Online Appendix for

"Import Liberalization as Export Destruction? Evidence from the United States"

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A Proofs and derivations

A.1 Derivation of equation (2)

Expenditure $X_{n,s}$ on sector s in country n is the sum of consumer expenditure and intermediate input expenditure. Since sectoral output is non-tradable, market clearing requires $X_{n,s} = P_{n,s}Q_{n,s}$. We can write $P_{n,s} = \left(\sum_i P_{ni,s}^{1-\epsilon}\right)^{\frac{1}{1-\epsilon}}$ where $P_{ni,s}$ is defined as the price index for the bundle of varieties imported by country n from country i. Letting $p_{ni,s}(\omega)$ denote the price of variety ω produced in i and sold in n, we have: $P_{ni,s} = \left(\int_{\omega\in\Omega_{i,s}} p_{ni,s}(\omega)^{1-\sigma}d\omega\right)^{\frac{1}{1-\sigma}}$. Using this definition, expenditure $X_{ni,s}$ by country n on products from country i in sector s is given by:

$$X_{ni,s} = \left(\frac{P_{ni,s}}{P_{n,s}}\right)^{1-\epsilon} X_{n,s}. \tag{14}$$

As firms face elasticity of demand σ, they charge a mark-up $\frac{\sigma}{\sigma-1}$ over marginal costs implying $p_{ni,s}(\omega) = \frac{\sigma}{\sigma-1}\frac{\tau_{ni,s}c_{i,s}}{T_{i,s}}$ and:

$$P_{ni,s} = \frac{\sigma}{\sigma-1}\frac{\tau_{ni,s}c_{i,s}}{T_{i,s}}N_{i,s}^{-\frac{1}{\sigma-1}}, \tag{15}$$

where $N_{i,s}$ denotes the mass of varieties produced by country i in sector s. Free entry requires that in equilibrium profits net of entry costs are zero. Since profits are a fraction $1/\sigma$ of revenues $Y_{i,s}$, the free entry condition is:

$$\frac{Y_{i,s}}{\sigma} = N_{i,s} f_{i,s} c_{i,s}, \tag{16}$$

which determines the mass of varieties produced in each country. Using (15) to substitute for the price index $P_{ni,s}$ in equation (14) and then the free entry condition (16) to eliminate $N_{i,s}$ yields the bilateral trade equation (2).

A.2 Proof of Proposition 1

We start by solving for the sectoral price index. Substituting the free entry condition (16) into equation (15) yields:

$$P_{nj,s} = \frac{\sigma}{\sigma - 1} \sigma^{\frac{1}{\sigma-1}} \frac{\varphi_{nj,s}^{\frac{1}{1-\epsilon}}}{T_{j,s}} \left(\frac{c_{j,s}^{\sigma} f_{j,s}}{Y_{js}} \right)^{\frac{1}{\sigma-1}}.$$

Next, substituting this expression into $P_{n,s} = \left(\sum_j P_{nj,s}^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}$ gives:

$$P_{n,s} = \frac{\sigma}{\sigma - 1} \sigma^{\frac{1}{\sigma-1}} \left[\sum_j \frac{\varphi_{nj,s}}{T_{j,s}^{1-\epsilon}} \left(\frac{c_{j,s}^{\sigma} f_{j,s}}{Y_{js}} \right)^{\frac{1-\epsilon}{\sigma-1}} \right]^{\frac{1}{1-\epsilon}}. \tag{17}$$

Differentiating this expression with $n = U$ while holding all trade costs other than $\varphi_{UC,s}$ constant gives:

$$\begin{aligned} d \log P_{U,s} = {} & -\frac{\lambda_{UC,s}}{\epsilon - 1} d \log \varphi_{UC,s} + \frac{\lambda_{UU,s}}{\sigma - 1} \left(\sigma d \log c_{U,s} - d \log Y_{U,s} \right) \\ & + \sum_{j \neq U} \frac{\lambda_{Uj,s}}{\sigma - 1} \left(\sigma d \log c_{j,s} - d \log Y_{j,s} \right), \end{aligned} \tag{18}$$

The first term on the right hand side of equation (18) is the direct negative effect of import liberalization on domestic prices. The second term is an indirect price effect resulting from changes in US input costs and industry output. Because of scale economies, an increase in output reduces the sectoral price index. The third term captures foreign price changes; for a small economy the third term is zero.

Next, differentiating equation (4) with $i = U$ gives:

$$(\sigma - \epsilon)\, d\log Y_{U,s} = -\sigma(\epsilon - 1) d\log c_{U,s} + (\sigma - 1)\, \mu_{UU,s} \left(d\log X_{U,s} + (\epsilon - 1) d\log P_{U,s}\right) + (\sigma - 1) \sum_{j \neq U} \mu_{jU,s} \left(d\log X_{j,s} + (\epsilon - 1) d\log P_{j,s}\right),$$

which holds even when $\sigma = \epsilon$. Substituting equation (18) into this expression then yields:

$$d\log Y_{U,s} = \frac{1}{\frac{\sigma-1}{\epsilon-1} - 1 + \lambda_{UU,s}\mu_{UU,s}} \left\{ -\frac{\sigma - 1}{\epsilon - 1} \lambda_{UC,s}\mu_{UU,s} d\log \varphi_{UC,s} - \sigma\left(1 - \lambda_{UU,s}\mu_{UU,s}\right) d\log c_{U,s} + \frac{\sigma - 1}{\epsilon - 1} \mu_{UU,s} d\log X_{U,s} + \frac{\sigma - 1}{\epsilon - 1} \sum_{j \neq U} \mu_{jU,s} \left(d\log X_{j,s} + (\epsilon - 1) d\log P_{j,s}\right) + \sum_{j \neq U} \lambda_{Uj,s}\mu_{UU,s} \left(\sigma d\log c_{j,s} - d\log Y_{j,s}\right) \right\}, \tag{19}$$

Note that for a small country the final two terms, which only depend on changes in foreign variables, are zero. In addition, when firms do not use intermediate inputs, equation (1) gives $c_{i,s} = w_i$ and, since only consumers demand non-tradable output, we have $X_{i,s} = \beta_{i,s} w_i L_i$. Therefore, $d\log c_{i,s} = d\log X_{i,s} = d\log w_i$, which does not vary by sector.

