Cross-border Threats to Health: Impacts of Trade Liberalization on Nutritional Transition*

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Abstract

This paper examines the nutritional and health implications of trade liberalization in the food sector, using South Korea's free trade agreements (FTAs) with the European Union and the United States in the early 2010s as a natural experiment. We document that imports of unhealthy food products from FTA partners increased relative to non-FTA origins, with tariff reductions in the food sector fully passed through to domestic prices. Leveraging a novel product-brand scanner dataset for the Korean chocolate market, we find that FTA-induced tariff cuts reduced imported chocolate prices by approximately 16% and raised purchase quantities by over 100%. Incorporating tariff reductions as cost shifters into a structural demand–supply framework, we structurally estimate demand and cost parameters and conduct counterfactual simulations to assess substitution patterns between domestic and foreign products in the absence of tariff cuts. Combining these results with detailed nutritional information, we estimate the consequent increase of 2.58% in sugar intake attributable to trade liberalization. The findings highlight underexplored nutritional side effects of trade policy, underscoring the importance of integrating health considerations into trade policy design.

Keywords: Chocolate Market, Food Imports, Free Trade Agreements, Nutritional Transition, Tariff Pass-through, Trade Liberalization, Unhealthy Foods
JEL Code: D12, F13, F14, F60, I10, L11, L66

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1 Introduction

International trade improves consumer welfare by providing greater variety of products and lowering prices through efficiency gains (Melitz, 2003; Melitz and Trefler, 2012). In theory, cross-border food trade can alleviate global hunger by reducing prices and improving access to staple foods in poorer countries, while also increasing the diversity of food varieties available to consumers in more developed economies. Hence, trade liberalization is expected to generate welfare gains worldwide. However, in practice, the cross-border flow of unhealthy food products can undermine public health.

The obesity epidemic in the Pacific Islands illustrates this concern (WHO, 2002). According to WHO, in 2016, approximately 43% of adults in Pacific Island Countries (PIC) are obese or overweight, more than triple the global average (Tong et al., 2022). International trade in PICs is widely regarded as a key contributor to these high obesity rates, as it has increased the availability of processed and imported foods and accelerated the shift away from traditional nutrient-rich diets toward less healthy alternatives.[1] Consequently, the extent to which international trade has causally contributed to the increase in obesity in this region, as well as the magnitude of its impact, constitutes an important research question.

Although the link between international trade, nutritional transition, and health outcomes appears plausible, research in this field remains relatively scarce, partly due to data limitations and the challenge of identifying exogenous variation in international trade. A notable exception is Giuntella et al. (2020), who investigated the relationship between food trade and obesity in Mexico, demonstrating that increased imports of unhealthy foods from the United States exacerbated obesity rates at the state level. Building on this literature, we draw on micro-level datasets and employ a novel identification strategy, combined with a structural framework, to examine whether trade liberalization facilitates the inflow of unhealthy food products into domestic markets, substitutes domestic food, and contributes to broader nutritional transitions.

Specifically, we exploit South Korea's Free Trade Agreements (FTAs) with the European Union (EU) and the United States (US), enacted in the early 2010s, as a quasi-natural experiment that substantially reduced tariffs on food products.[2] Leveraging this policy shock, we draw on multiple micro-level datasets—(i) the UN Comtrade database, (ii)

[1] A notable example is Samoa, where obesity rates gradually increased after World War II as the U.S. began exporting high-fat turkey tails—a slaughterhouse by-product. The Samoan government eventually banned their import, but later lifted the ban after joining the WTO.

[2] Specifically, as shown in Appendix Figure B.1, the United States and the European Union are the two largest exporters of unhealthy foods to South Korea as in 2011.

the Korea International Trade Association (KITA) database, (iii) Free Trade Agreements Concession Tables, (iv) NielsenIQ Korea, and (v) the Ministry of Food and Drug Safety Database—, combined with difference-in-differences (DID), instrumental variable (IV) regression, and structural estimation techniques to examine whether these FTAs induced nutritional transitions by facilitating the importation and consumption of unhealthy food products in South Korea.

First, we find that imports of unhealthy food products increased following the enforcement of South Korea's FTAs. Following Giuntella et al. (2020), we classify unhealthy products (e.g., margarine, sausages, processed meats, sugar, sweets, chocolate, etc.) at the 4-digit HS code level. We construct two definitions of unhealthy foods: (i) a broad definition, based on the USDA classification as in Giuntella et al. (2020), and (ii) a narrow definition, based on the average sugar content by food category from the Ministry of Food and Drug Safety database. The EU and the United States are assigned to the treatment group, while all other countries that never signed an FTA with South Korea serve as the control group. Using the UNCOMTRADE dataset, we conduct a difference-in-differences analysis and find that, under the broad definition, the import value of unhealthy food products increased by an average of 36%, and the import quantity increased by 43%. This upward trend remains robust under the narrow definition of unhealthy food products. Furthermore, the results remain robust when the treatment group is extended to include other countries that have signed FTAs with South Korea.

Second, we estimate the extent to which the FTA tariff cuts are passed through to domestic prices by applying the method of Fajgelbaum et al. (2020). To assess the incidence of these tariff reductions, we compile the FTA concession tables with the EU and the U.S., construct tariff schedules at the 10-digit HS code level, and merge them with detailed South Korean import data from the Korea International Trade Association (KITA) database. Exploiting variation in product-level tariff cuts over time, we find that import values and quantities increase sharply with tariff reductions, after controlling for product-country, country-time, and product-time fixed effects. Moreover, we find no effect of tariff cuts on before-duty unit values, whereas duty-inclusive import prices—corresponding to domestic prices—decline following tariff reductions. Using tariff cuts as instruments, we estimate export supply and import demand elasticities and document a horizontal export supply curve alongside a downward-sloping import demand curve, consistent with evidence of complete tariff pass-through.

Third, we focus on the Korean chocolate market to assess substitution between domestic and foreign products. To this end, we use a novel product-level sales dataset from NielsenIQ Korea. With this rich dataset, we classify each product as either domestic or imported and estimate whether prices and quantities changed following the implementation of the FTAs. The difference-in-differences estimates indicate that the unit prices of imported chocolate products declined by approximately 16 percent, while purchased quantities increased by more than 100 percent relative to domestic products, consistent with a substitution effect induced by trade liberalization. Furthermore, because imported chocolate contains higher levels of sugar, these results imply an increase in sugar intake following trade liberalization.

Finally, we incorporate tariff changes as a cost shifter on the supply side and structurally estimate the chocolate market's demand–supply framework using a random-coefficient mixed logit model (e.g., Berry et al., 1995; Nevo, 2001). Counterfactual simulations under unchanged tariffs yield product-level sales, which we combine with the Processed Foods Nutritional Information Database to quantify nutritional side effects. The results indicate increased chocolate imports, increased overall consumption, and a 2.58 percent rise in national sugar intake, highlighting the nutritional consequences of trade liberalization. Following Grieco et al. (2024), we calculate the consumer surplus in a way that is robust to fluctuations in the value of the outside good, comparing baseline and counterfactual scenarios. We then quantify the resulting increase in external health consequences from increased sugar intake using estimates from the health literature. We find that higher per-capita sugar consumption leads to a proportional rise in estimated health costs, reflecting increased diet-related externalities from greater chocolate imports.

The remainder of the paper is organized as follows. Section 1.1 reviews the relevant literature. Section 2 describes the data sources. Section 3 examines the impact of FTAs on unhealthy food imports. Section 4 estimates the degree of pass-through of the FTA tariff cuts to domestic price. Section 5 investigates to what extent imports substitute domestic products in the chocolate market using a reduced-form approach. Section 6 estimates a structural model, performs counterfactual analysis in the chocolate market, and investigates changes in consumer surpluses and health costs induced by increased sugar intake. Section 7 concludes.

1.1 Related Literature

We contribute to the literature on the nexus between trade liberalization and health outcomes in importing countries. Giuntella et al. (2020) show that increased imports of unhealthy foods following trade liberalization exacerbated obesity in Mexico at the state level. Gračner (2021) highlight the price channel, documenting that trade liberalization after NAFTA in 1994 reduced the prices of sugary foods, which in turn contributed to higher rates of obesity and diabetes in Mexico. Lin et al. (2018) provide cross-country evidence using the United Nations Comtrade dataset, showing that sugar and processed foods imports significantly increased the average BMI in 172 countries between 1995 and 2010, even after controlling for globalization and trade flows. Building on this literature, we examine how tariff cuts under FTAs affect imports of unhealthy foods and their domestic consumption through price channels. Our main contribution is the introduction of a new product-brand-level scanner dataset on the Korean chocolate market, combined with multiple identification strategies, to estimate the impact of import-driven price changes on domestic nutritional intake.

Our paper is also related to the literature on tariff pass-through. Fajgelbaum et al. (2020) embed a CES-based utility framework into a multi-level demand and supply system—varieties within products, products within sectors, and domestic versus imported goods. Assuming tariff shocks are exogenous to contemporaneous demand and supply innovations, they recover substitution elasticities at each level and show that U.S. import tariffs were fully passed through to duty-inclusive domestic prices, implying that consumers bore the full incidence of the 2018 tariffs. Flaaen et al. (2020) take a complementary approach in the context of U.S. washing machines. Using weekly retail scanner data and untreated control appliances, they difference out non-tariff shocks and product life cycle effects while tracing multinational firms' relocation strategies in response to anti-dumping and safeguard duties. They find that the 2018 Section 201 tariffs raised washer prices by about 12 percent and dryer prices by a similar amount, implying tariff elasticities of 108–225 percent—far exceeding tariff revenues and highlighting the burden on U.S. households. In line with this literature, we apply the approach of Fajgelbaum et al. (2020) to FTA tariff cuts in South Korea and show that tariff pass-through in the food sector was almost complete.

Our work also relates to studies estimating demand systems through structural models with indirect utility and discrete choice. Nevo (2001) analyzes U.S. cereal demand with a brand-level panel and supply-side equations, showing that non-collusive pricing in differentiated markets yields high margins via willingness to pay and within-firm substitution. Kim and Kim (2025) examine the 2013 Namyang Dairy boycott in Korea using a discrete-choice model with a "boycott penalty," finding that strategic price cuts offset revenue losses by 76%, highlighting consumer power and firm adaptability. Kim (2023) studies the 2019–21 U.S. tariffs on Scotch whisky with a random-coefficients nested-logit model, documenting heterogeneous pass-through—15% price hikes for low-quality bottles versus 2% for high-quality—and a 21% variety loss concentrated among premium products. Building on this literature, we estimate the nutritional transition induced by

FTAs using a random-coefficient mixed logit model. Incorporating tariffs into the supply side, we estimate the system with GMM-IV and simulate counterfactuals. Moreover, combining product-level nutrition data, we quantify changes in sugar intake at the product level.

Finally, we situate our methodology within the broader literature that quantifies consumer surplus using mixed-logit demand systems. Grieco et al. (2024) study the U.S. automobile industry from 1980 to 2018 and show that the consumer surplus rose despite increases in real prices, driven by improvements in product quality and technological progress. Their key contribution is a welfare measure that is invariant to fluctuations in the outside option: they average compensating variation across alternative normalizations of the outside value, thereby purging movements in the outside option from the surplus metric. To estimate the health costs associated with sugar, we draw upon evidence from studies on sugar-sweetened beverages (SSBs). Imamura et al. (2015) and Xi et al. (2015) estimate how an incremental unit of SSB consumption increases the probability of obesity-related diseases, and Kang et al. (2011) quantifies the aggregate costs of these diseases in South Korea. Building on this work, we first calculate the consumer surplus in the domestic chocolate market under both baseline and counterfactual scenarios. We then translate the resulting change in sugar intake into disease risk and monetary externalities, using estimates from Imamura et al. (2015), Xi et al. (2015), and Kang et al. (2011), to quantify the health costs of trade liberalization.

2 Data and Summary Statistics

Our empirical analysis necessitates granular data on product-level international trade flows as well as item-level sales information in South Korea's chocolate market. To this end, we use five main datasets: (i) the UN Comtrade database, (ii) Free Trade Agreements Concession Tables, (iii) the Korea International Trade Association (KITA) database, (iv) NielsenIQ Korea databse, and (v) the Ministry of Food and Drug Safety database. Additionally, we complement the above datasets with (vi) the Korea Labor and Income Panel Survey (KLIPS) and (vii) the 2016 Ministry of Agriculture, Food and Rural Affairs Report on Processed Products Markets. The following subsection provides a brief description of each dataset.

2.1 UN Comtrade Database

To examine whether the signing of the two FTAs led to higher imports of unhealthy food products in South Korea, we use the UN Comtrade dataset. The data consist of HS 6-digit product–country–year level trade values in current U.S. dollars and net trade weights in kilograms, compiled on a customs basis. Because the dataset covers all United Nations member states, it allows for an effective identification strategy: countries that never signed FTAs with South Korea serve as the control group, while the European Union and the United States constitute the treatment group.

Hereafter, we use the term 'unhealthy foods,' following the definition of Giuntella et al. (2020). Appendix Table A.1 lists the HS 4-digit codes corresponding to unhealthy foods. Appendix Table A.6 presents summary statistics of unhealthy food import values and quantities by FTA status for 2010 and 2020. The two panels reveal a notable difference: between 2010 and 2020, both import values and quantities of unhealthy foods from the EU and the U.S.—countries that signed FTAs with South Korea—increased substantially, whereas no such trend is observed for trade with non-FTA countries.[3]

2.2 Free Trade Agreements Concession Tables

To assess how tariff reductions were implemented under the FTAs with the EU and the United States, we begin by examining the respective FTA appendices. The South Korea–United States tariff concession schedule classifies products into concession categories from A to Z and assigns a category to each 10-digit HSK product. Similarly, the South Korea–European Union tariff schedule specifies 20 concession categories at the 10-digit HSK level. We manually collect these schedules and merge them with our trade dataset, thereby exploiting rich product-by-time variation in tariff reduction paths.

