Lecture 11: Trade, Welfare, Volatility

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Introduction

- Lectures 1-9 :
  - Review the most important theoretical frameworks used to model international trade
  - Assess their capacity to predict international trade flows
- Can be used to answer broader economic questions :
  1. What is the impact of trade on welfare ? (Lecture 10)
  2. What is the impact of specific experiments of trade liberalization ?
  3. How does trade affect the organization of production processes ?
  4. How much does trade spread the benefit of local improvements in technology ?
  5. What is the impact of trade liberalization on domestic labor markets ?
  6. How does specialization affect the volatility of GDPs ?
- Today's and next week's classes will cover questions 2, 3 and 6 / Second semester's course : Other "topics"

Today's class

- Use Eaton & Kortum (2002) as a benchmark
- Enrich the benchmark model with as many properties a possible : Multiple sectors, IO linkages, NT good sectors, Exogenous shocks, etc.
- Calibrate the model to actual data / estimate the unobserved parameters
- Use the estimated model to run counterfactual analyses
- Advantage over alternative approaches (eg CGE models) : Transparency + relatively parsimonious in terms of the required data (trade, sectoral production, tariffs, IO matrix)

Welfare Impact of Trade Liberalization

Trade and Welfare Impact of Trade Liberalization

- Caliendo & Parro (2015) build a Ricardian model to evaluate the trade and welfare impact of NAFTA
- NAFTA : A free trade area between the US, Mexico and Canada
  - Enhance trade within the area / Divert existing trade between the area and the RoW
  - Increase welfare : Access to cheaper consumption goods plus increased competitiveness through a drop in input prices

  $\rightarrow$ Potentially important Ricardian gains since the integrated countries have very different production structures
- Main insights :
  - Important role of sectoral IO linkages to amplify the trade and welfare effect of the partnership

Theoretical framework

i. Multiple sectors :

$$U_i = \prod_{k=1}^{K} {Q_i^k}^{\alpha_i^k}, \quad \sum_{k=1}^{K} \alpha_i^k = 1, \quad Q_i^k = \left[\int_0^1 Q_i^k(j)^{\frac{\sigma^k - 1}{\sigma^k}} dj \right]^{\frac{\sigma^k}{\sigma^k - 1}}$$

ii. Input-Output linkages :

$$c_i^k = {w_i}^{\gamma_i^k} \prod_{k'=1}^{K} {P_i^{k'}}^{\gamma_i^{k,k'}}, \quad \sum_{k=1}^{K} \gamma_i^{k,k'} = 1 - \gamma_i^k$$

iii. Non tradable sectors :

$$d_{ni}^k = +\infty \text{ for some } k$$

iv. Sector-specific productivity distributions (Fréchet) :

$$F_i^k(z) = e^{-T_i^k z^{-\theta^k}}$$

Analytical predictions

- Equilibrium prices under PC :

$$p_{ni}^k(j) = \frac{c_i^k}{z_i^k(j)} d_{ni}^k \quad \Rightarrow \quad P_n^k = A^k \left[\sum_{h=1}^{I} T_h^k \left[c_h^k d_{nh}^k \right]^{-\theta^k} \right]^{-1/\theta^k}$$

- Expenditure shares :

$$\begin{aligned} \pi_{ni}^k &= Pr[p_{ni}^k(j) \leq min_s\{p_{ns}^k(j); s \neq i\}] \\ &= \frac{T_i^k \left[c_i^k d_{ni}^k \right]^{-\theta^k}}{\sum_{h=1}^{I} T_h^k \left[c_h^k d_{nh}^k \right]^{-\theta^k}} \end{aligned}$$

  Changes in tariffs affect π_{ni}^k directly (through d_{ni}^k) and indirectly (through the price of inputs encapsulated in c_i^k)

- GE solution under the assumption of balanced trade at the world level (but country-specific trade deficits) gives the vector of equilibrium wages **w** which is specific to a tariff vector

