

Supplemental Appendix

Non-Tariff Barriers in the U.S.-China Trade War

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A Derivation

A.1 Derivation of Equations to Estimate ϵ and γ

We start by decomposing the following six variables: import quantity C_{if}^j , preference parameter b_{if}^j , cif price p_{if}^j , non-tariff barriers ϕ_{if}^j , tariff τ_{if} , and supply shifter A_{if} into its mean value and deviation from the mean. Specifically, for the variables that are vary by type of importer j ,

$$X_{if}^j = X_f \tilde{X}_{if}^j \quad (1)$$

where $X \in \{C, p, 1 + \phi\}$. For the variables that do not differ by importer type,

$$X_{if} = X_f \tilde{X}_{if} \quad (2)$$

where $X \in \{1 + \tau, A\}$. The first term X_f represents the average X for the source country f , and the second term $\tilde{X}_{if}^j$ or $\tilde{X}_{if}$ represents the demeaned X_f .¹ The second component $\tilde{X}_{if}^j$ or $\tilde{X}_{if}$ represents the demeaned X_f . By construction, the log value of the second component has zero mean.

Consider the import of good i from country f by firm j :

$$C_{if}^j = (b_{if}^j)^{\epsilon-1} \left(\frac{\text{Shadow Price}_{if}^j}{P_i^j} \right)^{-\epsilon} C_i^j \quad (3)$$

where

$$P_i^j = \left(\sum_f \left(\frac{\text{Shadow Price}_{if}^j}{b_{if}^j} \right)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} \quad (4)$$

and the shadow price follows shadow price equation in the paper.

Substituting the supply curve for p_{if}^j in the shadow price establishes

$$(C_{if}^j)^{1+\frac{\epsilon}{\gamma}} = (b_{if}^j)^{\epsilon-1} \left(\frac{(1 + \tau_{if})(1 + \phi_{if}^j)}{A_{if} P_i^j} \right)^{-\epsilon} C_i^j$$

This leads to

$$\Delta \log C_{if}^j = -\frac{\gamma\epsilon}{\gamma + \epsilon} \left[\Delta \log(1 + \tau_{if}) + \Delta \log(1 + \phi_{if}^j) - \Delta \log(A_{if}) \right] + \alpha(i \times j). \quad (5)$$

¹ $\log(X_f) \equiv \frac{1}{N(i) \times N(j)} \sum_i \log(X_{if}^j)$ for $X \in \{C, p, 1 + \phi\}$ and $\log(X_f) \equiv \frac{1}{N(i)} \sum_i \log(X_{if})$ for $X \in \{1 + \tau, A\}$, where $N(i)$ and $N(j)$ denote the number of HS6 products and importer types, respectively.

where $\alpha(i \times j) \equiv \frac{\gamma}{\gamma+\epsilon} \Delta \log \left(\left(P_i^j \right)^\epsilon C_i^j \right)$. The preference parameter b_{if}^j disappears because it is time-invariant. The definition of $\Delta \log C_f$, together with the zero sum of the demeaned supply shift, tariff and non-tariff barriers, establishes

$$\Delta \log C_f = -\frac{\gamma\epsilon}{\gamma+\epsilon} [\Delta \log(1 + \tau_f) + \Delta \log(1 + \phi_f) - \Delta \log(A_f)] + \Gamma \quad (6)$$

where the constant term $\Gamma = \frac{\gamma}{\gamma+\epsilon} \frac{1}{N(i) \times N(j)} \sum_i \sum_j \left(\Delta \log \left(\left(P_i^j \right)^\epsilon C_i^j \right) \right)$. Combining the above two equations and using equations (1) and (2), we obtain the first equation to estimate ϵ and γ .