We exclude categories that impose import quotas allocated on a first-come, first-served basis. In addition, we omit exceptional categories—U, V, and W—which primarily apply to seasonal imports and cover only a small number of products, making their quantitative impact negligible. Products subject to safeguard provisions are also excluded. Finally, because the HS classification system underwent a major revision in 2012, we carefully trace code concordances and incorporate these adjustments into our dataset to ensure consistency over time.[4]

[3] Appendix Figure B.2 shows that import values from these two FTA partner countries have increased over time relative to those from non-FTA countries exporting to South Korea.

[4] Appendix Figure B.3 compares the distribution of tariffs on unhealthy products in 2011 and 2019 using the FTA tariff-concession schedules and reveals a pronounced leftward shift, consistent with broad-based tariff reductions.

2.3 Korea International Trade Association Database

In addition, we collect South Korea's import data from the Korea International Trade Association (KITA). The dataset is constructed from Customs Declaration Records reported by importers and is available at the 10-digit HS product level. It includes detailed trade variables such as import value (in thousands of U.S. dollars) and import quantity (in kilograms) by product and year.

We merge these data with the FTA tariff concession schedules using the 10-digit HS code as the matching key. Our sample includes annual import data from the EU and the United States. EU27 countries with fewer than 80 products at the 10-digit HS level per year—specifically Cyprus, Estonia, Croatia, Luxembourg, Latvia, Malta, Romania, and Slovenia—are excluded due to limited product coverage.

To mitigate excessive within-year volatility, we aggregate the data to the 6-digit HS level. Under the assumption that tariff reductions are exogenously determined by the FTA schedules, the merged dataset yields an identification strategy in the spirit of Fajgelbaum et al. (2020), with the log difference in tariffs serving as the primary explanatory variable.

Appendix Table A.7 presents descriptive statistics of the outcome and independent variables for food products from 2012 to 2019. The mean value of the log (first) difference of the tariff rate, $\Delta(1 + \tau_{igt})$, is negative, reflecting tariff reductions under the FTAs. The mean values of the log differences in import value, $\Delta ln(1 + p^*_{igt} m_{igt})$, and import quantity, $\Delta ln(1 + m_{igt})$, indicate that food imports have increased. In contrast, the mean values of the log differences in unit price, $\Delta ln(1 + p^*_{igt})$, and duty-inclusive unit price, $\Delta ln(1 + p_{igt})$, show that only the duty-inclusive unit price decreased.

2.4 NielsenIQ Korea Database

We construct a novel dataset on the South Korean chocolate market covering regional, monthly sales from 2010 to 2016. The data are based on retail scanner records and provide detailed information at the item, brand, manufacturer, and product-type levels. In addition to sales, the dataset includes product-level promotion indicators. Sales volume is measured in kilograms, and unit price is defined as sales revenue divided by quantity sold.

Our identification strategy exploits variation between imported and domestically produced chocolate products. Imported products are classified based on brand and manufacturer information, allowing us to distinguish foreign-origin products from domestic ones within narrowly defined product categories.

Appendix Table A.8 reports summary statistics on sales, weight, quantity, and unit prices for domestic and imported chocolate products in 2010Q1 and 2016Q4. Relative to 2010Q1, the number of domestic chocolate products declines by 2016Q4, while their average unit prices increase. In contrast, the number of imported chocolate products rises over the same period, accompanied by a decline in unit prices. The observed patterns are consistent with tariff-induced price declines for imported products, which may have contributed to consumer substitution toward imports.

Appendix Figure B.4 illustrates divergent trends by import status. Imported products experience rising purchase weight and declining unit prices over time, whereas domestic products show the opposite pattern, suggestive of substitution toward imports.

Appendix Table A.9 reports sales revenue (in millions of KRW) and sales volume (in thousands of kilograms) for the top 20 domestic and imported chocolate brands. Within each group, the top 10 brands account for a substantial share of total sales revenue and volume. Taken together, these 40 brands represent more than 93% of the South Korean chocolate market over the period from 2010Q1 to 2016Q4.

2.5 Ministry of Food and Drug Safety Database

To estimate the random-coefficient logit model of discrete choice and analyze nutritional transitions—particularly in terms of sugar content—we incorporate an additional dataset containing product-level nutritional information. Specifically, we use the *Processed Foods Nutritional Information* dataset compiled by the Ministry of Food and Drug Safety, which reports nutrient contents per 100 grams (e.g., sugar, cholesterol, and sodium) as well as each product's country of origin.

Using this database, we construct a narrow definition of unhealthy foods based on average sugar content within each food category. Appendix Table A.3 reports the mean sugar content of domestic, EU, and U.S. products across food categories. Based on these values, we construct a narrow definition of unhealthy foods, summarized in Appendix Table A.2, which includes only high-sugar products most directly associated with diet-related health risks.

Appendix Table A.10 reports summary statistics for nutritional content per 100 grams for domestic chocolate products and those imported from the EU and the United States. The table indicates that imported products contain, on average, higher levels of sugar and sodium. Merging the NielsenIQ Korea sales data with this nutrition dataset provides a suitable framework to quantify changes in sugar intake as imported chocolate products expand their market share following FTA-induced tariff reductions.

2.6 Other Database

We incorporate two additional datasets: (i) the Korea Labor and Income Panel Survey (KLIPS) and (ii) the 2016 *Ministry of Agriculture, Food and Rural Affairs Report on Processed Products Markets*.

KLIPS is a nationally representative longitudinal survey of urban households, initiated in 1998 and conducted annually by the Korea Labor Institute (KLI). It provides harmonized information on income, education, employment status, household composition, and other demographic characteristics. In Section 6 (Structural Estimation in the Chocolate Market), we use KLIPS to construct region-specific empirical distributions of income and education. Following the standard random-coefficients logit framework, we draw consumer characteristics from these empirical distributions to simulate heterogeneous preferences and identify income- and education-dependent taste variation.

The 2016 *Ministry of Agriculture, Food and Rural Affairs Report on Processed Products Markets* contains a dedicated "Chocolate Market" section, including product descriptions, trade statistics, and consumer survey evidence. We use the report's estimate of annual per-capita chocolate consumption to calibrate market size. This allows us to recover outside-good shares and properly scale demand in the BLP estimation.

3 Impact of FTAs on Unhealthy Food Imports

3.1 Main Results

We begin by examining whether trade liberalization led to an increase in imports of unhealthy food products.[5] Our analysis focuses on two FTAs: (i) the South Korea–EU FTA (SK–EU FTA) and (ii) the South Korea–U.S. FTA (SK–US FTA), as the EU and the U.S. were the two largest exporters of unhealthy foods to South Korea in 2011. To assess the impact of these FTAs on South Korea's imports of unhealthy foods, we restrict the sample to unhealthy food products and estimate the following difference-in-differences regression equation:

$$lny_{igt} = \alpha_{it} + \alpha_g + \sum_{k \neq 2012} \beta_k \cdot FTA_g \mathbf{1}(t = k) + \varepsilon_{igt},$$

[5] We propose wide and narrow definitions of unhealthy foods. The wide definition of unhealthy foods is defined based on USDA as in Giuntella et al. (2020), and the narrow definition is defined based on the average sugar consumption by food category from the Ministry of Food and Drug Safety Database. Please refer to Appendix Table A.1 and A.2 for the two definition of unhealthy foods.

where y_{igt} denotes the import value or import quantity of 6-digit HS product i from country g in year t. α_{it} captures product–year fixed effects, and α_g represents country fixed effects. We define the treatment group as the two major countries that signed FTAs with South Korea—the EU and the U.S.—while the control group consists of countries that never entered into an FTA with South Korea. FTA_g is an indicator variable equal to one if country g belongs to the treatment group. The South Korea–EU FTA took effect in July 2011, and the South Korea–US FTA in March 2012. The sample covers the period from 2009 to 2020, with 2012 set as the reference year. Finally, $\mathbf{1}(\cdot)$ denotes a year indicator variable.

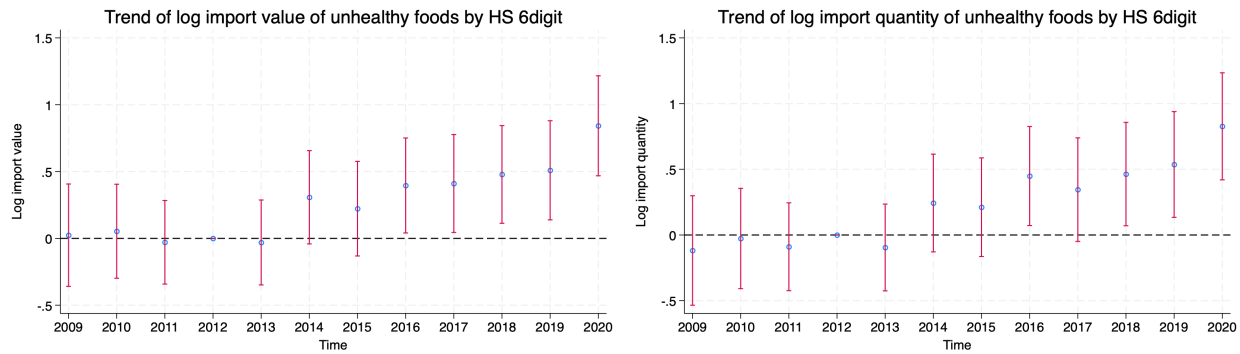
Table 1 reports the estimation results. The main outcome variables are the import value of unhealthy food products in current U.S. dollars, $lnp^*_{igt}m_{igt}$, and the import quantity of unhealthy food products in kilograms, lnm_{igt}. Columns (1) and (3) present the difference-in-differences results with product, country, and year fixed effects. Columns (2) and (4) present the difference-in-differences results with country and product–year fixed effects, which absorb time-invariant country unobserved heterogeneity as well as product–year unobserved shocks. The results show a significant increase in unhealthy food imports as a result of FTAs. Specifically, in the preferred specifications (columns (2) and (4)), the import value and quantity of unhealthy foods from FTA partner countries increased by 36% and 43%, respectively, relative to imports from non-FTA countries. Figure 1 presents the event-study estimates corresponding to the difference-in-differences results. From one to nine years after the FTA took effect, both the import value and quantity of unhealthy foods increased gradually.

Table 1: Imports of Unhealthy Food Products—DiD Results

Dependent Variable:	$lnp^*_{igt}m_{igt}$ (1)	$lnp^*_{igt}m_{igt}$ (2)	lnm_{igt} (3)	lnm_{igt} (4)
$FTA_g * Post_t$	0.3237***	0.3562***	0.3976***	0.4315***
Product FE	✓		✓	
Year FE	✓		✓	
Country FE	✓	✓	✓	✓
Product x Year FE		✓		✓
Observations	31,010	30,967	31,010	30,967

Notes: "$lnp^*_{igt}m_{igt}$, Import Value" is measured in USD dollars. "lnm_{igt}, Import Quantity" is measured in metric kilograms. $Post_t$ is an indicator variable that equals one if the year is after 2012. The sample comprises HS 6-digit level trade values of unhealthy foods aggregated to yearly level from 2009 to 2020. The list of unhealthy foods is provided in Appendix Table A.1. Standard errors are clustered at the 4-digit HS code and country levels. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1: Event Study Plot of Unhealthy Food Products



Notes: The dependent variable in the left (right) panel is log import value (log import quantity), respectively. The sample comprises HS 6-digit level trade values of unhealthy foods aggregated to yearly level from 2009 to 2020. The list of unhealthy foods is provided in Appendix Table A.1. Standard errors are clustered at the 4-digit HS code and country levels. Error bars represent 95% confidence intervals.

3.2 Robustness Checks

We conduct a series of robustness checks to verify that the main results are robust to alternative specifications. We first begin by further narrowing the definition of unhealthy foods to high-sugar items as in Appendix Table A.2 and redo the anaylsis. Appendix Table A.4 reports the difference-in-differences estimation results. The coefficients remain statistically significant, and their magnitudes are slightly larger than those in the main specification. Appendix Figure B.5 reports the event-study estimates. The upward post-treatment trend remains evident under the narrow definition of unhealthy foods, mirroring the pattern observed in the baseline results.

Next, we expand the analysis to include other FTA partner countries of South Korea during the sample period, grouping them into cohorts as listed in Appendix Table A.5, given that South Korea implemented FTAs with numerous additional countries over this period. To implement the analysis with different FTA enforcement timing, we adopt the methodology from Sun and Abraham (2021) and specify the regression as follows:

$$y_{igct} = \sum_{k \neq 0} \beta_k \, \mathbf{1}\{t - c = k\} \cdot \mathbf{1}\{g \in \mathcal{G}_c\} \; + \; \alpha_{ict} \; + \; \gamma_{igc} \; + \; \varepsilon_{igct},$$

where subscript i refers product (HS6), g means country, t indicates calendar year, and c indicates the cohort (i.e., stack) defined by FTA implementation year. Event time k is defined as $k = t - c$, with $k = 0$ omitted as the reference period. $\mathcal{G}_c$ is a group of countries that implemented FTAs with South Korea during the sample period in Appendix Table

A.5. The term α_{ict} represents product–cohort–year fixed effects, which absorb any shocks common to product i in year t within stack c, such as global product-specific demand or supply shocks that vary over time. The term γ_{igc} denotes product–country–cohort fixed effects, which control for time-invariant bilateral heterogeneity between product i and country g within cohort c, including baseline comparative advantage, persistent trade costs, or pre-existing trade relationships. By combining these fixed effects, identification comes from within-product, within-cohort, over-time variation in treated versus never-treated countries, netting out both common product-year shocks and fixed bilateral differences. The stacked specification is constructed by forming one stack for each cohort c, retaining the treated countries in that cohort together with the never-treated ("Other") countries as controls. This procedure isolates cohort-specific treatment dynamics while avoiding contamination from already-treated units.