Impact of trade liberalization

- Equilibrium in relative changes implies :

$$\ln \frac{\hat{w}_n}{\hat{P}_n} = \underbrace{-\sum_{k=1}^{K} \frac{\alpha_n^k}{\theta^k} \ln \hat{\pi}_{nn}^k}_{\textit{Final goods}} \underbrace{-\sum_{k=1}^{K} \frac{\alpha_n^k}{\theta^k} \frac{1-\gamma_n^k}{\gamma_n^k} \ln \hat{\pi}_{nn}^k}_{\textit{Intermediate goods}} \underbrace{-\sum_{k=1}^{K} \frac{\alpha_n^k}{\gamma_n^k} \ln \prod_{l=1}^{J} \left(\hat{P}_n^l / \hat{P}_n^k\right)^{\gamma_n^{l,k}}}_{\textit{Sectoral Linkages}}$$

$$\ln \hat{\pi}_{ni}^k = -\theta^k \left[\ln \hat{c}_i^k + \ln \hat{d}_{ni}^k - \ln \hat{P}_n^k\right]$$

where $\hat{x} = x'/x$, $\{\hat{c}_i^k\}$ and $\{\hat{P}_n^k\}$ are non-linear functions of $\{\hat{w}_n\}$ and $\{\hat{d}_{ni}^k\}$

- Impact of trade liberalization on real wages can be summarized by the impact it has on domestic shares ($\{\pi_{nn}^k\}$) and sectoral price indices ($\{P_n^k\}$)

Impact of trade liberalization (ii)

- Trade liberalization increases real wages by reducing the sectoral shares of domestic consumption ($\ln \hat{\pi}^k_{nn}$), i.e.
  i. Giving consumers access to cheaper imported goods (See ARC if $\gamma^k_n = 1,\ \forall n, k$)
  ii. Reducing the cost of same sector imported inputs (Only role of intermediates if $\gamma^k_n \neq 1$ and $\gamma^{k,k}_n = 1 - \gamma^k_n$
  iii. Reducing the cost of imported inputs for other sectors (when $\gamma^{k,k}_n \neq 1 - \gamma^k_n$)
- Note : Changes in real wages do not directly map into changes in welfare in this model because of trade deficits (D_n) and tariff revenues (R_n) :

$$\ln \hat{W}_n = \ln \frac{\hat{I}_n}{\hat{P}_n} = \frac{w_n L_n}{I_n} \ln \frac{\hat{w}_n}{\hat{P}_n} + \frac{R_n}{I_n} \ln \frac{\hat{R}_n}{\hat{P}_n} + \frac{D_n}{I_n} \ln \frac{\hat{D}_n}{\hat{P}_n}$$

Welfare Impact

- Using the equilibrium conditions of the model :

$$\ln \frac{\hat{I}_n}{\hat{P}_n} = \underbrace{\sum_{h=1}^{I}\sum_{k=1}^{K}\left(\frac{E_{hn}^k}{I_n}\ln \hat{c}_n^k - \frac{M_{nh}^k}{I_n}\ln \hat{c}_h^k\right)}_{Terms\ of\ trade} + \underbrace{\sum_{h=1}^{I}\sum_{k=1}^{K}\frac{d_{nh}^k M_{nh}^k}{I_n}\left(\ln \hat{M}_{nh}^k - \ln \hat{c}_h^k\right)}_{Volume\ of\ trade}$$

- Terms of trade effect due to an increase in exporter prices relative to the change in importer prices
- Volume of trade effect due to the creation of additional trade flows following trade liberalization

