How Did China's WTO Entry Affect U.S. Prices?

Mary Amiti
Federal Reserve Bank of New York

Mi Dai
Beijing Normal University

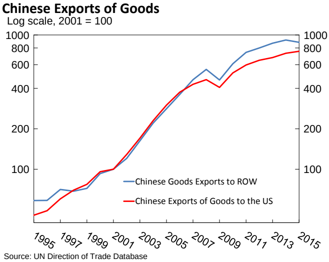
Robert C. Feenstra
University of California, Davis

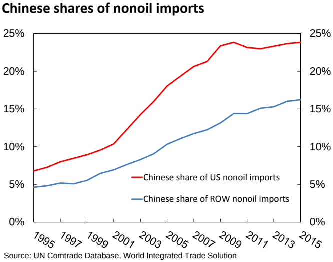
John Romalis
University of Sydney

Trade Policy Reform

- China joined the WTO in 2001
  - It was granted Permananent Normal Trade Relations (PNTR) by U.S. Congress
  - China reduced its own import tariffs
  - China implemented other trade reforms
    - ⇒ export restrictions
    - ⇒ import restrictions
    - ⇒ FDI restrictions
- After joining the WTO, China's world exports initially grew 30% annually (2001-2006)
  - China's share in U.S. merchandise imports is now 21%
  - China's share of "world" merchandise imports is 13%

Chinese Export Growth





Connecting Trade Policy to Export Participation and Prices

- Study effects of detailed trade policy changes upon WTO entry
- Study the relationship between intermediate input use and firm productivity
  - Theoretically, introducing the role of Chinese trade policy
  - Empirically using Chinese firm-level data
- Study effect of WTO entry on Chinese firms' export participation and prices
  - Theoretically, introducing the role of tariff uncertainty
  - Empirically, using a proxy for U.S. tariff uncertainty
  - Construct instruments for export participation and export prices

Connecting Trade Policy to Export Participation and Prices

- Estimate the impact on U.S. Prices
  - Measuring the U.S. Price Index
    - $\Rightarrow$ CES price index accounting for product variety
  - Estimating the impact of new Chinese goods
  - Estimating the impact of lower Chinese export prices

Related Literature

- China's effect on U.S. economy:
  - Autor et al. (2013), Acemoglu et al. (2016) and Pierce and Schott (2016) find negative employment and wage effects in competing U.S. manufacturing industries
  - Pierce and Schott (2016) attribute the fall in U.S. manufacturing employment to changed U.S. trade policy, which granted PNTR.
  - Handley and Limao (forthcoming) show that PNTR reduced uncertainty, increased U.S. imports from China, and lowered and lowered the U.S. price index (using industry-level data).
  - Bai and Stunpner (2017) association between rising Chinese import penetration and U.S retail prices
    - ⇒ *We exploit Chinese firmXproduct data and mostly focus on how China's lower input tariffs affected US prices, while also accounting for PNTR.*

Related Literature

- Input tariffs and TFP
  - Blaum et al. (2016), Antras et al. (2017), Gopinath and Neiman (2014), and Halpern et al. analyze how expanded sourcing of inputs can raise productivity
  - Amiti and Konings (2007), Kasahara and Rodrigue (2008), Goldberg et al. (2010), Halpern et al. (2015), Yu (2017), and Brandt et al. (forthcoming) empirically study effect of lower input tariffs on firm TFP.

Related Literature

- General equilibrium models of China's overall welfare effect:
  - Hsieh and Ossa (2016) calibrate a multi-country model with 2-digit industry data and find that China transmitted small gains to the rest of the world.
  - Caliendo, Dvorkin and Parro (2015) combine a model of heterogeneous firms with a dynamic labor search model find short-run U.S. employment losses, but long-run welfare gains.
- *These GE models assume an unbounded Pareto distribution and a limited sourcing strategy for inputs.*
- *Our empirical approach does not depend on any particular producitivity distribution and allows for more general sourcing of inputs.*

Theory: U.S. Consumers

Upper level utility from consuming g (HS 6-digit industry) in the U.S.

$$U_t = \left(\sum_{g \in G} (\alpha_g Q_{gt})^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}}$$

- Good g is a CES aggregate of HS6 goods from each country i.

$$Q_{gt} = \left(\sum_{i \in I_{gt}} \left(Q^i_{gt} \right)^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}}$$

- Each country's good is a CES aggregate of individual varieties sold by each country i within g, with $\alpha^i_g > 0$ a quality or taste parameter:

$$Q^i_{gt} = \left(\sum_{\omega \in \Omega^i_{gt}} (\alpha^i_g(\omega) q^i_{gt}(\omega))^{\frac{\rho_g - 1}{\rho_g}} \right)^{\frac{\rho_g}{\rho_g - 1}}$$

