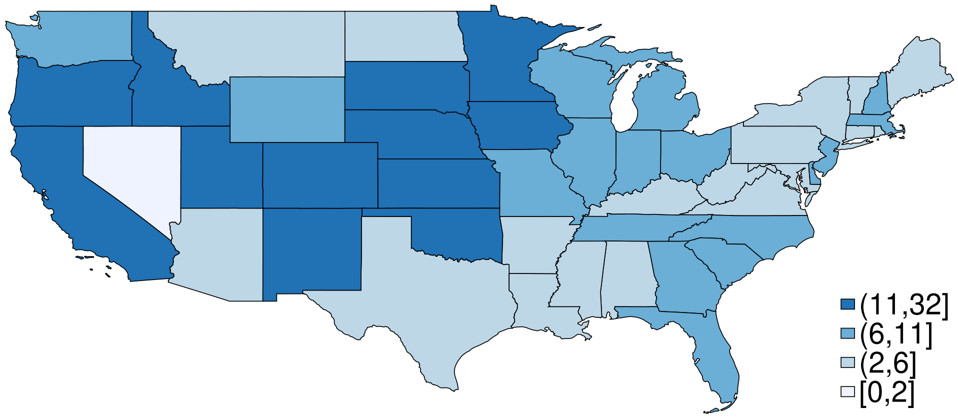
[17] Woven fabrics of cotton, containing >85% cotton by weight, dyed, plain weave (HS 520852); Woven fabrics of synthetic filament yarn, containing >85% polyester, unbleached or bleached (HS 540761); Woven fabrics of synthetic filament yarn, containing >85% nylon or polyamides, dyed (HS 540742).

[18] Polyvinyl chloride (PVC), not mixed with other substances (HS 390410).

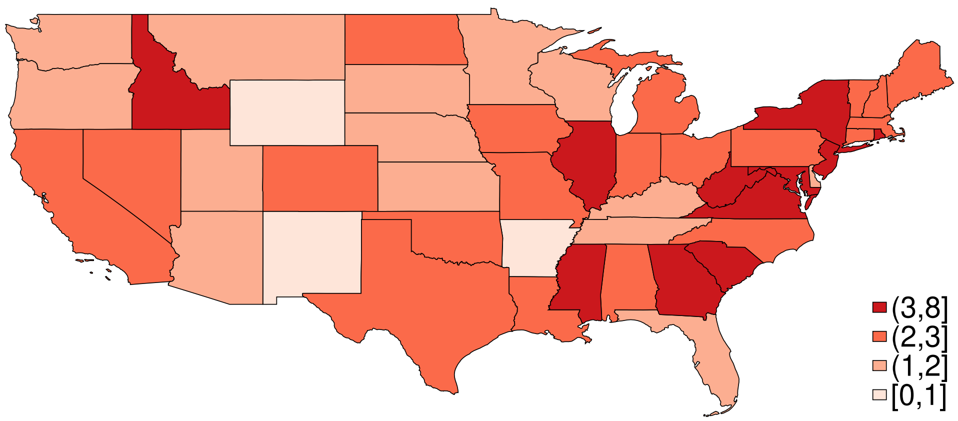
[19] Aluminum structures and parts of structures, not elsewhere specified or included (HS 761090).

Figure 1: Regional variations in trade barriers

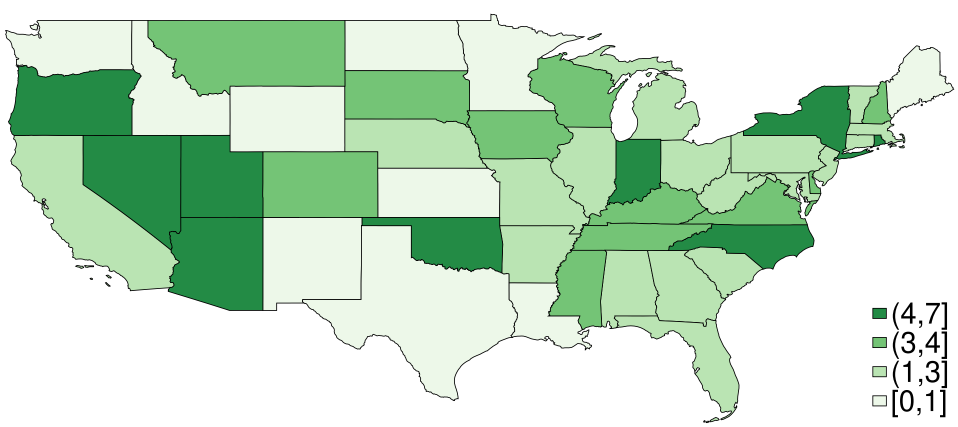
(a) Export Barrier




(b) Protective Barrier




(c) Input Barrier




*Notes:* The figure shows the measured sizes of three trade barriers faced by different states in 2011, prior to the FTA, expressed in percents. Darker colors indicate higher barriers, with cutoffs determined using the boxplot method.

Table 4: Barrier correlations

| | $B^{Export}$ | $B^{Prot}$ | $B^{Input}$ |
|---|---|---|---|
| **Export Barrier** $B^{Export}$ | 1 | | |
| **Protective Barrier** $B^{Prot}$ | -0.21 | 1 | |
| | (0.14) | | |
| **Input Barrier** $B^{Input}$ | -0.07 | 0.34 | 1 |
| | (0.65) | (0.02) | |

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

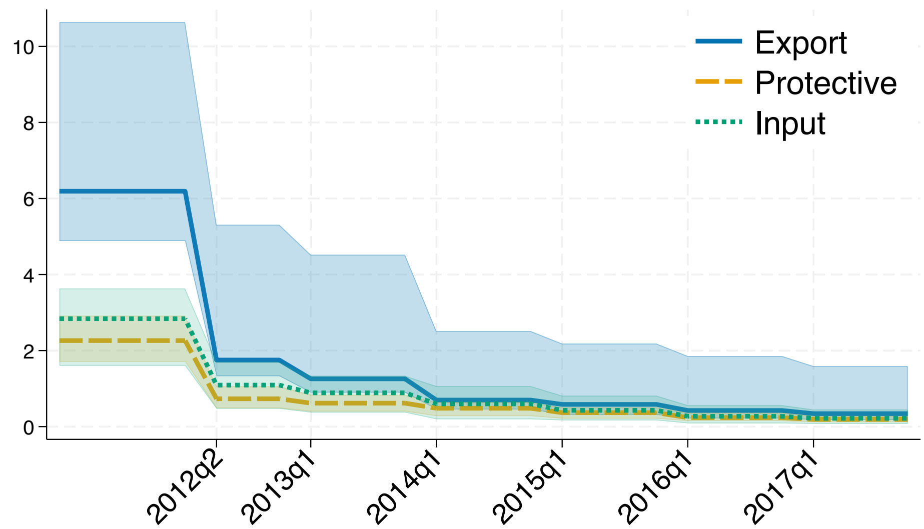
requires the tariff rates to eventually reach zero, the extent of changes in the initial years primarily reflects the pre-FTA tariff levels. As the Export Barrier is larger than the other barriers prior to the FTA (Table 3), significant reductions in Export Barriers were observed immediately after the FTA. On the other hand, Protective and Input Barriers experienced smaller and more gradual reductions compared to Export Barriers, with some states showing negligible or no changes by 2016. The sharp reduction in the first year reflects the the fact that a large share of products are in staging category A (Table 2). For all of the barriers, there is considerable heterogeneity in the size of reductions across states, though this difference narrows over time as the barriers converge to zero.

## 2.4 Limitation of Conventional Measures

The most commonly used measure of tariff barriers is its weighted average where the weights are given by the trade value. These average tariff on exports and imports, denoted by $T_S^{Export}$ and $T_S^{Import}$, respectively, can be written as

$$
\begin{aligned}
T_S^{Export} &= \sum_i \omega_S^{Export,i}\, \tau_K^i & \qquad \omega_S^{Export,i} &= \frac{X_{SK}^i}{\sum_i X_{SK}^i} \\
T_S^{Import} &= \sum_i \omega_S^{Import,i}\, \tau_{US}^i & \qquad \omega_S^{Import,i} &= \frac{X_{KS}^i}{\sum_i X_{KS}^i}
\end{aligned} \tag{4}
$$

Figure 2: Barrier changes after the FTA




*Notes:* The figure shows distribution of barrier measure changes following the implementation of the FTA. The lines show the median across states, and the shaded area represents the interquartile range. It covers 49 states in the US, including the District of Columbia and excluding Alaska and Hawaii.

where $X_{SK}^i$ is the export from state $S$ to Korea of product $i$, and $X_{KS}^i$ is the import of state $S$ from Korea of product $i$.