Empirical strategy

- Calibration of the observed parameters :
  - $\{\pi_{ni}^k\}$ calibrated using trade and production data
  - $\{\alpha_i^k\}$ fitted to data on sectoral absorption
  - $\{\gamma_i^k\}$ and $\{\gamma_i^{k,k'}\}$ fitted to IO tables
- Estimation of the unobserved parameters $\{\theta^k\}$:

$$\ln \frac{X_{ni}^k X_{im}^k X_{mn}^k}{X_{in}^k X_{mi}^k X_{nm}^k} = -\theta^k \ln \frac{d_{ni}^k d_{im}^k d_{mn}^k}{d_{in}^k d_{mi}^k d_{nm}^k}$$

$$\ln d_{ni}^k = \ln(1+\tau_{ni}^k) + \nu_{ni}^k + \mu_n^k + \delta_i^k + \varepsilon_{ni}^k, \quad \nu_{ni}^k = \nu_{in}^k$$

$$\Rightarrow \quad \ln \frac{X_{ni}^k X_{im}^k X_{mn}^k}{X_{in}^k X_{mi}^k X_{nm}^k} = -\theta^k \ln \frac{(1+\tau_{ni}^k)1+\tau_{im}^k)(1+\tau_{mn}^k)}{(1+\tau_{in}^k)(1+\tau_{mi}^k)(1+\tau_{nm}^k)} + \varepsilon_{nim}^k$$

Use sectoral bilateral trade and tariff data

Sectoral trade elasticities

Table 1. Dispersion-of-productivity estimates

	Full sample			99% sample			97.5% sample		
Sector	θ^j	s.e.	N	θ^j	s.e.	N	θ^j	s.e.	N
Agriculture	8.11	(1.86)	496	9.11	(2.01)	430	16.88	(2.36)	364
Mining	15.72	(2.76)	296	13.53	(3.67)	178	17.39	(4.06)	152
Manufacturing									
Food	2.55	(0.61)	495	2.62	(0.61)	429	2.46	(0.70)	352
Textile	5.56	(1.14)	437	8.10	(1.28)	314	1.74	(1.73)	186
Wood	10.83	(2.53)	315	11.50	(2.87)	191	11.22	(3.11)	148
Paper	9.07	(1.69)	507	16.52	(2.65)	352	2.57	(2.88)	220
Petroleum	51.08	(18.05)	91	64.85	(15.61)	86	61.25	(15.90)	80
Chemicals	4.75	(1.77)	430	3.13	(1.78)	341	2.94	(2.34)	220
Plastic	1.66	(1.41)	376	1.67	(2.23)	272	0.60	(2.11)	180
Minerals	2.76	(1.44)	342	2.41	(1.60)	263	2.99	(1.88)	186
Basic metals	7.99	(2.53)	388	3.28	(2.51)	288	-0.05	(2.82)	235
Metal products	4.30	(2.15)	404	6.99	(2.12)	314	0.52	(3.02)	186
Machinery n.e.c.	1.52	(1.81)	397	1.45	(2.80)	290	-2.82	(4.33)	186
Office	12.79	(2.14)	306	12.95	(4.53)	126	11.47	(5.14)	62
Electrical	10.60	(1.38)	343	12.91	(1.64)	269	3.37	(2.63)	177
Communication	7.07	(1.72)	312	3.95	(1.77)	143	4.82	(1.83)	93
Medical	8.98	(1.25)	383	8.71	(1.56)	237	1.97	(1.36)	94
Auto	1.01	(0.80)	237	1.84	(0.92)	126	-3.06	(0.86)	59
Other Transport	0.37	(1.08)	245	0.39	(1.08)	226	0.53	(1.15)	167
Other	5.00	(0.92)	412	3.98	(1.08)	227	3.06	(0.83)	135
Test equal parameters			F(17, 7294) = 7.52					Prob > F = 0.00	
Aggregate elasticity	4.55	(0.35)	7212	4.49	(0.39)	5102	3.29	(0.47)	3482

Source : Caliendo & Parro, 2015. The "99% sample" and "97.5% sample" drop from the estimation the smallest countries in each sector.