To derive the second regression equation to estimate ϵ and γ , we replace C_{if}^j with the supply curve.

$$\Delta \log p_{if}^j = -\frac{\epsilon}{\gamma+\epsilon} \left[\Delta \log(1 + \tau_{if}) + \Delta \log(1 + \phi_{if}^j) \right] - \frac{\gamma}{\gamma+\epsilon} \Delta \log(A_{if}) + \beta(i, j) \quad (7)$$

where $\beta(i, j) \equiv \frac{1}{\gamma+\epsilon} \Delta \log \left(\left(P_i^j \right)^\epsilon C_i^j \right)$. Analogous to $\Delta \log C_f$, we derive

$$\Delta \log p_f = -\frac{\epsilon}{\gamma+\epsilon} [\Delta \log(1 + \tau_f) + \Delta \log(1 + \phi_f)] - \frac{\gamma}{\gamma+\epsilon} \Delta \log(A_f) + \Lambda$$

where the constant term $\Lambda = \frac{1}{\gamma+\epsilon} \frac{1}{N(i) \times N(j)} \sum_i \sum_j \left(\Delta \log \left(\left(P_i^j \right)^\epsilon C_i^j \right) \right)$. We then obtain the second equation to estimate ϵ and γ .

A.2 Derivation of Equation to Estimate σ

We derive the result under the assumption that $\gamma \rightarrow \infty$.

Rewrite equation (3) by replacing the aggregated consumption using $C_i^j = \left(\frac{P_i^j}{P_i} \right)^{-\eta} \left(\frac{P_i}{P} \right)^{-\sigma} \frac{1}{P}$, with expenditure normalized to unity:

$$C_{if}^j = P^{\sigma-1} \cdot P_i^{\eta-\sigma} \cdot \left(P_i^j \right)^{\epsilon-\eta} \cdot \left(b_{if}^j \right)^{\epsilon-1} (A_{if})^\epsilon \left((1 + \tau_{if})(1 + \phi_{if}^j) \right)^{-\epsilon} \quad (8)$$

Take the log difference of equation (8) and subtract equation (6), we obtain:

$$\begin{aligned} \Delta \log \tilde{C}_{if}^j &= (\sigma - 1) \Delta \log P + (\eta - \sigma) \Delta \log P_i + (\epsilon - \eta) \Delta \log P_i^j \\ &\quad + \epsilon \Delta \log \tilde{A}_{if} - \epsilon \Delta \log(1 + \tilde{\tau}_{if}) - \epsilon \Delta \log(1 + \tilde{\phi}_{if}^j) - \Gamma \end{aligned} \quad (9)$$

We invoke the assumption that $1 + \tilde{\tau}_{if}$ is independent on the preference parameter b_{if}^j , demeaned non-tariff barriers $1 + \tilde{\phi}_{if}^j$, and demeaned productivity $\tilde{A}_{if}$. Then, the price index P_i^j follows

$$\begin{aligned} P_i^j &= \left[\sum_f \left(\frac{(1 + \tau_{if})(1 + \phi_{if}^j)}{b_{if}^j A_{if}} \right)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}} \\ &= M_i^j (1 + \tilde{\tau}_i) \end{aligned} \quad (10)$$

with

$$M_i^j \equiv \left[\frac{1}{N(f)} \left(\sum_f \left(b_{if}^j \right)^{\epsilon-1} (1 + \tilde{\phi}_{if}^j)^{1-\epsilon} (\tilde{A}_{if})^{\epsilon-1} (1 + \tau_f)^{1-\epsilon} (1 + \phi_f)^{1-\epsilon} (A_f)^{\epsilon-1} \right) \right]^{\frac{1}{1-\epsilon}},$$

where $N(f)$ is the number of source countries, and $1 + \bar{\tau}_i \equiv \left(\sum_f (1 + \tilde{\tau}_{if})^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}$. We can write the aggregated price P_i as

$$\begin{aligned} P_i &= \left(\sum_j \left(P_i^j \right)^{1-\eta} \right)^{\frac{1}{1-\eta}} \\ &= (1 + \bar{\tau}_i) \left(\sum_j \left(M_i^j \right)^{1-\eta} \right)^{\frac{1}{1-\eta}} \end{aligned} \quad (11)$$