Finally, differentiating the bilateral trade equation (2) and using equation (19), while holding domestic input costs, domestic expenditure and all foreign variables constant, gives equation (5) in the main text.

A.3 Equilibrium conditions

Labor is the only primary factor of production. Therefore, labor market clearing implies that labor income equals the sum of value-added in all sectors:

$$w_i L_i = \sum_s \gamma_{i,s} Y_{i,s}. \tag{20}$$

Consumer expenditure in country i is the sum of labor income and the trade deficit D_i, which we treat as being exogenously determined with $\sum_i D_i = 0$. Since total expenditure by country i on sector s output is the sum of consumer expenditure and intermediate input expenditure we have:

(21) $$X_{i,s} = \beta_{i,s}\left(w_i L_i + D_i\right) + \sum_v \gamma_{i,vs} Y_{i,v}.$$

Equations (1), (4), (17), (20) and (21) form a system of $N + 4NS$ equations in the set of wages w_i, expenditure levels $X_{i,s}$, output levels $Y_{i,s}$, price indices $P_{i,s}$ and input costs $c_{i,s}$. We define an equilibrium as a solution to this set of equations.[27]

A.4 Alternative models with scale economies

The baseline model in Section I is a generalization of the Krugman (1980) homogeneous firms model in which scale economies result from love of variety. To obtain Proposition 1 we used the bilateral trade equation (2) together with the equilibrium conditions (4) for output and (17) for the price index. We now show that equilibrium conditions equivalent to equations (2), (4) and (17) hold in three alternative scale economies models featuring: (i) external economies of scale; (ii) endogenous technology investment, or; (iii) heterogeneous firms. It follows that the mechanism through which import liberalization reduces exports by lowering real market potential exists in each of these models of trade with scale economies.

(i) External economies. Suppose the economy is as described in Section I.A except that varieties from the same country are perfect substitutes (i.e. $\sigma \to \infty$) and that there are sector-level external economies of scale in production. In particular, assume the marginal cost of production in country i and sector s is $\frac{c_{i,s}}{T_{i,s}}\left(\frac{w_i L_{i,s}}{\gamma_{i,s} c_{i,s}}\right)^{-\psi}$ where $L_{i,s}$ denotes employment in sector s in country i and ψ determines the degree of external economies of scale.[28] We assume $0 < \psi < 1/(\epsilon - 1)$. Firms take sector-level employment as given when making production decisions.

Since sector-level profits are zero, labor market clearing requires $w_i L_{i,s} = \gamma_{i,s} Y_{i,s}$. Using this expression, following the same steps required to solve the baseline model, and letting $\sigma \to \infty$ gives the bilateral trade equation:

$$X_{ni,s} = \Gamma_0 \varphi_{ni,s} T_{i,s}^{\epsilon-1}\left(\frac{Y_{i,s}}{c_{i,s}^{\frac{1+\psi}{\psi}}}\right)^{\psi(\epsilon-1)} X_{n,s} P_{n,s}^{\epsilon-1}.$$

Summing sales across destinations then implies that equilibrium output satisfies:

[27] If $\sigma = \epsilon$, equation (4) is not well-defined and is replaced by: $1 = \Gamma_0 \frac{T_{i,s}^{\epsilon-1}}{c_{i,s}^{\sigma} f_{i,s}} \sum_n \varphi_{ni,s} X_{n,s} P_{n,s}^{\epsilon-1}$.

[28] Assuming the marginal cost depends upon $\left(w_i/\gamma_{i,s} c_{i,s}\right)^{\psi}$ in addition to employment $L_{i,s}$ is a normalization that ensures all sectoral equilibrium conditions are equivalent to the baseline model even when production uses intermediate inputs. Without this normalization, the equations for $X_{ni,s}$, $Y_{i,s}$ and $P_{n,s}$ in the external economies model would include additional terms in $\gamma_{i,s} c_{i,s}/w_i$. These terms would affect counterfactual quantitative analysis, but not the qualitative impact of import liberalization on exports.

$$Y_{i,s} = \Gamma_0^{\frac{1}{1-\psi(\epsilon-1)}} T_{i,s}^{\frac{\epsilon-1}{1-\psi(\epsilon-1)}} c_{i,s}^{-\frac{(1+\psi)(\epsilon-1)}{1-\psi(\epsilon-1)}} \left(\sum_n \varphi_{ni,s} X_{n,s} P_{n,s}^{\epsilon-1} \right)^{\frac{1}{1-\psi(\epsilon-1)}},$$

and solving for the sectoral price index yields:

$$P_{n,s} = \left[\sum_j \frac{\varphi_{nj,s}}{T_{j,s}^{1-\epsilon}} \left(\frac{c_{j,s}^{\frac{1+\psi}{\psi}}}{Y_{js}} \right)^{\psi(1-\epsilon)} \right]^{\frac{1}{1-\epsilon}}.$$

Inspection of these equations shows that they are equivalent to equations (2), (4) and (17) in the baseline model (in terms of their dependence on endogenous variables) except that the scale elasticity equals ψ instead of $\frac{1}{\sigma-1}$.

It is also worth noting that with external economies of scale equations (1), (20) and (21) are unchanged from the baseline model. It follows that the external economies model is equivalent to the baseline model for quantitative purposes.

(ii) Endogenous technology investment. Suppose the economy is as described in Section I.A, except that the mass of varieties $N_{i,s}$ is exogenous and each firm makes a technology investment before producing that determines its productivity. To obtain productivity z, the firm must invest z^ξ units of the country i sector s input good at cost $c_{i,s}z^\xi$. The parameter ξ determines the convexity of technology investment costs and we assume $\xi > \sigma - 1 \geq \epsilon - 1$. The marginal production cost of a firm with productivity z is $c_{i,s}/(zT_{i,s})$.