Recall that the three measures derived in Equations (1), (2), and (3) can be rewritten as

$$
\begin{aligned}
B_S^{Export} &= \frac{\sum_i w_S^{Export,i} \ \ \varepsilon_K^i \ \ \tau_K^i}{\sum_i w_S^i \ \ \varepsilon_K^i}, & w_S^{Export,i} &= \frac{X_{SK}^i \left(1 - X_{SK}^i/Y_K^i\right)}{\sum_i X_{SK}^i \left(1 - X_{SK}^i/Y_K^i\right)} \\
B_S^{Prot} &= \frac{\sum_i w_S^{Prot,i} \ \ \varepsilon_{US}^i \ \ \tau_{US}^i}{\sum_i w_S^i \ \ \varepsilon_{US}^i}, & w_S^{Prot,i} &= \frac{X_{K,US}^i X_{S,US}^i / Y_{US}^i}{\sum_i X_{K,US}^i X_{S,US}^i / Y_{US}^i} \\
B_S^{Input} &= \frac{\sum_i w_S^{Input,i} \ \ \varepsilon_{US}^i \ \ \tau_{US}^i}{\sum_i w_S^i \ \ \varepsilon_{US}^i}, & w_S^{Input,i} &= \frac{m_{KS}^i \left(1 - m_{KS}^i/M_S^i\right)}{\sum_i m_{KS}^i \left(1 - m_{KS}^i/M_S^i\right)}.
\end{aligned} \tag{5}
$$

Each measure takes the form of a weighted average, with the weights, $w_S^{Export,i}$, $w_S^{Prot,i}$ and $w_S^{Input,i}$, varying based on the underlying channel they represent. It is the parallel structure in their definition and derivation that gives the three measures a similar closed form. Leveraging this similarity, we establish a connection between these measures and the conventional import-weighted average tariff.

To do so, 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 $\bar{x}$. Then we can express any of the above barrier measures as

$$
B_S \ = \ \sum_i w_S^i \ \ \hat{\varepsilon}_S^i \ \ \tau^i \ = \ \sum_i w_S^i \ \tau^i + \sum_i w_S^i (\tau^i - \bar{\tau}_S)(\hat{\varepsilon}^i - \bar{\varepsilon}_S) \tag{6}
$$

where $\bar{\tau}_S = \sum_i w_S^i \tau^i$, $\bar{\varepsilon}_S = \sum_i w_S^i \varepsilon^i$, and $\hat{\varepsilon}_S^i = \varepsilon_S^i / \bar{\varepsilon}_S$. 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: the weighted average of tariff and the weighted covariance of tariff and the demand elasticity, with both the average and covariance being assigned a weight $w^i$.

Comparing Equations (4) and (6), the barrier measure $B_S$ differs from the conventional tariff average $T_S$ in two key aspects. First, the weights are defined differently, as shown in

Equations (4) and (5). The weights of Export Barriers and the conventional average tariff on exports are both increasing functions of state exports to Korea, $X^i_{SK}$. However, while the conventional measure relies solely on these trade flows as weights, the Export Barrier takes into account the demand responses, reflected in the exports share in total expenditure, $X^i_{SK}/Y^i_K$. On the import side, the conventional trade-weighted average tariff uses a single weight based on import flows, $X^i_{KS}$. This simple weighting does not distinguish between tariffs that protect domestic firms from foreign competition and tariffs that affect imported intermediate inputs. In contrast, Protective Barriers and Input Barriers separately capture these two distinct channels, providing a more nuanced understanding of the impact of import tariffs.

More importantly, while both include the average tariff term, $B_S$ has the additional term of covariance between tariffs and demand elasticity. This difference highlights how the new measure corrects the bias in the conventional one coming from the demand adjustments to tariffs. If products with higher demand elasticity are imposed higher tariffs, there will be greater substitution away from these goods so that the tariff is more effective in reducing trade. In this case, the covariance is positive, and $B_S$ will be larger than $T_S$, capturing how the prohibitive impact of tariffs is understated by the conventional measure. In some cases it is also possible for $T_S$ to already accurately represent trade barriers and equals $B_S$. However, this occurs only when the covariance is zero−either because all products are subjected to identical tariff rates or because the elasticities of all products are equal.

Table 5 examines the relationship between tariff rates and import demand elasticity. In column (1), the coefficient for elasticity is positive and significant, suggesting that countries do impose higher tariffs on products with higher import demand elasticity. This finding underscores how tariffs can have amplified distortionary effects by targeting responsive products. This relationship persists with time fixed effects, as shown in columns (2) and (3). Columns (4) and (5) show how the relationship between elasticity and tariffs differs between the U.S. and Korea. While the coefficients are positive and significant for both countries, they are larger for Korea, indicating that the Korean government relies more heavily on elasticity when setting

Table 5: Tariff and demand elasticity

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Elasticity | 0.019*** | 0.020*** | 0.037** | | |
| | (0.003) | (0.003) | (0.017) | | |
| Elasticity#US | | | | 0.003*** | 0.013*** |
| | | | | (0.000) | (0.004) |
| Elasticity#Korea | | | | 0.062*** | 0.091* |
| | | | | (0.012) | (0.053) |
| Korea | 3.909*** | 3.862*** | 8.252*** | 3.377*** | 7.615*** |
| | (0.146) | (0.145) | (0.671) | (0.139) | (0.647) |
| Constant | 0.773*** | 0.791*** | 3.448*** | 1.012*** | 3.751*** |
| | (0.052) | (0.051) | (0.257) | (0.025) | (0.152) |
| Observations | 93,320 | 93,320 | 8,295 | 93,320 | 8,295 |
| R-squared | 0.009 | 0.022 | 0.019 | 0.024 | 0.020 |
| Year FE | NO | YES | Pre-FTA | YES | Pre-FTA |

*Notes:* The dependent variable is the tax rate. Sector fixed effect is at HS2 level. For Time FE, 'Pre-FTA' denotes that only base rate prior to the FTA is used. Robust standard errors, clustered at HS2 is sector FE is used, in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

tariff rates.

Additionally, the analysis confirms that Korea imposes higher tariffs than the U.S., consistent with the summary statistics in Table 3. The coefficient on Korea is consistently positive and highly significant across all specifications. In the pre-FTA period, as shown in column (4), Korea's average tariff rate exceeds that of the U.S. by more than 8 percentage points. Even after the FTA, Korea's tariffs tend to remain higher than those of the U.S.

Figure 3 presents the histograms of the derived weighted covariance using these tariffs at the product level.[20] While there is some heterogeneity in the sizes of the covariance, it tends to skew towards positive values. In other words, average tariffs indeed tend to be smaller than the new measures, failing to capture the full extent of the trade barrier. This is especially the case for import-side tariffs. Consequently, even if the tariff on imports is lower than the tariff

[20]While Table 5 compares the tariff and elasticity at the product level, Figure 3 presents the weighted covariance at the state level. The weighted covariance is same as the difference between the barrier measures and the average tariffs, or the last term in Equation (6).

on exports on average, it still functions as a substantial trade barrier.

# 3 Dynamic Responses to Barrier Changes

In this section, I use the three barriers from Section 2 to estimate their dynamic impact on output and labor market outcomes. I discuss the estimation strategy, present the results, and then compare them with those obtained using the conventional trade-weighted average tariff.

## 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.[21] The response at time horizon $h$ can be defined as a difference between the forecast path for the outcome variable and its counterfactual:

$$\beta_h = E(\Delta_h \; y_{S,t+h} | \Delta B_t = -1\%p, \mathcal{X}) - E(\Delta_h \; y_{S,t+h} | \Delta B_t = 0, \mathcal{X}) \tag{7}$$

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.[22] In other words, $\beta_h$ is the average cumulative response across states and across time of the outcome variable $y$ at $h$ periods ahead in response to a 1 percentage point decrease in a barrier, conditional on the information available at the initial time $t$.