Appendix Figure B.6 reports the dynamic treatment effects from the stacked event-study specification. We observe sustained post-FTA increases in both import value and quantity under both the broad and narrow (high-sugar) definitions of unhealthy foods, reinforcing the robustness of the baseline findings.

4 Estimating the Tariff Pass-through

In this section, we estimate the degree of pass-through from FTA tariff cuts to domestic prices, following the methodology of Fajgelbaum et al. (2020). Specifically, we construct annual tariff rates from the FTA concession tables based on concession categories. Appendix Table A.11 provides illustrative examples of tariff schedules affected by the FTAs.[6]

To merge the tariff schedules with South Korea's detailed import data from the Korea International Trade Association (KITA), we concord the 10-digit HS codes in the import dataset with those in the tariff schedules.[7] We then estimate the pass-through effects of the two FTAs—the SK–EU FTA and the SK–US FTA—following the methodology of Fajgelbaum et al. (2020). The main regression specification is given by:

$$\Delta lny_{igt} = \alpha_{ig} + \alpha_{gt} + \alpha_{it} + \beta \Delta ln(1 + \tau_{igt}) + \varepsilon_{igt}, \tag{1}$$

where Δlny_{igt} denotes the log difference of import outcomes for HS-6-digit product i

[6] For products classified under Category A in the U.S. Concession Table, tariffs were eliminated immediately upon FTA implementation. In contrast, products in Category C experienced uniform tariff reductions phased out over five years.

[7] Since the 10-digit HS classification has undergone several revisions, we use the HS codes in the tariff schedules as the benchmark. Products appearing only in the tariff dataset are excluded from the analysis.

from country j in year t. We consider four outcome variables: (i) the log difference of import value in dollars, $\Delta lnp^*_{igt}m_{igt}$; (ii) the log difference of import quantity in kilograms, Δlnm_{igt}, (iii) the log difference of before duty unit price, Δlnp^*_{igt}; and (iv) the log difference of the duty-inclusive unit price, Δlnp_{igt}. The duty-inclusive unit price is defined as the unit import price including tariff duties, i.e., $p_{igt} = (1 + \tau_{igt})p^*_{igt}$. The regression specification includes three sets of fixed effects: (i) product–country, (ii) country–year, and (iii) product–year fixed effects. These absorb unobserved heterogeneity at the product–country, country–year, and product–year levels. The key independent variable, $\Delta ln(1 + \tau_{igt})$, captures tariff reductions under the tariff change for product i, from g (EU countries or the U.S.) in year t. Identification relies on variation in product-level tariffs over time, after controlling for these three-way fixed effects. The sample period spans 2008–2019, covering both the pre-FTA and post-FTA periods.

Following Fajgelbaum et al. (2020), we exploit variation in FTA tariffs to jointly estimate export supply and import demand elasticities. Specifically, we estimate the export supply elasticity and the import demand elasticity and using two instrumental variable (IV) regressions:

$$\Delta lnp^*_{igt} = \alpha^{p^*}_{ig} + \alpha^{p^*}_{gt} + \alpha^{p^*}_{it} + \omega^* \Delta lnm_{igt} + \varepsilon^{p^*}_{igt}, \tag{2}$$

$$\Delta lnm_{igt} = \alpha^{m}_{ig} + \alpha^{m}_{gt} + \alpha^{m}_{it} - \sigma \Delta lnp_{igt} + \varepsilon^{m}_{igt}. \tag{3}$$

Under the exogeneity assumption of the tariff cuts, $\Delta ln(1+\tau_{igt})$ can serve as an instrument for both Δlnm_{igt} and Δlnp_{igt}. A statistically significant coefficient ω^* in equation (2) allows us to reject the null hypothesis that $\omega^* = 0$, indicating that the supply curve is infinitely elastic. Similarly, a statistically significant coefficient σ in equation (3) allows us to reject the null hypothesis that $\sigma = 0$, indicating that demand is infinitely elastic. In particular, if we fail to reject a horizontal supply curve, this provides additional evidence consistent with complete pass-through in our context.

Table 2 presents the main regression results. Columns (1) and (2) show that import value and import quantity increased significantly following the tariff cuts. Columns (3) and (4) indicate complete pass-through: exporter prices remained almost unchanged, while domestic food prices declined in response to FTA tariff cuts. The estimates suggest full pass-through of tariff reductions because the regression coefficient is significantly positive only for the duty-inclusive unit import price, but not for the before-duty unit price. In other words, the before-duty unit price, equivalent to the CIF exporter price, did not change significantly, whereas the duty-inclusive unit price, corresponding to the domestic price, responded strongly to the FTA tariff cuts.

Additionally, columns (5) and (6) report the estimated supply and demand elasticities

Table 2: FTA Tariff Pass-through

Dependent Variable:	$\Delta lnp^*_{igt}m_{igt}$ (1)	Δlnm_{igt} (2)	Δlnp^*_{igt} (3)	Δlnp_{igt} (4)	Δlnp^*_{igt} (5)	Δlnm_{igt} (6)
Δln(1+τ_{igt})	-3.9909***	-3.3004***	0.2951	0.9327***		
Δlnm_{igt}					-0.0894	
Δlnp_{igt}						-3.5385***
Product x Country FE	✓	✓	✓	✓	✓	✓
Country x Year FE	✓	✓	✓	✓	✓	✓
Product x Year FE	✓	✓	✓	✓	✓	✓
First Stage F					10.69	13.91
Observations	15,741	15,741	15,741	15,741	15,741	15,741

Notes: The sample data comprises a full-balanced panel of 6-digit HS products from 2008 to 2019. The regression units are aggregated at the 6-digit HS level. EU countries with few observations are dropped. Standard errors are clustered at the 4-digit HS code and country levels. *** p<0.01, ** p<0.05, * p<0.1.

from equations (2) and (3), respectively. Column (5) shows that we cannot reject the null hypothesis of a horizontal export supply curve, consistent with the reduced-form results indicating complete pass-through. Column (6) indicates that the import demand curve is elastic.

We further conduct a placebo test to examine whether pre-trends exist in the outcome variables. Equation (4) presents the estimation specification used for this placebo test:

$$\Delta lny_{ig,09-11} = \alpha_{k(i),g} + \alpha_i + \beta \Delta ln(1 + \tau_{ig,11-19}) + \varepsilon_{ig}. \tag{4}$$

Here, $\Delta lny_{ig,09-11}$ represents the log difference of the four import outcome variables, as defined in equation (1), calculated between 2009 and 2011, before the FTAs came into effect. $\alpha_{k(i),g}$ denotes sector–country fixed effects, and α_i denotes product fixed effects. The key independent variable, $\Delta ln(1 + \tau_{ig,11-19})$, is constructed as the difference between 2011 and 2019 to capture post-FTA changes in tariffs.

Appendix Table A.12 presents the estimation results of the placebo test for each outcome variable. The results indicate that none of the coefficients are statistically significant, providing little evidence of pre-trends. This further supports the exogeneity of the main independent variable, $\Delta \ln(1 + \tau_{igt})$.

5 Reduced-form Analysis in Chocolate Market

Our analysis so far shows that trade liberalization through the FTAs increased imports of unhealthy food products, with tariff cuts fully passed through to domestic prices. The remaining question is the extent to which these imports substitute for domestic products and affect nutritional transitions. To investigate this, we focus on the Korean chocolate market, using a micro-level product-level sales dataset from NielsenIQ Korea. Leveraging this rich dataset, we classify each product as domestic or imported and examine whether prices and quantities in each category changed following the implementation of the FTAs.

Prior to estimating the structural demand model, we perform a reduced-form analysis based on the rich product-level sales data. To avoid confounding seasonal effects, we first adjust for recurring first-quarter price fluctuations driven by special promotional events. The right panel of Appendix Figure B.4 shows a recurring seasonal decline in chocolate unit prices, which coincides with promotional discounts during Valentine's Day (February 14) and White Day (March 14) in South Korea. To account for this pattern, we construct a seasonality-adjusted unit price through the following procedure. We first estimate the regression equation as follows:

$$y_{it} = \alpha_i + Year_t + Month_t + \varepsilon_{it} \tag{5}$$

where y_{it} denotes the sales revenue (in millions of KRW) or the quantity purchased (in thousands of units) of chocolate product i in period t, where t represents the year–month combination. α_i captures product fixed effects. To account for monthly variation in sales revenue and quantities, we include both year and month fixed effects in the regression. The sample spans January 2010 to December 2016.[8]

In estimating equation (5), we omit the month with the lowest aggregate sales to serve as the baseline reference category. To construct our seasonally adjusted measures, we net out the seasonal effects by subtracting the estimated monthly coefficients ($\widehat{Month_t}$) from the raw data. We apply this adjustment to both sales revenue and quantity purchased separately. Finally, we compute the seasonally adjusted unit price by dividing the adjusted sales revenue by the adjusted quantity. We then use this seasonally adjusted unit price as the main outcome variable in our difference-in-differences estimation below.

Next, we employ difference-in-differences (DiD) and event-study approaches to estimate the impact of FTA-induced tariff cuts on substitution patterns between domestic and

[8] We excluded products from four brands that were not affected by the tariff cuts under the two FTAs, as they are produced in countries outside the U.S. and EU: Kitkat (Japan), Morinaga (Japan), Bon O Bon (Mexico), and Hershey's Nuggets (Malaysia).

imported chocolate products. The event-study framework, which nests the DiD design, can be specified as follows:

$$lny_{it} = \alpha_i + \alpha_t + \sum_{k \neq 2011Q3} \beta_k \cdot Import_i \cdot \mathbf{1}(t = k) + \varepsilon_{it},$$

where y_{it} denotes the seasonality-adjusted unit price or the quantity purchased of chocolate product i in year–quarter t. α_i and α_t represent product and year–quarter fixed effects, respectively. The sample period spans from the first quarter of 2010 to the fourth quarter of 2016. We set 2011Q3 as the reference period prior to the FTA implementation. $Import_i$ is an indicator variable equal to one for imported goods, defined at the brand–manufacturer level.[9]

Table 3: Substitution between Imported and Domestic Chocolate—DiD results

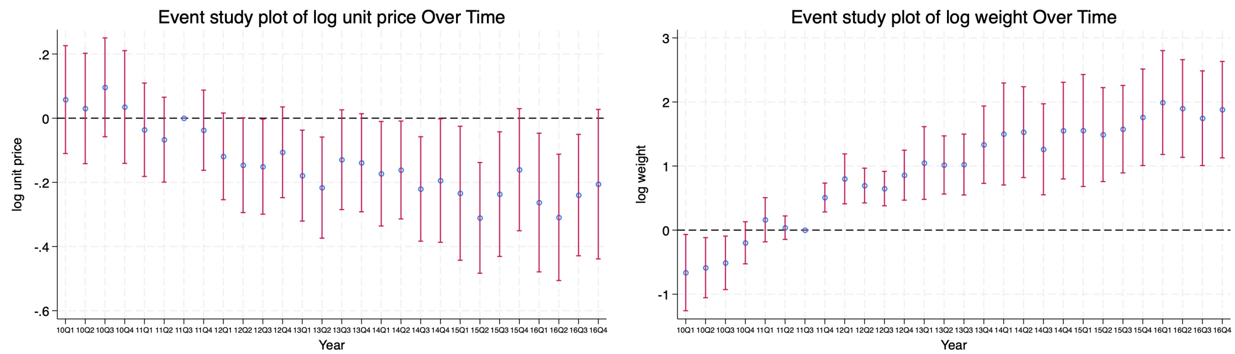
Dependent Variable:	$ln\ Price_{it}$ (1)	$ln\ Price_{it}$ (2)	$ln\ Quantity_{it}$ (3)	$ln\ Quantity_{it}$ (4)
$Import_i * Post_t$	-0.1652***	-0.1641***	1.1142***	1.1183***
Product FE	✓	✓	✓	✓
Year FE	✓		✓	
Quarter FE	✓		✓	
Year-Quarter FE		✓		✓
Observations	54,978	54,978	56,138	56,138

Notes: $Price_{it}$ is measured in KRW, and $Quantity_{it}$ in metric kilograms. $Post_t$ is an indicator variable equal to one for year–quarters after 2011Q3. The sample consists of a product-month–level sales dataset for the domestic chocolate market from January 2010 to December 2016. Imported goods are manually identified at the brand–manufacturer level. Standard errors are clustered at the brand level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3 and Figure 2 present the difference-in-differences (DiD) estimates and event-study plots, respectively, using the NielsenIQ Korea dataset on chocolate products. In Table 3, the DiD results indicate that the FTAs significantly reduced the unit price of imported chocolate products while increasing their quantity purchased relative to domestic products. Quantitatively, the FTAs reduced the price by an average of 16% and increased the quantity purchased by more than 100%. Figure 2 shows the corresponding event-study plots, which mirror the DiD results: unit prices decline while quantities purchased increase after the FTAs took effect.