Substituting equation (10) and (11) into (9) establishes

$$\Delta \log \tilde{C}_{if} \equiv \sum_j \Delta \log \tilde{C}_{if}^j = -\epsilon \Delta \log(1 + \tilde{\tau}_{if}) + (\epsilon - \sigma) \Delta \log(1 + \bar{\tau}_i) + \Delta \log \psi_{if}, \quad (12)$$

where

$$\begin{aligned} \Delta \log \psi_{if} &= (\sigma - 1) \Delta \log P + (\epsilon - \eta) \sum_j \left(\Delta \log(M_i^j) \right) + \frac{\eta - \sigma}{1 - \eta} \Delta \log \left(\sum_j \left(M_i^j \right)^{1-\eta} \right) \\ &\quad + \epsilon \Delta \log \tilde{A}_{if} - \epsilon \sum_j \left(\Delta \log(1 + \tilde{\phi}_{if}^j) \right) - \Gamma \end{aligned} \quad (13)$$

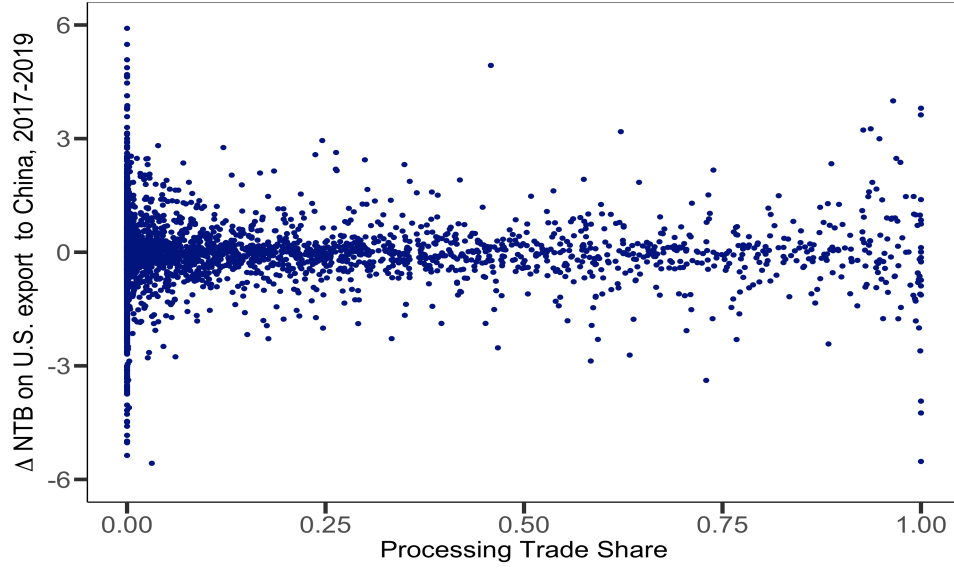
Rewrite equation (13), we obtain

$$\begin{aligned} \left(\sum_f \tilde{C}_{if}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{1-\epsilon}} &= \left(\sum_f (1 + \tilde{\tau}_{if})^{1-\epsilon} (1 + \bar{\tau}_i)^{\frac{(\epsilon-1)(\epsilon-\sigma)}{\epsilon}} (\psi_{if})^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{1-\epsilon}} \\ &= (1 + \bar{\tau}_i)^{-\sigma} \Psi_i \end{aligned} \quad (14)$$

where $\Psi_i \equiv \left(\sum_f \psi_{if}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{1-\epsilon}}$. We then obtain the equation to estimate σ , where $\bar{C}_i \equiv \left(\sum_f C_{if}^{(\epsilon-1)/\epsilon} \right)^{\epsilon/(\epsilon-1)}$ and $e_i \equiv \ln \Psi_i$.