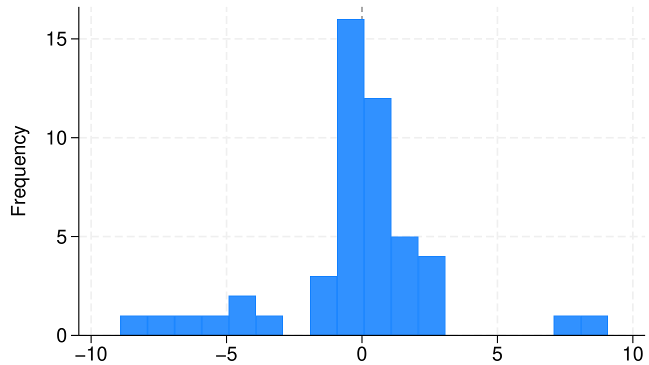
In specific, I use the Local Projection Method (Jordà, 2005) and estimate $\beta_h^{Export}$, $\beta_h^{Input}$, and

[21]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.

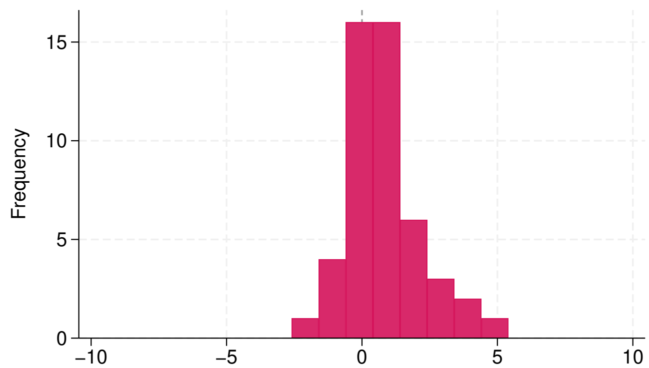
[22]For construction of barrier measures, the weights are fixed using data from pre-FTA period, while dependent variable changes over time.

Figure 3: Barrier measures vs. trade-weighted average tariff

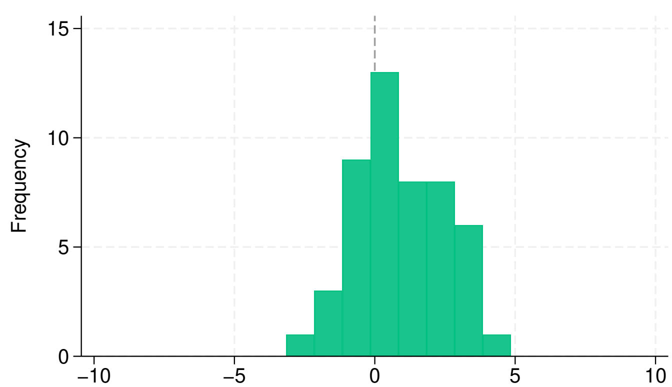
(a) Export Barrier




(b) Protective Barrier




(c) Input Barrier




*Notes:* The figures show the histogram of the weighted covariance between tariffs and rescaled demand elasticities, calculated using the corresponding weights of each barrier measure. Base rates prior to the FTA are used. The gray dashed line represents a covariance value of zero.

$\beta_h^{Prot}$ in the following equation:[23]

$$\Delta_h \ y_{s,t+h} = -\beta_h^{Export} \Delta B_{st}^{Export} - \beta_h^{Input} \Delta B_{st}^{Input} - \beta_h^{Prot} \Delta B_{st}^{Prot} \tag{8}$$

$$+ \sum_{k=-8}^{4} \omega_{t+k}^{h} \Delta B_{st+k} + \gamma^h \Delta_1 \ y_{s,t-1} + \mu_s^h + \mu_{t+h}^h + \varepsilon_{t+h}. \tag{9}$$

where $\mu_s^h$ and $\mu_{t+h}^h$ are state and time fixed effects. It is a set of estimations of a 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 simultaneously, which helps identifying the role of each channel from the effects of the common tariff lines within a state. This is 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 agreement 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 4 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 $h = -2, \cdots, 12$. 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 ($h \geq 0$), GDP moves in directions that we would intuitively expect:

[23] The negative signs are used in front of the coefficients for the barriers in Equation 8. This is to interpret the estimates as the impact of liberalization, instead of pure changes in the barriers. Note that $\beta_h$ is defined as a response to a tariff reduction in Equation 7.

with easier access to the export market, GDP gradually increases, reaching 0.8 percentage points by the 12th quarter (Export Barrier, solid 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, dashed yellow). The impact of lower barriers to cheaper inputs is rather negative (Input Barrier, dotted green). However, when we focus on the durable sectors only, cheaper inputs induce an increase in the GDP, as expected. Note that lower import tariff has two opposite effects: it restricts 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 the production of durable goods (Panel b).

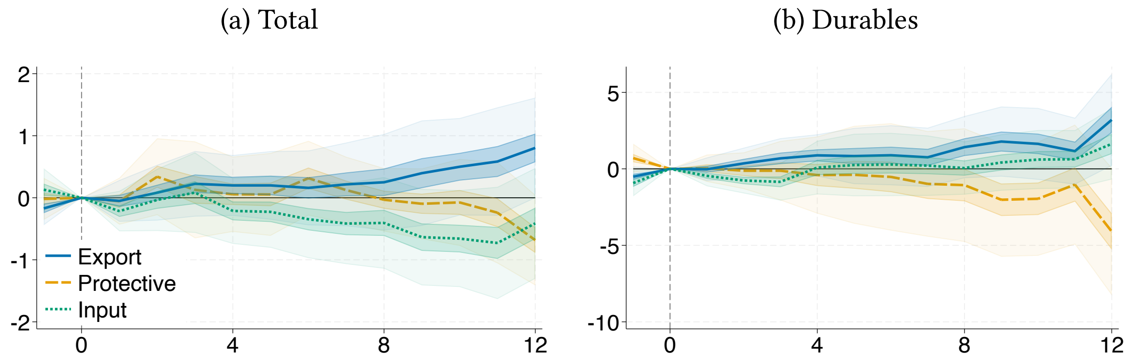
Using the estimates we can quantify the impact of trade liberalization from a state's perspective. For example, consider the barrier changes in 2012 when the FTA was first implemented. Comparing two states, one at the 75th percentile of the Export Barrier change and the other at the 25th percentile, the state with the larger barrier cut would be expected to experience a 1.42 percentage point larger increase in GDP[24] in the 12th quarter. In the case of the Protective Barrier cut, a state at the 75th percentile would be expected to experience a 0.39 percentage point larger decline in GDP. As for the Input Barrier, its cut yields a larger decline in GDP and employment of 0.26 percentage points by 12th quarter.

I further study the labor market outcome. In Figure 5, employment response is similar to those of GDP, where the employment shows a delayed movements. Specifically, the cut in the Export Barrier gradually increases it by up to 0.41 percentage points by the 12th quarter, while a lower Protective Barrier reduces employment by 0.14 percentage points in the same timeframe. Minimal benefits are observed from cheaper inputs (Panel a).

On the other hand, the unemployment rate presents unexpected findings: although statistically insignificant, it tends to rise with reductions in the Export and Input Barriers, while

[24]The interquartile range in the state-level Export Barrier changes in 2012 is (-1.85)-(-3.55)=1.78 percentage points (Figure 2). The differential change between states at the upper and lower quartile of the barrier change is calculated by multiplying the interquartile range by the point estimate at the 12th quarter (Table 9), which results in $1.78 \times 0.80 = 1.42$. The rest of the discussion is obtained in a similar way.