Counterfactual analysis

i. Introduce the change in the tariff structure from 1993 to 2005 between NAFTA members, fixing the tariff structure for the RoW unchanged

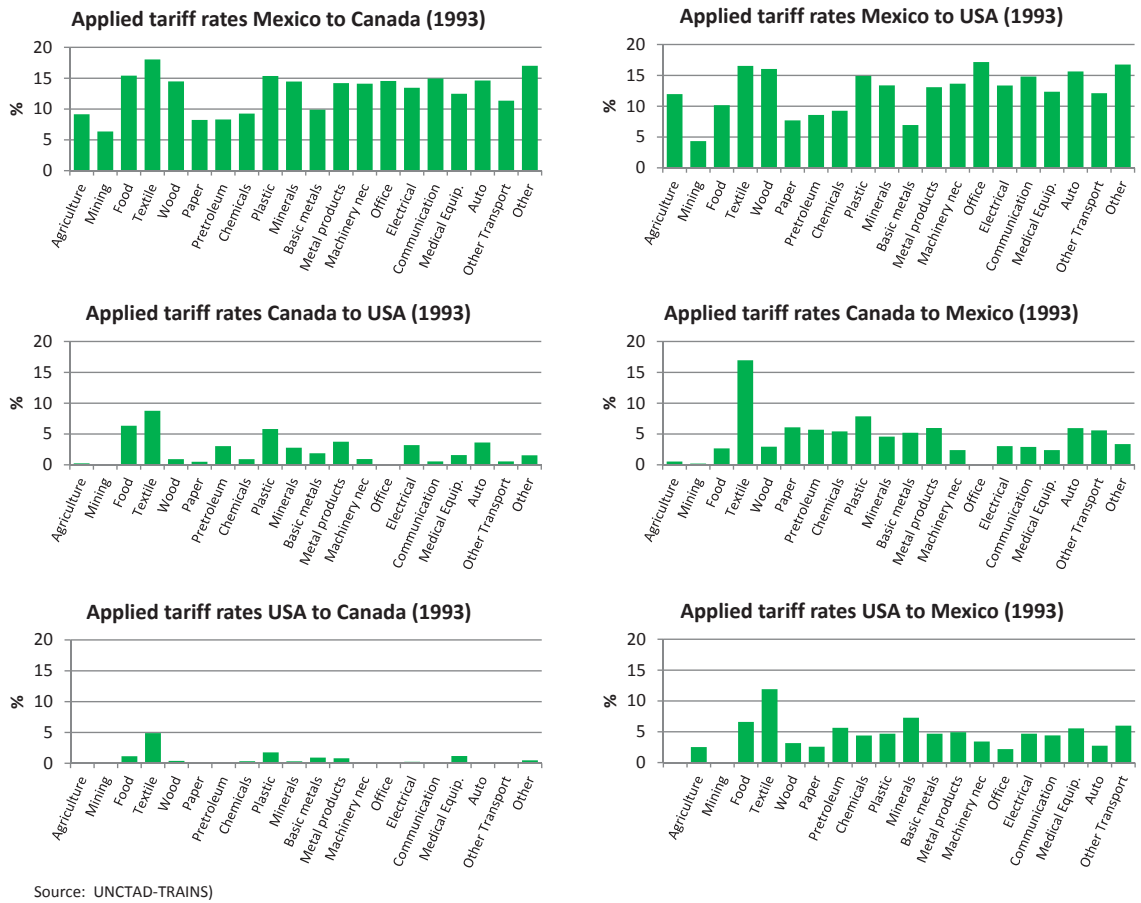
ii. Introduce the change in the tariff structure from 1993 to 2005 between NAFTA members, given the observed changes in the tariff structure for the RoW

iii. Introduce the observed changes in world tariff structure from 1993 to 2005, holding NAFTA tariffs fixed to the year 1993

ii.-iii. say something about the gains from world tariff reductions with and without NAFTA

- Note : In principle, trade liberalization might also have an impact on trade deficits, which the model does not take into account (they are exogenous). This is a shortcoming of the analysis

Pre-NAFTA tariffs



Source : Caliendo & Parro, 2015. In 1993, sectoral tariff rates applied by Mexico, Canada and the US to NAFTA members were on average 12.5, 4.2 and 2.7%. By 2005, they dropped to almost zero between NAFTA members but tariffs that Mexico, Canada and the US applied to the RoW were on average 7.1, 2.2 and 1.7%, respectively