[9]Because the NielsenIQ Korea dataset does not report the origin country, we cannot precisely identify whether a product is imported from the U.S. or the EU. Since the U.S. and EU are the two largest chocolate exporters to South Korea, we expect the contribution of imports from other countries to be marginal. Accordingly, our estimates should be interpreted as a lower bound of the true effect, as the impact of chocolate products imported from countries other than the U.S. and EU is likely to be either negligible or positive due to substitution effects.

Figure 2: Event Study Plot of Substitution between Imported and Domestic Chocolate



Notes: The dependent variable in the left (right) panel is the log unit value (log purchase quantity), respectively. The sample consists of a product-month–level sales dataset for the domestic chocolate market from January 2010 to December 2016. Imported goods are manually defined at the brand–manufacturer level. Standard errors are clustered at the brand level, and error bars represent 95% confidence intervals.

6 Structural Estimation in Chocolate Market

6.1 Identification Strategy

The random coefficient discrete choice logit model incorporates consumer heterogeneity by allowing price sensitivity and disutility to vary across individuals. This framework also captures substitution patterns toward imported products whose prices decline following the FTA. Following the literature (e.g., Berry et al., 1995; Nevo, 2001) and recent applications such as Kim (2023), Grieco et al. (2024), and Kim and Kim (2025), we define consumer i's utility from consuming chocolate product j in market m as follows:

$$u_{ijm} = \alpha_{im} p_{jm} + \beta_{im} \mathbf{x}_j + \xi_{jm} + \varepsilon_{ijm} \tag{6}$$

where p_{jm} denotes the price of product j in market m. The vector $\mathbf{x}_j$ captures the observed characteristics of product j, while ξ_{jm} represents unobserved characteristics that vary across products and markets. Following Nevo (2001), we define a market m as a region–year-quarter combination, such as *City 1 in 2010Q1*, resulting in 132 markets in our sample. Following the conventional BLP framework, the utility of outside goods is normalized as 0.

$$\alpha_{im} = \alpha + \sum_h \alpha_h D_{im}^h + \sigma_1 v_{im} \tag{7}$$

$$\beta_{ikm} = \beta + \sum_h \beta_{kh} D_{im}^h + \sigma_k v_{ikm} \tag{8}$$

$$\xi_{jm} = \xi_j + \xi_m + \tilde{\xi}_{jm}, \tag{9}$$

substituting equations (7) and (8) into equation (6) yields:

$$\begin{aligned} u_{ijm} &= \alpha p_{jm} + \beta \mathbf{x}_j + \xi_{jm} \\ &(\sum_h \alpha_h D_{im}^h + \sigma_1 v_{im}) p_{jm} + (\sum_h \beta_{kh} D_{im}^h + \sigma_k v_{ikm}) \mathbf{x}_j + \varepsilon_{ijm} \\ &= \delta_{jm} + \mu_{ijm} + \varepsilon_{ijm}. \end{aligned} \tag{10}$$

In equation (7), h indexes dimensions of consumer demographics. We assume that the consumer-specific marginal utility of income depends on mean constant term, individual income y_{im} and its square term whose distribution can differ at market level and unobserved characteristics v_{im}. Similarly, in equation (8), k denotes the kth observed product characteristics (e.g., sugar) and h indexes the dimension of consumer demographics again. The consumer-specific marginal utility of product characteristics is assumed to depend on individual demographics (e.g., education) and unobserved characteristics v_{ikm}. Both v_{im} and v_{ikm} are assumed to follow a standard normal distribution, with zero covariance for simplicity.

Equation (9) decomposes the unobserved product characteristics ξ_{jm} into three components: product fixed effects, market fixed effects, and a product–market specific term $\tilde{\xi}_{jm}$, which is assumed to be independent across markets. Following the previous literature, ε_{ijm} is assumed to be i.i.d. Type I extreme value distributed. Next, equation (10) expresses the indirect utility function as the sum of the mean utility term δ_{jm}, which is common across consumers, and a mean-zero heteroskedastic deviation, μ_{ijm}, which captures the effects of random coefficients.

Following Kim and Kim (2025), we define market size based on sales volume. We utilize annual per capita chocolate consumption data from the Ministry of Agriculture, Food and Rural Affairs, observing a steady trend from 556g in 2011 to 607g in 2015 (specifically 556g, 567g, 580g, 593g, and 607g for the years 2011–2015, respectively). We allocate these annual amounts across four quarters, setting consumption in the first quarter to twice that of each of the remaining quarters to reflect increased demand during Valentine's Day and White Day. Accordingly, we define market size as the population aged 10 to 60 multiplied by the allocated quarterly consumption.

To estimate the random coefficients that vary across individuals, we sample 500 households from the Korean Labor & Income Panel Study (KLIPS) for each region and year. For each household, we randomly assign average income, following Kim and Kim (2025), to allow the price coefficient (i.e., the marginal utility of income with respect to price) to vary by income. In addition, we draw 500 individuals' education levels in each region and year from the individual-level KLIPS dataset and let the coefficient of brand-level characteristics (e.g., average sugar content) vary with education, under the assumption that more educated individuals are more sensitive to nutritional attributes. Assuming that unobserved characteristics v_{im} and v_{ikm} are independent of demographic variables, the market share of product j in market m can then be derived from the logit model as follows:

$$s_{jm} = \int_i \frac{\exp\big(\beta_{im}\mathbf{x}_j + \alpha_{im}p_{jm} + \xi_{jm}\big)}{\exp\big(\gamma_m\big) + \sum_{l=1}^{J} \exp\big(\beta_{im}\mathbf{x}_l + \alpha_{im}p_{lm} + \xi_{lm}\big)}\, dF(i) \tag{11}$$

Using the contraction mapping theorem, we can recover the mean utility term δ_{jm} from the iterative equation, $\delta^{I+1}_{jm} = \delta^{I}_{jm} + ln(s^{obs}_{jm}) - ln(s^{pred}_{jm})$, where s^{obs}_{jm} denotes the observed market share from the dataset and s^{pred}_{jm} is the numerically approximated market share from equation (11). The mean utility is specified as $\delta_{jm} = \alpha p_{jm} + \mathbf{x}_j\beta + \xi_j + \xi_m + \tilde{\xi}_{jm}$, from which the price coefficient α can be identified using GMM. The corresponding moment condition exploits the orthogonality between the unobserved component $\tilde{\xi}_{jm}$ and the set of instrumental variables Z_{jm}:

$$E[\tilde{\xi}_{jm}|Z_{jm}] = 0 \tag{12}$$

where the set of instrumental variables Z_{jm} is constructed using the average prices of the product j in other regions in previous periods. With this specification, the moment condition allows the GMM estimator to identify coefficients α and β, as well as the random coefficient parameters.

Next, to incorporate tariff cuts into the model, we introduce the supply side, since tariffs directly affect the marginal costs of suppliers. Following Nevo (2001), the supply model can be specified as follows:

$$\Pi_{fm} = \sum_{j \in J_{fm}} \left(p_{jm} - mc_{jm}\right) s_{jm}(\mathbf{p}_m) \;-\; FC_f, \tag{13}$$

$$\Omega_{jr,m} = \begin{cases} -\dfrac{\partial s_{rm}(\mathbf{p}_m)}{\partial p_{jm}} & \text{if } \exists\, f : \{r, j\} \subset J_{fm}, \\ 0 & \text{otherwise}, \end{cases} \tag{14}$$

$$\underbrace{\mathbf{p}_m - \mathbf{mc}_m}_{\text{markups}} = \Omega_m^{-1}\, s(\mathbf{p}_m), \tag{15}$$

$$mc_{jm} = \tau_{jt}\,\gamma \;+\; \eta_j \;+\; \zeta_m \;+\; \omega_{jm}. \tag{16}$$

There are F manufacturers, each producing a subset J_{fm} of products in market m. Equation (13) defines firm f's profit function in market m, with market size normalized to one. Here, J_{fm} denotes the firm's product set in market m, mc_{jm} the marginal cost of product j, $s_{jm}(\mathbf{p}_m)$ the market share of product j as a function of the market price vector $\mathbf{p}_m$, and FC_f the fixed cost of firm f. Following Nevo (2001), equation (14) specifies the ownership (or elasticity) matrix $\Omega_{jr,m}$. Using this ownership matrix together with the first-order condition of the profit function, the markup equation can be derived as shown in equation (15).

Equation (16) specifies the marginal cost function. We include product fixed effects η_j to capture product-level characteristics that are invariant across markets, such as production and packaging costs. Market fixed effects ζ_m account for market-level factors that apply uniformly to all products within a market, such as transportation costs, distribution cost differences across regions, and region–time varying wages in the food manufacturing sector. The tariff rate on chocolate products, τ_{jt}, varies by year t, import status, and origin country, declining uniformly in five steps from 8% in 2011. The term ω_{jm} represents product–market-specific unobserved characteristics affecting marginal cost. As in the demand equation, product characteristics and region–year variables are assumed exogenous with respect to the unobserved product characteristics. Accordingly, the orthogonality condition between the tariff rate and ω_{jm} is given as follows:

$$E[\omega_{jm}|\tau_{jt}] = 0. \tag{17}$$

Next, the demand- and supply-side equation can be written as:

$$y_{jm}^{D} \equiv \delta_{jm}(\tilde{\theta}) + \alpha\, p_{jm} = \left(x_{jm}^{D}\right)' \beta^{D} + \xi_{jm}, \tag{18}$$

$$y_{jm}^{S} \equiv p_{jm} - \eta_{jm}\left(\alpha, \delta_{jm}(\tilde{\theta}), \tilde{\theta}\right) = \left(x_{jm}^{S}\right)' \gamma^{S} + \omega_{jm}. \tag{19}$$

Here, y_{jm}^D and y_{jm}^S denote the endogenous variables on the demand and supply sides, respectively. The vectors β^D and γ^S represent the demand- and supply-side coefficients. The term $\eta_{jm}(\alpha, \tilde{\delta}_{jm})$ corresponds to an element of the matrix $\Omega_m^{-1} s(\mathbf{p}_m)$. Since the parameter α also enters the supply side, it is treated as endogenous and is estimated in the outer loop of the GMM procedure, in contrast to the case where only the demand system is estimated. This simultaneous system can thus be expressed as a stacked GMM–IV framework, with orthogonality conditions defined in equations (12) and (17):

$$\underbrace{\begin{pmatrix} y^D \\ y^S \end{pmatrix}}_{2N\times 1} = \underbrace{\begin{pmatrix} X_D & 0 \\ 0 & X_S \end{pmatrix}}_{2N\times(K_1+K_3)} \underbrace{\begin{pmatrix} \beta \\ \gamma \end{pmatrix}}_{(K_1+K_3)\times 1} + \underbrace{\begin{pmatrix} \xi \\ \omega \end{pmatrix}}_{2N\times 1}.$$

Let N denote the number of observations, and K_1 and K_3 the numbers of independent variables on the demand and supply sides, respectively. The estimation proceeds as follows: First, recover the mean utility δ_{jm} using the contraction mapping theorem applied to the demand system. Second, estimate the demand parameters $\tilde{\alpha}$ and β via the equation $\delta_{jm} = \tilde{\alpha} p_{jm} + \mathbf{x}_j \beta + \xi_j + \xi_m + \Delta\xi_{jm}$ using price instruments. Third, construct $\Omega_m^{-1} s(\mathbf{p_m})$ from the estimated parameters and predicted market shares. Fourth, recover marginal costs mc_{jm} from the supply system. Lastly, stack the estimated δ_{jm}'s and mc_{jm}'s, and estimate the simultaneous system using GMM–IV with the relevant moment conditions. This procedure ensures consistent estimation of both demand- and supply-side parameters while accounting for endogeneity in prices and tariffs.

In the final step, we conduct a counterfactual analysis by simulating the scenario in which tariffs are removed. Since the model was estimated under a gradually decreasing tariff schedule, we can compute the difference in sales volumes relative to the case in which tariffs remain unchanged. By combining these results with data from the Processed Foods Nutritional Information Database, we then calculate the corresponding changes in nutritional intake, multiplying the differences in product sales volumes by their respective nutritional contents to obtain the average effect.

6.2 Empirical Results

Table 4 reports the mixed logit model estimates for the domestic chocolate market. As discussed above, we allow price, sugar, sodium, kcal and protein coefficients to vary with wage, wage squared, age and the number of family members.[10] The interaction between wage and price is positive and significant, showing that higher-wage consumers are less price sensitive. The negative and statistically significant coefficient of the interaction between the number of family members and prices indicates that households with larger number of members are more sensitive to price. On the supply side, the tariff coefficient is positive and significant, implying that a tariff increase raises marginal cost.[11]

Table 4: Coefficient Estimates

			Demographic interactions			
	β	σ	Wage	Wage^2	Age	N. family
Demand Side						
Price	-1.980	–	0.712	0.319	–	-1.340
	(0.448)		(0.177)	(0.584)		(0.551)
Sugar	-0.067	0.0318	–	–	-0.127	–
	(0.013)	(1.140)			(0.143)	
Sodium	0.063	0.383	–	–	0.363	–
	(0.017)	(0.917)			(0.222)	
Kcal	0.072	0.000	–	–	–	-0.604
	(0.017)	(1.460)				(0.253)
Protein	-0.035	0.0331	–	–	–	-0.500
	(0.014)	(1.030)				(0.242)
Constant	–	–	-14.50	–	–	–
			(18.30)			
	γ					
Supply Side						
Tariff	3.770	–	–	–	–	–
	(1.130)					

Notes: The sample covers 2010Q4 to 2016Q1. On the supply side, firms are identified at the brand level, and the own-ownership matrix is calculated accordingly. Wage is normalized to have zero mean and unit variance. The mean utility coefficients of time-invariant product characteristics are estimated using the minimum-distance procedure in Chamberlain (1982).