Figure 4: GDP

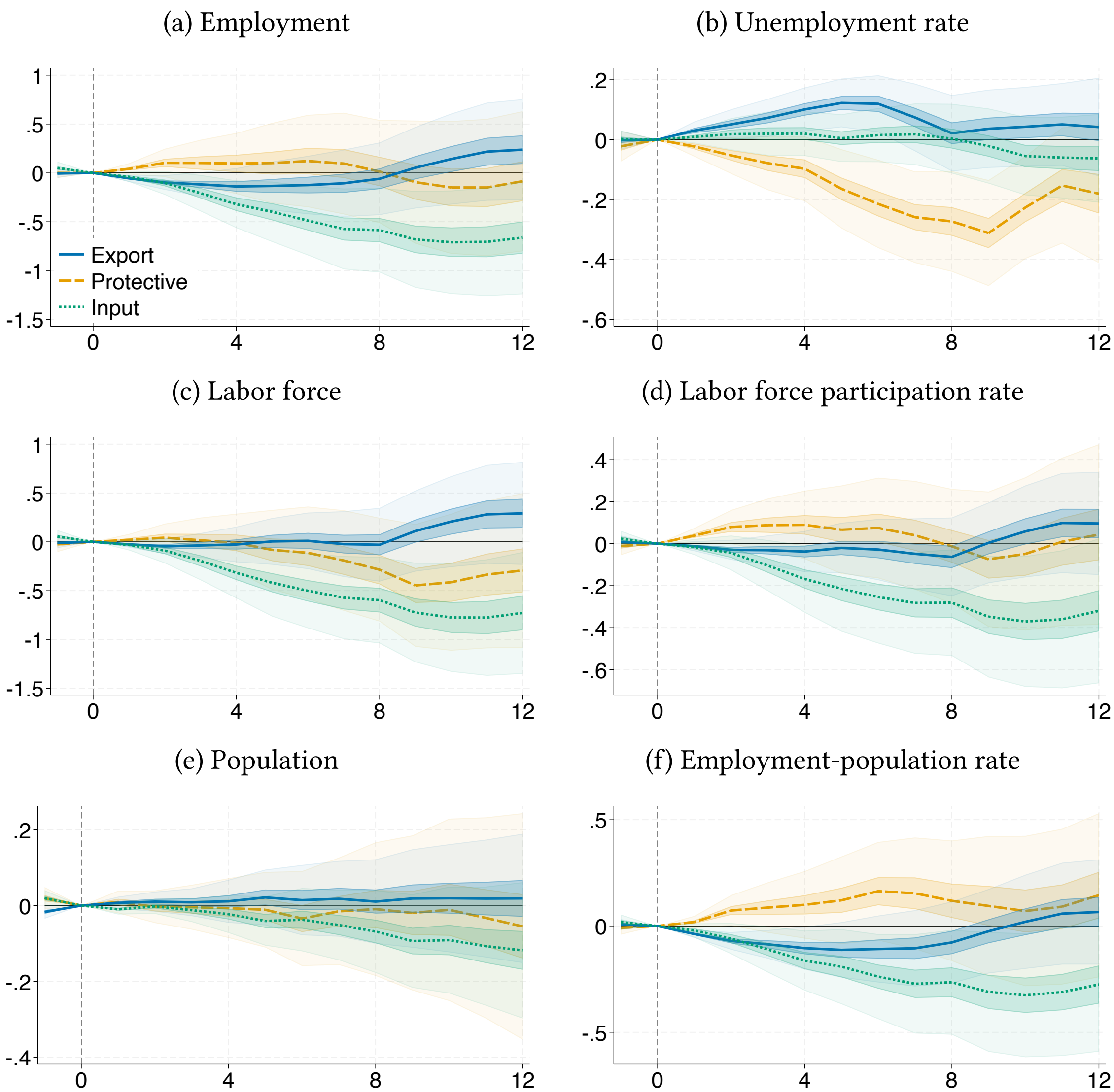



*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$ (quarters). The light and dark shaded areas display 90% and 68% confidence intervals, respectively. All dependent variables are logged and multiplied by 100.

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 5, 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 imply 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 are due to the overall labor force adjustments, rather than shifts in the proportion of employed individuals within the labor force.

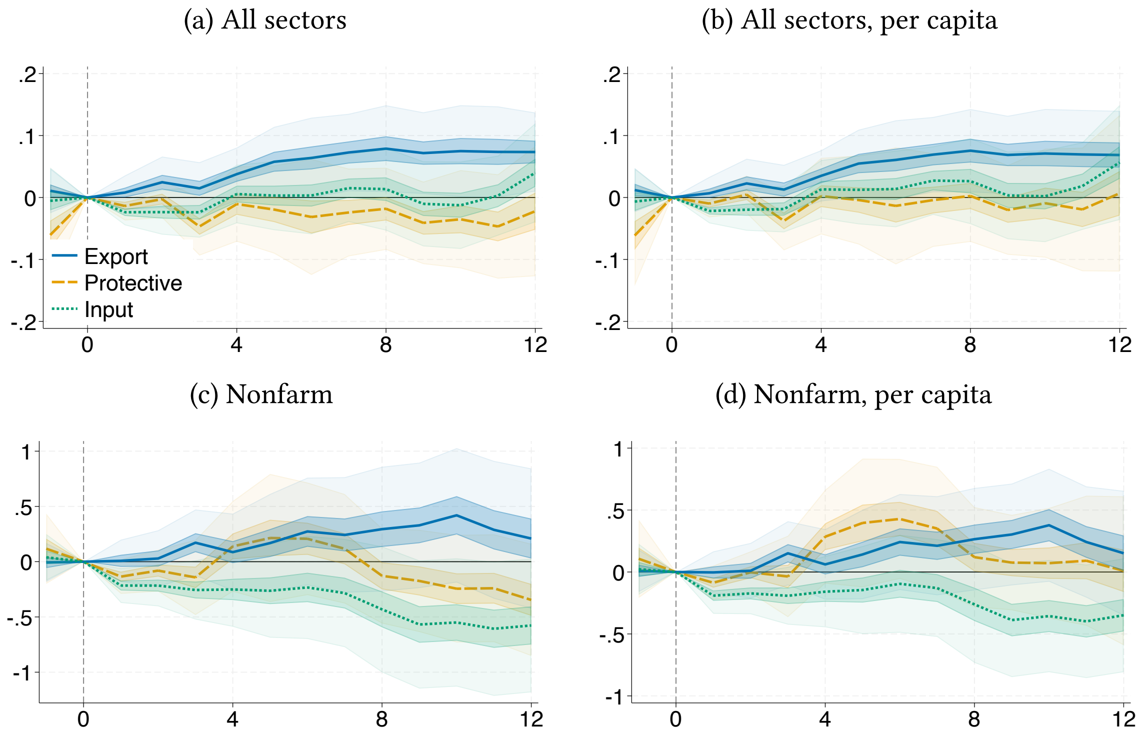
The personal income presents more intuitive responses. Figure 6 displays the responses in personal income. Income from all sectors, both measured as a whole and per capita, shows an increase in response from the Export Barrier cut (Panels a and b). On the other hand, when focusing on the nonfarm sector, the response is more similar to those of GDP and employment (Panels c and d). This result suggests that the nonfarm sector plays an important role in driving

Figure 5: Labor market responses




*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$ (quarters). The shaded areas display 90% and 68% confidence intervals. Dependent variables in (a)-(d) are logged and multiplied by 100.

Figure 6: Personal income




*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$ (quarters). The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

movements in the aggregate economy. Given that there were substantial tariff changes in the farming sector during the agreement in Korea, and that this sector behaves differently from other sectors, considering both farming and nonfarming together could potentially dilute the income changes that are concentrated in the farming sector.

To explore further, I decompose personal income by its sources and analyze the responses of each component. Figure 7 illustrates the responses across the different components of personal income. Wages and salaries show a clear pattern consistent with the findings in Figure 4: a positive and gradual impact from the Export Barrier cut, a mostly insignificant impact from the Protective Barrier cut, and a negative impact from the Input Barrier cut (Panel a). Since wages and salaries account for the largest share of personal income,[25] this channel primarily

[25] Personal income consists of the following components: Wages and salaries (50%), Dividends, interest, and rent (20%), Proprietors' income (10%), and Transfers (17%) based on the 2012–2016 average.

drives the overall income responses for U.S. residents.

