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Impacts of TTIP on Processed Food Trade under Monopolistic Competition and Firm Heterogeneity

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Abstract

Food processing firms vary in size, exhibit productivity differences, engage in monopolistic competition, and produce highly differentiated products. As the TTIP negotiation is gaining momentum and trade in processed food is becoming more important, it is worth analyzing the impact of this potential trade liberalization on the US and EU processed food markets. This study develops a three-region (United States, European Union, and ROW) monopolistic competition trade model with heterogeneous firms to analyze the effects of US-EU bilateral tariff elimination and non-tariff barrier harmonization on prices, domestic production, consumption, bilateral trade, cutoff productivity levels, and aggregate productivity in the processed food sector. The empirical results show that this trade liberalization expands cross hauling, with US exports to the European Union increasing by 113.58% and EU exports to the United States rising by 96.19%. This increased cross hauling displaces exports from ROW to the United States and European Union by 47.26% and 16.10%, respectively. US and EU processed food production increases by 4.89% and 3.91%, respectively. Consequently, aggregate utility expands in all three regions.

Keywords: Cross hauling, Heterogeneous firms, Imperfect competition, Non-tariff barriers, Processed food trade, Tariffs, TTIP

JEL: F12, F13, F15

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26 **Impacts of TTIP on Processed Food Trade under Monopolistic Competition** 27 **and Firm Heterogeneity**

28 Processed food exports have experienced substantial growth from \$37 billion in
29 1998 to \$104 billion in 2012, an increase of 178% (BEA, 2015). Furthermore, food process-
30 ing firms engage in monopolistic competition, produce highly differentiated food products,
31 and differ in size, which are unique characteristics of this industry and important deter-
32 minants of whether firms operate only domestically or also export (Francois et al., 2013).
33 The United States is actively negotiating the Transatlantic Trade and Investment Part-
34 nership (TTIP) with the European Union. This comprehensive trade agreement will call
35 for the phasing out of trade restrictions and harmonization of NTBs, which will enhance
36 market access to value-added food products in both countries.

37 The European Union-28 and the United States are key players in the world pro-
38 cessed food market, accounting for almost a third of global trade in this market. In 2013,
39 the European Union was the world's largest processed food exporter with \$97 billion
40 worth of exports, which was almost twice the value of US exports of \$51 billion, but EU
41 imports of \$67 billions were only slightly more than US imports of \$61 billions (UNCom-
42 trade, 2015). The United States and European Union are also the largest bilateral trade
43 partners in value-added food products (FAS/USDA, 2014; Olper et al., 2014) because of
44 similar tastes and preferences of their consumers and traditional trade links. In 2013, EU
45 exports to the United States were valued at \$16.5 billion, while imports from the United
46 States were worth only \$5.1 billion. The lower EU imports from the United States are due
47 to processed food trade restrictions, particularly tariffs; the EU trade weighted import
48 tariff is 14.6% and, in contrast, the US trade weighted import tariff is 3.3% (Francois
49 et al., 2013). In particular, US dairy, tobacco, and sugar products face high EU tariffs.

50 Both the European Union and the United States protect their processed food
51 sector more than any other manufacturing sector through significant non-tariff barriers
52 (NTBs) because of Sanitary and Phytosanitary measures and disparate regulations (Arita
53 et al., 2014). In fact, NTBs¹ have become more prominent and are considerably more
54 egregious than tariffs (USTR, 2013). Consequently, NTBs severely hamper processed

55 food trade between the two countries. Berden et al. (2009) estimate, because of cross
56 border NTB trade restrictions, the European Union imposes a 56.8% additional cost to
57 US processed food exports, and the United States levies a 73.3% additional cost to EU
58 exports. As a result, bilateral food exports in these growing markets are heavily restricted
59 by NTBs. For instance, Berden et al. (2013) report that if both the United States and the
60 European Union could agree to eliminate the *actionable* regulatory measures (i.e., rules,
61 policies, and regulations that impose artificial burdens on trade but could be removed
62 if the United States and European Union reach an agreement) which account for about
63 half of the total NTB costs, then EU and US NTBs will be reduced to 27% and 35%,
64 respectively.

65 Food processing firms differ considerable in size. For instance, Berden et al. (2009)
66 observe large food processing firms constitute only 1% of the total number of companies
67 but account for about 52% of total sales, whereas small and medium sized enterprises
68 comprise of 99% of the total number of companies, but their sales amount to only about
69 48%. These size differences and product differentiation are root causes for firms in this
70 industry to operate under imperfect competition.

71 A series of Economic Research Service papers highlight the importance of the US
72 processed food industry by studying US trade patterns and cross-hauling (Neff et al.,
73 1996), the complementarity and substitutability of foreign direct investment versus trade
74 (Malanoski et al., 1996), technological advancements in communication and transporta-
75 tion (MacDonald, 1996), interrelationships between trade and domestic policies in global
76 food marketing (Neff, 1996; Neff and Malanoski, 1996), environmental quality and impli-
77 cations for food production and trade (Gray et al., 1996), and intellectual property rights
78 of food product firms in the global market (Henderson, 1996). Though these studies cov-
79 ered various aspects of the processed food industry, they did not quantify the impacts of
80 any trade liberalization on processed food market and also did not focus on the differences
81 in firm sizes which are important characteristics of this industry.

82 More recently, based on the firm heterogeneity and monopolistic competition
83 framework of Melitz (2003), studies develop econometric frameworks to test if trade lib-

84 eralization and import penetration impact total factor productivity. Ruan and Gopinath
85 (2008) find that global trade liberalization increases average productivity in the food
86 processing sector and benefits countries with higher productivity growth. Vancauterem
87 and de Frahan (2011) conclude that harmonization of the Dutch and EU food processing
88 industry augments total factor productivity of firms due to competitive pressure. Kugler
89 and Verhoogen (2012) extend Melitz's (2003) model to incorporate input choice and its
90 impact on the quality of food output and show that larger plants not only charge more
91 for outputs but also pay a premium on production inputs. Olper et al. (2014) conclude
92 that an increase in import penetration positively influences productivity growth for nine
93 food industries in 25 European countries. Thus, these studies stress the prevalence of firm
94 heterogeneity in the processed food industry.