Theory: U.S. Consumers

- The CES price index corresponding to the utility function:

$$P^i_{gt} = \left(\sum_{\omega \in \Omega^i_{gt}} \left(p^i_{gt}(\omega) / \alpha^i_g(\omega) \right)^{1-\rho_g} \right)^{\frac{1}{1-\rho_g}}$$

- with share of product variety ω within the exports of country i:

$$s^i_{gt}(\omega) \equiv \left(\frac{p^i_{gt}(\omega) q^i_{gt}(\omega)}{\sum_{\omega \in \Omega^i_{gt}} p^i_{gt}(\omega) q^i_{gt}(\omega)} \right) = \left(\frac{p^i_{gt}(\omega) / \alpha^i_g(\omega)}{P^i_{gt}} \right)^{1-\rho_g}$$

Theory: Production

- Heterogeneous firms model as in Melitz (2003) extended to incorporate domestic and intermediate inputs
- Within each industry g, firms pay a sunk cost of entry F_g^E to draw productivity φ, and then choose whether to pay per-period fixed costs of exporting F_g
- Production function (as in Blaum et al. 2016):

$$Y_{ft} = \varphi_{ft} L_{ft}^{\gamma} \left(\left(\alpha_D Q_{ft}^D \right)^{\frac{\sigma-1}{\sigma}} + \left(\alpha_M Q_{ft}^M \right)^{\frac{\sigma-1}{\sigma}} \right)^{(1-\gamma)\frac{\sigma}{\sigma-1}}$$

  - We assume aggregate imported input is a CES aggregate of all imported inputs $n \in \Sigma_{ft}$ (sourcing strategy) purchased by firm f :

$$Q_{ft}^M = \left(\sum_{n \in \Sigma_{ft}} \left(\alpha_n q_{fnt} \right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}$$

Theory: Tariffs

- τ_{nt} is one plus the *advalorem* Chinese tariff on imported input n;
- τ_{ht} is one plus the *advalorem* U.S. tariff on Chinese export h;
  - Chinese firms face two possible values of the U.S. tariff: $\tau_{ht} \in \left\{\tau_h^{MFN}, \overline{\tau}_h\right\}$

Step 1: Intermediate Inputs and Firm Productivity

- Unit cost function dual to production function (with nominal wage always set to unity from now onwards):

$$C_{ft} = C(P_t^D, c_{ft}^M, \varphi_{ft}) = \varphi_{ft}^{-1}\left((P_t^D/\alpha_D)^{1-\sigma} + (c_{ft}^M/\alpha_M)^{1-\sigma}\right)^{\frac{1-\gamma}{1-\sigma}}.$$

  - Where P_t^D is the price index for domestic inputs and c_{ft}^M is the unit cost function for imported inputs:

$$c_{ft}^M = \left(\sum_{n\in\Sigma_{ft}} (p_{nt}\tau_{nt}/\alpha_n)^{1-\rho}\right)^{\frac{1}{1-\rho}}$$

- Change in unit cost function can be rewritten in terms of share of intermediate input expenditure spent on domestic inputs (Blaum et al. 2016):

$$\frac{C_{ft}}{C_{f0}} = \frac{\varphi_{f0}}{\varphi_{ft}}\left(\frac{P_t^D}{P_0^D}\right)^{1-\gamma}\left(\frac{S_{ft}^D}{S_{f0}^D}\right)^{\frac{1-\gamma}{\sigma-1}}$$

Step 1: Intermediate Inputs and Firm Productivity

- Change in unit cost function can alternatively be written to directly incorporate costs of imported inputs:

$$\frac{C_{ft}}{C_{f0}} = \frac{\varphi_{f0}}{\varphi_{ft}} \left(\frac{P_t^D}{P_0^D}\right)^{W_{ft}^D(1-\gamma)} \left(\frac{c_{ft}^M}{c_{f0}^M}\right)^{W_{ft}^M(1-\gamma)}$$

  - Where $\frac{c_{ft}^M}{c_{f0}^M}$ is the price index for imported inputs and W_{ft}^M is the Sato Vartia ideal log-change index number weight:

$$\frac{c_{ft}^M}{c_{f0}^M} = \left[\prod_{n\in\overline{\Sigma}_f} \left(\frac{p_{nt}\tau_{nt}}{p_{n0}\tau_{n0}}\right)^{w_{nt}}\right] \left(\frac{\lambda_{ft}}{\lambda_{f0}}\right)^{\frac{1}{\rho-1}}$$

  - Where λ_{ft} is expenditure on imported inputs in the common set $\overline{\Sigma}_f$ relative to total expenditure in period t, and w_{nt} is the Sato Vartia weight for input n.