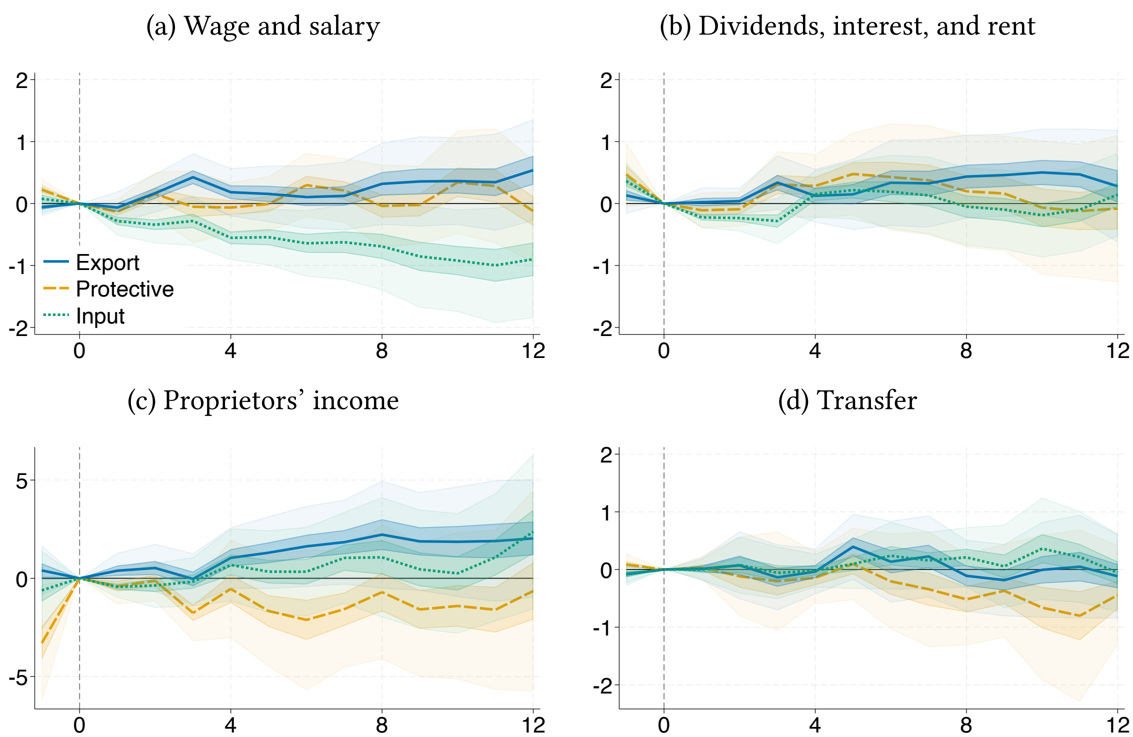
Income from other sources tends to exhibit similar patterns to lower Export Barrier. For example, proprietors' income responds positively, with a much larger magnitude (Panel c). In contrast, lower Input Barrier is associated with an increase in proprietors' income, particularly in the long run. This suggests that most of the benefits from cheaper inputs accrue to proprietors rather than wage workers. The responses in dividends, interest, and rent as well as those in transfer is mostly insignificant (Panel b and d). This divergence from overall personal income arises because wages are directly tied to the state's production, while these income sources are often linked to economic activity outside the region. For example, interest income is influenced by financial markets, where local impact of trade barriers less direct. As a result, these income sources respond more weakly or inconsistently to changes in state-level trade conditions.

### 3.3 Comparison with Results using Conventional Measures

To highlight the use of the new barrier measures, I provide the results estimated with the conventional tariff measures of Equation (4). Figure 8 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 4. The results in fact are very different, suggesting that using conventional measures to evaluate the effect of the agreement can be problematic.

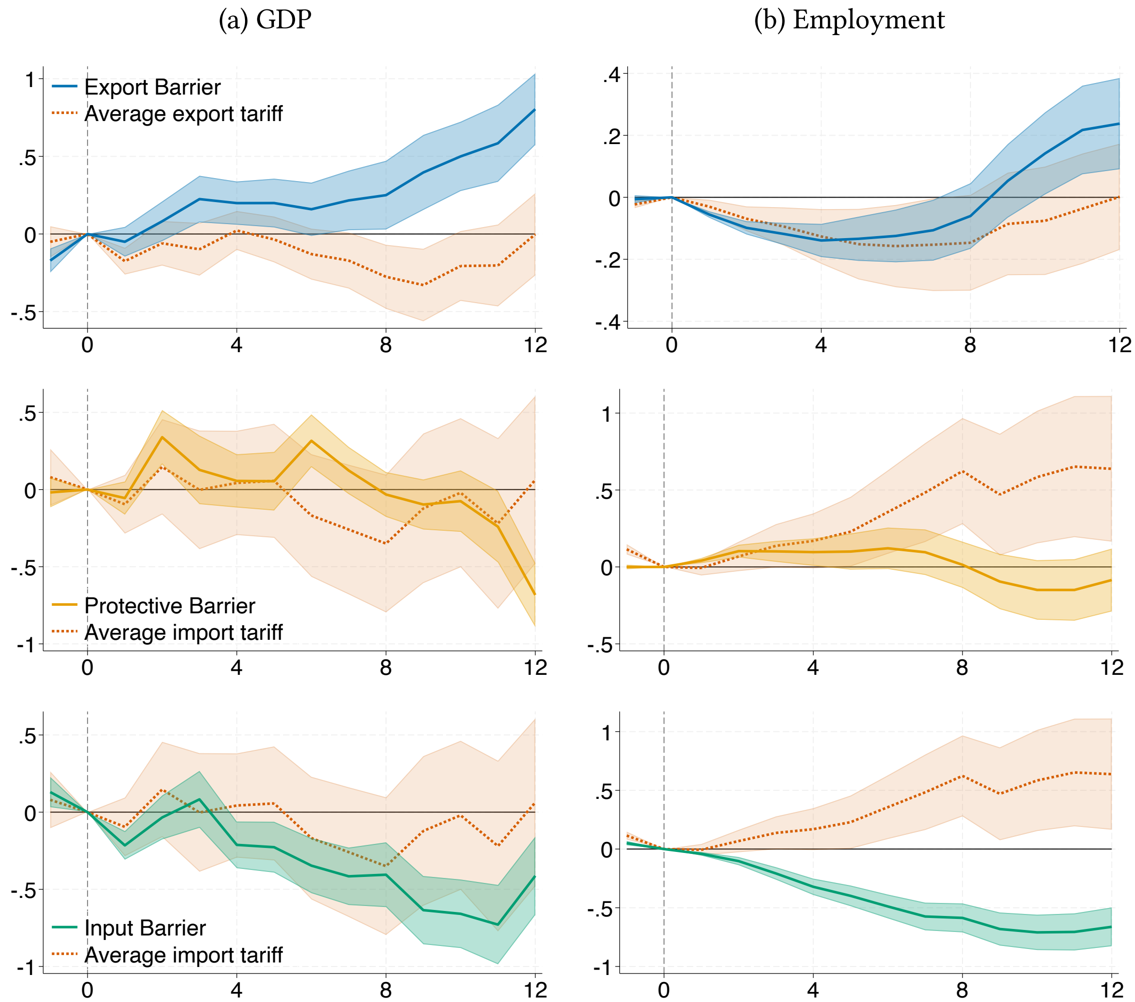
First, using the Barrier measure clearly reveals the effects of the agreement, whereas the average export tariff does not. For example, only with the Barrier measure do we find a positive effect of lower export tariffs on GDP and employment. Similarly, a delayed negative effect on GDP following an import tariff reduction is observed only when using the new measure. In contrast, conventional measures yield insignificant results across all tariff channels. Thus,

Figure 7: Personal income by source




*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$ (quarters). The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

Figure 8: Estimation with different measures




*Notes:* Each of two columns is from a separate regression. The solid blue, yellow, and green lines are a reproduction of those in Figure 6 Panel (a) and Figure 4 Panel (d). Red dotted lines labeled as $T$ Export and $T$ Import denote estimates for the conventional measures defined in Equations (4). The shaded areas display 90% confidence intervals. All dependent variables are logged and multiplied by 100.

relying on conventional methods may understate the impact of the new agreement.

Second, the new barrier measures give a much more precise estimate than the conventional measures a narrower confidence interval. The estimate with the new measures (solid lines) has a narrower confidence interval than that with the conventional measures (dotted red), especially in the case of the Protective and Input Barriers in comparison to the average import tariff.

Finally, the new barrier measures allow us to disentangle two opposite forces of import tariffs. If we use conventional measures, we only see a combined effect of lower import tariffs on output and input (red dotted line in the second or the third rows). However, by using the new measures, we can disentangle the impact of lower import tariff via protection channel (Protective Barrier cut, yellow solid lines) from those via input channel (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 discuss the usuage of estimates of import demand elasticity. Second, I consider using an applied tariff instead of a scheduled tariff for each country's tariff rates. Finally, I redo the analysis with different numbers of lags in the Local Projection Method. The main results hold in general for these alternative specifications.

## 4.1 Elasticity Estimates

This section compares different estimates of product-level demand elasticity. Namely, I consider the estimates of Soderbery (2018) and Soderbery (2015) along with those of Kee et al. (2009) that I use in the baseline analysis.