95 Several studies model the food processing industry in a general equilibrium frame-
96 work. Rae and Josling (2003) and Burfisher et al. (2014) analyze the effects of trade
97 liberalization using the GTAP (Global Trade Analysis Project) model. While Rae and
98 Josling (2003) study the effects of trade liberalization on developing countries' food sec-
99 tor, Burfisher et al. (2014) examine the impacts of the Trans-Pacific Partnership (TPP)
100 on several agricultural sectors under perfect competition. Beckman et al. (2015) employ
101 the GTAP model to evaluate US and EU trade liberalization under TTIP, with a par-
102 ticular focus on tariff-rate quotas in several agricultural sectors. Their results reveal a
103 substantial increases in US-EU trade from the removal of tariffs, an increase in the tariff-
104 rate quotas, and harmonization of the NTBs. Disdier et al. (2015) use the MIRAGE
105 (Modeling International Relationships in Applied General Equilibrium) CGE model and
106 show that tariff reduction and NTB harmonization from the TTIP and TPP agreements
107 would potentially provide the largest benefits to the US agri-food sectors, only modest
108 benefits to their trading partners, and some sectors may lose. The above studies do not
109 capture important features of the processed food industry such as imperfect competition
110 and heterogeneity of firms. Tseng and Sheldon (2015) develop a theoretical framework to
111 include the quality of intermediate inputs in a heterogeneous-firms model and conclude

112 that larger and exporting firms produce higher quality goods and charge higher prices.
 113 However, their analysis does not examine the effects of TTIP trade agreements.

114 We contribute to the literature on trade agreements by analyzing the impacts of
 115 tariff reduction and NTB harmonization on US and EU food trade by capturing imperfect
 116 competition and productivity differences among firms in the food processing sector. In
 117 doing so, our study captures the cross hauling observed in processed food trade. The spe-
 118 cific objectives of this study are to develop a multi-regional trade model with monopolistic
 119 competition, heterogeneous firms, and endogenous entry and exit; calibrate the model to
 120 the US and EU processed food sectors; and simulate the effects of tariff removal and NTB
 121 harmonization under TTIP on prices, consumption, production, and productivity.

122 **Model**

123 To accurately capture real-world phenomena observed in processed food production, con-
 124 sumption, and trade, we formulate a three-region model (United States, European Union,
 125 and rest of the world (ROW)) based on Krugman’s (1980) monopolistic competition and
 126 Melitz’s (2003) firm-heterogeneity studies.² In addition, our model accounts for differ-
 127 ences in preferences across countries, firm-level production technologies, regional sizes,
 128 and trade policies by incorporating NTBs in addition to tariffs. A representative con-
 129 sumer optimizes utility over a continuum of domestic and imported processed food items.
 130 Heterogeneous firms that produce processed food engage in monopolistic competition and
 131 make endogenous entry, operating, and exit decisions for both the domestic and export
 132 markets. All three regions impose bilateral tariff and non-tariff barriers on imports of
 133 processed food.

134 *Consumers’ Problem*

135 A representative consumer in region i derives utility C_i from consumption of domestic
 136 and imported processed foods. We consider a constant elasticity of substitution (CES)
 137 utility function postulated by Dixit and Stiglitz (1977). The consumer maximizes

$$C_i = \max_{c_{ii}, c_{ji}, c_{ki}} \left(\sum_m n_m \int_{\bar{z}_m} c_{mi}(z)^{\rho_i} dG_m(z) \right)^{\frac{1}{\rho_i}} \quad (1)$$

138 subject to the budget constraint

$$\sum_m n_m \int_{\bar{z}_{mi}} p_{mi}(z) c_{mi}(z) dG_m(z) \leq I_i, \quad (2)$$

139 where n_m is the measure of firms in region m ($= i, j$, and k which are alias indexing
140 US, EU, ROW), \bar{z}_{mi} is the cutoff productivity of the marginal firm that produces in m
141 and sells in i and earns zero profits, $c_{mi}(z)$ is processed food produced by a firm with
142 productivity z in region m and consumed in region i , $\rho_i \in (0, 1)$ is the CES parameter with
143 elasticity of substitution $\sigma_i = \frac{1}{1-\rho_i} > 1$, $p_{mi}(z)$ is the price of $c_{mi}(z)$, $G_m(z)$ represents
144 the cumulative distribution function of the productivity random variable z , and I_i is
145 income spent on processed food.

146 We solve the first-order conditions of the above utility maximization problem to
147 obtain demand functions for $c_{mi}(z)$:

$$c_{mi}(z) = \frac{I_i}{P_i} \left(\frac{p_{mi}(z)}{P_i} \right)^{-\sigma_i}, \quad (3)$$

148 where P_i is the aggregate price index

$$P_i = \left(\sum_m n_m \int_{\bar{z}_{mi}} (p_{mi}(z))^{\frac{-\rho_i}{1-\rho_i}} dG_m(z) \right)^{-\frac{1-\rho_i}{\rho_i}} \quad (4)$$

149 derived using the relationship $P_i = \frac{I_i}{C_i}$.