Step 1: Intermediate Inputs and Firm Productivity

- Substituting and rearranging:

$$\left(\frac{P_t^D}{P_0^D}\right)^{W_{ft}^D(1-\gamma)} \left[\prod_{n\in\overline{\overline{\Sigma}}_f} \left(\frac{p_{nt}\tau_{nt}}{p_{n0}\tau_{n0}}\right)^{w_{nt}}\right]^{W_{ft}^M(1-\gamma)} \left(\frac{C_{ft}}{C_{f0}}\right)^{-1} =$$

$$\frac{\varphi_{ft}}{\varphi_{f0}} \left(\frac{\lambda_{ft}}{\lambda_{f0}}\right)^{-\frac{W_{ft}^M(1-\gamma)}{\rho-1}}$$

  - LHS is a dual measure of productivity (input costs / unit costs), while RHS includes exogenous productivity parameter and endogenous import variety growth. We will construct instruments for the latter from trade liberalization upon WTO entry.

Trade Liberalization

Table: Average Tariffs

	China's tariffs on intermediate inputs					
	HS8 digit		IO category		Gap	
Year	Average	Std Dev	Average	Std Dev	Average	Std Dev
	(1)	(2)	(3)	(4)	(5)	(6)
2000	0.15	0.10	0.13	0.05	0.24	0.15
2001	0.14	0.09	0.12	0.05	0.24	0.15
2002	0.11	0.08	0.09	0.03	0	0
2003	0.10	0.07	0.08	0.03	0	0
2004	0.10	0.07	0.08	0.03	0	0
2005	0.09	0.06	0.07	0.03	0	0
2006	0.09	0.06	0.07	0.02	0	0

Notes: All tariffs are defined as the log of 1 plus the ad valorem tariff. Column 1 presents the simple average of China's import tariffs on HS 8-digit industries. Column 3 presents the mean of the cost-weighted averages of China's input tariffs within an IO industry codes. Column 5 presents the simple average "gap" between the U.S. column 2 tariff and the U.S. MFN tariff in 2000.

Chinese Firm Input Imports

- Import Value

$$\ln M_{fnt} = \gamma_1 \ln \tau^i_{nt} + \gamma_2 \ln \tau^i_{nt} \times Process_f + \gamma_f + \gamma_t + \epsilon_{1fnt},$$

- Import Participation:

$$\begin{aligned} I^M_{fnt} = \ & \theta_1 \ln \tau^i_{nt} + \theta_2 \ln \tau^i_{nt} \times Process_f + \theta_3 \ln ShareEligible_{gt} + \\ & \theta_4 \ln ShareEligible_{gt} \times Foreign_f + \theta_f + \theta_t + \epsilon_{2fnt} \end{aligned}$$

Chinese Firm Input Imports

Table: Chinese Input Imports

Dependent variable	I^M_{fnt} =1 if M_{fnt} >0	$ln(M_{fnt})$		
	(1)	(2)	(3)	(4)
$ln(\tau_{nt})$	-0.200***	-5.466***	-5.378***	-5.121***
	(0.026)	(0.662)	(0.660)	(0.665)
$ln(\tau_{nt}) \times Process_f$	0.536***	5.531***	5.100***	4.619***
	(0.051)	(0.780)	(0.778)	(0.811)
$ln(ShareEligible_{gt})$	-0.075***			
	(0.005)			
$ln(ShareEligible_{gt}) \times Foreign_f$	0.186***			
	(0.005)			
Selection Control		no	yes	yes
Year FE	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes
# obs.	25,599,921	7,027,916	7,027,916	7,027,916
R^2	0.048	0.152	0.152	0.153

Notes: All observations are at the HS8-firm-year level.

Chinese Firm Input Imports

- Chinese tariff reductions cause more imports on extensive and intensive margins; leading to higher TFP
- Instruments for λ_{ft} from predicted values
- Many firms did not have common imported inputs over sample period, so constuct separate instruments for components of λ_{ft}
  - $\ln \hat{M}_{tot,ft}$: predicted total imports (corresponds to denominator of λ_{ft})
  - $\ln \hat{M}_{max,ft}$: predicted imports in firm's largest import category
  - $\ln \hat{\lambda}_{ft} = \ln \hat{M}_{max,ft}$ - $\ln \hat{M}_{tot,ft}$: proxy negatively related to extensive margin

Chinese Productivity Growth

Table: Chinese Productivity Growth

Year	Total factor productivity			Real value added per worker		
	All exporters	Matched sample		All exporters	Matched sample	
	Simple av	Simple av	Weighted av	Simple av	Simple av	Weighted av
2001	0.00	0.01	0.05	0.00	0.00	0.07
2002	0.08	0.11	0.10	0.10	0.11	0.09
2003	0.13	0.14	0.13	0.15	0.15	0.15
2004	0.10	0.12	0.11	0.11	0.12	0.13
2005	0.18	0.17	0.13	0.21	0.20	0.14
2006	0.11	0.11	0.07	0.15	0.13	0.10
Average	0.10	0.11	0.10	0.12	0.12	0.11

Notes: Total factor productivity is estimated at the firm level as in Olley and Pakes (1996). More recent approaches also used during robustness checks.