Solving this model implies that the equilibrium productivity $z_{i,s}$ of producers in country i and sector s is given by:

$$z_{i,s} = \left[\frac{1}{\xi} \left(\frac{\sigma-1}{\sigma} \right)^\epsilon N_{i,s}^{-\frac{\sigma-\epsilon}{\sigma-1}} \frac{T_{i,s}^{\epsilon-1}}{c_{i,s}^\epsilon} \right]^{\frac{1}{\xi-(\epsilon-1)}} \left(\sum_n \varphi_{ni,s} X_{n,s} P_{n,s}^{\epsilon-1} \right)^{\frac{1}{\xi-(\epsilon-1)}}.$$

Thus, productivity is increasing in real market potential and decreasing in the unit input cost $c_{i,s}$. Given this expression for $z_{i,s}$ it can be shown that:

$$X_{ni,s} = \Gamma_1 \varphi_{ni,s} N_{i,s}^{\frac{\xi-(\sigma-1)}{\xi}\frac{\epsilon-1}{\sigma-1}} T_{i,s}^{\epsilon-1} \left(\frac{Y_{i,s}}{c_{i,s}^{1+\xi}}\right)^{\frac{\epsilon-1}{\xi}} X_{n,s} P_{n,s}^{\epsilon-1},$$

$$Y_{i,s} = \Gamma_1^{\frac{\xi}{\xi-(\epsilon-1)}} N_{i,s}^{\frac{\xi-(\sigma-1)}{\xi-(\epsilon-1)}\frac{\epsilon-1}{\sigma-1}} T_{i,s}^{\frac{\xi(\epsilon-1)}{\xi-(\epsilon-1)}} c_{i,s}^{-\frac{(1+\xi)(\epsilon-1)}{\xi-(\epsilon-1)}} \left(\sum_n \varphi_{ni,s} X_{n,s} P_{n,s}^{\epsilon-1}\right)^{\frac{\xi}{\xi-(\epsilon-1)}},$$

$$P_{n,s} = \xi^{\frac{1}{\xi}} \left(\frac{\sigma}{\sigma-1}\right)^{\frac{1+\xi}{\xi}} \left[\sum_j \frac{\varphi_{nj,s}}{T_{j,s}^{1-\epsilon}} N_{j,s}^{\frac{\xi-(\sigma-1)}{\xi}\frac{\epsilon-1}{\sigma-1}} \left(\frac{c_{j,s}^{1+\xi}}{Y_{j,s}}\right)^{\frac{1-\epsilon}{\xi}}\right]^{\frac{1}{1-\epsilon}},$$

where $\Gamma_1 \equiv \left(\frac{1}{\xi}\right)^{\frac{\epsilon-1}{\xi}} \left(\frac{\sigma-1}{\sigma}\right)^{\frac{(1+\xi)(\epsilon-1)}{\xi}}$. Inspection of these equations shows they are equivalent to those in the baseline model except that the scale elasticity equals $\frac{1}{\xi}$. Thus, with endogenous technology investment the strength of scale economies is decreasing in the convexity of technology investment costs.

Since there is no entry, sector-level profits are positive and enter the labor market clearing condition (20) and the expenditure equation (21). Consequently, the model's quantitative implications are not identical to the baseline model. However, this difference disappears if entry is permitted. In a model featuring both free entry and endogenous technology investment, all adjustment to trade shocks occurs on the extensive margin of entry, profits net of entry costs are zero, and the scale elasticity again equals $\frac{1}{\sigma-1}$.

(iii) Heterogeneous firms. Suppose we modify the baseline model in Section I.A to allow for firm heterogeneity following Melitz (2003). Assume that after paying the entry cost $f_{i,s}c_{i,s}$ a firm draws its productivity z from a Pareto distribution with scale parameter one and shape parameter k. The marginal production cost of a firm with productivity z is $c_{i,s}/(zT_{i,s})$. Firms in country i and sector s must also pay a fixed cost $\tilde{f}_{ni,s}^x$ to enter market n. We assume $k > \sigma - 1 > \epsilon - 1$.

To solve this model it is convenient to define the real market potential of country i in sector s as:

$$RMP_{i,s} = \sum_n \left[\left(\tilde{f}_{ni,s}^x\right)^{-\frac{(\epsilon-1)(k+1-\sigma)}{k(\sigma-1)}} \tau_{ni,s}^{1-\epsilon} X_{n,s} P_{n,s}^{\epsilon-1}\right]^{\frac{k(\sigma-1)}{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}}.$$

Then bilateral trade, output and the price index are given by:

$$
X_{ni,s} = \Gamma_2 \left(\frac{T_{i,s} Y_{i,s}^{\frac{1}{k}}}{c_{i,s}^{\frac{1+k}{k}} f_{i,s}^{\frac{1}{k}}} \right)^{\frac{k(\epsilon-1)(\sigma-1)}{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}} \left[\left(\tilde{f}^x_{ni,s} \right)^{-\frac{(\epsilon-1)(k+1-\sigma)}{k(\sigma-1)}} \tau_{ni,s}^{1-\epsilon} X_{n,s} P_{n,s}^{\epsilon-1} \right]^{\frac{k(\sigma-1)}{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}},
$$

$$
Y_{i,s} = \Gamma_2^{\frac{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}{k(\sigma-\epsilon)}} \left(\frac{T_{i,s}}{c_{i,s}^{\frac{1+k}{k}} f_{i,s}^{\frac{1}{k}}} \right)^{\frac{(\epsilon-1)(\sigma-1)}{\sigma-\epsilon}} RMP_{i,s}^{\frac{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}{k(\sigma-\epsilon)}},
$$

$$
\begin{aligned}
P_{n,s} = {} & (\sigma-1)^{\frac{k+1-\sigma}{k(\sigma-1)}} \left(\frac{\sigma}{\sigma-1} \right)^{\frac{\sigma}{\sigma-1}} (k+1-\sigma)^{\frac{1}{k}} \\
& \times \left\{ \sum_j \left[\frac{\tau_{nj,s}}{T_{j,s}} \frac{c_{j,s}^{\frac{1+k}{k}} f_{j,s}^{\frac{1}{k}}}{Y_{j,s}^{\frac{1}{k}}} \left(\frac{\tilde{f}^x_{nj,s}}{X_{n,s}} \right)^{\frac{k+1-\sigma}{k(\sigma-1)}} \right]^{\frac{k(1-\epsilon)(\sigma-1)}{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}} \right\}^{\frac{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}{k(1-\epsilon)(\sigma-1)}},
\end{aligned}
$$

where:

$$
\Gamma_2 \equiv \left[\left(\frac{1}{\sigma-1} \right)^{k(\epsilon-1)} \left(\frac{\sigma-1}{\sigma} \right)^{k\sigma(\epsilon-1)} \left(\frac{\sigma-1}{k+1-\sigma} \right)^{(\epsilon-1)(\sigma-1)} \right]^{\frac{1}{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}}.
$$