The role of intermediate goods and sectoral linkages

- In 1993, the role of intermediate goods is already substantial...
  - Respectively 68, 61.5 and 64.6% of Mexico's, Canada's and the US imports from non-NAFTA countries were intermediate goods
  - Respectively 82.1, 72.3 and 72.8% of Mexico's, Canada's and the US imports from NAFTA countries were intermediate goods
- ... As is the extent of cross-sectoral linkages :
  - In the IO Tables, the mean share of own-sector inputs is around 15-20%
  - More than 70% of intermediate consumption is addressed to other sectors
  - Average share of tradables in the production of non-tradables is 23% for the US and 32% for Mexico / Average shares of non-tradables in the production of tradables are 34% for the US and 26% for Mexico

Welfare effect from NAFTA's Tariff reductions

Table 2. Welfare effects from NAFTA's tariff reductions

	Welfare			
Country	Total	Terms of trade	Volume of Trade	Real wages
Mexico	1.31%	-0.41%	1.72%	1.72%
Canada	-0.06%	-0.11%	0.04%	0.32%
U.S.	0.08%	0.04%	0.04%	0.11%

Source : Caliendo & Parro, 2015. Analysis holds RoW tariffs unchanged

- Mexico gains the most, both in terms of welfare and in terms of real wages
- Most important source of gains is increase in the volume of trade (mostly within NAFTA, while trade vis-à-vis the RoW decreases, trade divertion)
- US terms-of-trade improved (both vis-à-vis NAFTA members and the RoW)
- Welfare effects widely vary across sectors

Trade effect from NAFTA's Tariff reductions

Table 5. Trade effects from NAFTA's tariff reductions

	Mexico	Canada	U.S.
Mexico's imports	-	116.60%	118.31%
Canada's imports	58.57%	-	9.49%
U.S.'s imports	109.54%	6.57%	-

Source : Caliendo & Parro, 2015. Analysis holds RoW tariffs unchanged

- Large aggregate effects for all members
- Canada and the US increased a lot their imports from Mexico : role as a supplier of intermediates to NAFTA
- Strong impact on the specialization of countries : Mexico becomes more specialized

Specialization due to NAFTA

Table 6. Export shares by sector before and after NAFTA's tariff reductions

	Mexico		Canada		United States	
Sector	Before	After	Before	After	Before	After
Agriculture	4.72%	3.03%	4.99%	5.04%	6.91%	6.35%
Mining	15.53%	7.85%	8.99%	8.96%	1.72%	1.52%
Manufacturing						
Food	2.33%	1.48%	4.82%	4.68%	5.09%	4.73%
Textile	4.42%	6.92%	1.05%	1.49%	2.68%	3.49%
Wood	0.59%	0.52%	8.12%	8.05%	2.02%	1.98%
Paper	0.62%	0.51%	8.34%	8.44%	4.99%	4.89%
Petroleum	1.62%	5.28%	0.59%	0.78%	4.30%	5.71%
Chemicals	4.40%	2.53%	5.58%	5.40%	10.00%	9.25%
Plastic	0.80%	0.48%	2.06%	2.06%	2.28%	2.43%
Minerals	1.32%	0.84%	0.81%	0.78%	0.94%	0.92%
Basic metals	3.24%	2.00%	10.29%	10.19%	3.05%	3.11%
Metal products	1.22%	1.03%	1.47%	1.53%	2.23%	2.59%
Machinery n.e.c.	4.30%	2.53%	4.69%	4.49%	10.37%	9.70%
Office	3.34%	5.07%	2.44%	2.54%	7.70%	7.29%
Electrical	20.79%	34.07%	2.50%	2.35%	6.07%	7.97%
Communication	8.57%	7.08%	3.11%	3.02%	7.19%	6.81%
Medical	2.48%	3.28%	0.98%	1.03%	5.16%	4.79%
Auto	16.43%	13.05%	24.42%	24.07%	8.20%	8.09%
Other Transport	0.28%	0.26%	3.21%	3.58%	7.32%	6.65%
Other	3.02%	2.20%	1.55%	1.52%	1.77%	1.74%
Normalized Herfindahl	0.092	0.138	0.083	0.081	0.042	0.040