Chinese Productivity Growth

Table: Chinese Firm TFP and Importing

Dependent variable	$ln(TFP_{ft})$			$ln(TFP_{ft})$	First Stage: $ln(S^D_{ft})$
	(1)	(2)	(3)	(4)	(5)
$ln(S^D_{ft})$			-0.036***	-0.655***	
			(0.009)	(0.063)	
$ln(\hat{M}_{max,ft})$	-0.041***	-0.042***			
	(0.012)	(0.013)			
$ln(\hat{M}_{tot,ft})$	0.052***	0.052***			
	(0.005)	(0.005)			
$ln(\hat{\lambda}_{ft})$					0.084***
					(0.003)
$ln(Input\tau_{gt})$		0.243			
		(0.442)			
$ln(Gap_g) \times WTO_t$		0.027			
		(0.062)			
# obs.	82,203	79,276	76,603	76,603	76,603

Note: All columns include firm fe and year fe.

We use Column 1 estimates to construct $\ln(\hat{TFP}_{ft}) = -0.04 \times \ln \hat{M}_{max,ft} + 0.05 \times \ln \hat{M}_{tot,ft}$ to estimate export equations.

Step 2: Chinese Firm Exports

- Firm's price is a markup over marginal costs:

$$p_{fht} = \frac{\rho_g}{(\rho_g - 1)} C(P_t^D, c_{ft}^M, \varphi_{ft}) \tau_{ht}$$

  - where τ_{ht} is one plus the *ad valorem* U.S. MFN tariff.
  - Assume that firms make pricing decision after tariff is known

- Firm Exports

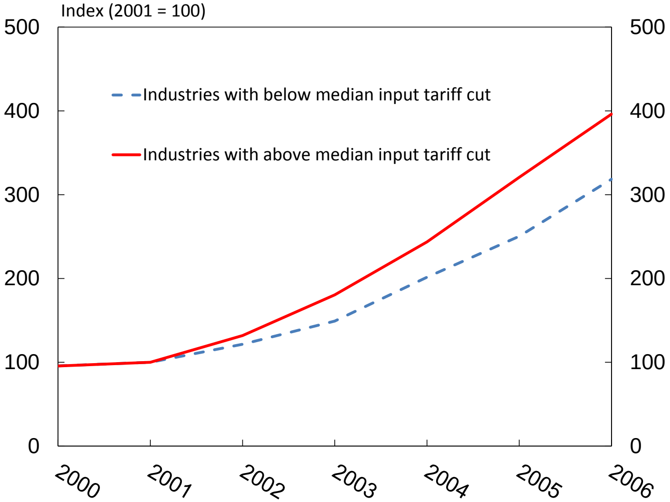
$$p_{fht} q_{fht} = X_{gt} \left(\frac{\rho_g C_{ft} \tau_{ht}}{(\rho_g - 1) P_{gt}} \right)^{1-\rho_g}$$

  - where X_{gt} is the expenditure on all varieties that the U.S. imports from China

- Zero Profit Cutoff

$$\frac{p_{fht} q_{fht}}{\tau_{ht} \rho_g} \geq F_g$$

China's U.S. Exports and China's Input Tariffs



Uncertainty in Tariffs

- $\tau_{gt} \in \left\{\tau_g^{MFN}, \overline{\tau}_g\right\}$, where $\overline{\tau}_g > \tau_g^{MFN}$.
- We use simplified model of Handley and Limão (2017).
  - Firm sets price after tariff is known; export participation decision is made before the tariff is known
  - If the tariff starts at τ_g^{MFN} it remains there in the next period with probability π, and with probability $(1-\pi)$ the tariff moves to its column 2 level, $\bar{\tau}_g$; if it starts at $\bar{\tau}_g$ it stays there forever.
  - Some component of fixed cost of exporting is sunk, F_g^E, with remaining per period fixed cost of exporting, F_g
- One-period profits:

$$v(\varphi_f, \tau_{ht}) = \frac{p_{fht} q_{fht}}{\tau_{ht} \rho_g} - F_g = \frac{X_{gt}}{\tau_{ht} \rho_g} \left(\frac{\rho_g C_f \tau_{ht}}{(\rho_g - 1) P_{gt}} \right)^{1-\rho_g} - F_g$$