These expressions are more complex than the corresponding equations in the models considered above and depend upon how the fixed market entry costs $\tilde{f}^x_{ni,s}$ are denominated, which we have not specified. However, note that the equation for $X_{ni,s}$ implies that in this model the trade elasticity is $\frac{k(\epsilon-1)(\sigma-1)}{k(\sigma-\epsilon)+(\epsilon-1)(\sigma-1)}$, while the scale elasticity equals the inverse Pareto shape parameter $\frac{1}{k}$. Using these observations it is straightforward to show that, when written in terms of the trade elasticity and the scale elasticity, the dependence of $X_{ni,s}$, $Y_{i,s}$ and $P_{n,s}$ on bilateral trade costs $\tau_{ni,s}$, output $Y_{i,s}$ and the input cost $c_{i,s}$ is the same as in the previous models. In addition, trade costs enter the equations above only through the bundle $\tau^s_{ni} \left(\tilde{f}^x_{ni,s} \right)^{\frac{k+1-\sigma}{k(\sigma-1)}}$. It follows that a reduction in the fixed trade cost $\tilde{f}^x_{ni,s}$ has qualitatively the same effects on trade flows as a decline in the variable trade cost τ^s_{ni}.

B Estimation data

Bilateral trade data for 1995-2017 at the 6-digit level of the Harmonised System (HS) 1992 classification is from the CEPII BACI database. We aggregate the trade data to NAICS industries at approximately the 6-digit level using a concordance from Pierce and Schott (2012). The concordance maps Schedule B US export codes, which are 10-digit extensions of HS codes, to NAICS industries. We use the 1995 concordance and allocate each 6-digit trade flow across industries using the share of 10-digit codes with that 6-digit base that map to each NAICS industry. For 94 percent of 6-digit codes, all 10-digit products map to the same NAICS industry.

We calculate the NTR gap using tariff rates on 8-digit US imports from Feenstra, Romalis and Schott (2002). To obtain NTR gaps by NAICS industry, we use a concordance from 10-digit US Harmonized Tariff System import codes to NAICS industries from Pierce and Schott (2012). We calculate the NTR gap for each NAICS industry as a weighted average of NTR gaps at the 8-digit level, where the weights are given by the share of 10-digit codes within the 8-digit group that map to the NAICS industry. In our analysis the tariffs and concordance are for 1999, but using data for other years before 2000 makes little difference to the results.

The $CostShock$ and $IOExposure$ variables are constructed from the 1997 US input-output accounts. We start by mapping the NTR gap from NAICS industries to input-output industries using a Bureau of Economic Analysis concordance. The mapping is one-to-one for most industries and we take the simple average across industries in cases with many-to-one mappings. We then calibrate the input-output coefficients $\gamma_{U,sv}$ from the Use Table as the ratio of expenditure on industry v inputs by industry s to the output of industry s and use these coefficients to calculate $CostShock$ and $IOExposure$ for input-output industries. Finally, we map these variables back to NAICS industries.

From the NBER manufacturing database, we obtain the annual output (value of shipments) of each NAICS manufacturing industry and calculate measures of industry-level input, skill and capital intensity in 1995. Input intensity is defined as one minus the ratio of value-added to output. Skill intensity is defined as the share of non-production workers in employment and capital intensity is defined as the log capital stock per worker. Population data is taken from the CEPII gravity dataset.

C Empirical analysis

Tables A1 and A2 report robustness checks on the baseline reduced form results in Table 2. Unless noted otherwise, the specification and sample are the same as in column (i) of Table 2.

Table A1. Although Congress approved PNTR in October 2000, China did not formally join the WTO until December 2001. However, dating PNTR to 2001 and using 1995-2001 as the pre-period and 2001-07 as the post-period makes a negligible difference to our estimates (column a). Defining the NTR gap by $NTRGap_s = \text{Non-NTR tariff}_s - \text{NTR tariff}_s$ as in Pierce and Schott (2016) reduces the statistical significance of the NTR gap, but the estimated coefficient remains negative and significant at the 10 percent level (column b). Alternatively, using Handley and Limão's

(2017) NTR gap measure $NTRGap_s = 1 - [(1 + \text{Non-NTR tariff}_s) / (1 + \text{NTR tariff}_s)]^{-3}$ slightly increases the significance of the NTR gap compared to the baseline estimates (column c).[29]

In column (d) we adjust for variation across industries in US exposure to Chinese imports when computing the input cost shock. We define:

$$CostShock^w = -\left(I - \Gamma_U^1\right)^{-1} \Gamma_U^0 NTRGap,$$

where Γ_U^0 is a matrix with elements $\lambda_{UC,v}\gamma_{U,sv}$ and Γ_U^1 is a matrix with elements $\lambda_{UU,v}\gamma_{U,sv}$. The import shares $\lambda_{UC,v}$ and $\lambda_{UU,v}$ are computed in 1997 since the input-output accounts used to calibrate $\gamma_{U,sv}$ are from that year. For consistency, we also recalculate each industry's input-output exposure as $\left(I - \Gamma_U^1\right)^{-1} \Gamma_U^0 \tilde{I}$. We continue to find that the NTR gap has a negative effect on US export growth, while the input cost shock boosts exports. The magnitude of the estimated coefficient on the input cost shock variable is greater than in the baseline results, but only because adjusting for import shares shrinks the cost shock variable.

The results are also robust to estimating the export growth equation in levels using Poisson pseudo-maximum likelihood (PPML) estimation instead of OLS (column e). The bilateral trade data contains many missing values, probably corresponding to zeroes in the trade matrix.[30] To investigate whether our estimates are biased by missing zeroes, we aggregate across all importers (except for US, China, Hong Kong and Macao) to obtain total exports by industry. After aggregating, we observe positive total exports for over 99 percent of the possible exporter-industry-period combinations in our OECD exporter sample. Using the aggregated data, we find that US industries with higher NTR gaps had lower total export growth following PNTR regardless of whether we estimate the model using OLS (column f) or PPML (column g). But it is worth noting that the input cost shock variable loses significance in these specifications.