After estimating the model using the GMM-IV approach, we "turn off" the tariff to predict marginal costs without the FTA-induced tariff cuts. Counterfactual prices are then derived from the predicted marginal costs using equation (15), and counterfactual market

[10] As noted earlier, 500 demographics are randomly drawn from the Korea Labor & Income Panel Survey—at the household-year and individual-year levels, respectively—and assigned to each market in the mixed logit model.

[11] Please refer to the tariff schedules in Appendix Table A.11.

Table 5: Consumption Shares and National Net Changes (Baseline vs. Counterfactual)

Panel A. Domestic vs. Imported			
Percent of total (%) : Composition Change			
Import status	Baseline	Counterfactual	Change (pp)
Domestic	65.02	71.24	−6.22pp
Imported	34.98	28.76	+6.22pp
Consumption (thousand kg)			
Import status	Baseline	Counterfactual	% Change
Domestic	60,554	65,204	−7.13%
Imported	32,577	26,323	+23.76%

Panel B. National totals and net changes				
Consumption (thousand kg)				
National-level	Baseline	Counterfactual	Net change	Net change (% of base)
	93,131	91,527	1,603	+1.72%
Sugar intake (thousand kg)				
National-level	Baseline	Counterfactual	Net change	Net change (% of base)
	42,056	40,972	1,084	+2.58%

Notes: In Panel A, percentages are calculated using the sum of domestic and imported products within each scenario as the denominator, and raw totals are reported in thousand kilograms. In Panel B, "Net change" equals Base−Counterfactual, with percentages relative to the baseline totals. The baseline reflects current tariff levels, while the counterfactual simulates consumption without the FTA tariff cuts.

shares are calculated via equation (11). Table 5 reports the results, comparing the baseline scenario (with FTA tariff cuts) to a counterfactual scenario (without cuts).

Panel A shows that tariff cuts shifted the composition of chocolate products by 6.22 pp toward imports, as domestic products were substituted through the price channel. The increase in imported chocolate consumption substantially exceeded that of domestic products, consistent with Figure 2.

Panel B reports nation-level changes: accounting for population by year-quarter, total chocolate consumption rose under the FTAs. Using the Ministry of Food and Drug Safety Database, we estimate that sugar intake increased by 2.58%, or roughly 1.08 billion grams, relative to the counterfactual. Yearly decomposition (Appendix Table B.7) shows that the gap between baseline and counterfactual scenarios widened over time for imported products, while domestic products showed no significant change.

6.3 Welfare Analysis

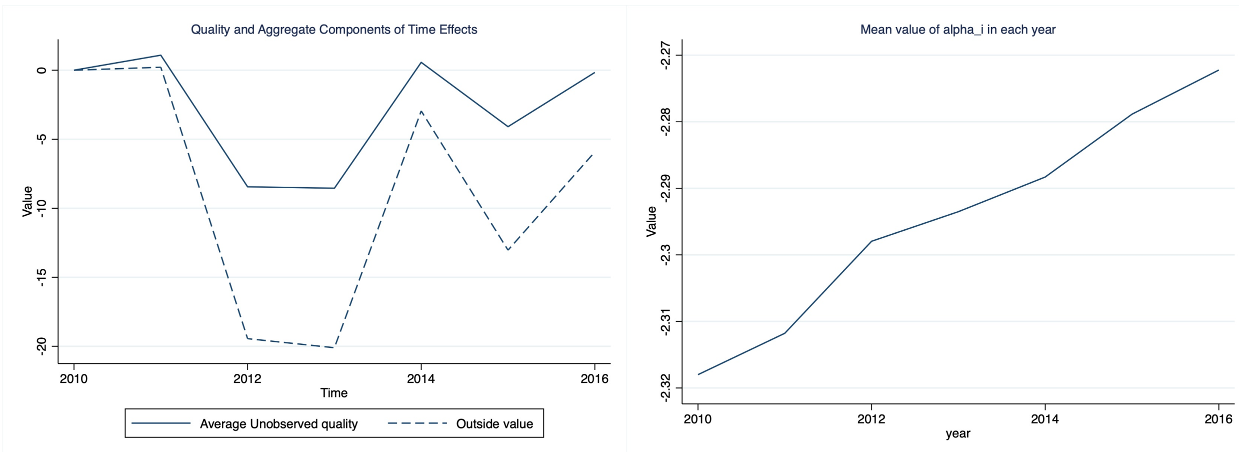
In this section, we conduct a welfare analysis using the fitted mixed logit model to trace the evolution of consumer surplus over the sample period. Specifically, we compare observed welfare outcomes to a counterfactual scenario in which tariffs on imported chocolate products remained at their pre-liberalization levels. This exercise allows us to isolate the surplus gains attributable to trade liberalization through expanded product variety, price adjustments, and changes in market shares captured by the demand system. We then integrate these surplus estimates with information from the Nutritional Database to quantify the welfare implications of diet-related health externalities. By mapping product-level sugar content into changes in aggregate sugar intake induced by import expansion, we estimate the associated health costs and express them in welfare-comparable monetary terms. This combined framework enables us to evaluate whether the health-related welfare losses linked to increased sugar consumption are economically substantial relative to the consumer surplus gains from trade, or instead remain quantitatively marginal.

In our framework, we allow both market size and demographic distribution to vary across markets, which enables the value of outside goods and the distribution of estimated random coefficients to differ by market. For example, outside goods may become less attractive once the FTAs take effect, and the marginal utility of price may decrease more rapidly as consumers' incomes rise. Grieco et al. (2024) introduces an approach for cases in which the value of outside goods fluctuates, recovering this value by imposing the restriction that the quality of continuing goods within each market remains unchanged. Following Grieco et al. (2024), we adopt a similar restriction in our setting, extending it to the region–time level at which our markets are defined. As we define markets at the region (r) and year-quarter (t) level, equation (9) can be written as $\xi^r_{j,t} = \xi_j + \xi^r_t + \tilde{\xi}^r_{j,t}$. Then the within-region restriction is as follows:

$$\forall j \in \mathcal{C}^r_t, \quad \forall r = 1, ..., R: \quad \mathbb{E}\big[\xi^r_{j,t} - \xi^r_{j,t-1}\big] = \mathbb{E}\Big[(\tau^r_t - \tau^r_{t-1}) + (\tilde{\xi}^r_{j,t} - \tilde{\xi}^r_{j,t-1})\Big] = 0. \tag{20}$$

As in Pakes et al. (1993) and Grieco et al. (2024), let $\mathcal{C}^r_t$ denote the set of continuing chocolate products offered in both t and $t-1$ within region r. Because we now index markets by region r, market t in equation (20) is defined at the year–quarter level. We add the restriction that (20) holds within each region: innovations in continuing product characteristics $\xi_{j,t}$ are mean zero across year–quarters within a region and are independent across regions. This restriction allows us to identify the region-specific yearly average unobserved product quality τ^r_t independently across regions. The identification procedure follows Grieco et al. (2024): (i) first, in the inner loop of the GMM for mean utility δ_{jt}, we estimate market (region–year–quarter) fixed effects, which equal $\tau_t^r - \gamma_t^r$; (ii) second, using the region–quarter moment condition (20) for continuing products, we independently identify τ_t^r within each region.

Figure 3: Decomposition of the Outside Value and the Dynamics of the Price Coefficient



Notes: The left graph displays the decomposition of time effects into average unobserved quality and the value of outside goods by year in KRW scale. The region-time level decomposition result is averaged across regions. The right graph draws the mean value of estimated α_is in each year from the full mixed logit model.

Figure 3 presents two descriptive statistics: (i) the decomposition of time effects into average unobserved quality and the value of outside goods using equation (20); and (ii) the time trend of the mean price coefficient α_i. The first panel shows that the value of the outside good is more volatile than average unobserved quality—consistent with Grieco et al. (2024)—but turns negative after 2010. We interpret this large negative swing in outside value as the effect of FTA tariff cuts, which increase market variety and reduce the relative prices of imported chocolate products compared to domestic ones. The right panel clearly displays an upward trend (i.e., becoming less negative) in the price coefficient as individuals' incomes rise over time, thereby lowering the marginal utility of price, in line with Grieco et al. (2024).

Following Grieco et al. (2024), we then quantify consumer surplus using compensating variation from the estimated model in a way that is invariant to market-specific swings in the value of the outside good.

$$CS_m(\gamma) = \int_i \frac{1}{\alpha_{im}} \left[\log \left(\exp(\gamma) + \sum_{l=1}^{J} \exp\left(\beta_{im}\mathbf{x}_l + \alpha_{im} p_{lm}^{(\gamma)} + \xi_{lm}\right) \right) - \gamma \right] dF_m(i). \quad (21)$$

$$\widetilde{CS}_m = \frac{1}{V}\sum_{\nu=0}^{V} CS_m(\gamma_\nu) \tag{22}$$

Equation (21) defines compensating variation in market m relative to an outside good valued at γ. Here, $p_{lm}^{(\gamma)}$ denotes the equilibrium price evaluated at outside value γ. However, as noted above, the outside value varies across markets, so this relative compensating variation can depend on fluctuations in γ. To address this, following Grieco et al. (2024), equation (22) computes consumer surplus in each market m by evaluating it at every γ_v from other markets, where V refers to the number of markets, averaging across these values to obtain a measure that is invariant to variation in γ.

Appendix Figure B.8 plots consumer surplus for the baseline and counterfactual cases, as well as their differences by year, computed from equations (21) and (22). The counterfactual uses predicted marginal costs under the assumption that tariffs were not reduced, as in the previous section. We find that consumer surplus is higher in the baseline case, with the magnitude of the difference increasing over time.

Finally, to quantify the welfare losses associated with increased sugar intake induced by FTAs in the chocolate market, we draw on the existing literature estimating the social health costs of sugar-sweetened beverages (SSBs), as relatively few studies focus directly on chocolate products. Specifically, we examine how higher sugar consumption affects the probability of four obesity-related diseases: (i) diabetes, (ii) hypertension, (iii) stroke, and (iv) coronary heart disease (CHD). Imamura et al. (2015) report an 18% higher incidence of type 2 diabetes per serving / day of SSB (standardized to 250 ml / day) after adjustment for adiposity. Xi et al. (2015) report an 8% higher incidence of hypertension, a 17% higher incidence of coronary heart disease, and a 6% higher incidence of stroke per serving / day of SSB. Building on these estimates, we compute the per gram risk of the disease using the average sugar content of a representative SSB (Coke) per 250 ml. Under a log-linear dose–response assumption, the yearly social cost increase can be written as follows:

$$\Delta C_{\text{year}} = \left(RR_{\text{per g, disease}}^{\Delta s_{\text{year}}} - 1\right) C_{\text{year,disease}} \tag{23}$$

where $RR_{\text{per g, disease}}$ is the per-gram increase in disease risk associated with higher sugar intake; Δs is the average annual increase in per-capita sugar intake estimated in our data; and we divide the annual increase in sugar intake by the number of consumers in each market and by 365 to obtain the daily increase. $C_{\text{year,disease}}$ denotes the total social cost of each disease in South Korea, taken from Kang et al. (2011).[12]

[12]Total costs are reported in thousands of U.S. dollars for 2005. We convert to KRW using the contempo-

Appendix Figure B.9 plots the annual change in per-capita sugar intake alongside the aggregate health cost implied by equation (23). Both series exhibit a steady upward trajectory over the sample period. The rise in per-capita sugar consumption translates into a commensurate increase in estimated health costs, reflecting the growing diet-related externalities associated with higher chocolate imports. Taken together, these patterns highlight the latent social costs of trade liberalization—costs that operate through nutritional risk channels and can be directly linked to FTA-induced changes in the structure of the chocolate market.

7 Conclusion

This paper demonstrates that tariff reductions under Korea's FTAs with the EU and the United States were fully passed through to retail prices. The resulting decline in import prices induced a shift in consumer demand from domestic chocolate products toward foreign brands with higher sugar content. Using scanner data and a structural BLP model, we find increased purchases of imported chocolate, higher overall consumption, and a 2.6% rise in national sugar intake once nutrition facts are matched to quantity data. Counterfactual analyses suggest that, without the tariff cuts, both consumption and sugar intake would have been lower. This implies that the primary health impact of the FTAs stems from lower prices and altered consumption patterns. The key takeaway is that trade policy can produce unintended public health costs, highlighting the importance of considering nutritional side effects alongside conventional welfare gains. Our findings suggest that excluding certain products—such as those with significant health risks—from preferential tariff treatment may help mitigate these negative externalities. Relevant examples include Nauru's sugar levy and Fiji's import duties on soft drinks, both implemented as part of broader policy strategies to restrict imports of unhealthy products and combat rising obesity rates. From this perspective, our findings shed light on ongoing policy debates regarding proposals by the Korean president to introduce a sugar tax or levy as a public health measure.

raneous exchange rate and then update to 2010–2016 KRW using the inflation rate.

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Appendix

Appendix A: Additional Tables

Table A.1: Definition of Unhealthy Foods - Wide

HS	Product	HS	Product
0201	Beef	1806	Chocolate
0203	Pork	1902	Pasta
0401	Milk & cream	1905	Bakery products
0402	Milk & cream	2007	Jams, jellies, marmalades
0403	Fermented dairy (yogurt, kefir)	2009	Fruit & vegetable juices
0405	Butter	2101	Coffee & tea extracts/preparations
0406	Cheese	2103	Sauces & condiments
1101	Wheat or meslin flour	2104	Soups & broths
1517	Margarine; fat blends	2105	Ice cream
1601	Sausages & similar	2106	Snack foods / ready meals
1602	Prepared/preserved meats	2202	Sweetened beverages
1701	Cane/beet sugar (solid)	2203	Beer
1702	Other sugars & syrups	2204	Wine
1703	Molasses (sugar by-products)	2208	Spirits & liqueurs
1704	Sugar confectionery (sweets)	-	-

Notes: This table lists the wide definition of unhealthy foods used in the analysis, following Giuntella et al. (2020). HS refers to the 4-digit Harmonized System classification.