Source : Caliendo & Parro, 2015. Analysis holds RoW tariffs unchanged

Decomposition of trade and welfare effects

Table 11. Trade and welfare effects from NAFTA across different models

	Welfare			Imports growth from NAFTA members			
		Multi sector			Multi sector		
Country	One sector	No materials	No I-O	One sector	No materials	No I-O	Benchmark
Mexico	0.41%	0.50%	0.66%	60.99%	88.08%	98.96%	118.28%
Canada	-0.08%	-0.03%	-0.04%	5.98%	9.95%	10.14%	11.11%
U.S.	0.05%	0.03%	0.04%	17.34%	26.91%	30.70%	40.52%

Source : Caliendo & Parro, 2015. Analysis holds RoW tariffs unchanged

- Welfare gains are always reduced in comparison to benchmark

$\Rightarrow$ Trade in intermediates, Sectoral heterogeneity and Sectoral linkages all matter

Trade and the Volatility of Economies

Trade and Volatility

- Caselli et al. (2015) build a dynamic Ricardian model to evaluate the impact of trade on the volatility of the economy
- Argument :
  - Trade might induce sectoral specialization which would increase the exposure of countries to sectoral shocks ($\uparrow$ Volatility except if specialization in low-volatile sectors)
  - Trade also offers additional opportunities of diversification (against country-specific shocks, across markets) ($\downarrow$ Volatility)
- Main insights :
  - Tariffs reduction since the 70s has reduced volatility
  - Diversification across countries is an important driver of decreased volatility
  - Specialization does not always push volatility up

Theoretical framework

i. Multiple sectors + IO Linkages (Caliendo & Parro, 2015)
ii. Stochastic shocks to the sector- and country-specific TFP : A_{it}^k
iii. Frictions to the allocation of labor across sectors :

$$L_{it}^k = \int_0^1 l_{it}^k(j)dj$$

is determined ex-ante (maximizes the representative consumer's expected value of utility) but $l_{it}^k(j)$ allocates across firms after the realization of shocks

iv. No intertemporal trade and no capital $\rightarrow$ A sequence of static equilibria

Solution in Autarky

- FOC of the ex-ante program ($u(C) = \ln C$) :

$$\frac{L_{nt}^k}{L_{nt}} = E_{t-1}\left[\frac{w_{nt}^k L_{nt}^k}{\sum_j w_{nt}^j L_{nt}^j}\right] = \alpha^k$$

- Consumption maximization :

$$Q_{nt}^k = \alpha^k \left(\frac{P_{nt}^k}{P_{nt}}\right)^{-1} Q_{nt} \quad \textit{and} \quad Q_{nt}^k(j) = \left(\frac{p_{nt}^k(j)}{P_{nt}^k}\right)^{-\sigma} Q_{nt}^k$$

- Equilibrium prices :

$$\begin{aligned}
p_{nt}^k(j) &= B^k \frac{{w_{nt}^k}^{\gamma^k} {P_{nt}}^{1-\gamma^k}}{A_{nt}^k z_n^k(j)}, \quad B^k = {\gamma^k}^{-\gamma^k}(1-\gamma^k)^{\gamma^k - 1} \\
P_{nt}^k &= \xi B^k \frac{{w_{nt}^k}^{\gamma^k} {P_{nt}}^{1-\gamma^k}}{A_{nt}^k \; {T^k}^{1/\theta}}, \quad \xi = \left[\Gamma\left(\frac{1-\sigma}{\theta} - 1\right)\right]^{\frac{1}{1-\sigma}} \\
P_{nt} &= \prod_k {\alpha^k}^{-\alpha^k} {P_{nt}^k}^{\alpha^k}
\end{aligned}$$