Table A2. Column (a) omits all exporters other than the US from the sample. This requires dropping the importer-industry-period fixed effects $\delta_{n,s}^t$ since the sample no longer includes the control group of non-US exports. Making this change increases the magnitude of the estimated NTR gap effect. We prefer the baseline specification to column (a) as dropping $\delta_{n,s}^t$ implies we do not control for either technology shocks that are common across exporters or import demand shocks, such as those caused by growth in China's export supply capacity. Expanding the sample to include non-OECD exporters with a population above one million in 1995 (column b) or to include all exporters and importers in the trade data (column c) makes little difference to the estimates.[31]

The next two columns restrict the set of sample industries. In column (d) we drop industries

[29] When using the Pierce and Schott (2016) or Handley and Limão (2017) NTR gap measures, we also recalculate the input cost shock $CostShock$ based on equation (7).

[30] Note that the PPML estimation in column (d) does not include zero trade flows since the dependent variable is $X_{ni,s}^t / X_{ni,s}^{t-1}$.

[31] We do not include China, Hong Kong and Macao in the expanded samples.

that have an NTR gap in the bottom or top 5 percent of the NTR gap distribution for manufacturing industries. In column (e) we drop all industries in the textiles and apparel sector. In both cases we continue to find that PNTR led to lower export growth in industries with higher NTR gaps. This alleviates any concern that our baseline results are driven by outlier industries or by the abolition of Multi Fibre Arrangement quotas for textile and apparel trade at the end of 2004.

PNTR occurred around the same time as the broader China shock that led to rapid growth in Chinese exports to the US and other countries (Autor, Dorn and Hanson 2013). We do not expect shocks to China's export supply capacity to affect export growth for the US relative to other OECD countries because, unlike PNTR, the global China shock is not US-specific. Nevertheless, it is useful to assess whether our results are robust to controlling for growth in US imports from China due to shocks other than PNTR. In the spirit of Autor, Dorn and Hanson (2013), we measure the China shock in period t as the annualized change in US imports from China during the period relative to start-of-period industry employment:

$$ChinaShock_s^t = \frac{\Delta X_{UC,s}^t}{L_{U,s}^{t-1}},$$

where imports are measured in million US dollars. In column (f) we include $US_i \times ChinaShock_s^t$ as an additional control. Since US imports from China are endogenous to US demand and supply shocks, we instrument this variable with US_i times the change in Chinese exports to non-OECD countries relative to industry employment five years before the start of the period. As anticipated, the China shock effect is insignificant and the estimated NTR gap and input cost shock coefficients are similar to before. We have also experimented with using growth in US imports from China as a measure of the China shock (not normalizing by industry employment) while constructing the instrument using Chinese export growth to non-OECD countries, either on its own or relative to the export growth of other non-OECD countries to non-OECD destinations. Again, the baseline results are unaffected and we do not find a significant impact of the China shock.

Proposition 1 characterizes the effect of import liberalization on exports conditional on domestic expenditure. In addition to the direct effect of greater Chinese import competition, PNTR may have affected US real market potential through changes in downstream demand for intermediate inputs. To control for this channel, we define:

$$ExpenditureShock_s = -\sum_v \nu_{U,vs} NTRGap_v,$$

where $\nu_{U,vs}$ denotes the share of industry s output sold to industry v. $ExpenditureShock_s$ is a sales share weighted average of downstream NTR gaps. We also calculate the share of industry s output sold to final demand, which we label $Final_s$. The expenditure shock and final demand share variables are constructed from the 1997 US input-output accounts following the same procedure used for $CostShock_s$ and $IOExposure_s$.

In column (f) we add $Post^t \times US_i \times ExpenditureShock_s$ to the baseline specification, while in column (g) we also control for $Post^t \times US_i \times Final_s$. We find that industries where final demand accounts for a higher share of sales had greater export growth in the post-PNTR period, while the expenditure shock coefficient changes signs across the two specifications and is insignificant. However, the estimated NTR gap effect is unaffected.

D Calibration

D.1 Counterfactual changes

Using equations (1), (4), (17), (20) and (21), the equilibrium in changes can be written as:

$$\hat{c}_{i,s} = (\hat{w}_i)^{\gamma_{i,s}} \prod_v \left(\hat{P}_{i,v}\right)^{\gamma_{i,sv}}, \tag{22}$$

$$\hat{Y}_{i,s} = \hat{c}_{i,s}^{-\frac{\sigma(\epsilon-1)}{\sigma-\epsilon}} \left(\sum_n \mu_{ni,s} \hat{\varphi}_{ni,s} \hat{X}_{n,s} \hat{P}_{n,s}^{\epsilon-1}\right)^{\frac{\sigma-1}{\sigma-\epsilon}}, \tag{23}$$

$$\hat{P}_{i,s} = \left[\sum_j \lambda_{ij,s} \hat{\varphi}_{ij,s} \left(\frac{\hat{c}_{j,s}^{\sigma}}{\hat{Y}_{j,s}}\right)^{\frac{1-\epsilon}{\sigma-1}}\right]^{\frac{1}{1-\epsilon}}, \tag{24}$$

$$\hat{w}_i = \sum_s \frac{\gamma_{i,s} Y_{i,s}}{Y_i} \hat{Y}_{i,s}, \tag{25}$$

$$\hat{X}_{i,s} = \frac{\beta_{i,s} Y_i}{X_{i,s}} \hat{w}_i + \frac{\beta_{i,s} D_i'}{X_{i,s}} + \sum_v \frac{\gamma_{i,vs} Y_{i,v}}{X_{i,s}} \hat{Y}_{i,v}. \tag{26}$$

Given trade shares $\mu_{ni,s}$ and $\lambda_{ij,s}$, output levels $Y_{i,s}$, expenditure $X_{i,s}$ and aggregate value-added $Y_i = w_i L_i$ in the initial equilibrium, the parameters ϵ, σ, $\beta_{i,s}$, $\gamma_{i,s}$ and $\gamma_{i,sv}$, the trade deficit in the new equilibrium D_i', and the trade openness shocks $\hat{\varphi}_{ni,s}$, this system of equations determines $\hat{w}_i$,

$\hat{X}_{i,s}$, $\hat{c}_{i,s}$, $\hat{Y}_{i,s}$ and $\hat{P}_{i,s}$ for all countries i and sectors s. We set the trade deficit D'_i such that each country's deficit as a share of global value-added is unaffected by PNTR. Using equations (22), (25) and (26) to substitute for $\hat{w}_i$, $\hat{X}_{i,s}$ and $\hat{c}_{i,s}$ in equations (23) and (24) allows us to simplify the above system to $2NS$ equations in $\hat{Y}_{i,s}$ and $\hat{P}_{i,s}$.