Table A.2: Definition of Unhealthy Foods - Narrow

HS	Product	HS	Product
0402	Milk & cream (powdered/condensed)	2007	Jams, jellies, marmalades
1701	Cane/beet sugar (solid)	2009	Fruit & vegetable juices
1702	Other sugars & syrups	2101	Coffee & tea extracts/preparations
1703	Molasses (sugar by-products)	2103	Sauces & condiments
1704	Sugar confectionery (sweets)	2105	Ice cream
1806	Chocolate	2106	Snack foods / ready meals
1905	Bakery products	2202	Sweetened beverages

Notes: The narrow definition includes only high-sugar products most directly linked to diet-related health risks, such as confectionery, sweetened beverages, jams, and bakery items.

Table A.3: Mean Sugar Content (per 100 g) by Product: Domestic vs Imported (EU & U.S.)

	Obs	Mean
Chocolate		
Domestic	1,237	36.9797
Imported (EU & U.S.)	1,252	44.0645
Ice Cream		
Domestic	2,755	16.2708
Imported (EU & U.S.)	231	20.1084
Snacks & Bakeries		
Domestic	37,702	19.1430
Imported (EU & U.S.)	2,384	31.5611
Sugar & Jam		
Domestic	1,831	38.6280
Imported (EU & U.S.)	292	47.9050
Beverages		
Domestic	9,242	11.9781
Imported (EU & U.S.)	560	12.4816

Notes: Sugar content is reported per 100-gram serving. The data are sourced from the *Processed Foods Nutritional Information* database compiled by the Ministry of Food and Drug Safety.

Table A.4: Imports of Unhealthy Food Products–Narrow version

Dependent Variable:	$lnp^*_{igt}m_{igt}$ (1)	$lnp^*_{igt}m_{igt}$ (2)	lnm_{igt} (3)	lnm_{igt} (4)
$FTA_g * Post_t$	0.3519**	0.3810***	0.4556***	0.4824***
Product FE	✓		✓	
Year FE	✓		✓	
Country FE	✓	✓	✓	✓
Product x Year FE		✓		✓
Observations	20,868	20,867	20,868	20,867

Notes: "$lnp^*_{igt}m_{igt}$, Import Value" is measured in USD dollars. "lnm_{igt}, Import Quantity" is measured in metric kilograms. $Post_t$ is an indicator variable that equals one if the year is after 2012. The sample comprises HS 6-digit level trade values of narrow unhealthy foods aggregated to yearly level from 2009 to 2020. The list of narrow unhealthy foods is provided in Appendix Table A.2. Standard errors are clustered at the 4-digit HS code and country levels. *** p<0.01, ** p<0.05, * p<0.1.

Table A.5: FTA Cohorts Used in the Stacked DiD

Country	Year	Country	Year
United States	2012	European Union	2012
Peru	2011	Turkey	2013
Australia	2014	China	2015
Canada	2015	New Zealand	2015
Vietnam	2015	India	2010
Colombia	2016	Other (never-treated)	—

Table A.6: Descriptive Statistics of Unhealthy Foods Import Value and Weight

	Obs	Mean	Std. Dev.	Min	Max
Panel A: EU Countries & US					
$lnp^*_{igt}m_{igt}$ (2010)	633	9.2507	4.3901	0.6931	19.2262
$lnp^*_{igt}m_{igt}$ (2020)	881	9.7036	4.5080	0	20.1583
lnm_{igt} (2010)	633	7.4576	4.6298	0.6931	18.0615
lnm_{igt} (2020)	881	7.7113	4.8597	0.0815	18.8382
Panel B: Other Non-FTA Countries					
$lnp^*_{igt}m_{igt}$ (2010)	962	7.3625	4.3352	0	20.2753
$lnp^*_{igt}m_{igt}$ (2020)	1,365	7.4182	4.3060	0	19.6078
lnm_{igt} (2010)	962	5.7109	4.6303	0.6931	20.9218
lnm_{igt} (2020)	1,365	5.4998	4.6958	0.0099	20.7058

Notes: "$lnp^*_{igt}m_{igt}$, Import Value" is measured in USD dollars. "lnm_{igt}, Import Quantity" is measured in metric kilograms. Panel A covers EU and US; Panel B covers all other non FTA countries. The definition of unhealthy foods are from Giuntella et al. (2020). The data are sourced from UN-COMTRADE.

Table A.7: Descriptive Statistics of Foods Import and Tariff Cuts

	Obs	Mean	Std. Dev.	Min	Max
$\Delta(1+\tau_{igt})$	13,064	-0.0198	0.0420	-1.7698	0
$\Delta ln(1+p^*_{igt}m_{igt})$	13,064	0.1173	2.7667	-16.1654	15.8451
$\Delta ln(1+m_{igt})$	13,064	0.0913	2.3182	-17.4824	17.294
$\Delta ln(1+p^*_{igt})$	13,064	0.0100	0.6524	-8.9832	7.666475
$\Delta ln(1+p_{igt})$	13,064	-0.0025	0.6621	-8.9832	7.6664

Notes: The sample period spans from 2012 to 2019. "$p^*_{igt}m_{igt}$, Import Value" is measured in USD dollars. "m_{igt}, Import Quantity" is measured in metric kilograms. "p^*_{igt}, unit price" is defined as import value divided by import quantity. "p_{ig}, The duty-inclusive unit price" is defined as the import unit price including the duty value from the tariff, i.e., $p_{igt} = (1+\tau_{igt})p^*_{igt}$. The data are sourced from KITA trade database and the FTA concession tables.

Table A.8: Descriptive Statistics in Chocolate Market

	Obs	Mean	Std. Dev.	Min	Max
Panel A: Domestic Products					
Sales (in millions KRW) (2010Q1)	1,180	64.2501	130.7908	0	1407.91
Weight (in thousands of KG) (2010Q1)	1,180	3.8643	9.4367	0	131.01
Quantity (in units) (2010Q1)	1,180	67.4646	151.2036	0	1414.48
Unit price (in KRW) (2010Q1)	1,113	2104.625	2453.245	0	26000
Sales (in millions KRW) (2016Q4)	962	78.0336	202.9974	0	1688.3
Weight (in thousands of KG) (2016Q4)	962	3.7980	11.3064	0	107.48
Quantity (in units) (2016Q4)	962	50.3752	151.851	0	1396.36
Unit price (in KRW) (2016Q4)	888	3080.872	3042.285	200	20000
Panel B: Imported Products					
Sales (in millions KRW) (2010Q1)	1,036	55.0021	145.9023	0	2103.09
Weight (in thousands of KG) (2010Q1)	1,036	2.1444	4.7573	0	48.21
Quantity (in units) (2010Q1)	1,036	28.2448	99.4262	0	1145.21
Unit price (in KRW) (2010Q1)	968	5423.416	5065.591	0	42000
Sales (in millions KRW) (2016Q4)	1,768	47.7179	159.4274	0	2127.98
Weight (in thousands of KG) (2016Q4)	1,768	1.5750	4.3135	0	40.06
Quantity (in units) (2016Q4)	1,768	24.3408	103.6896	0	1457.1
Unit price (in KRW) (2016Q4)	1,648	4840.058	4395.815	0	30500

Notes: The sample consists of monthly observations at the product–brand–manufacturer level. The sample period spans from January 2010 to December 2016, and the data are aggregated to the year–quarter level for analysis. Unit price is defined as sales revenue divided by the quantity sold. The data are sourced from NielsenIQ Korea.

Table A.9: Top 20 Chocolate Brands by Sales Revenue and Import Status

Brand	Revenue	Volume	Brand	Revenue	Volume
Panel A: Domestic Products					
Ghana	453 914.29 (23.80%)	21 981.25 (22.49%)	Atlas	41 073.76 (2.15%)	3 356.50 (3.43%)
Free Time	312 137.64 (16.37%)	18 774.34 (19.21%)	White Angel	34 005.34 (1.78%)	950.98 (0.97%)
ABC	217 887.60 (11.42%)	12 850.18 (13.15%)	Sunflower	28 878.17 (1.51%)	1 155.92 (1.18%)
Crunky	207 045.89 (10.86%)	9 681.93 (9.90%)	To You	26 860.45 (1.41%)	1 363.66 (1.40%)
Dream Cacao	109 565.08 (5.74%)	4 609.57 (4.72%)	Flake	17 408.65 (0.91%)	1 077.55 (1.10%)
Hot Break	94 778.67 (4.97%)	6 921.53 (7.08%)	Stone Age	16 704.17 (0.88%)	753.39 (0.77%)
Market O	83 654.03 (4.39%)	2 815.33 (2.88%)	Iris	16 187.25 (0.85%)	576.48 (0.59%)
Mini Shell	69 069.86 (3.62%)	3 508.55 (3.59%)	Kids Tree	13 246.56 (0.69%)	439.44 (0.45%)
Kicker	55 052.74 (2.89%)	2 841.98 (2.91%)	SaEal	12 995.53 (0.68%)	876.48 (0.90%)
Almond Choco Ball	54 896.86 (2.88%)	1 546.20 (1.58%)	T.P.	9 762.07 (0.51%)	517.71 (0.53%)
Panel B: Imported Products					
Ferrero Rocher	327 814.60 (20.95%)	6 557.77 (11.64%)	Ferrero Collection	35 306.24 (2.26%)	490.58 (0.87%)
Snickers	204 085.42 (13.04%)	11 522.18 (20.46%)	KitKat	32 159.49 (2.05%)	1 303.98 (2.31%)
Hershey's Bar	168 587.21 (10.77%)	6 192.54 (10.99%)	Toblerone	30 634.72 (1.96%)	1 004.33 (1.78%)
Twix	146 303.22 (9.35%)	7 838.74 (13.92%)	Dove	23 405.03 (1.50%)	902.20 (1.60%)
Kisses	146 026.36 (9.33%)	5 983.49 (10.62%)	Loacker	21 492.79 (1.37%)	720.33 (1.28%)
Kinder Joy	98 439.52 (6.29%)	1 442.29 (2.56%)	Bon o Bon	12 922.53 (0.83%)	792.84 (1.41%)
Kinder Chocolate	96 427.47 (6.16%)	3 690.00 (6.55%)	Oreo	11 551.39 (0.74%)	450.05 (0.80%)
M&M's	56 111.66 (3.59%)	2 651.79 (4.71%)	Hershey's Miniatures	11 300.77 (0.72%)	411.72 (0.73%)
Hershey's Nuggets	44 888.95 (2.87%)	1 649.42 (2.93%)	Chuetcheats	9 892.87 (0.63%)	803.41 (1.43%)
Guylian	44 571.56 (2.85%)	877.12 (1.56%)	Lindor	8 787.90 (0.56%)	195.83 (0.35%)

Notes: Revenue is reported in millions of KRW, and volume is measured in thousands of kilograms. Percentages are shown in parentheses. The data are sourced from the NielsenIQ Korea database.

Table A.10: Summary Statistics of Nutritional Content among Chocolate Products

	Obs	Mean	Std. Dev.	Min	Max
Panel A: Domestic Chocolate Products					
Sugar (g)	1,237	36.98	15.16	0	116.67
Calories (kcal)	1,237	537.42	70.15	2	1 467
Protein (g)	1,237	7.40	4.88	0	53.33
Fat (g)	1,237	33.95	7.76	0.1	83.33
Carbohydrate (g)	1,237	51.67	11.17	0.26	166.67
Sodium (mg)	1,237	70.15	70.69	0	881
Cholesterol (mg)	1,237	8.33	11.40	0	97
Saturated fat (g)	1,237	21.85	7.03	0	45.83
Trans fat (g)	1,237	0.08	0.37	0	8.20
Panel B: Imported Chocolate Products from the EU and the U.S.					
Sugar (g)	1,252	42.18	13.02	0	69
Calories (kcal)	1,252	541.71	46.47	215	711
Protein (g)	1,252	6.72	2.73	0	33.33
Fat (g)	1,252	35.04	8.19	1.7	64.40
Carbohydrate (g)	1,252	49.84	11.25	7.5	100
Sodium (mg)	1,252	85.14	100.70	0	880
Cholesterol (mg)	1,252	8.21	12.76	0	125
Saturated fat (g)	1,252	20.27	6.68	0	46.40
Trans fat (g)	1,252	0.12	0.25	0	2.50

Notes: The full sample comprises 2,801 products. Nutrient values are reported per 100-gram serving. The data are sourced from the *Processed Foods Nutritional Information* database compiled by the Ministry of Food and Drug Safety.