Uncertainty in Tariffs

- With a discount rate $\delta < 1$, discounted value of Chinese firm facing MFN tariffs is:

$$V\left(\varphi_f, \tau_h^{MFN}\right) = v(\varphi_f, \tau_h^{MFN}) + \delta\left[\pi V(\varphi_f, \tau_h^{MFN}) + (1-\pi) V(\varphi_f, \overline{\tau}_h)\right]$$

- From assumption that column 2 tariff is an absorbing state, the entry condition for a firm facing MFN tariffs:

$$\int_{\varphi} V(\varphi, \tau_h^{MFN}) dG = \int_{\varphi} \left\{ \frac{v(\varphi, \tau_h^{MFN})}{(1-\delta\pi)} + \frac{\delta(1-\pi) v(\varphi, \overline{\tau}_h)}{(1-\delta)(1-\delta\pi)} \right\} dG \geq F_g^E$$

- This can be rewritten in terms of one-period profits:

$$\int_{\varphi} v(\varphi, \tau_g^{MFN}) dG \geq (T_g - 1) F_g + T_g (1-\delta) F_g^E$$

$$\textit{with } T_g \equiv \left\{ \tfrac{(1-\delta)}{(1-\delta\pi)} + \tfrac{\delta(1-\pi)}{(1-\delta\pi)} \left(\tfrac{\overline{X}_g / \overline{\tau}_g}{X_g^{MFN} / \tau_g^{MFN}} \right) \right\}^{-1}.$$

If discounting is small $\delta \to 1$

$$\ln T_g \to \left(\ln \overline{\tau}_g - \ln \tau_g^{MFN}\right) - \left(\ln \overline{X}_g - \ln X_g^{MFN}\right)$$

Chinese Firms' U.S. Exports

Table: Chinese Firms' U.S. Exports

Dependent variable	I^X_{fht} =1 if X_{fht} >0	$ln(s_{fht})/(1-\bar{\rho})$		$ln(price_{fht})$		
		IV	IV			
	(1)	(2)	(3)	(4)	(5)	(6)
$ln(\widehat{TFP}_{ft})$	1.918***			-1.000†	-1.000†	-1.000†
	(0.033)					
$ln(TFP_{ft})$		-0.938***	-1.062***			
		(0.149)	(0.292)			
$ln(Input\tau_{gt})$	-1.948***			3.101***	3.645**	3.632**
	(0.452)			(1.167)	(1.583)	(1.594)
$ln(Input\tau_{gt}) \times Process_{fh}$	-0.198			-1.689***	-1.165**	-1.157**
	(0.153)			(0.572)	(0.516)	(0.518)
$Process_{fh}$	0.020			0.172**	0.113*	0.113*
	(0.012)			(0.066)	(0.064)	(0.064)
$ln(P^D_{gt})$	0.024			0.466**	0.470**	0.469**
	(0.096)			(0.188)	(0.187)	(0.187)
$ln(Gap_g) \times WTO_t$	0.070*					-0.034
	(0.036)					(0.111)
$ln(ShareEligible_{gt})$	-0.012					
	(0.024)					
$ln(ShareEligible_{gt}) \times Foreign_f$	0.251***					
	(0.017)					

Chinese Firms' Export Prices

- Reintroducing quality parameter, quality-adjusted prices are a markup over marginal costs:

$$\frac{p_{fht}}{\alpha_{fht}} = \frac{\rho_g}{(\rho_g - 1)} C(P_t^D, c_{ft}^M, \varphi_{ft})\tau_{ht}$$

- Measuring MC using (endogenous) TFP, the index of input tariffs, and the price index for domestic intermediate inputs, and modelling unobserved quality as the error term:

$$\ln p_{fht} = \beta_1 \ln TFP_{ft} + \beta_2 \ln Input\tau_{gt} + \beta_3 \ln P_{gt}^D + \beta_f + \beta_h + \beta_t + \epsilon_{4fht}$$

- Product quality usually correlated with TFP, so IV for TFP does not give unbiased estimates. From the demand side, quality adjusted price should be reflected in market share:

$$\frac{\ln s_{fht}}{(1-\bar{\rho})} = \ln\left(\frac{p_{fht}}{\alpha_{fht}}\right) - \ln P_{gt} = \beta_f + \beta_{gt} + \beta_1 \ln TFP_{ft} + (\epsilon_{4fht} - \ln \alpha_{fht})$$

- $\ln \hat{M}_{max,ft}$ - $\ln \hat{M}_{tot,ft}$ used as instruments for TFP, should return unbiased estimate of β_1. Estimates very close to the expected -1, which we impose on export price regressions.