Kee et al. (2009) examines 117 countries during the period of 1988–2002, focusing on products at the HS6 level. They extend the GDP function approach (Kohli, 1991; Harrigan, 1997),

Table 6: Elasticity Statistics

| | $N$ | p01 | p25 | p50 | p75 | p99 | Mean | Sd |
|---|---|---|---|---|---|---|---|---|
| Soderbery (2018) | 1820 | 1.55 | 2.49 | 2.91 | 3.59 | 10.00 | 21.16 | 610.45 |
| Soderbery (2015) | 14230 | 1.01 | 1.45 | 1.91 | 3.38 | 131.05 | 5.89 | 16.96 |
| Kee (2008) | 6997 | 0.08 | 0.90 | 1.19 | 3.29 | 171.19 | 8.65 | 30.53 |

*Notes:* The table shows the statistics of import demand elasticity for the US and Korea. $N$ is number of observations, p01-p99 denote percentiles, and Sd is standard deviation.

which accounts for general equilibrium effects arising from exogenous changes in prices or endowments. They modify this framework to estimate import price elasticities at the tariff line level. On the other hand, Soderbery (2018) studies a larger set of 192 countries during 1991–2007, providing bilateral estimates for 1,243 products at the HS4 level. He estimates both import demand and export supply, leveraging variations in prices and quantities in bilateral trade data. Soderbery (2015) focuses on the U.S. for the period 1993–2007, providing more granular estimates at the HS10 level. He extends the methods of Feenstra (1994) and Broda et al. (2008) using limited information maximum likelihood to correct for small sample biases and constrained search inefficiencies.

Table 6 shows summary statistics of these demand elasticity estimates. The average of Soderbery (2018) estimate is exceptionally high, even exceeding its 99th percentile. This is driven by a few extreme outliers in the right tail. Looking at these outliers, however, many of them are associated with large standard errors.

For a clearer comparison, Table 7 presents the relationship between different estimates. The upper panel compares the demand estimates of the U.S. from Kee et al. (2009) and Soderbery (2015). Interestingly, there is not much correlation between these two sources. In the lower panel, when comparing both U.S. and Korean estimates from Soderbery (2018), we do not find similarities either. This is true even if I exclude the estimates with large standard errors (column 3). However, once I exclude outliers above 99th percentiles, as in columns 4 and 5, the coefficient becomes positive and significant.

For the robustness check, I redo the analysis by constructing the barrier measures using the demand elasticity estimates from Soderbery (2015). In this exercise, extreme values above the 99th percentile are excluded. The results, presented in Figure 9, are broadly consistent with the baseline analysis. In particular, the lower Protective Barrier consistently shows a delayed, negative effect. Moreover, the Input Barrier results are similar to the baseline. On the other hand, the Export Barrier cut now has a slightly different effect on GDP (Panel a), employment (Panel b), and labor force (Panel c), while it still shows a positive effect on personal income (Panel d).

I use the estimates from Kee et al. (2008) for the baseline analysis, as other estimates tend to capture short-run elasticities, and Kee et al. (2008)'s framework aligns more closely with the theoretical foundation I use to construct the variables.

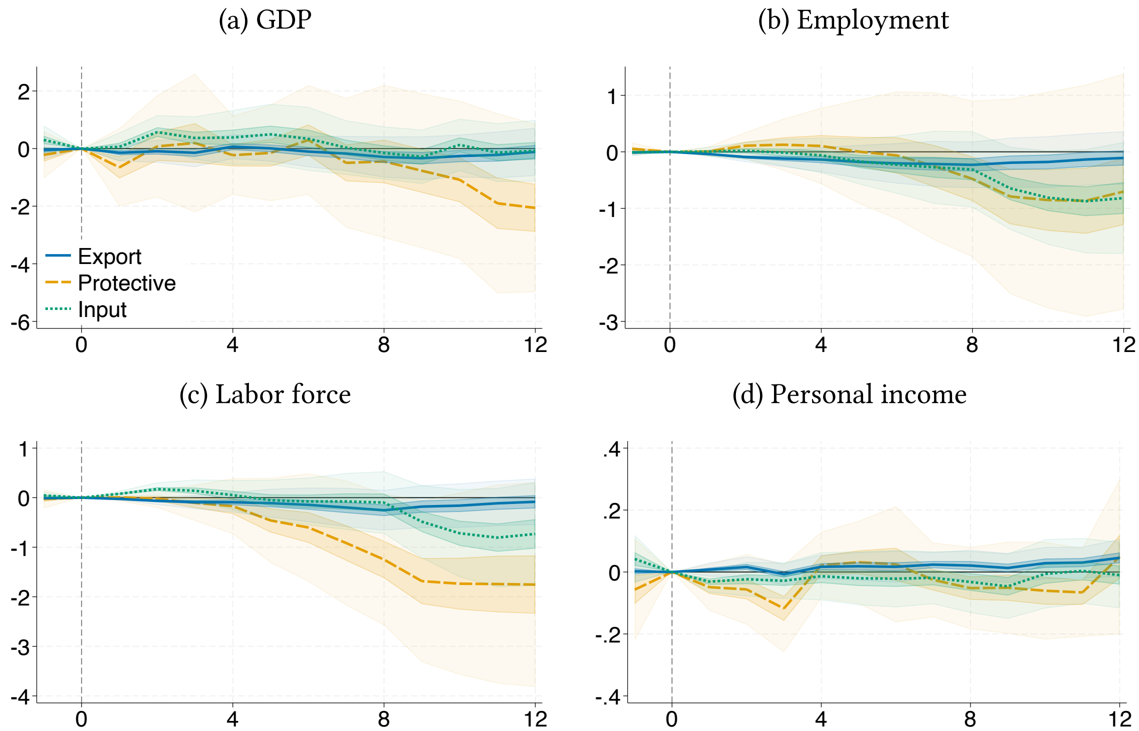
Table 7: Elasticity regressions on Kee et al. (2009)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Soderbery (2015) | 0.014 | -0.000 | 0.013 | 0.013 |
| | (0.016) | (0.001) | (0.015) | (0.015) |
| Constant | 6.946*** | 1.309*** | 4.829*** | 4.829*** |
| | (0.295) | (0.013) | (0.153) | (0.153) |
| | | | | |
| Observations | 9,037 | 6,699 | 8,839 | 8,839 |
| R-squared | 0.000 | 0.000 | 0.000 | 0.000 |
| Trim | None | SE | Percentile | Percentile |

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Soderbery (2018) | -0.002 | -0.004 | 0.012 | 0.543*** | 0.489** |
| | (0.004) | (0.004) | (0.020) | (0.198) | (0.196) |
| Constant | 7.433*** | 7.441*** | 1.240*** | 3.369*** | 3.535*** |
| | (0.346) | (0.344) | (0.060) | (0.626) | (0.621) |
| | | | | | |
| Observations | 6,282 | 6,282 | 3,820 | 6,155 | 6,155 |
| R-squared | 0.000 | 0.010 | 0.000 | 0.001 | 0.015 |
| Country FE | NO | YES | YES | NO | YES |
| Trim | None | None | SE | Percentile | Percentile |

*Notes:* 'SE' trim indicates that elasticity estimates with standard errors below the 75th percentile are used, while 'Percentile' trim indicates that only the elasticity estimates below the 99th percentile are included. The upper panel only uses the US data. Standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 9: Elasticity estimates




*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$. The light and dark shaded areas display 90% and 68% confidence intervals, respectively. All dependent variables are logged and multiplied by 100.

## 4.2 Applied Tariff

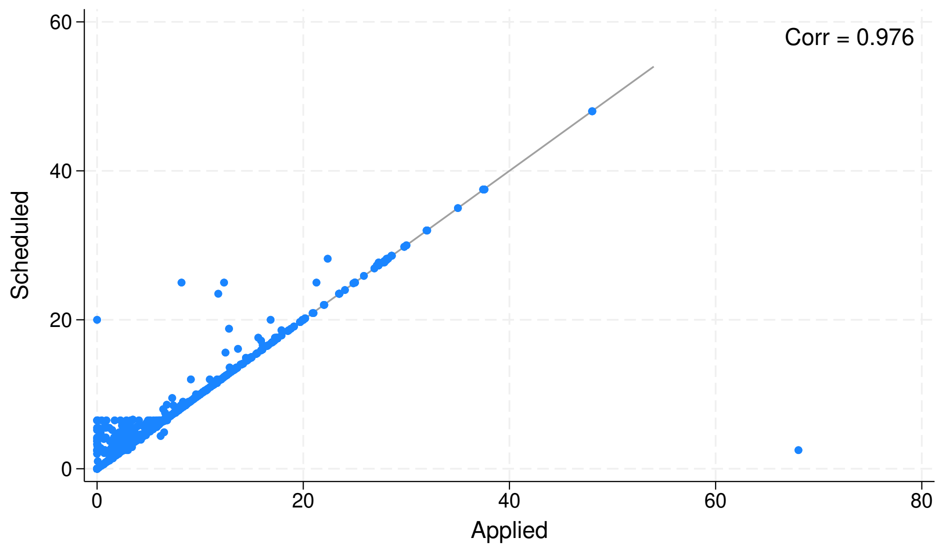
In the baseline analysis, I use scheduled tariff rates from the FTA document, which provide base tariff rates along with their scheduled reductions across different staging categories. Alternatively, product-level tariff rates can be derived from actual applied tariffs, calculated as the ratio of tax revenue to total import value.[26]

Data on applied tariffs and scheduled tariffs differ in several ways. First, their availability varies. Our dataset includes scheduled tariff rates only for those expressed in ad valorem terms, excluding tariffs listed as a dollar amount per unit weight or volume, as well as those combining ad valorem and specific dollar values.[27] Applied tariff data, in contrast, are only available for

[26]Specifically, the applied tariffs used in this analysis are calculated as the share of calculated duty in customs value for 2010 and 2011, based on data from the U.S. Census Bureau.