Table A.11: Tariff Cuts by Concession Category

US Concession Category					
HSK code	Product	Year	Category	Tariff	Note
1904101000	Cereal	2011	A	5.4%	Tariff eliminated at once
1904101000	Cereal	2012	A	0%	
1904101000	Cereal	2013	A	0%	
1806201000	Chocolate	2011	C	8%	Tariff eliminated uniformly for 5 years
1806201000	Chocolate	2012	C	6.4%	
1806201000	Chocolate	2013	C	4.8%	
1806201000	Chocolate	2014	C	3.2%	
1806201000	Chocolate	2015	C	1.6%	
1806201000	Chocolate	2016	C	0%	
EU Concession Category					
HSK code	Product	Year	Category	Tariff	Note
1904101000	Cereal	2011	0	5.4%	Tariff eliminated at once
1904101000	Cereal	2012	0	0%	
1904101000	Cereal	2013	0	0%	
1806201000	Chocolate	2011	5	8%	Tariff eliminated uniformly for 6 years
1806201000	Chocolate	2012	5	6.66%	
1806201000	Chocolate	2013	5	5.33%	
1806201000	Chocolate	2014	5	4%	
1806201000	Chocolate	2015	5	2.66%	
1806201000	Chocolate	2016	5	1.33%	
1806201000	Chocolate	2017	5	0%	

Notes: In practice, tariffs on products from the U.S. have been reduced each January since March 2012, while tariffs on products from the EU have been reduced each July since July 2011. Because monthly-level trade data for South Korea are unavailable in the UN COMTRADE dataset and excessively volatile in the KITA dataset, we assume that tariffs on EU imports also decline at the beginning of each year.

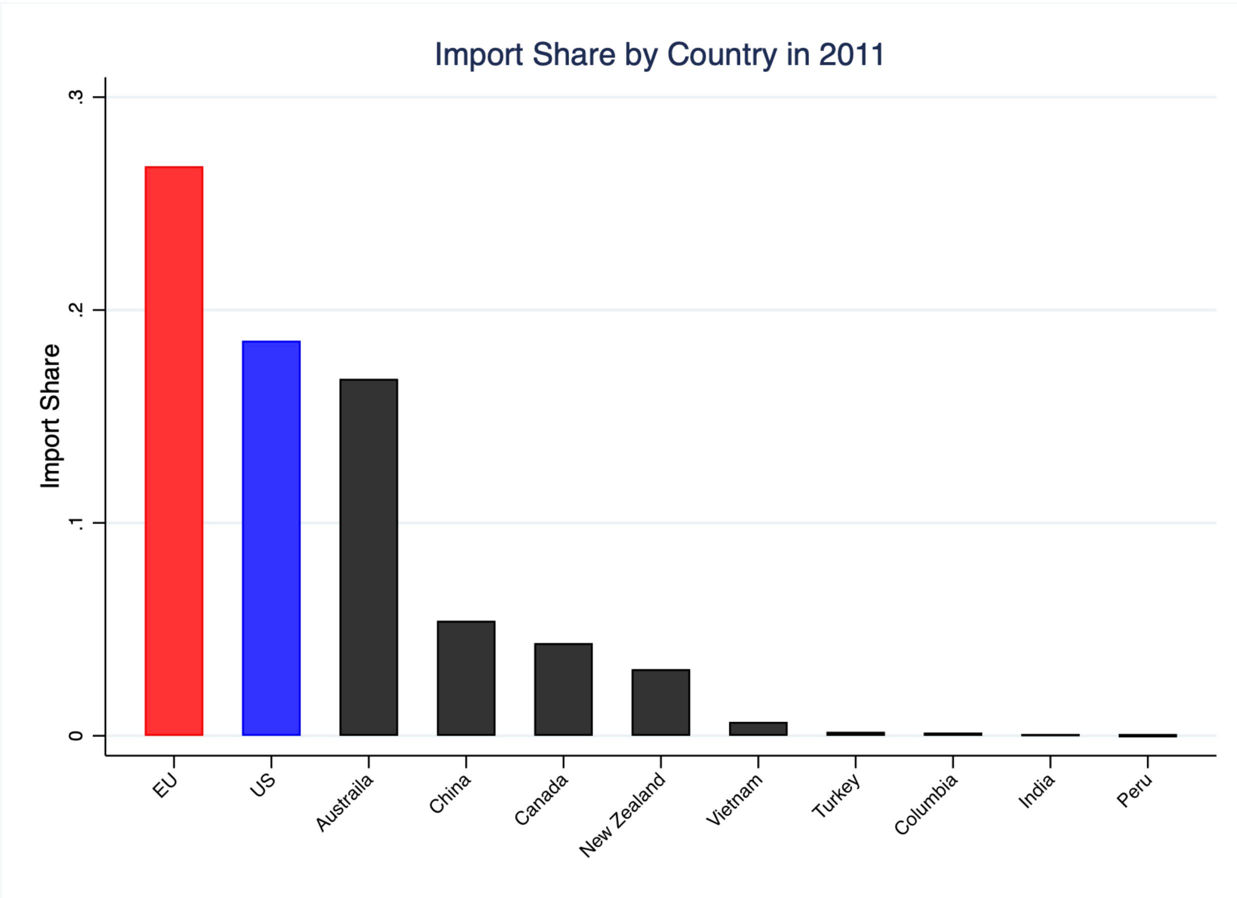
Table A.12: Placebo Test of the Tariff Cuts

Dependent Var.:	$\Delta \ln(1 + p^*_{ig,09\text{–}11} m_{ig,09\text{–}11})$ (1)	$\Delta \ln(1 + m_{ig,09\text{–}11})$ (2)	$\Delta \ln(1 + p^*_{ig,09\text{–}11})$ (3)	$\Delta \ln(1 + p_{ig,09\text{–}11})$ (4)
$\Delta \ln(1 + \tau_{ig,11\text{–}19})$	2.6321	3.1855	-0.5849	-0.6274
Sector×Cty. FE	✓	✓	✓	✓
Product FE	✓	✓	✓	✓
Observations	890	890	890	890

Notes: The sample comprises product–country level long-differenced variables over 2009–2011. Standard errors are clustered at the 4-digit HS code and country levels. *** p<0.01, ** p<0.05, * p<0.1.

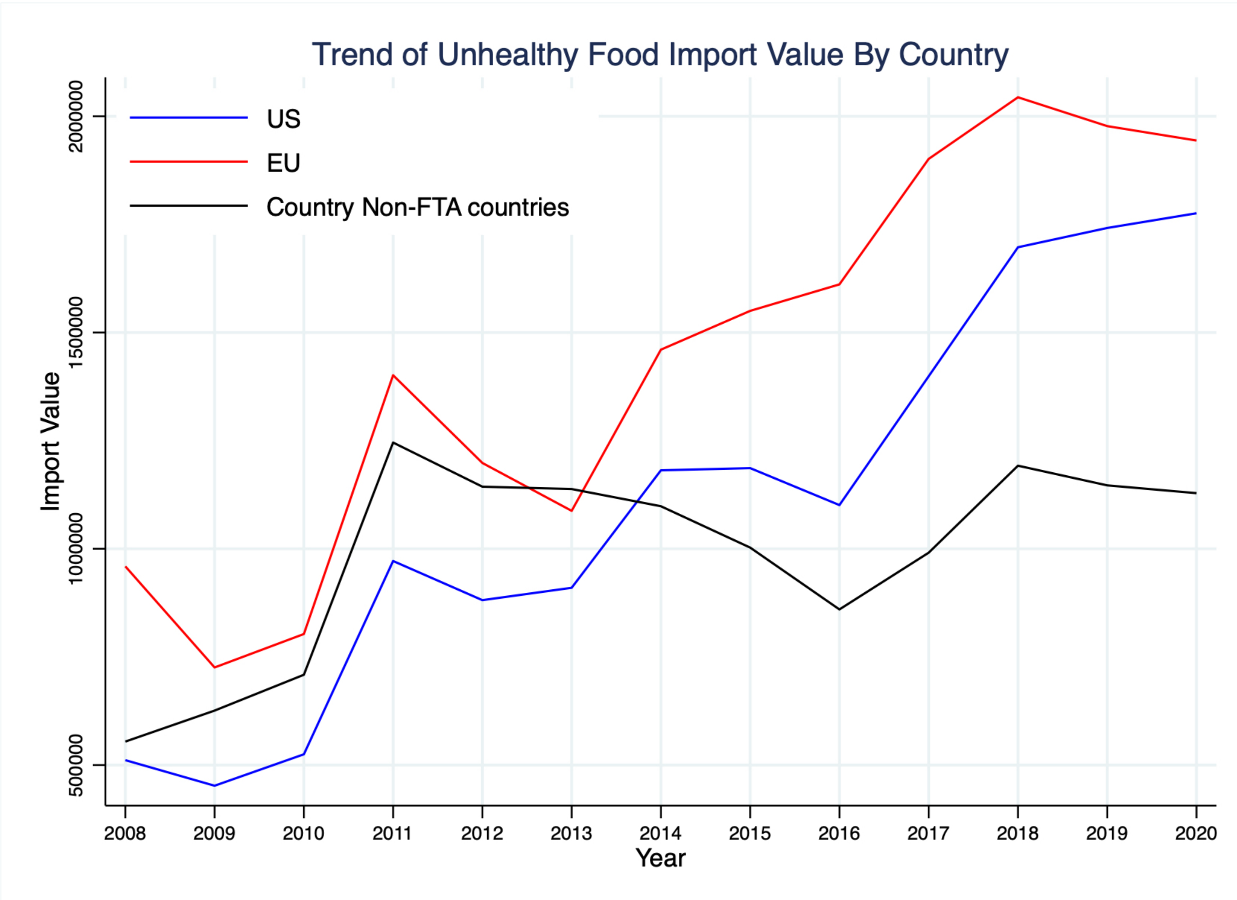
Appendix B: Additional Figures

Figure B.1: Unhealthy Food Import Shares by Country of Origin



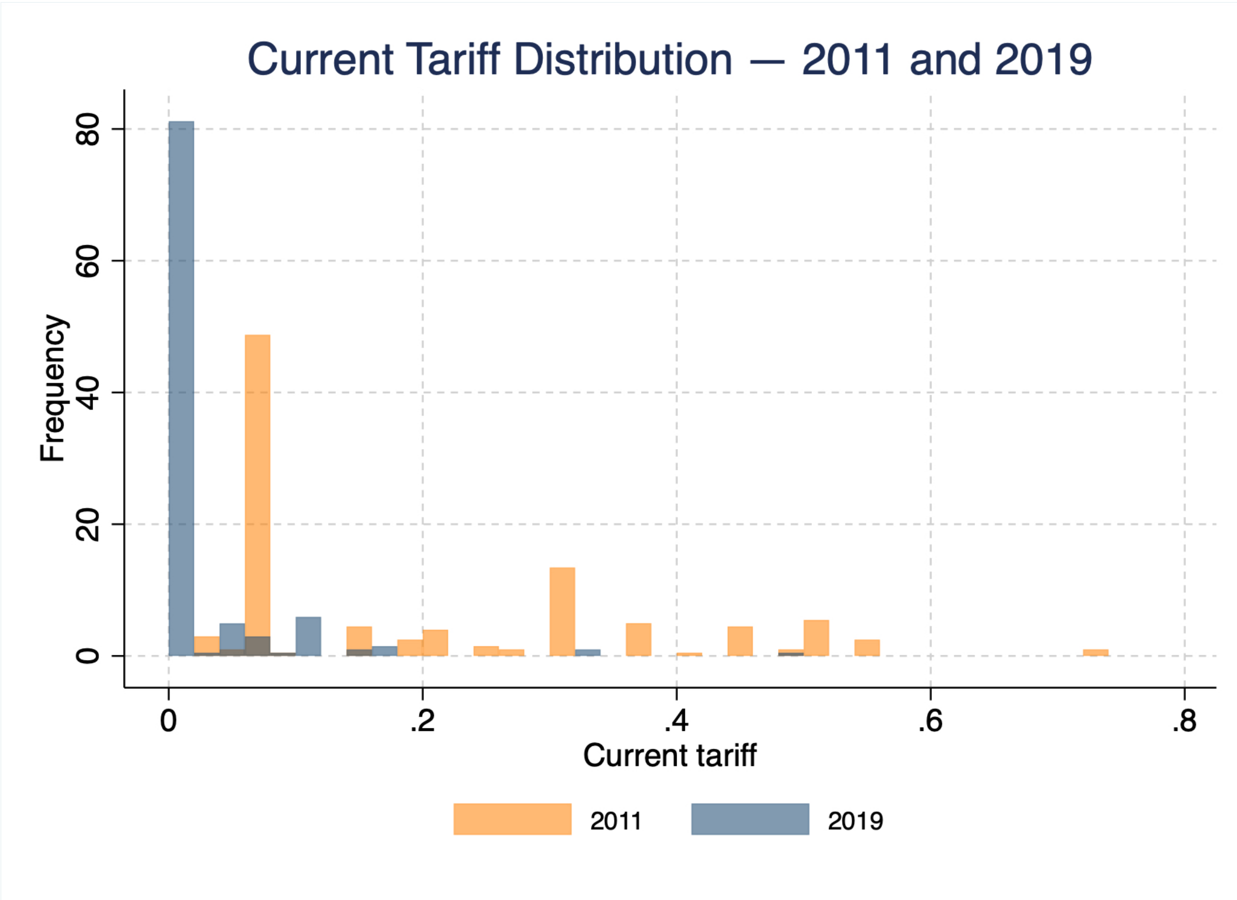
Notes: The data are sourced from the UN Comtrade database. The y-axis represents the share of unhealthy food imports from each country

Figure B.2: Trend of Unhealthy Food Import Value across the U.S., EU, and Other Non-FTA Countries



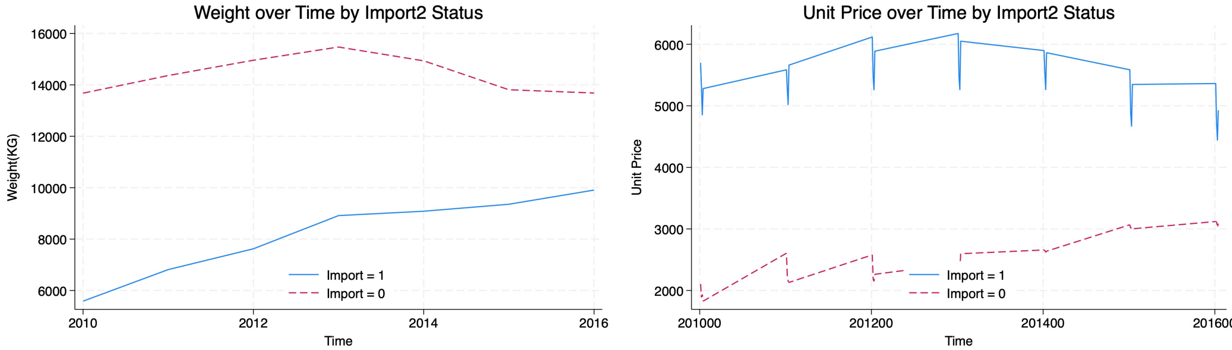
Notes: The data are sourced from the UN Comtrade database. The y-axis represents the import value of unhealthy food from each exporting country.