From equation (2), the change in bilateral trade between any pair of countries satisfies:

$$\hat{X}_{ni,s} = \hat{\varphi}_{ni,s} \left(\frac{\hat{Y}_{i,s}}{\hat{c}_{i,s}^{\sigma}} \right)^{\frac{\epsilon-1}{\sigma-1}} \hat{X}_{n,s} \hat{P}_{n,s}^{\epsilon-1}, \tag{27}$$

and the change in the export supply capacity of country i in sector s is:

$$\hat{S}_{i,s} = \left(\frac{\hat{Y}_{i,s}}{\hat{c}_{i,s}^{\sigma}} \right)^{\frac{\epsilon-1}{\sigma-1}}.$$

Let M_i denote real income per capita in country i and E_i denote real expenditure per capita. Since the representative consumer has Cobb-Douglas preferences, the changes in real income and expenditure per capita are given by:

$$\hat{M}_i = \frac{\hat{w}_i}{\prod_v \left(\hat{P}_{i,v} \right)^{\beta_{i,v}}}, \qquad \hat{E}_i = \frac{\frac{w_i L_i}{w_i L_i + D_i} \hat{w}_i + \frac{D'_i}{w_i L_i + D_i}}{\prod_v \left(\hat{P}_{i,v} \right)^{\beta_{i,v}}}.$$

When trade is balanced, $D_i = D'_i = 0$, meaning that real income and real expenditure are equal.

D.2 Calibration data

The calibration uses data for 2000 from the 2013 release of the World Input-Output Tables (WIOT). The tables cover 40 countries plus a rest of the world aggregate and 35 ISIC Revision 3 industries. To reduce the dimensionality of the computational problem, we aggregate the data to 12 countries and 24 sectors. The countries are each of the G7 nations, China, regional aggregates for Europe, Asia and the Americas, and the rest of the world aggregate from WIOT. We preserve the WIOT industry aggregation for goods sectors, except for combining the Leather and Textiles industries, and we aggregate services industries to nine sectors. Table A3 shows the sector classification used for the calibration, together with the NTR gap for each sector.

The NAICS goods industries in our estimation dataset map many-to-one into WIOT sectors. To calculate the NTR gap, CostShock and IOExposure for WIOT goods sectors, and the input intensity, skill intensity and capital intensity for WIOT manufacturing sectors, we take the average across NAICS industries within each WIOT sector.

D.3 Output elasticity calibration

To compute the simulated effect of the NTR gap on US exports for a given output elasticity ψ, we start by solving the calibrated model with the output elasticity equal to ψ for goods sectors and zero for services sectors. Solving the model gives the change in export supply capacity $\hat{S}_{i,s}$ due to PNTR. We then calculate the NTR gap effect on US exports by estimating:

$$\frac{1}{7}\log \hat{S}_{i,s} = \delta_i + \delta_s + \alpha_{Sim,1} US_i \times NTRGap_s + \alpha_{Sim,2} US_i \times CostShock_s + \beta_{Sim} US_i \times Z_s + \epsilon_{i,s}, \tag{28}$$

where Z_s includes sector-level input-output exposure together with each sector's input, skill and capital intensity. Equation (28) is the model equivalent of the specification estimated in column (i) of Table 2 and $\alpha_{Sim,1}$ gives the simulated NTR gap effect shown in Figure 3.[32] To ensure consistency with the empirical estimates, when estimating equation (28) we do not include China in the set of exporters and only use manufacturing sectors.

D.4 Sectoral import liberalization

It is instructive to consider the impact of opening up a single sector at a time to Chinese imports. To this end, we simulate the local elasticity of US exports $EX_{U,s} = \sum_{n \neq U} X_{nU,s}$ to openness $\varphi_{UC,s}$ at the calibrated equilibrium with aggregate US GDP as the numeraire.[33] Figure 7 plots the export elasticity for each goods sector in the calibrated model (left hand bar for each sector) and in an alternative model without scale economies where the output elasticity equals zero in all sectors (right hand bar).

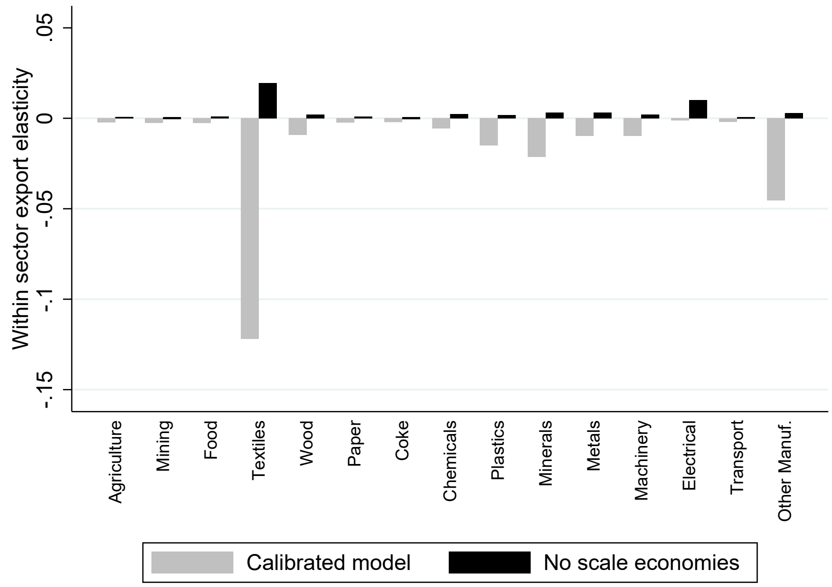
With scale economies the elasticities are negative in all sectors, implying that reducing barriers to Chinese imports in a given sector decreases US exports relative to GDP in the same sector. In this sense, import liberalization is export destroying within sectors. However, in the model without scale economies the elasticities are positive for all sectors. Moreover, the correlation between the elasticities with and without scale economies is negative 0.83. This comparison shows how the existence of scale economies leads to qualitative changes in the within-sector effects of import liberalization.