150 *Firm's Problem*

151 Consider a continuum of firms each producing a different variety indexed by the produc-
152 tivity parameter z , which has a one-to-one correspondence with varieties consumed; this
153 relationship explicitly captures the market clearing conditions defined below in equation
154 (10). The profit function for a firm producing in i selling in m with productivity z is

$$\pi_{im}(z) = p_{im}(z) y_{im}(z) - w_i l_{im}(z) - w_i f_{im}, \quad (5)$$

155 where $y_{im}(z)$ is firm-level output, $l_{im}(z)$ is a composite input comprised of intermediate
156 inputs, labor, and capital, and f_{im} is the fixed cost. The production technology is

$$y_{im}(z) = \frac{z l_{im}(z)}{\tau_{im}}, \quad (6)$$

157 where $\tau_{im} = 1 + t_{im} + \phi_{im} + \eta_{im}$ is the per-unit trade cost consisting of transport costs
158 (t_{im}), tariffs (ϕ_{im}), and ad valorem equivalent of NTBs (η_{im}).

159 Invert the demand function (3) to express price as a function of quantity, substitute
 160 for $p_{im}(z)$ in the profit function (5), and maximize profits to obtain the pricing rule

$$p_{im}(z) = \frac{w_i \tau_{im}}{z \rho_m}, \quad (7)$$

161 which differs from the competitive pricing rule as evident from the markup $\frac{1}{\rho_m}$ due to
 162 product differentiation.

163 Next we discuss the entry and operating decisions of a firm. A food processing
 164 firm decides to enter if expected profit equals the fixed cost of entry $w_i f_{ei}$:

$$\sum_m \int_{\bar{z}_{im}} \pi_{im}(z) dG_i(z) = w_i f_{ei}. \quad (8)$$

165 We characterize the productivity differences using the Pareto distribution ($G_i(z) = (1 - \frac{\mu_i}{z})^{\alpha_i}$),
 166 where the location parameter μ_i is such that $0 < \mu_i \leq z$ and the shape parameter satisfies
 167 $\alpha_i > 1$. The Pareto distribution is commonly used in the firm heterogeneity literature
 168 because it lends itself for analytical solutions, and, more importantly, is consistent with
 169 size distribution of firm-level data where only a small proportion of firms are large and
 170 highly productive (Melitz and Ottaviano, 2008).

171 Once a firm enters, whether or not it stays in business depends on its profitability,
 172 i.e., a firm operates if it earns nonnegative profits and otherwise it exits. The minimum
 173 (cutoff) productivity level \bar{z}_{im} , at which a firm is willing to operate, satisfies

$$\pi_{im}(\bar{z}_{im}) = 0. \quad (9)$$

174 This equation implies that the marginal food manufacturing firm earns zero profits, while
 175 firms with productivity greater than \bar{z} earn positive profits.

176 *Market Clearing*

177 The market clearing condition for each food item is

$$c_{im}(z) = y_{im}(z), \quad (10)$$

178 where consumption of each variety is equal to its production. Market clearing for the
 179 composite input in each region is

$$\gamma_i w_i^{\varepsilon_i} = n_i f_{ei} + n_i \sum_m \int_{\bar{z}_{im}} f_{im} dG_i(z) + n_i \sum_m \int_{\bar{z}_{im}} l_{im}(z) dG_i(z), \quad (11)$$

180 where the term on the left-hand side is the input supply function with γ_i and ε_i repre-
 181 senting scale and elasticity of supply parameters, the first term on the right-hand side
 182 is composite input used for the fixed entry fee, the second term is composite input used
 183 for fixed operating costs, and the third term is composite input used for variable cost in
 184 production.

185 *Aggregation and Productivity*

186 We define aggregate variables for real income, production, input use, and productivity.
 187 Real income is the utility in equation (1):

$$C_i = \left(\sum_m n_m \int_{\bar{z}_{mi}} c_{mi}(z)^{\rho_i} dG_m(z) \right)^{\frac{1}{\rho_i}}.$$

188 Total domestic production of all firms in region i and exports from region i to regions j
 189 and k are

$$Y_{im} = n_i \int_{\bar{z}_{im}} y_{im}(z) dG_i(z).$$

190 Total production in region i , including exports to regions j and k , is

$$Y_i = \sum_m Y_{im}.$$

191 Average composite input used in the production of processed food for domestic
 192 sales in region i and exports from region i to regions j and k are

$$L_{im} = \int_{\bar{z}_{im}} l_{im}(z) dG_i(z).$$

193 With the measures of firms that choose to operate in region i and export to regions j and
 194 k given by

$$\bar{n}_{im} = n_i(1 - G_i(\bar{z}_{im})), \tag{12}$$

195 total domestic sales in region i and exports from region i to regions j and k can be
 196 expressed as

$$Y_{im} = \frac{Z_{im} L_{im} \bar{n}_{im}}{\tau_{im}}, \tag{13}$$

197 where

$$Z_{im} = \frac{\int_{\bar{z}_{im}}^{\infty} z_{im} dG_i(z)}{1 - G_i(\bar{z}_{im})} \tag{14}$$

198 is a weighted average of operating firms' productivities. The aggregate productivity (Z_i)
 199 in country i is the weighted average of Z_{im} :

$$Z_i = \frac{\sum_m Z_{im} \bar{n}_{im}}{\sum_m \bar{n}_{im}}. \quad (15)$$

200 *System of Equations*

201 Equations (3)-(11) define a system of 63 equations in 63 variables $c_{im}(z)$, P_i , $\pi_{im}(z)$,
 202 $y_{im}(z)$, $p_{im}(z)$, n_i , \bar{z}_{im} , $l_{im}(z)$, and w_i .³ To avoid multiple corner solutions in the empirical
 203 analysis of the above asymmetric three-region model, we abstract from entry and exit
 204 decisions of firms.⁴ This implies that the fixed entry fee f_e is zero, equation (8) is dropped
 205 from the model, and the measure of total entrants n_i is exogenous. The zero-profit (9)
 206 and labor clearing (11) conditions can be simplified using the demand function (3), profit
 207 equation (5), production technology (6), pricing rule (7), and output market clearing
 208 condition (10):

$$\pi_{im}(\bar{z}_{im}) = \frac{1}{\sigma_m - 1} \frac{I_m}{\rho_m^{-\sigma_m}} \left(\frac{w_i \tau_{im}}{\bar{z}_{im} P_m} \right)^{1-\sigma_m} - w_i f_{im} = 0 \quad (16)$$

$$\gamma_i w_i^{\varepsilon_i} = n_i \left(\sum_m \int_{\bar{z}_{im}} f_{im} dG_i(z) \right) + n_i \left(\sum_m \int_{\bar{z}_{im}} I_m \left(\frac{w_i}{\rho_m} \right)^{-\sigma_m} \left(\frac{\tau_{im}}{z P_m} \right)^{1-\sigma_m} dG_i(z) \right). \quad (17)$$