Step 3: Exact U.S. Import Price Index (China)

- U.S. price index for imports from China (country$i$):

$$\frac{P^i_{gt}}{P^i_{g0}} = \underbrace{\left[\prod_{\omega \in \overline{\Omega}^i_g} \left(\frac{p^i_{gt}(\omega)}{p^i_{g0}(\omega)}\right)^{w^i_{gt}(\omega)}\right]}_{ChinaP_g} \underbrace{\left(\frac{\lambda^i_{gt}}{\lambda^i_{g0}}\right)^{\frac{1}{\rho_g - 1}}}_{ChinaVg}$$

- with Sato-Vartia weights, $w^i_{gt}(\omega)$ at the variety level within the common set.
- and variety correction (Feenstra (1994)):

$$\lambda^i_{gt} \equiv \frac{\sum_{\omega \in \overline{\Omega}^i_g} p^i_{gt}(\omega) q^i_{gt}(\omega)}{\sum_{\omega \in \Omega^i_{gt}} p^i_{gt}(\omega) q^i_{gt}(\omega)}$$

  - where $\overline{\Omega}^i_g$ denotes common varieties in time t and 0.
  - quality in "common" set is assumed constant
  - quality in λ terms can change

Step 3: Exact U.S. Price Indexes (country j)

- Other countries in U.S. Price Index (country j):

$$\frac{P^j_{gt}}{P^j_{g0}} = \underbrace{\left[\prod_{\omega \in \overline{\Omega}^j_g} \left(\frac{uv^j_{gt}(\omega)}{uv^j_{g0}(\omega)}\right)^{w^j_{gt}(\omega)}\right]}_{\text{country } j \ P_g} \underbrace{\left(\frac{\lambda^j_{gt}}{\lambda^j_{g0}}\right)^{\frac{1}{\rho_g - 1}}}_{\text{country } j \ Vg}$$

- where $uv^i_{gt}(\omega)$ is unit value at HS-10 digit level within HS 6-digit industry exported to U.S. by each country j over common set $\omega \in \overline{\Omega}^j_g$.
- For domestic U.S. sales, we use NAICS 6-digit PPI for P_g component; and the share of top 4 U.S. firms for V_g component.

Step 3: Decomposition of U.S. Price Index

The U.S. Price Index in industry g (aggregating across all countries):

$$\frac{P_{gt}}{P_{g0}} = \left[\prod_{j \in \bar{I}_g^j} \left(\frac{P_{gt}^j}{P_{g0}^j}\right)^{W_{gt}^j}\right] \left(\frac{\Lambda_{gt}}{\Lambda_{g0}}\right)^{\frac{1}{\sigma_g - 1}}$$

- Decomposition of U.S. price index:

$$\ln \frac{P_{gt}}{P_{g0}} = \underbrace{\ln \left[\prod_{\omega \in \bar{\Omega}_g^i} \left(\frac{p_{gt}^i(\omega)}{p_{g0}^i(\omega)}\right)^{W_{gt}^i w_{gt}^i(\omega)}\right]}_{\text{China} P_g} + \underbrace{\ln \left[\prod_{j \in \bar{I}_g \setminus i} \prod_{\omega \in \bar{\Omega}_g^k} \left(\frac{uv_{gt}^j(\omega)}{uv_{g0}^j(\omega)}\right)^{W_{gt}^j w_{gt}^j(\omega)}\right]}_{\text{Other} P_g}$$

$$+ \underbrace{\ln \left(\frac{\lambda_{gt}^i}{\lambda_{g0}^i}\right)^{\frac{W_{gt}^i}{\rho_g - 1}}}_{\text{China} V_g} + \underbrace{\ln \left(\left[\prod_{j \in \bar{I}_g \setminus i} \left(\frac{\lambda_{gt}^j}{\lambda_{g0}^j}\right)^{\frac{W_{gt}^j}{\rho_g - 1}}\right] \left(\frac{\Lambda_{gt}}{\Lambda_{g0}}\right)^{\frac{1}{\sigma_g - 1}} \right)}_{\text{Other} V_g}$$

Data: China

Chinese firm-product-country data, 2000 to 2006 (China Customs)

- values and quantities for imports and exports by HS8-firm-country (focus on manufacturing)
  - Number of U.S. exporters triples
  - construct exact price indices, elasticity of substitution between varieties – median ρ_g for China is 4.6
- China Annual Survey of Industrial Firms (ASIF), 1998 to 2006
  - survey of firms with annual sales greater than RMB 5 million (90% of manufacturing, 98% of export value).
  - variables to construct TFP: production, material costs, employment, capital - all at the firm level
- Matched Sample
  - intersection of China Customs and ASIF, matched by firm name, address, etc
  - covers a third of the exporting firms, which account for 50% of China's total U.S. exports

Data: U.S.