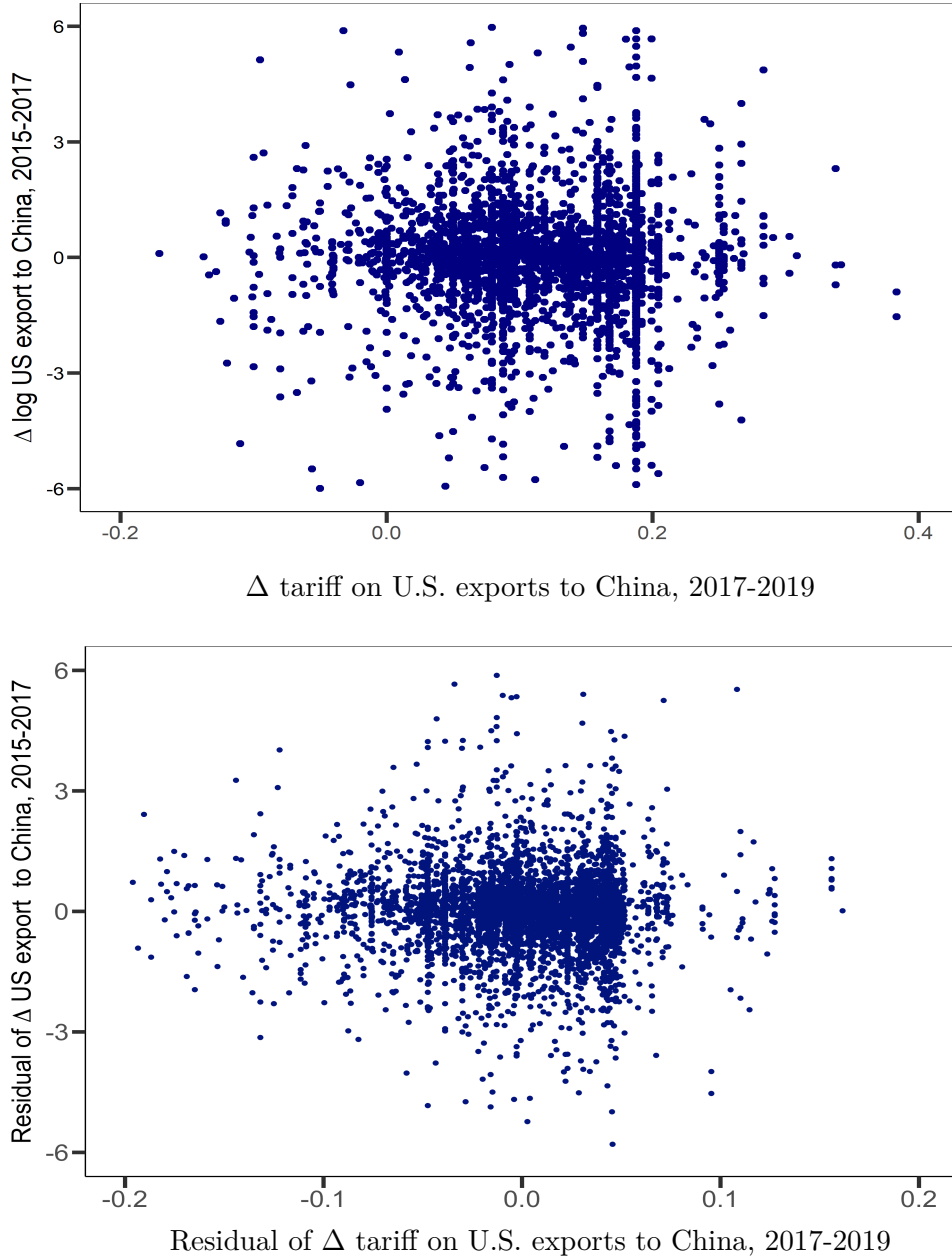
B Figures

Figure A1: Δ Non-Tariff Barriers vs. Share of Processing Trade



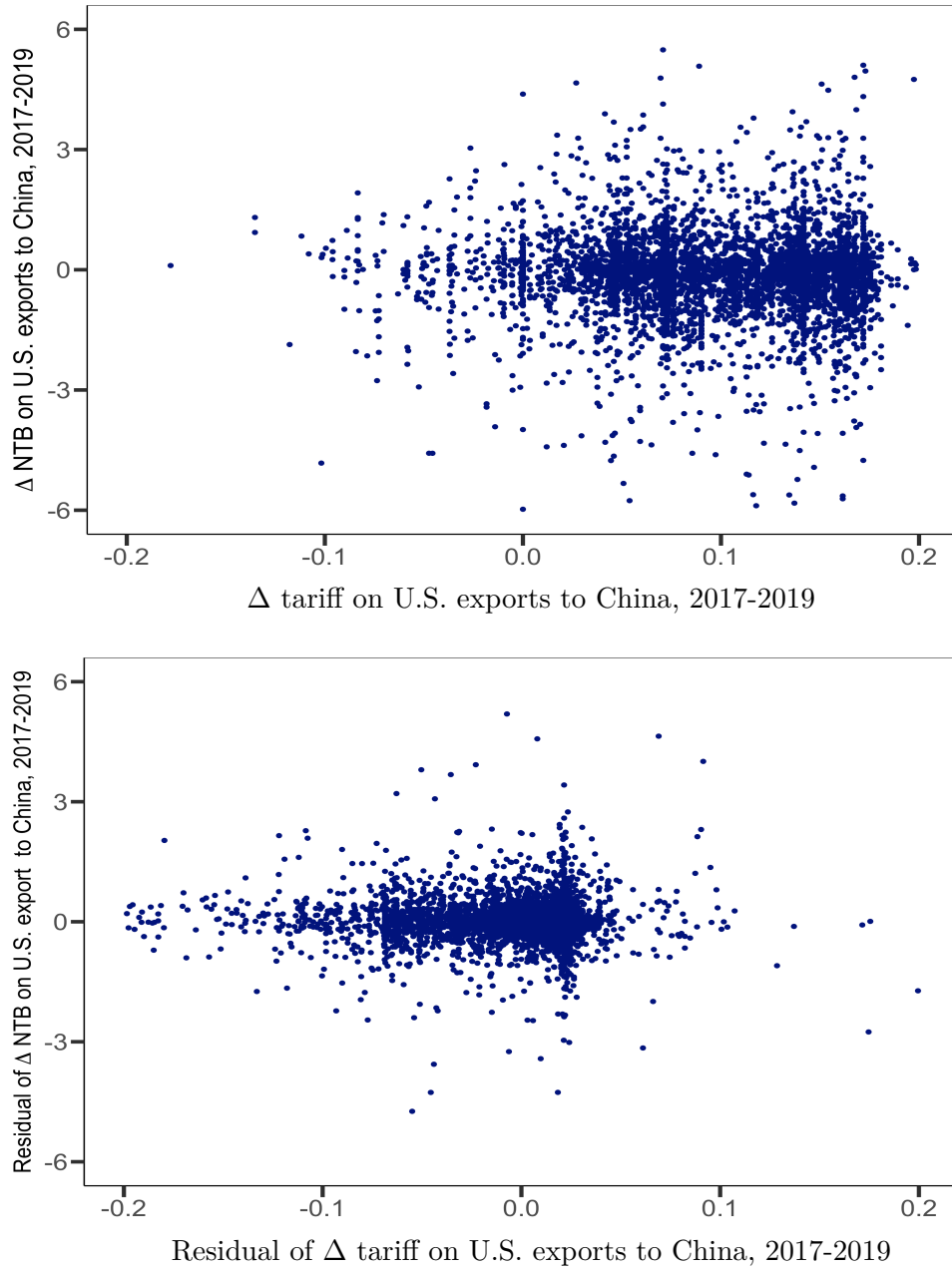
Notes: Each observation is a HS-6 product. x-axis represent Figure shows scatterplot of change in NTB between 2017 and 2019 (y-axis) on share of processing trade in each HS-6 product in 2016 (x-axis). Coefficient from linear regression between the two variables is 0.11 (s.e. = 0.069).