210 Similarly, substituting the pricing rule (7) into the price index equation (4) yields

$$P_i = \left(\sum_m n_m \int_{\bar{z}_{mi}} \left(\frac{w_m \tau_{mi}}{z \rho_i} \right)^{\frac{-\rho_i}{1-\rho_i}} dG_m(z) \right)^{-\frac{1-\rho_i}{\rho_i}}. \quad (18)$$

211 Equations (16)-(18) represent a reduced system of 15 equations which can be
 212 solved for the 15 endogenous variables \bar{z}_{im} , w_i , and P_i .

213 **Quantitative Analysis**

214 This section contains a description of data, sources, and calibration; simulation of baseline
 215 and alternate scenarios; and results and discussion.

216 *Data and Calibration*

217 We use aggregate processed food (code numbers 19-26 corresponding to sectors CMT,
 218 OMT, VOL, MIL, PCR, SGR, OFD, and B_T)⁵ data for 2011 from the GTAP 9 Data
 219 Base. We collect data for the value of domestic production, inputs, imports, and exports,

220 and transport costs and tariffs. Because the GTAP database contains only value data, we
221 calculate quantity data by dividing values by the unit price. The unit price is computed
222 by dividing the value of US imports by the quantity of imports from the European Union,
223 which comes from FAS (2015). The purchasing power parity index collected from OECD
224 (2015) is used to convert the US unit price into the EU and ROW unit price. We obtain
225 bilateral NTB data from Berden et al. (2009) and Dean et al. (2009).

226 We normalize the measure of firms to one in all three regions. To account for the
227 differences in preference across regions, we consider different values of the elasticity of
228 substitution (σ_i). Since the literature does not have specific estimates of the elasticity of
229 substitution for processed foods, we consider σ_i of 2.3 for the United States, 2.2 for the
230 European Union, and 1.4 for ROW. We use a parameter value of 0.5 for the elasticity
231 of supply (ε_i) for the composite input. The food processing industry is characterized by
232 a small number of firms with high productivity and a large number of firms with low
233 productivity levels. The Pareto distribution depicts this feature of the food processing
234 industry with shape and scale parameters. We consider a shape parameter of 3 for the
235 United States, 3.6 for the European Union, and 6 for ROW. We calibrate the scale
236 parameters using the processed food data. Because of the similar tastes and preferences
237 between the United States and European Union and considerable history of bilateral
238 trade between the two regions, a significant percentage of firms engage in exports. We
239 assume that in the United States and European Union, 90% of firms operate domestically
240 and 20% of these firms also export.⁶ However, because of limited trade between ROW
241 vis-a-vis the United States and ROW vis-a-vis the European Union in processed food,
242 we consider 90% of the ROW firms operate domestically, but only 10% of these firms
243 engage in exports. We calibrate the remaining parameters—fixed operating and export
244 costs f_{im} , scale parameter for the Pareto distribution μ_i , and the scale parameter for the
245 supply functions γ_i —to match domestic sales and exports y_{im} , composite input L_i , and
246 expenditure on processed food I_i data.

247 *Simulation Analysis*

248 This section presents the simulation analysis of the baseline and three alternate scenarios.
249 Based on the above calibration, the baseline simulation replicates the GTAP 9 data. To
250 simulate the effect of a potential TTIP agreement, the first alternate scenario eliminates
251 bilateral US-EU tariffs and reduces the bilateral US-EU NTBs by 50%. We consider com-
252 plete elimination of tariffs because tariffs are easier to negotiate and phase out compared
253 to NTBs. In contrast, we consider only a 50% cut in NTBs because of complex regulations
254 and restrictions that cannot be readily harmonized, and elimination of some NTBs are
255 not possible due to sanitary and phytosanitary reasons. Consequently, total elimination
256 of NTBs is not realistic, which is also confirmed by Berden et al. (2009) who estimate
257 that bilateral US-EU NTBs in the processed food sector could potentially be reduced by
258 no more than about 50%.

259 We also quantify the effects of tariff elimination and NTB reduction separately.
260 The second alternate scenario examines complete removal of bilateral US-EU tariffs while
261 leaving NTBs unchanged. The third alternate scenario analyzes a 50% reduction in bilat-
262 eral US-EU NTBs while keeping tariffs unaltered. A comparison of these three alternate
263 scenarios to the baseline quantifies the impacts of the trade liberalization on the aggre-
264 gate price index, domestic production, bilateral trade, aggregate consumption, measure of
265 operating firms, cutoff productivity levels, and aggregate productivity in all three regions.
266 Table 1 reports the simulation results for all three alternate scenarios.

267 *Reduction of Bilateral US-EU Tariffs and NTBs*

268 In this scenario, we examine the impacts of the removal of the US-EU bilateral tariffs
269 and a 50% cut in US-EU bilateral NTBs on the processed food market, while maintaining
270 the current US-ROW and EU-ROW bilateral tariffs and NTBs. This trade liberalization
271 reduces the cost of exporting and expands US-EU bilateral trade. EU tariffs (NTBs) of
272 14.2% (56.8%) on imports from the United States are higher (smaller) than US (NTBs)
273 tariffs of 3.3% (73.3%) on imports from the European Union. Reduction of these bilateral
274 tariffs and NTBs augments cross hauling, leading to an increase in US exports to the Eu-
275 ropean Union of 113.58%, while EU exports to the United States expand by only 96.19%.