Figure B.3: Changes in the Tariff Distribution of Unhealthy Food Products



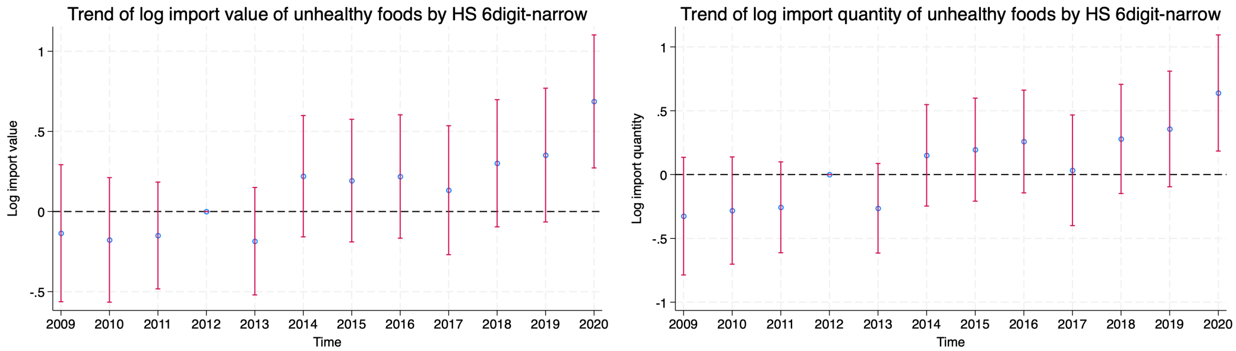
Notes: The data are sourced from FTA tariff concession schedules. The x-axis represents the tariff rate of unhealthy foods identified at the 10-digit HSK code level.

Figure B.4: Quantity and Unit Price of Chocolate Products



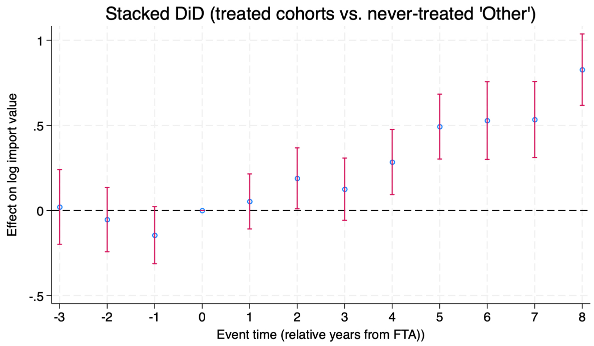
Notes: The left panel shows annual sales quantities (thousand kilograms), and the right panel plots unit prices (KRW) by year–quarter over 2010–2016. Imported products are shown in solid blue and domestic products in dotted red. Seasonal price dips reflect promotional discounts around Valentine's Day and White Day.

Figure B.5: Event Study Plot of Unhealthy Food Products–Narrow version

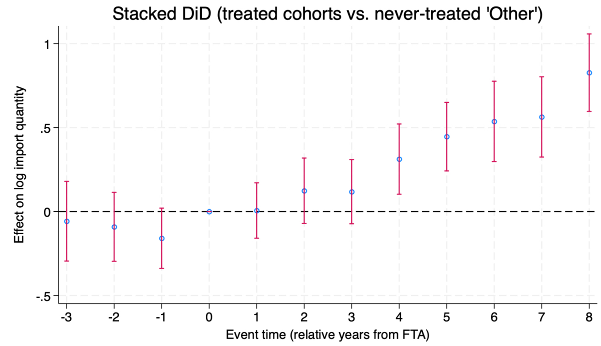


Notes: The dependent variable in the left (right) panel is log import value (log import quantity), respectively. The sample comprises HS 6-digit level trade values of narrow unhealthy foods aggregated to yearly level from 2009 to 2020. The list of narrow unhealthy foods is provided in Appendix Table A.2. Standard errors are clustered at the 4-digit HS code and country levels. Error bars show 95% confidence intervals.

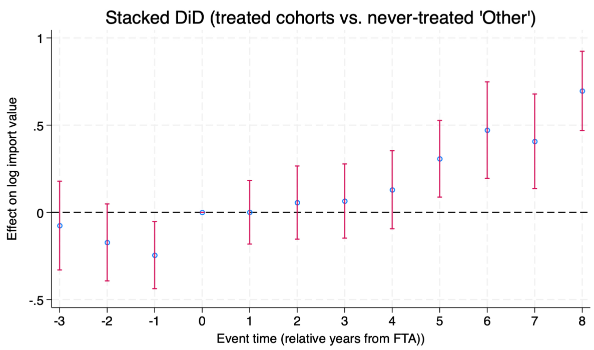
Figure B.6: Event Study Plots of Unhealthy Food Products (More FTA Countries)



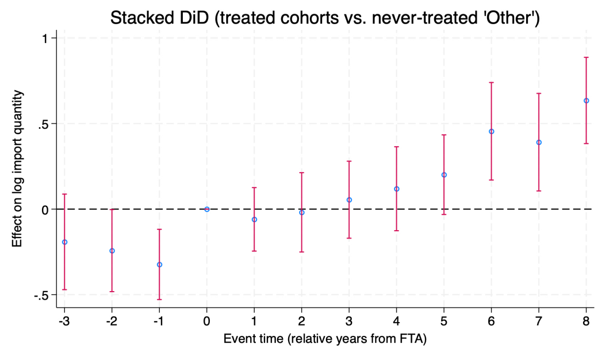
(a) Log value — Wide



(b) Log quantity — Wide



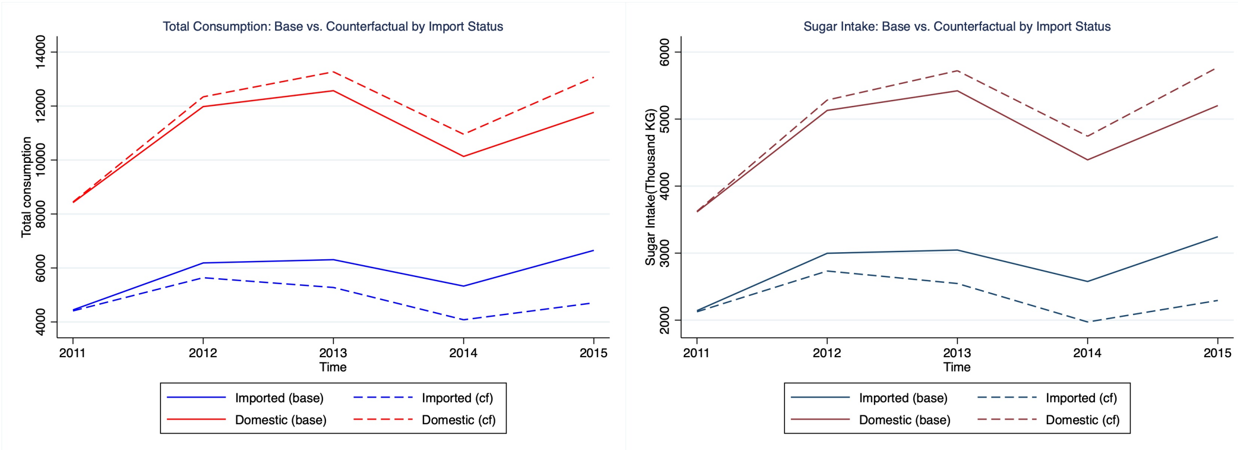
(c) Log value — Narrow



(d) Log quantity — Narrow

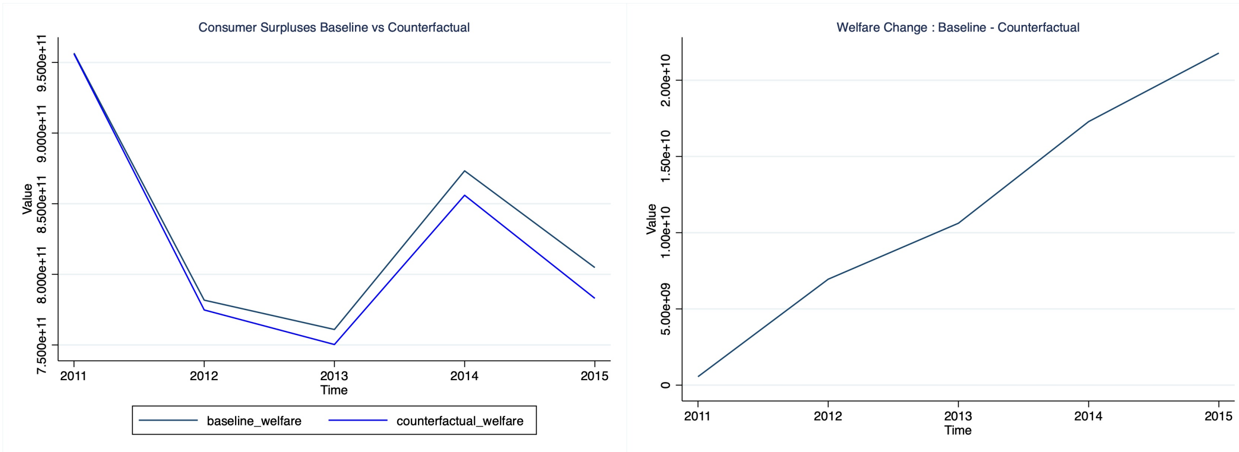
Notes: The dependent variable in the left (right) panel is log import value (log import quantity). The wide and narrow definition of unhealthy products follow Appendix Tables A.1 and A.2. The sample uses HS 6-digit "unhealthy" products from UN Comtrade, aggregated to the yearly level, 2009–2020. Cohort (FTA) years are listed in Appendix Table A.5; "Other" denotes the never-treated control group. Standard errors are clustered at the 4-digit HS code and country levels; error bars show 95% confidence intervals.

Figure B.7: Total Consumption in Chocolate and Sugar Intake by Import Status



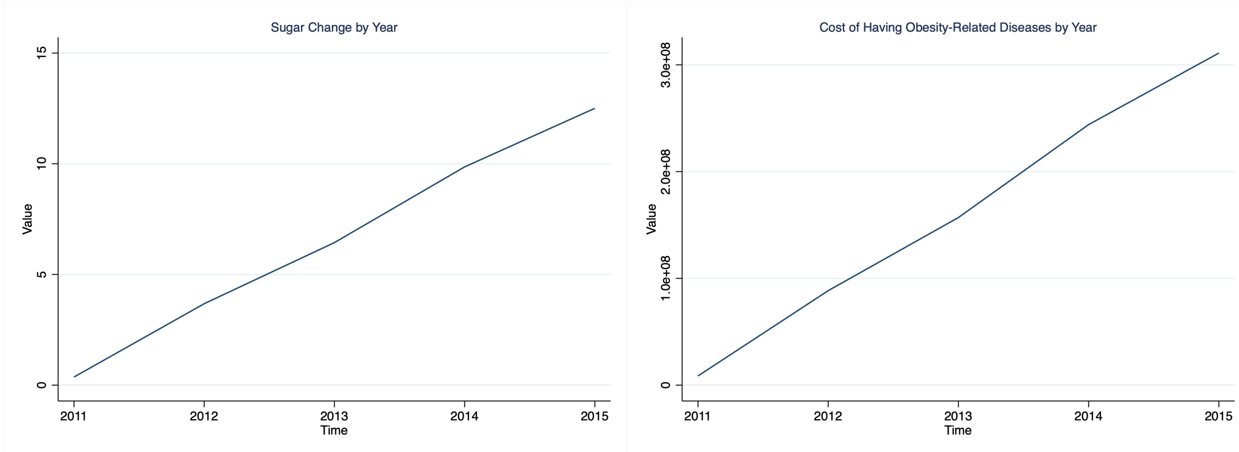
Notes: The left panel reports baseline and counterfactual chocolate consumption by import status, while the right panel presents the corresponding sugar intake. Solid lines indicate baseline values and dotted lines counterfactuals. Only Q4 is included for 2010 and only Q1 for 2016.

Figure B.8: Total Welfare Change



Notes: The left panel reports baseline and counterfactual consumer surpluses using the equation (22) and the right panel illustrates the welfare difference between the baseline and counterfactual case. 2010 and 2016 are omitted as only Q4 and Q1 are included in those years.

Figure B.9: Welfare Changes from Increased Risk of Four Obesity-Related Diseases



Notes: The left panel reports annual change in sugar intake in grams per capita. The right panel reports the increased risk of having four obesity-related diseases calculated from the increased sugar intake and other sources with equation (23). 2010 and 2016 are omitted as only Q4 and Q1 are included in those years.