[27]Out of 10,333 U.S. tariff lines, 1,099 products (10.6 percent) are expressed in dollar-per-unit terms or combi-

Figure 10: Comparison of Scheduled and Applied Rates




*Notes:* Each observation show the scheduled and applied tariffs for different products at the HS8 level. The black line is a 45 degree line.

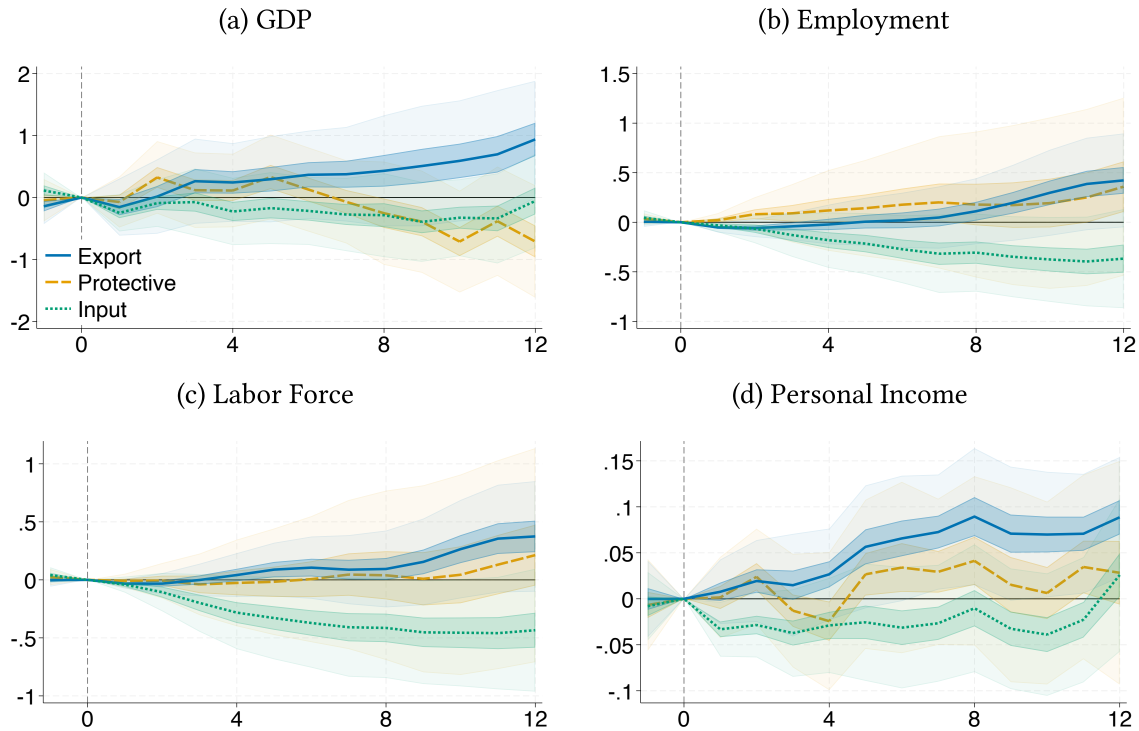
products with actual transactions. When tariffs are prohibitive and prevent imports, those products are omitted from the data, resulting in fewer observations overall.

Table 8 compares the summary statistics of two datasets on tariff rates. Among the 9,486 tariff lines in the scheduled tariff dataset, 4,440 lines (42.97%) appear only in the scheduled data, and these products lack corresponding applied rates due to the absence of transactions and tax revenue. The other 5,046 tariff lines (45.75%) are present in both datasets. On the other hand, 730 tariff lines appear exclusively in the applied tariff dataset, often due to Special Tariff Treatments, Temporary Tariffs, or Duties. Scheduled and applied tariff rates exhibit similar mean and median values, along with comparable interquartile ranges. However, products with the extremely high scheduled rates, such as the maximum of 350%, are likely not to be traded and thus are not reflected in the applied tariff data.

Figure 10 shows that for the tariff lines that appear in both datasets, scheduled and applied rates generally align closely. However, some discrepancies exist. When the rates differ, applied

nations of ad-valorem and per unit terms. Among theses, applied rates are available for 268 of these and the rest of the products have no transaction during our sample period.

Figure 11: Applied tariff




*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$ (quarters). The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

tariffs tend to be lower than scheduled tariffs. This discrepancy could be due to exemptions, reductions, or waivers that are temporarily applied by the U.S. government.

Figure 11 presents the estimation results when applied tariffs are used for barrier constructions. The differences in the rates yields slight differences in the results. Overall, negative effect of Protective Barrier cut becomes insignificant for employment (Panel b), labor force (Panel c), and personal income (panel d). On the other hand, effects of Export and Input Barrier cuts persist in this alternative specifications.

Table 8: Statistics of scheduled and applied rates

| | N | Mean | Std. | Min | p25 | Median | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| Scheduled | 9,486 | 4.20 | 11.18 | 0.00 | 0.00 | 2.70 | 6.00 | 350.00 |
| Applied | 5,792 | 4.10 | 5.87 | 0.00 | 0.00 | 2.71 | 5.80 | 68.04 |

## 4.3 Number of Lags

In the baseline analysis, a lag in the response variable of one period is used. I redo the estimation using two and four lags. The results are provided in Table 9. The response estimates are almost unchanged, 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 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.

## 4.4 Individual Channels

The agreement with Korea differs significantly from the China shock or the early periods of the U.S.-China trade war in that it was bilateral, bringing changes to both inward and outward trade barriers. Therefore, it is crucial to consider changes in both directions to correctly identify the impact of each channel. Moreover, both the Protective Barrier and the Input Barrier measure inward barriers and are constructed from U.S. tariffs on imports from Korea. For these reasons, I include all barriers–Export, Protective, and Input Barriers–in the baseline regression (Equation 8).

Consider instead running regressions on each barrier measure separately, rather than including them jointly in a single regression. Specifically, I estimate:

$$\Delta_h\, y_{s,t+h} = -\beta^i_h \Delta B^i_{st} + \sum_{k=-8}^{4} \omega^h_{t+k} \Delta B^i_{st+k} + \gamma^h \Delta_1\, y_{s,t-1} + \mu^h_s + \mu^h_{t+h} + \varepsilon_{t+h} \tag{10}$$

where is $B^i_{st}$ is one of $B^{Export}_{st}$, $B^{Prot}_{st}$, or $B^{Input}_{st}$.