276 Expansion in US-EU bilateral trade displaces exports from the ROW to the United States
277 by 47.26% and to the European Union by 16.10%; thus, trade is diverted from ROW to
278 the United States and the European Union.⁷ However, a rise in US imports creates ad-
279 ditional competition for US firms selling only domestically, reducing their domestic sales
280 by 14.66%. Similarly, higher EU imports bring more competition for the EU firms selling
281 domestically, curtailing their domestic sales by 9.53%. The higher US-EU trade offsets
282 the decline in domestic production/sales and imports from ROW, leading to higher con-
283 sumption and an increase in utility (real income) in the United States of 5.38% and in
284 the European Union of 2.04%. The elimination of tariffs and a reduction in NTBs lower
285 the aggregate price index in the United States by 7.54% and in the European Union by
286 4.21%.

287 Because US-EU trade liberalization displaces ROW exports to these regions, sales
288 within ROW expand by 1.31%. As a result of the bilateral US-EU trade liberalization,
289 both US and EU export firms find it more profitable to sell in each other's market, and
290 consequently, divert their exports from ROW. Thus, US and EU exports to ROW decline
291 by 2.80% and 1.69%, respectively. Higher domestic sales, despite the decline in US and
292 EU exports to ROW, cause total ROW consumption and thus utility (real income) to
293 rise by 2.00%, leading to a fall in the aggregate price index by 1.23%.

294 The higher US exports to the European Union (113.58%) offset the decline in
295 production for domestic sales (-14.66%) and exports to the ROW (-2.80), leading to an
296 increase in total US production by 4.89%. Similarly, the increase in EU exports to the
297 United States (96.19%) exceeds the decline in EU production for domestic sales (-9.53%)
298 and exports to ROW (-1.69%), resulting in a rise in total EU production of 3.91%.⁸
299 However, the decline in ROW exports to the United States (47.26%) and European Union
300 (16.10%) outweighs the increase in production for domestic sales (1.31%), leading to a
301 decline in total ROW production of 1.82%.

302 Next, we discuss the impacts of tariff elimination and NTB reduction on the cutoff
303 productivities and measures of operating firms. Trade liberalization reduces protection
304 to domestic firms from foreign competition. As a result, domestic firms must compete

305 with highly efficient foreign firms (as evident from the rise in US (EU) imports from
306 the European Union (United States) by 96.19% (113.58%)), which causes less efficient
307 firms to reduce their sales and become unprofitable. Because of this fierce competition,
308 the minimum productivity needed for US and EU domestic firms to survive increases by
309 8.25% and 4.09%, respectively. As profits decline and only the more efficient firms remain
310 in business, the measure of firms that produce for the US and EU domestic markets
311 declines by 21.17% and 13.08%, respectively.

312 Trade liberalization reduces variable cost of exports, and consequently less efficient
313 firms find it profitable to operate in the export market, which lowers the cutoff productiv-
314 ity for US firms exporting to the European Union by 21.20% and for EU firms exporting
315 to the United States by 15.71%. As a result, more US firms export to the European Union
316 (24.34%) and more EU firms export to the United States (81.91%).

317 Because both US and EU exporting firms gain by diverting exports from ROW,
318 profitability in this market to declines, leading to an increase in the cutoff productivity
319 of 1.43% and 0.68%, respectively. Consequently, less efficient US and EU exporting firms
320 no long operate in the ROW market and the measure falls by 4.17% and 2.35%. Because
321 of US-EU bilateral trade liberalization, ROW exporting firms face intense competition
322 in the United States and European Union, their exports decline, and these firms become
323 unprofitable. As a result, the minimum productivity needed for ROW firms exporting
324 to the United States and European Union rises by 7.33% and 3.57%. Consequently, the
325 measure of ROW firms exporting to the United States and the European Union falls by
326 34.60% and 19.00%. The lower US and EU exports to ROW are replaced by ROW firms'
327 domestic sales, which increase domestic production and these firms become more prof-
328 itable. Higher profits enable less efficient firms to survive, causing the cutoff productivity
329 to fall by 0.26% and the measure of operating firms to rise by 1.57%.

330 As trade liberalization brings greater efficiency, aggregate productivity computed
331 using equation (15) increases in the United States by 0.21%, European Union by 0.03%,
332 and ROW by 2.24%. The small increases in the aggregate productivities of US and EU
333 firms are due to a larger share of inefficient firms operating in the export markets. In

334 contrast, the relatively large increase in the aggregate productivity of ROW firms is due
335 to the large number of inefficient ROW exporting firms to the United States and European
336 Union exiting the industry.

337 *Elimination of Bilateral US-EU Tariffs*

338 In this subsection, we highlight key results from alternate scenario 2 which considers only
339 tariff elimination while leaving NTBs unchanged. Because tariffs account for a small por-
340 tion of total variable trade costs (τ_{im}) relative to NTBs, the impacts resulting from tariff
341 removal constitute a small portion of the total effects observed in scenario 1. Further-
342 more, EU tariff of 14.2% on imports from the United States is higher than the US tariff
343 of 3.3% on imports from the European Union. Consequently, elimination of these tariffs
344 expands cross hauling, with larger impacts for US firms exporting to the European Union
345 compared to EU firms exporting to the United States. For instance, US firms' exports to
346 the European Union increase by 24.63%, whereas EU firms' exports to the United States
347 rise by only 7.28%.⁹

348 Interestingly, since the reduction of the EU tariff is larger than that of the US tariff,
349 US firms divert their exports from ROW to the European Union because of enhanced
350 profitability from selling in the EU processed food market. However, due to the removal
351 of the small US tariff on EU food products and greater competition from US firms, EU
352 firms reallocate their domestic sales to ROW. Thus, while simultaneous tariff elimination
353 and NTB reduction result in EU firms exporting less to ROW in scenario 1, in isolation,
354 tariff elimination causes EU firms to augment exports to ROW. This leads to a reversal
355 in the sign of the cutoff productivity and measure of EU operating firms exporting to
356 ROW, compared to those in scenario 1. Also, in contrast to the results in scenario 1,
357 as US exports to the European Union expand, the fall in sales of EU firms operating in
358 the domestic market is not offset by the increase in EU exports to the United State and
359 ROW, and aggregate EU production declines by 0.34%.