By contrast, we find that the local elasticity of total US exports $\sum_v EX_{U,v}$ to openness $\varphi_{UC,s}$ is positive for all sectors s regardless of whether there are scale economies. And the correlation

[32] Note from equation (27) that $\alpha_{Sim,1}$ can be estimated using $\hat{S}_{i,s}$ instead of $\hat{X}_{ni,s}$ because $\hat{\varphi}_{ni,s} = 1$ for all exporters other than China. Consequently, the simulated NTR gap effect on US exports is separable from changes in openness and import demand.

[33] Formally, we solve for $\widehat{EX}_{U,s}$ when US openness to Chinese imports increases by one percent in sector s (i.e. $\hat{\varphi}_{UC,s} = 1.01$) and is unchanged in all other sectors.

Figure 7: Within sector elasticity of US exports to openness to Chinese imports



Notes: Simulated within sector percent change in US exports resulting from a one percent increase in openness to Chinese imports, holding openness of all other sectors constant. In calibrated economy output elasticity is 0.821 for goods sectors and zero for services sectors. In model without scale economies output elasticity is zero for all sectors. US GDP is the numeraire. Goods sectors only.

between the total export elasticities with and without scale economies is 0.58. This occurs because the cross-sectoral impact of import liberalization is export promoting and does not depend upon the existence of scale economies.

D.5 Alternative calibrations

Table A4 reports the impact of PNTR on US exports and welfare for a range of alternative calibrations. For reference, column (a) summarizes the results from the baseline calibration used in Section III.B and column (b) summarizes the results for the calibration with constant returns to scale. In column (c) we use a model without input-output linkages between sectors. To calibrate this model, we set value-added equal to observed output from WIOT. Since US GDP is the numeraire, the input cost effect does not impact US exports in this case. As is well known, the gains from trade liberalization are smaller when there is no trade in intermediate inputs (Costinot and Rodríguez-Clare 2014). Comparing column (c) to column (a) also shows that removing input-output linkages weakens the real market potential effect leading to a lower simulated NTR gap effect of -0.079 and a less negative specialization effect on real income. This comparison confirms that the interaction of input-output linkages with scale economies is quantitatively important to explain the baseline results.

The baseline calibration assumes that there are no scale economies in services sectors. In column (d) we set the output elasticity equal to 0.821 for all sectors, implying that the strength of scale economies is the same for goods and services. We find that the existence of scale economies in services leads to slight increases in the strength of the real market potential and input cost effects, as well as a higher ACR effect, which boosts the gains from trade. However, the results are qualitatively unaffected. In addition the specialization effect is essentially unchanged from column (a). It follows that cross-sectoral heterogeneity in scale economies is quantitatively unimportant for understanding the welfare effects of PNTR. Instead, the negative specialization effect results from the combination of scale economies with input-output linkages.

A notable feature of the baseline results is the large contraction of the Textiles and Leather sector. In column (e) we calibrate a 23 sector version of the model where Textiles and Leather is merged with Other Manufacturing, which is the sector with the second highest NTR gap. Otherwise, the calibration is unchanged. The results in column (e) are very similar to the baseline. At the sector level, we find that PNTR reduced exports in the merged Textiles and Leather plus Other Manufacturing sector by 14 percent.

In column (f) we calibrate the model allowing the trade and output elasticities to vary across goods sectors. For manufacturing sectors (except Other Manufacturing) we use trade and scale elasticities from Bartelme et al. (2019).[34] For all other sectors, the calibration is unchanged from the baseline economy. The model with heterogeneous elasticities yields a slightly less negative simulated NTR gap effect, partly because there is a negative correlation between the NTR gap and the calibrated trade elasticities. However, we continue to find that PNTR increased US exports relative to GDP because the positive input cost and foreign demand effects more than offset export destruction due to the real market potential effect. US gains from PNTR are smaller than in the baseline calibration (reflecting the fact that in column (f) the average trade elasticity for goods sectors increases to 6.5), but remain positive.

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[34] We use the median trade elasticities reported in Table B.3 and the scale elasticity estimates from column (2) of Table 1. Consistent with our model, we compute the output elasticity as the product of the trade and scale elasticities.

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Table A1: PNTR and US export growth, robustness checks

Dependent variable	Export growth						
	PNTR in 2001	Pierce-Schott NTR gap	Handley-Limão NTR gap	Import share weighted CostShock	PPML	Total exports OLS	Total exports PPML
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Post x US x NTRGap	-0.11	-0.056	-0.081	-0.074	-0.089	-0.15	-0.11
	(0.047)	(0.031)	(0.030)	(0.044)	(0.033)	(0.057)	(0.047)
Post x US x CostShock	-0.30	-0.25	-0.16	-7.94	-0.38	-0.11	-0.14
	(0.097)	(0.071)	(0.049)	(2.35)	(0.11)	(0.14)	(0.17)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Aggregation of exports	Bilateral	Bilateral	Bilateral	Bilateral	Bilateral	Total	Total
Estimator	OLS	OLS	OLS	OLS	PPML	OLS	PPML
Observations	1,019,305	1,010,551	1,010,551	1,010,551	1,010,551	17,573	17,573
R-squared	0.50	0.50	0.50	0.50	0.02	0.63	0.01

Notes: Standard errors clustered by exporter-industry in parentheses. Estimated in long differences using 1995-2000 as pre-PNTR period and 2000-07 as post-PNTR period, except column (a) where pre-period is 1995-2001 and post-period is 2001-07. Industry sample covers 384 NAICS manufacturing industries. Country sample includes countries with population above one million in 1995 and requires exporters to be OECD members at start of 1995. NTR gap is defined as the log difference between the US non-NTR and NTR tariffs, except in column (b) where the difference in levels is used as in Pierce and Schott (2016) and column (c) where the NTR gap is defined following Handley and Limão (2017). CostShock and input-output exposure variables in column (d) calculated adjusting for using US import shares. All columns include triple interactions of a post-period dummy, a US exporter dummy and the input-output exposure, and input, skill and capital intensity variables. All columns except (e) and (f) include importer-exporter-industry, importer-exporter-period and importer-industry-period fixed effects. In columns (e) and (f) the dependent variable is based on total exports to all destinations and these columns include exporter-industry, exporter-period and industry-period fixed effects. Pseudo R-squared reported for PPML regressions in columns (e) and (g).