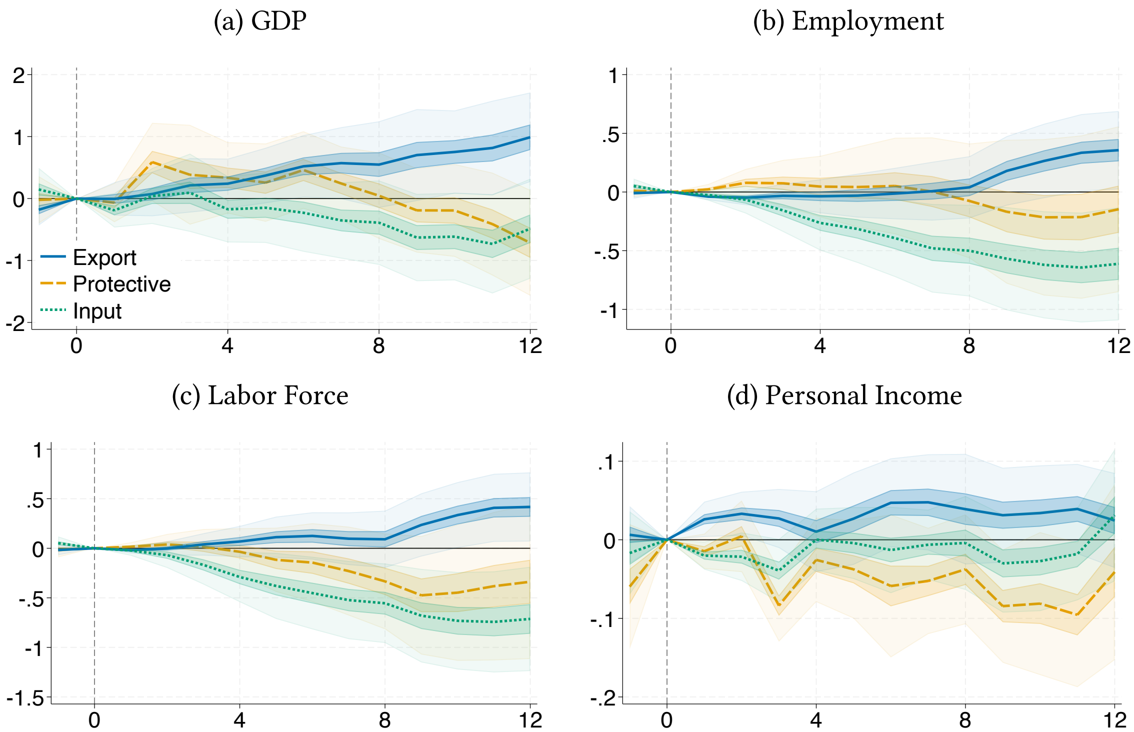
Figure 12 presents the results for GDP, employment, labor force, and personal income, with each channel estimated separately and combined into a single graph. Compared to Panel a of Figure 4, the Export Barrier continues to show a positive, though slightly smaller, response in

Table 9: GDP, lags

| | $L = 2$ | | | | $L = 4$ | | | |
|---|---|---|---|---|---|---|---|---|
| | Quarter 0 | Quarter 4 | Quarter 8 | Quarter 12 | Quarter 0 | Quarter 4 | Quarter 8 | Quarter 12 |
| $\Delta B^{Export}$ | -0.04 | 0.29 | 0.56 | 0.80** | -0.16 | 0.29 | 0.51 | 1.02** |
| | (0.16) | (0.29) | (0.47) | (0.40) | (0.28) | (0.42) | (0.59) | (0.50) |
| $\Delta B^{Prot}$ | 0.00 | 0.32 | -0.05 | -0.61 | -0.07 | 0.33 | -0.39 | -0.80 |
| | (0.20) | (0.41) | (0.37) | (0.49) | (0.25) | (0.42) | (0.50) | (0.55) |
| $\Delta B^{Input}$ | -0.19 | -0.17 | -0.58 | -0.32 | -0.25 | -0.17 | -0.39 | -0.01 |
| | (0.19) | (0.35) | (0.46) | (0.45) | (0.18) | (0.35) | (0.39) | (0.45) |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |
| State FE | YES | YES | YES | YES | YES | YES | YES | YES |
| $R^2$ | 0.491 | 0.587 | 0.647 | 0.765 | 0.391 | 0.553 | 0.618 | 0.784 |
| Observations | 441 | 441 | 392 | 343 | 294 | 294 | 294 | 294 |

*Notes:* See Equation (8) in the text. Robust standard errors in parentheses. Clustered at the state level. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

Figure 12: Individual regressions




*Notes:* The figure displays cumulative responses to 1%p barrier cuts in GDP, i.e. the estimates of $\beta_h^{Export}$, $\beta_h^{Prot}$, and $\beta_h^{Input}$ over the horizon of $h = -2, \cdots, 12$ (quarters). The shaded areas display 90% and 68% confidence intervals. All dependent variables are logged and multiplied by 100.

GDP. The Protective Barrier maintains a delayed but negative effect on GDP, consistent with the baseline results. The Input Barrier also demonstrates a consistent result. For employment and labor force outcomes (Panels b and c of Figure 12 vs Panels a and c of Figure 5), the Export and Input Barrier results remain similar to the baseline. However, the Protective Barrier now shows insignificant results.

These findings suggest that, to understand the role of input barriers, the other channels of import tariffs need to be properly controlled. Considering all channels jointly is crucial to accurately capture the multifaceted effects of changes in trade policy.

# 5 Conclusion

There remains significant uncertainty regarding the effects of trade policy changes. This paper revisits the topic by studying the dynamic effects of the U.S.-Korea FTA. I first introduce theoretically robust measures to quantify trade barriers. These new measures account for demand responses and provide a more accurate representation of the true extent of tariffs. This approach is especially useful when the trading partner tend to impose higher tariffs on more demand-elastic products, as in the case in the U.S.

By offering smaller standard errors and clearer path of the responses, the new measures reveal that the impact of export tariff reductions on GDP is larger than previously suggested by conventional methods. While lowering Export Barriers stimulates GDP and employment growth over time, reductions in Protective Barriers against imports lead to gradual declines in these variables. These findings highlight the limitations of conventional measures in capturing the dynamic effects of trade policy.

This study also underscores the multidimensional nature of bilateral policy changes. It thus emphasizes the need for trade reforms that balance the benefits and costs across different channels. While proponents of free trade argue that lowering import barriers can enhance domestic production through better access to inputs, the findings here suggest otherwise: the positive effects of such policies appear insignificant in the U.S., with any potential gains outweighed by negative impacts, particularly in the long run. This asymmetry highlights the importance of evaluating both sides of trade policy comprehensively.

Furthermore, the estimates of dynamic impacts along the transitional path offer a richer understanding of how trade liberalization shapes local economies. The impacts of trade barrier cuts differ not only in magnitude and direction but also in their gradualness and persistence. For instance, the Protective Barrier cut influences the economy over a longer time horizon, at least 12 quarters, whereas the response to Export Barrier cuts are realized in the earlier periods. While a purely empirical exercise, the result here may serve as a useful input into spatial trade with labor mobility frictions in the spirit of Caliendo et al. (2019).

# References


**Alessandria, George, Horag Choi, and Kim J Ruhl**, "Trade adjustment dynamics and the welfare gains from trade," *Journal of International Economics*, 2021, *131*, 103458.

**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.

**Baier, Scott L and Jeffrey H Bergstrand**, "The growth of world trade: tariffs, transport costs, and income similarity," *Journal of International Economics*, 2001, *53* (1), 1–27.

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

**Broda, Christian, Nuno Limao, and David E Weinstein**, "Optimal tariffs and market power: the evidence," *American Economic Review*, 2008, *98* (5), 2032–2065.

**Caliendo, Lorenzo, Maximiliano Dvorkin, and Fernando Parro**, "Trade and labor market dynamics: General equilibrium analysis of the china trade shock," *Econometrica*, 2019, *87* (3), 741–835.

**Chiquiar, Daniel**, "Globalization, regional wage differentials and the Stolper–Samuelson Theorem: Evidence from Mexico," *Journal of International Economics*, 2008, *74* (1), 70–93.

**Feenstra, Robert C**, "New product varieties and the measurement of international prices," *American Economic Review*, 1994, pp. 157–177.

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

**Glaeser, Edward L and Joseph Gyourko**, "Urban decline and durable housing," *Journal of Political Economy*, 2005, *113* (2), 345–375.

**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.

**Harrigan, James**, "Technology, Factor Supplies, and International Specialization: Estimating the Neoclassical Model.," *American Economic Review*, 1997, *87* (4).

**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.

**Kohli, Ulrich**, "Technology, duality, and foreign trade: the GNP function approach to modeling imports and exports," *The University of Michigan Press*, 1991.

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

**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.

**Ruhl, Kim J**, "The international elasticity puzzle," *New York University*, 2008.

**Soderbery, Anson**, "Estimating import supply and demand elasticities: Analysis and implications," *Journal of International Economics*, 2015, *96* (1), 1–17.

_ , "Trade elasticities, heterogeneity, and optimal tariffs," *Journal of International Economics*, 2018, *114*, 44–62.

**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.

**Topel, Robert H**, "Local labor markets," *Journal of Political Economy*, 1986, *94* (3, Part 2), S111–S143.

**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 2019.

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

# A Data

- Products: The product is defined at the HS-6 level. Although the tariff rates are defined at the finer level of HS-10 in both countries, HS-10 is 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 the HS-6 level. In a few cases where 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 Chapter 2 of the official Agreement, downloaded from the 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 cuts on these products do 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 the 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 the 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).