Figure A2: Δ U.S. Exports to China 2015-2017 vs. Δ tariff, 2017-2019



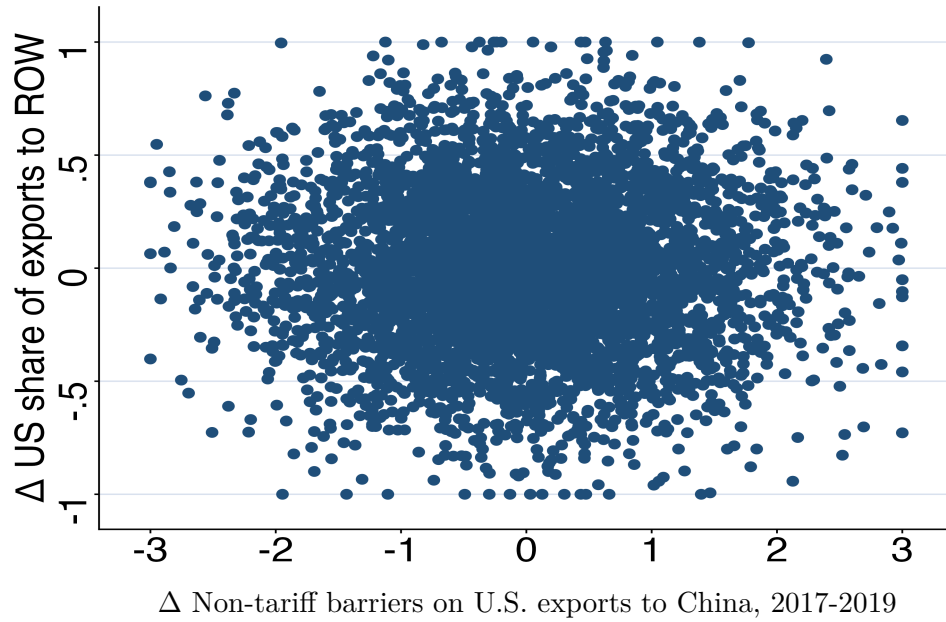
Notes: Observation is a HS6 product. Top panel shows scatter-plot of change in log U.S. exports to China between 2015 and 2017 (y-axis) against change in tariff rate on U.S. exports to China between 2017 and 2019. Correlation coefficient between the two variables is -0.02 (p-value=0.22). Bottom panel shows scatter-plot of residual of change in log U.S. exports to China between 2015 and 2017 (y-axis) against residual of the change in tariff rate on U.S. exports to China between 2017 and 2019. Residuals control for firm and HS6 fixed effects. Correlation coefficient between the two variables in bottom panel is -0.023 (p-value=0.14).

Figure A3: Δ Non-tariff barriers vs. Δ tariff, 2017-2019



Notes: Observation is a HS6 product. Top panel shows scatter-plot of change in non-tariff barriers on U.S. exports to China calculated from elasticities in Broda Weinstein 2006 (y-axis) against change in tariff rate on U.S. exports to China, both calculated between 2017 and 2019. Correlation coefficient between the two variables is -0.001 (p-value=0.94). Bottom panel shows the scatter-plot of residual of the change in non-tariff barriers on U.S. exports to China against residual of the change in tariff rate on U.S. exports to China between 2017 and 2019. Residuals control for firm and HS6 fixed effects. Correlation coefficient between the two variables in bottom panel is 0.002 (p-value=0.85).