360 *Reduction of Bilateral US-EU NTBs*

361 In this subsection, we discuss important results from alternate scenario 3 which examines
362 a 50% cut in bilateral US-EU NTBs while keeping tariffs unchanged. Because NTBs are

363 a large percentage of trade restrictions relative to tariffs, the impacts of a 50% NTB
364 reduction account for a large portion of the total effects observed in scenario 1. Contrary
365 to scenario 2, US NTBs of 73.3% on imports from the European Union are greater than
366 the EU NTBs of 56.8% on imports from the United States. As a result, a 50% reduction
367 in the US-EU bilateral NTBs increases cross hauling, with greater impacts for EU firms
368 exporting to the United States than for US firms exporting to the European Union.
369 For example, EU exports to the United States rise by 80.82%, while US exports to the
370 European Union increase by only 67.37%.

371 Since in this scenario the relative size of US-EU NTB reductions is opposite of
372 the relative size of US-EU tariffs reductions in scenario 2, the directions of US and EU
373 exports to ROW in this scenario are opposite to that of scenario 2, i.e., US firms increase
374 exports to ROW whereas EU firms reduce exports to ROW. As a result, EU firms redirect
375 their exports from ROW to the United States due to greater profitability in the US
376 market. However, because of the relatively smaller reduction of EU NTBs and enhanced
377 competition from EU firms, US firms divert domestic sales to ROW. Thus, compared to
378 trade liberalization of scenario 1, a 50% NTB reduction changes the sign of the direction
379 of US firms exports to ROW. This causes the cutoff productivity to fall and the measure
380 of operating firms to rise for US firms exporting to ROW compared to scenario 1. In
381 contrast to scenario 2, but similar to scenario 1, the fall in sales of EU firms operating
382 in the domestic market and exporting to ROW is offset by the increase in EU exports to
383 the United State and aggregate EU production increases by 4.30%.

384 **Conclusion and Discussion**

385 In this paper, we develop a three-region (United States, European Union, and ROW)
386 monopolistic competition trade model with heterogeneous firms to analyze the effects of
387 potential trade liberalization in the processed food sector under the TTIP trade agreement
388 on prices, domestic production, consumption, bilateral trade, cutoff productivity levels,
389 and aggregate productivity. The model is calibrated to data for the processed food market
390 and simulated to quantify the effects of three scenarios: a) a simultaneous US-EU bilateral
391 tariff removal and a 50% NTB reduction, b) tariff removal, and c) a 50% NTB reduction.

392 Because of trade liberalization, the aggregate price index of the food products
393 decreases and utility increases in all three regions. As the lowering of trade barriers brings
394 more competition, aggregate productivities of processed food firms in all three regions
395 rise, even though less efficient firms may enter in the export market because of the reduced
396 trade costs arising from the trade liberalization. While consumption and utility increase,
397 aggregate production does not necessarily rise as inefficient domestic firms are forced out
398 by more efficient foreign firms which increase their exports. Since the trade liberalization
399 is only between the United States and the European Union, bilateral trade flows between
400 these two countries expand.

401 Since combined tariff elimination and NTB reduction are larger by the United
402 States than by the European Union, US consumers gain more than EU consumers. As
403 this trade liberalization augments US and EU processed food production, both countries
404 expand their exports to ROW, which benefits the ROW consumers. The cutoff productiv-
405 ities decrease in the bilateral US-EU export markets because trade liberalization reduces
406 the trade cost, which attracts inefficient firms to enter in these markets. However, in
407 the US and EU domestic markets, cutoff productivities increase because of the intense
408 competition arising from trade liberalization.

409 In the tariff elimination scenario, because the tariff reduction by the European
410 Union is larger than that by the United States, this free trade benefits EU consumers
411 more than US consumers. Furthermore, US aggregate production increases while EU
412 aggregate production decreases. Consequently, US firms export more to the European
413 Union and, because of this intense competition, EU firms divert their sales from the
414 domestic market to ROW.

415 The NTB trade barriers in the processed food industry are very prominent, and
416 thus the NTB reduction is of considerable importance to this industry. In this scenario,
417 because US NTBs are larger than the EU NTBs, this trade liberalization brings greater
418 gain to US consumers than to EU consumers. Since US NTB trade liberalization is more
419 pronounced, EU firms expand their production and also divert their trade from ROW to
420 the United States.

421 Finally, the theoretical model and empirical analysis of the processed food trade
422 liberalization under TTIP are also applicable to other sectors, such as textiles, cloth-
423 ings, and electronics, which are characterized by heterogeneous firms with productivity
424 differences and imperfect competition.