Table A2: PNTR and US export growth, additional robustness checks

Dependent variable	Δ Log Exports							
	Only US exports	OECD & Non-OECD exporters	All exporters & importers	Trim sample on NTR gap	Drop textiles & apparel industries	China shock	Expenditure shock	Expenditure shock & final demand share
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Post x US x NTRGap	-0.17	-0.088	-0.098	-0.17	-0.096	-0.11	-0.10	-0.10
	(0.054)	(0.043)	(0.041)	(0.062)	(0.049)	(0.046)	(0.045)	(0.044)
Post x US x CostShock	-0.30	-0.28	-0.27	-0.39	-0.16	-0.33	-0.31	-0.21
	(0.10)	(0.093)	(0.091)	(0.096)	(0.11)	(0.093)	(0.091)	(0.094)
US x ChinaShock						0.63		
						(0.99)		
Post x US x ExpenditureShock							0.020	-0.092
							(0.052)	(0.066)
Post x US x Final								0.040
								(0.016)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimator	OLS	OLS	OLS	OLS	OLS	IV	OLS	OLS
Kleibergen-Paap F-stat.						12.1		
Observations	69,003	1,762,374	1,978,551	931,509	903,938	998,539	1,010,551	1,010,551
R-squared	0.42	0.48	0.48	0.51	0.50		0.50	0.50

Notes: Standard errors clustered by exporter-industry in parentheses. Estimated in long differences using 1995-2000 as pre-PNTR period and 2000-07 as post-PNTR period. Industry sample covers 384 NAICS manufacturing industries, except column (d) drops industries that have an NTR gap in the bottom or top 5 percent of the NTR gap distribution and column (e) drops all textile and apparel industries. Country sample includes countries with population above one million in 1995 and requires exporters to be OECD members at start of 1995, except column (a) drops all exporters other than US, column (b) includes all exporters with population above one million in 1995 and column (c) includes all exporters and importers regardless of population or OECD membership. In column (f) ChinaShock is the annualized change in US imports from China during the period in million dollars relative to start-of-period industry employment and US x ChinaShock is instrumented with US times the annualized change in Chinese exports to non-OECD countries relative to industry employment five years before the start of the period. All columns include triple interactions of a post-period dummy, a US exporter dummy and the input-output exposure, and input, skill and capital intensity variables. All columns except (a) include importer-exporter-industry, importer-exporter-period and importer-industry-period fixed effects. Column (a) includes importer-industry and importer-period fixed effects.

Table A3: Calibration sectors

Code	Name	NTR gap	Group
AtB	Agriculture	0.06	Other Goods
C	Mining	0.04	Other Goods
15t16	Food	0.13	Manufacturing
17t19	Textiles & Leather	0.35	Manufacturing
20	Wood	0.22	Manufacturing
21t22	Paper	0.26	Manufacturing
23	Coke	0.05	Manufacturing
24	Chemicals	0.21	Manufacturing
25	Plastics	0.30	Manufacturing
26	Minerals	0.25	Manufacturing
27t28	Metals	0.26	Manufacturing
29	Machinery	0.28	Manufacturing
30t33	Electrical	0.32	Manufacturing
34t35	Transport	0.22	Manufacturing
36t37	Other Manufacturing	0.34	Manufacturing
E	Utilities		Services
F	Construction		Services
50-52	Retail & Wholesale		Services
H	Hospitality		Services
60-64	Transport Services		Services
J	Finance		Services
70	Real Estate		Services
71t74	Business Services		Services
L-P	Other Services		Services

Notes: ISIC Revision 3 sectors. Sectoral NTR gap defined as average NTR gap for NAICS goods industries within each sector. Goods comprises Manufacturing and Other Goods sectors.

Table A4: Impact of PNTR on US exports, output and welfare for alternative model calibrations (percent changes)

	Baseline	No scale economies	No input-output linkages	Scale economies in services	23 sectors	Heterogeneous elasticities
	(a)	(b)	(c)	(d)	(e)	(f)
Total exports	3.2	2.5	3.2	3.2	3.4	3.0
of which: Real market potential effect	*-1.8*	*n/a*	*-0.17*	*-2.4*	*-1.7*	*-1.4*
Input cost effect	*2.4*	*0.53*	*n/a*	*3.1*	*2.3*	*2.7*
Foreign demand effect	*2.7*	*1.9*	*3.4*	*2.6*	*2.9*	*1.8*
Simulated NTR gap effect	-0.10	0.0075	-0.079	-0.10	-0.098	-0.071
Goods output	-0.55	-0.36	-0.36	-0.61	-0.49	-0.25
Services output	0.11	0.075	0.12	0.12	0.13	0.054
Real income	0.068	0.10	0.037	0.10	0.071	0.027
of which: ACR effect	*0.22*	0.10	*0.067*	*0.24*	*0.19*	*0.13*
Specialization effect	*-0.15*	*n/a*	*-0.030*	*-0.14*	*-0.11*	*-0.10*

Notes: Simulated percent changes. Services sectors: trade elasticity is five; output elasticity is zero, except in column (d) where output elasticity is 0.821. Goods sectors: trade elasticity is five in columns (a)-(e); output elasticity is 0.821 in columns (a), (c), (d) (and (e); output elasticity is zero in column (b); model in column (f) calibrated using trade and output elasticities for goods sectors from Bartelme et al. (2019). In column (e) Textiles & Leather sector merged with Other Manufacturing. US GDP is the numeraire. Export decomposition terms averaged across sectors using pre-PNTR US export shares as weights.