Figure A4: Δ U.S. exports to rest of world (except China) vs. Δ Non-tariff barriers, 2017-2019



Notes: Observation is a HS6 product. Scatter-plot of change in log U.S. exports to the rest of the world as a share of exports of the rest of the world to the rest of the world (y-axis) against change in non-tariff barriers on U.S. exports to China, both calculated between 2017 and 2019. The rest of the world excludes China. Trade of rest of the world calculated from Comtrade database.

C Tables

Table A1: Number of News Articles on Non-Tariff Barriers and Trade War, 2017-2020

Website	# Non-Tariff Articles	# Trade War Articles
abcnews.go.com	2	132
apnews.com	0	159
bbc.com	13	218
bloomberg.com	5	217
cnbc.com	10	214
cnn.com	6	215
dailymail.co.uk	1	213
economist.com	1	238
express.co.uk	0	227
finance.yahoo.com	4	216
forbes.com	5	229
fortune.com	0	231
foxnews.com	2	45
ft.com	5	194
independent.co.uk	0	138
latimes.com	4	229
mirror.co.uk	0	18
msnbc.com	0	19
nbcnews.com	1	222
newsweek.com	1	212
nikkei.com	6	215
npr.org	0	219
nytimes.com	8	237
politico.com	12	238
reuters.com	11	220
scmp.com	97	231
slate.com	0	24
standard.co.uk	0	6
telegraph.co.uk	1	65
theatlantic.com	0	120
theguardian.com	8	228
thehill.com	2	120
theintercept.com	0	19
thestreet.com	2	90
thetimes.co.uk	2	94
time.com	2	172
usnews.com	0	91
vox.com	2	188
washingtonpost.com	3	237
wsj.com	2	229
Total	218	6629

Table A2: Δ Non-Tariff Barriers and Tariffs on U.S. Products by HS2 Product, 2017-2019

	U.S. Share of Imports	Δ Tariff	Δ Non-Tariff Barriers
Agriculture			
Oil seeds, oleaginous fruits, etc.	8.75%	0.145	1.133
Pulp of wood, recovered paper etc.	2.37%	0.176	0.346
Wood and articles of wood	1.66%	0.149	0.154
Cereals	0.95%	0.25	1.653
Cotton	0.74%	0.25	-0.402
Meat and edible meat offal	0.57%	0.533	0.138
Fish and crustaceans, etc.	0.55%	0.282	-0.127
Raw hides and skins and leather	0.53%	0.03	0.688
Rubber and articles thereof	0.38%	0.119	0.368
Fruit and nuts, etc.	0.37%	0.428	-0.524
Food industries, residues and wastes thereof	0.29%	0.139	0.751
Dairy produce, birds' eggs, etc.	0.24%	0.201	0.326
Miscellaneous edible preparations	0.22%	0.063	-0.548
Preparations of vegetables, etc.	0.16%	0.115	0.075
Beverages, spirits and vinegar	0.07%	0.283	-0.147
Preparations of cereals, etc.	0.06%	0.156	-0.428
Sugars and sugar confectionery	0.04%	0.1	-0.236
Animal or vegetable fats, oils, etc.	0.03%	0.166	-0.275
Vegetables and certain roots and tubers	0.03%	0.199	0.151
Wool, fine or coarse animal hair	0.01%	0.188	-0.078
Manufacturing			
Electrical machinery and parts, etc.	1.49%	0.063	-0.064
Nuclear reactors and machinery, etc.	1.40%	0.07	0.038
Vehicles and parts and accessories thereof	1.36%	0.002	0.526
Aircraft, space craft and parts thereof	1.02%	0.001	0.315
Optical instruments, etc.	1.00%	0.073	-0.055
Plastics and articles thereof	0.61%	0.098	0.120
Pharmaceutical products	0.31%	0.007	0.071
Organic chemicals	0.29%	0.101	0.637
Chemical products n.e.c.	0.27%	0.03	-0.068
Copper and articles thereof	0.13%	0.233	0.064
Iron or steel articles	0.10%	0.137	0.021
Aluminium and articles thereof	0.10%	0.371	-0.177
Inorganic chemicals, etc.	0.08%	0.099	0.501
Glass and glassware	0.07%	0.093	-0.085
Essential oils and resinoids, etc.	0.07%	0.182	-0.516
Natural, cultured pearls, etc.	0.04%	0.134	0.021
Salt, sulphur, earths, etc.	0.03%	0.13	-0.006
Iron and steel	0.03%	0.13	0.072
Ores, slag and ash	0.02%	0.097	1.581
Cotton	0.01%	0.187	1.587