425 **References**

- 426 Arita, S., J. Beckman, L. Kuberka, and A. Melton (2014). Sanitary and Phytosanitary
427 Measures and Tariff-Rate Quotas for U.S. Meat Exports to the European Union.
428 Ldpm-245-01, Economic Research Service.
- 429 BEA (2015). International economic accounts. U.S. Department of Commerce.
430 <http://www.bea.gov/international/>.
- 431 Beckman, J., S. Arita, and L. Mitchell (2015). The Transatlantic Trade and Investment
432 Partnership and agriculture: A quantitative analysis. Paper Presented at the AAEA
433 Annual Meeting, San Francisco, CA, Economic Research Service.
- 434 Berden, K. G., J. Francois, S. Tamminen, M. Thelle, and P. Wymenga (2013).
435 Non-Tariff Measures in EU-US Trade and Investment-An Economic Analysis.
436 Reference: OJ 2007/S 180-219493, ECORYS.
- 437 Berden, K. G., J. Francois, M. Thelle, P. Wymenga, and S. Tamminen (2009).
438 Non-Tariff Measures in EU-US Trade and Investment-An Economic Analysis.
439 Reference: OJ 2007/S 180-219493, ECORYS.
- 440 Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2007). Firms in
441 international trade. *Journal of Economic Perspectives* 21(3), 105–130.
- 442 Burfisher, M. E., J. Dyck, B. Meade, L. Mitchell, J. Wainio, S. Zahniser, S. Arita, and
443 J. Beckman (2014). Agriculture in the Trans-Pacific Partnership. Economic Research
444 Report Number 176, USDA Economic Research Service.
- 445 Chaney, T. (2008). Distorted gravity: the intensive and extensive margins of
446 international trade. *The American Economic Review* 98(4), 1707–1721.

447 Dean, J. M., J. E. Signoret, R. M. Feinberg, R. D. Ludema, and M. J. Ferrantino
448 (2009). Estimating the price effects of non-tariff barriers. *The B.E. Journal of*
449 *Economic Analysis & Policy* 9(1), 1 – 39.

450 Disdier, A. C., C. Emlinger, and J. Fouré (2015). Atlantic versus Pacific agreement in
451 agri-food sectors: Does the winner take it all? Working Papers 2015-10, CEPII.

452 Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic competition and optimum product
453 diversity. *The American Economic Review*, 297–308.

454 FAS (2015). Global Agricultural Trade System. Foreign Agricultural Service.
455 <http://apps.fas.usda.gov/gats/>.

456 FAS/USDA (2014). Agricultural Exports to the European Union: Opportunities and
457 Challenges. Foreign Agricultural Service. [http://www.fas.usda.gov/data/agricultural-](http://www.fas.usda.gov/data/agricultural-exports-european-union-opportunities-and-challenges)
458 [exports-european-union-opportunities-and-challenges](http://www.fas.usda.gov/data/agricultural-exports-european-union-opportunities-and-challenges).

459 Francois, J., M. Manchin, H. Norberg, O. Pindyuk, and P. Tomberger (2013). Reducing
460 transatlantic barriers to trade and investment-an economic analysis. Trade10/a2/a16,
461 Centre for Economic Policy Research, London.

462 Gray, D., B. Krissoff, and M. Tsigas (1996). Trade and Environmental Linkages for
463 Food and Agriculture. In D. R. Henderson, C. R. Handy, and S. A. Neff (Eds.),
464 *Globalization of the Processed Foods Market*. USDA, Economic Research Service.

465 GTAP (2015). GTAP 9 Data Base. Agricultural Economics, Purdue University.
466 <https://www.gtap.agecon.purdue.edu/databases/>.

467 Henderson, D. (1996). Intellectual Capital in the Global Food Sector. In D. R.
468 Henderson, C. R. Handy, and S. A. Neff (Eds.), *Globalization of the Processed Foods*
469 *Market*. USDA, Economic Research Service.

470 Josling, T. (2014). A transatlantic free trade deal: Implications for food and agricultural
471 policy. *Estey Journal of International Law and Trade Policy* 15(2), 187–198.

472 Krugman, P. R. (1980). Scale economies, product differentiation, and the pattern of
473 trade. *The American Economic Review* 70(5), 950–959.

474 Kugler, M. and E. Verhoogen (2012). Prices, plant size, and product quality. *The*
475 *Review of Economic Studies* 79(1), 307–339.

476 MacDonald, J. (1996). Transportation and Communications. In D. R. Henderson, C. R.
477 Handy, and S. A. Neff (Eds.), *Globalization of the Processed Foods Market*. USDA,
478 Economic Research Service.

479 Malanoski, M., C. Handy, N. Seigle, and D. Henderson (1996). International Strategies
480 in the Global Market. In D. R. Henderson, C. R. Handy, and S. A. Neff (Eds.),
481 *Globalization of the Processed Foods Market*. USDA, Economic Research Service.

482 Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate
483 industry productivity. *Econometrica* 71(6), 1695–1725.

484 Melitz, M. J. and G. I. Ottaviano (2008). Market size, trade, and productivity. *The*
485 *Review of Economic Studies* 75(1), 295–316.

486 Neff, S. (1996). Regional and Multilateral Trade Agreements. In D. R. Henderson,
487 C. R. Handy, and S. A. Neff (Eds.), *Globalization of the Processed Foods Market*.
488 USDA, Economic Research Service.

489 Neff, S., M. Harris, M. Malanoski, and F. Ruppei (1996). U.S. Trade in Processed
490 Foods. In D. R. Henderson, C. R. Handy, and S. A. Neff (Eds.), *Globalization of the*
491 *Processed Foods Market*. USDA, Economic Research Service.

492 Neff, S. and M. Malanoski (1996). Food Industry Standards and Regulations. In D. R.
493 Henderson, C. R. Handy, and S. A. Neff (Eds.), *Globalization of the Processed Foods*
494 *Market*. USDA, Economic Research Service.

495 OECD (2015). 2011 PPP Benchmark results. Organisation for Economic Co-Operation
496 and Development. <http://stats.oecd.org/Index.aspx?DataSetCode=PPP2011>.

497 Olper, A., D. Curzi, and L. Pacca (2014). Trade, import competition and productivity
498 growth in the food industry. *Food Policy* 49(1), 71 – 83.

499 Rae, A. and T. Josling (2003). Processed food trade and developing countries:
500 protection and trade liberalization. *Food Policy* 28, 147–166.

501 Ruan, J. and M. Gopinath (2008). Global productivity distribution and trade
502 liberalisation: evidence from processed food industries. *European Review of*
503 *Agricultural Economics* 35(4), 439–460.