- U.S. imports (BEA)
  - import values and quantities at the HS10 digit level.
  - estimate elasticities of substitution between varieties within HS6-country, ρ_g, and elasticities of substitution across HS6, σ_g, with both medians equal to around 3.
- U.S. domestic (BEA)
  - production values and PPI at the 6-digit NAICS level, mapped to HS6

$\Rightarrow$ We take account of potential exit of other imported and domestic varieties

China's export growth to the U.S.

		Proportion of export growth due to different margins:					
		Variety at the HS8-firm level				Equivalent Price Change	
Year	Total Export Growth %	Intensive Margin	Extensive Margin	Extensive Margin new firms	Extensive Margin incumbents	Due to Chinese Variety	Weighted by China Share
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2001	4.2	0.09	0.91	0.75	0.17	-0.018	-0.001
2002	29.8	0.56	0.44	0.21	0.22	-0.040	-0.004
2003	32.2	0.61	0.39	0.23	0.16	-0.081	-0.004
2004	35.1	0.65	0.35	0.23	0.12	-0.026	-0.004
2005	29.4	0.57	0.43	0.22	0.21	-0.079	-0.005
2006	25.6	0.65	0.35	0.20	0.15	0.010	-0.003
2000-2006	290.0	0.15	0.85	0.69	0.16	-0.460	-0.031

- Most of China's export growth to the U.S. has been due to new varieties:
  - 85% of total growth is due to new varieties
  - 70% of total growth is due to new firms
- China's variety gain in the U.S. import price index is 46%
  - taking into account its share in U.S. consumption, it is 3.1%

Decomposition of U.S. Price Index

$$\ln \frac{P^j_{gt}}{P^j_{g0}} = \underbrace{ChinaP_g}_{IV1} + OtherP_g + \underbrace{ChinaV_g}_{IV2} + OtherV_g$$

- We regress the U.S. price index in industry g on the two instruments

$$ln\left(\frac{P_{gt}}{P_{g0}}\right) = \eta_0 + \eta_1 Chi\hat{n}aP_g + \eta_2 Chi\hat{n}aV_g$$

  - IV1 reflects China's common goods price index
  - IV2 reflects Chinese export variety
- We also regress each of the 4 components of the U.S. price index on the two China instruments (IV1 and IV2)

Construction of WTO China instruments

- IV1 is constructed from the predicted values from regression of China's export prices:

$$\hat{ChinaP_g} \equiv W^i_{gt} \ln \left[\prod_{fh \in \overline{\Omega}_g} \left(\frac{\hat{p}^i_{fht}}{\hat{p}^i_{fh0}} \right)^{w_{fht}} \right]$$

- The change in the predicted prices depends on the change in <u>China's input tariffs</u> but not on the <u>gap or PNR status</u>.

- IV2 is constructed from China's export participation equation.

$$\hat{ChinaV_g} \equiv \frac{W^i_{gt}}{\hat{\rho}_g - 1} \left[\ln \left(\frac{\sum_{fh \in \overline{\Omega}_g} \widehat{prob}_{fht}}{\sum_{fh \in \Omega_{gt}} \widehat{prob}_{fht}} \right) - \ln \left(\frac{\sum_{fh \in \overline{\Omega}_g} \widehat{prob}_{fh0}}{\sum_{fh \in \Omega_{g0}} \widehat{prob}_{fh0}} \right) \right]$$

- The change in the predicted probabilities depend on both the change in China's input tariffs and the gap.

Decomposition of WTO effect on U.S. Price Index

Dependent Variable		US Price Index (1)
	Growth 2000-2006	0.031
$\hat{ChinaP_g}$	-0.014	3.535***
		(0.815)
growth x regression coefficient contribution		
$\hat{ChinaV_g}$	-0.016	1.607***
		(0.157)
growth x regression coefficient contribution		
Total WTO effect		
N		1,599
R^2		0.096

Decomposition of WTO effect on U.S. Price Index

Dependent Variable		US Price Index (1)
	Growth 2000-2006	0.031
$\hat{ChinaP_g}$	-0.014	3.535***
		(0.815)
growth x regression coefficient		-0.049
contribution		65.2%
$\hat{ChinaV_g}$	-0.016	1.607***
		(0.157)
growth x regression coefficient		-0.026
contribution		34.8%
Total WTO effect		-0.076
N		1,599
R^2		0.096