Notes: Table shows U.S. exports of each HS-2 product as a share of total U.S. exports to China in 2017 (column 1) and weighted average of $\Delta \log(1 + \tau)$ (column 2) and $\Delta \log(1 + \phi)$ (column 3) across HS6 products for each HS-2 category (weights are expenditure share of a HS6 product in the HS2 sector).

Table A3: Monte-Carlo Simulation of Effect of Measurement Error

	Δ Non-Tariff Barriers				Welfare Loss
	Non-State	State	Avg.	Std. Dev.	(billion US\$)
<u>Agriculture 2019</u>					
Noise Std. Dev. = 0.2	0.798	0.257	0.702	0.821	8.20
Noise Std. Dev. = 0.4	0.797	0.256	0.701	0.825	8.22
Noise Std. Dev. = 0.6	0.796	0.255	0.700	0.833	8.26
Noise Std. Dev. = 0.72	0.795	0.254	0.699	0.839	8.29
 <u>Agriculture 2020</u>					
Noise Std. Dev. = 0.2	0.219	0.133	0.203	0.588	4.10
Noise Std. Dev. = 0.4	0.219	0.133	0.204	0.595	4.18
Noise Std. Dev. = 0.6	0.220	0.133	0.204	0.608	4.24
Noise Std. Dev. = 0.72	0.220	0.133	0.204	0.617	4.42

Notes: Table simulates effect of measurement error in $\Delta \log \left(C_{if}^j / C_{i'f}^j \right)$ on our estimates of non-tariff barriers in the agricultural sector in 2019 (top panel) and 2020 (bottom panel). The maximum standard error of the measurement error is 0.72, corresponding to the standard deviation of the log change in imports during the normal period (2015–2017). Each row corresponds to a different level of measurement error. The columns report, respectively, the log change in non-tariff barriers for non-state firms, state firms, and all firms (relative to 2017), the standard deviation of the change in non-tariff barriers, as well as the welfare loss (which can be compared with the welfare changes in the second row of Table 9 in the paper). All results are based on one thousand Monte Carlo simulations.

Table A4: Comparison of Residual Based with Direct Measures of NTBs in Mexico

	Dependent Variable: NTB on non-NAFTA countries in Mexico		
#Rules of Origin	0.057 (0.023)	0.027 (0.025)	0.047 (0.027)
Exports to NAFTA		0.097 (0.025)	
#Rules of Origin × Exports to NAFTA		0.037 (0.015)	
Tariff MFN - NAFTA			-0.162 (0.088)
#Rules of Origin × Tariff MFN - NAFTA			0.088 (0.054)

Notes: Unit of observation is an HS6 product (N=1,613). The dependent variable is our estimate of non-tariff barriers on Mexican imports from non-NAFTA countries, calculated following the same procedure used to estimate non-tariff barriers on U.S. exports to China, where we use the HS6 product-level estimates of ϵ in Broda Weinstein 2006. Independent variables from Conconi et al 2018, where “#Rules of Origin” is the number of final goods with rules of origin requirements on the given intermediate inputs at HS6 level (“*RoO*” in Footnote 31), “Exports to NAFTA” is the log of Mexican exports to Canada and the U.S., and “Tariff MFN - NAFTA” is the difference between the MFN tariff and the NAFTA tariff. We use demeaned “Exports to NAFTA” and “Tariff MFN - NAFTA” interacted with “#Rules of Origin.”