504 Tseng, E. and I. Sheldon (2015). Food processing firms, input quality upgrading and
505 trade. Paper presented, 2015 Allied Social Sciences Association (ASSA) Annual
506 Meeting, January 3-5, 2015, Boston, Massachusetts.

507 UNComtrade (2015). UN Comtrade Database. International Trade Center.
508 <http://comtrade.un.org/>.

509 USTR (2013). 2013 Report on Technical Barriers to Trade. Fourth annual report, Office
510 of the United States Trade Representative.

511 Vancauteran, M. and B. H. de Frahan (2011). Trade Policy, Competition and
512 Productivity: The Impact of EU Harmonization in the Dutch Food Processing
513 Industry. *De Economist* 159, 483–509.

514 Notes

516 ¹NTBs in processed food trade include Sanitary and Phytosanitary measures, genetically modified
515 organism and food labeling requirements, certification, traceability, classifications, security related mea-
517 sures, geographical indications, and differences in trademark legislation (also see Josling (2014)).

519 ²Also see Melitz and Ottaviano (2008) for a trade model with firm heterogeneity and nonconstant
520 markups.

521 ³Note that any equation that has a left-hand side variable with subscripts im contains 9 equations,
522 and any equation that has a left-hand side variable with a subscript i contains 3 equations. Similarly, any
523 variable with subscripts im contains 9 variables, and a variable with a subscript i contains 3 variables.

524 ⁴The multiple corner solutions problems is also pointed out by Chaney (2008).

525 ⁵The description of processed food items corresponding to the code numbers and sectors is as follows.
526 19 CMT: meat from cattle, sheep, goats, and swine; 20 OMT: fresh and chilled fowl and turkey meat

527 and products; 21 VOL: Vegetable oils and fats; 22 MIL: Dairy products; 23 PCR: Processed rice; 24
528 SGR: Sugar; 25 OFD: Other food products such as flour, cocoa, processed fruit and vegetables, sea food
529 products; 26 B_T: Beverages and tobacco products.

530 ⁶Bernard et al. (2007) show that, in the United States, on average 18% of manufacturing firms export,
531 while 12% and 23% of food manufacturing (NAICS Code 311) and beverage and tobacco product (NAICS
532 Code 312) firms export, respectively.

533 ⁷Disdier et al. (2015) show full tariff liberalization and a 25% reduction in NTBs for agri-food products
534 (all products covered by the WTO Agreement on Agriculture plus fish and fish products) increase the
535 value of US exports to the European Union by 34.9% and the value of EU exports to the United States
536 by 11.6%. Beckman et al. (2015) find tariff removal for processed foods causes the value of US exports to
537 the European Union to expand by 38.85% and EU export to the United States to rise by 1.40%. Their
538 results also show the value of US exports (imports) to (from) ROW decreases by 0.90% (0.06%) and EU
539 exports (imports) to (from) ROW rise (fall) by 0.10% (4.07%). Since these two studies have different
540 magnitude of trade liberalization and report their impacts for *value* of exports and imports, their results
541 cannot be directly compared to our results.

542 ⁸Beckman et al. (2015) find that tariff and NTB removal causes US and EU processed food production
543 to increase by 0.36% and 0.10%, respectively. Since our study incorporates imperfect competition, firm
544 size and productivity differences, our production impacts are more pronounced than what is found in
545 Beckman et al. (2015).

546 ⁹Beckman et al. (2015) find tariff removal for processed foods leads to the value of US exports to the
547 European Union to increase by 39.08% and EU export to the United States increase by 1.24. While the
548 value of US exports (imports) to (from) ROW decreases by 0.72% (0.09%) and EU exports (imports) to
549 (from) ROW decreases slightly by 0.01% (4.08%). Beckman et al. (2015) find that tariff removal results
550 in US and EU processed food production to increase by 0.37% and 0.04%, respectively.

Table 1: Results of the Implementation of TTIP, Percent Changes

	Alternate Scenario 1			Alternate Scenario 2			Alternate Scenario 3		
Bilateral Trade Flows									
y_{ij}	US	EU	ROW	US	EU	ROW	US	EU	ROW
US	-14.66	113.58	-2.80	-1.58	24.63	-2.64	-11.65	67.37	1.69
EU	96.19	-9.53	-1.69	7.28	1.82	1.90	80.82	-6.21	-4.83
ROW	-47.26	-16.10	1.31	-0.82	5.40	0.17	-44.10	-6.88	0.99
Bilateral Cutoff Productivity									
\bar{z}_{ij}	US	EU	ROW	US	EU	ROW	US	EU	ROW
US	8.25	-21.20	1.43	0.80	-6.51	1.35	6.39	-15.47	-0.83
EU	-15.71	4.09	0.68	-2.06	0.74	-0.75	-13.71	2.60	2.00
ROW	7.33	3.57	-0.26	0.10	1.12	-0.03	6.74	1.44	-0.20
Bilateral Measure of Operating Firms									
\bar{n}_{ij}	US	EU	ROW	US	EU	ROW	US	EU	ROW
US	-21.17	24.34	-4.17	-2.37	5.22	-3.94	-16.96	15.28	2.54
EU	81.91	-13.08	-2.35	7.55	-2.53	2.67	67.56	-8.59	-6.69
ROW	-34.60	-19.00	1.57	-0.62	-6.44	0.20	-32.37	-8.20	1.19
Aggregate Price, Real Income, Production, and Productivity									
	US	EU	ROW	US	EU	ROW	US	EU	ROW
P_i	-7.54	-4.21	-1.23	-0.21	-1.21	-0.17	-6.85	-2.01	-0.95
C_i	5.38	2.04	2.00	0.25	0.56	0.28	4.64	0.88	1.50
Y_i	4.89	3.91	-1.82	1.96	-0.34	-0.23	1.17	4.30	-1.38
Z_i	0.21	0.03	2.24	0.04	0.01	0.26	0.14	0.02	1.68