- U.S. Price Index is 7.6 percent lower due to WTO

Decomposition of WTO effect on U.S. Price Index

Dependent Variable		US Price Index (1)	$ChinaP_g$ (2)	$OtherP_g$ (3)	$ChinaV_g$ (4)	$OtherV_g$ (5)
	Growth 2000-2006	0.031	0.013	0.049	-0.031	0.000
$\hat{ChinaP_g}$	-0.014	3.535***	1.266***	3.210***	-0.055	-0.885***
		(0.815)	(0.124)	(0.686)	(0.194)	(0.337)
growth x regression coefficient		-0.049	-0.018	-0.045	0.001	0.012
contribution		65.2%	23.3%	59.2%	-1.0%	-16.3%
$\hat{ChinaV_g}$	-0.016	1.607***	-0.086***	-0.003	1.744***	-0.049
		(0.157)	(0.024)	(0.132)	(0.037)	(0.065)
growth x regression coefficient		-0.026	0.001	0.000	-0.029	0.001
contribution		34.8%	-1.9%	-0.1%	37.8%	-1.1%
Total WTO effect		-0.076	-0.016	-0.045	-0.028	0.013
N		1,599	1,599	1,599	1,599	1,599
R^2		0.096	0.327	0.037	0.649	0.006

- U.S. Price Index is 7.6 percent lower due to WTO
  - 65% of the effect is due to lower import prices from China
  - Lower import prices are due to lower input tariffs, not PNTR
  - Lower Chinese prices reduce competitor prices and lead to exit

Robustness

	US Price Index					
	HHI	TFP	Final Goods	Inputs	HS4	Other Reforms
	(1)	(2)	(3)	(4)	(5)	(6)
$\hat{ChinaP_g}$	3.406***	3.412***	1.461**	1.978	3.800**	4.286***
	(0.815)	(0.836)	(0.633)	(1.790)	(1.554)	(0.887)
growth x regression coefficient	-0.048	-0.048	-0.037	-0.014	-0.047	-0.056
contribution	*64.1%*	*64.9%*	*41.4%*	*60.8%*	*81.1%*	*66.7%*
$\hat{ChinaV_g}$	1.623***	1.599***	1.787***	1.057***	0.768**	1.724***
	(0.158)	(0.157)	(0.137)	(0.238)	(0.315)	(0.161)
growth x regression coefficient	-0.027	-0.026	-0.052	-0.009	-0.011	-0.028
contribution	*35.9%*	*36.1%*	*58.6%*	*39.2%*	*18.9%*	*33.3%*
Total WTO effect	-0.075	-0.073	-0.090	-0.023	-0.058	-0.084
N	1,599	1,602	489	850	539	1,597

- Results are robust to alternative specfications
- Column 6 includes controls for other reforms: MFA, FDI, output tariffs, import licenses.

Conclusions

- China's WTO entry reduced the U.S. Price Index by 7.6% (around 1% per year between 2000-2006).
  - The price (as opposed to variety) impact accounts for two-thirds of this reduction, coming from lower input tariffs.
  - The predominant price effect is somewhat surprising, given the large growth in new varieties from China.
  - 60% of the WTO entry effect comes from reductions in U.S. price indexes for Chinese goods, and 40% through price indexes of competing goods.
- The gap only affects China's exports to the U.S. through its effect on export participation, but not through prices or TFP.
- The results suggest that the most significant effect on the U.S. price index is due to China's lower input tariffs
  - directly affecting export prices and indirectly through increasing TFP.
  - we find no effect of PNTR on Chinese firm TFP or export prices.

Appendix

Interpretation of Results

- Largest effect is on competitor prices:

$$OtherP_g = \sum_{j \in \bar{I}_g^j \setminus i} W_{gt}^j \ln\left(\frac{P_{gt}^j}{P_{g0}^j}\right) = 3.210\, Chi\hat{n}aP_g - 0.003\, Chi\hat{n}aV_g$$

- Note that $\sum_{j \in \bar{I}_g^j \setminus i} W_{gt}^j = 1 - W_{gt}^i$ where W_{gt}^{ij} is Chinese share in U.S. consumption within industry g
  - Instruments have weights W_{gt}^i
- Divide the terms $Chi\hat{n}aP_g$ and $Chi\hat{n}aV_g$ by $\overline{W}_t^i$ (average over industries g of Chinese shares=0.14) and $OtherP_g$ by $1 - \overline{W}_t^i$.

$$\frac{OtherP_g}{1 - \overline{W}_t^i} = 0.538 \frac{Chi\hat{n}aP_g}{\overline{W}_t^i} - 0.000 \frac{Chi\hat{n}aV_g}{\overline{W}_t^i}$$