Solution in Autarky (2)

- Demand for inputs :

$$I_{nt}^k(j) = \gamma^k \frac{p_{nt}^k(j) Q_{nt}^k(j)}{w_{nt}^j} \Rightarrow w_{nt}^k L_{nt}^k = \gamma^k P_{nt}^k Q_{nt}^k$$

$$M_{nt}^k(j) = (1-\gamma^j) \frac{p_{nt}^k(j) Q_{nt}^k(j)}{P_{nt}} \Rightarrow P_{nt} M_{nt}^k = (1-\gamma^k) P_{nt}^k Q_{nt}^k$$

- Finally, real output :

$$Y_{nt} = \prod_{k=1}^{k} R_n^k \left(\frac{\alpha^k \gamma^k}{\sum_j \alpha^j \gamma^j} \right)^{\frac{\alpha^k \gamma^k}{\sum_j \alpha^j \gamma^j}} {A_{nt}^k}^{\alpha^k/\gamma^k} L_{nt}$$

with R_n a constant

Solution with international trade

- Inputs can potentially be sourced from different countries :

$$G_{nt}^{k}(p) = 1 - e^{-\Phi_{nt}^{k} p^{\theta}}, \quad \Phi_{nt}^{k} = \sum_{m} T_{m}^{k} \left(\frac{B^{k} \; {w_{mt}^{k}}^{\gamma^{k}} \; {P_{mt}^{1-\gamma^{k}}} \; d_{mnt}^{k}}{A_{mt}^{k}} \right)^{-\theta}$$

$$\pi_{nmt}^{k} = \frac{T_{n}^{k} \left(\frac{B^{k} \; {w_{nt}^{k}}^{\gamma^{k}} \; {P_{nt}^{1-\gamma^{k}}} \; d_{mnt}^{k}}{A_{nt}^{k}} \right)^{-\theta}}{\Phi_{mt}^{k}}$$

- Equilibrium prices :

$$p_{nmt}^{k}(j) = B^{k} d_{nmt}^{k} \frac{{w_{nt}^{k}}^{\gamma^{k}} \; {P_{nt}}^{1-\gamma^{k}}}{A_{nt}^{k} z_{n}^{k}(j)}, \quad B^{k} = {\gamma^{k}}^{-\gamma^{k}} \left(1 - \gamma^{k}\right)^{\gamma^{k}-1}$$

$$P_{nt}^{k} = \xi \; {\Phi_{nt}^{k}}^{-1/\theta}, \quad \xi = \left[\Gamma \left(\frac{1-\sigma}{\theta} - 1 \right) \right]^{\frac{1}{1-\sigma}}$$

$$P_{nt} = \prod_{k} {\alpha^{k}}^{-\alpha^{k}} \; {P_{nt}^{k}}^{\alpha^{k}}$$

Solution with international trade (2)

- Market equilibria

$$
\begin{aligned}
w_{nt}^k L_{nt}^k &= \gamma^k \sum_{m=1}^{J} \left[\alpha^k + \frac{1-\gamma^k}{\gamma^k} \frac{w_{mt}^k L_{mt}^k}{w_{mt} L_{mt}} \right] w_{mt} L_{mt} \\
w_{nt} L_{nt} &= \sum_k w_{nt}^k L_{nt}^k \\
\frac{L_{nt}^k}{L_{nt}} &= E_{t-1} \left[\frac{w_{nt}^k L_{nt}^k}{\sum_j w_{nt}^j L_{nt}^j} \right]
\end{aligned}
$$

- Resolution : i) Given L_{nt}^j, equilibrium conditions give prices and market shares as a function of $Z_{nt}^k \equiv T_n^k \left[L_{nt} \left(A_{nt}^k \right)^{1/\gamma^k} \right]^{\gamma^k \theta}$, the augmented productivity, ii) solve for the sectoral shares (expected value of sectoral VA shares)

Volatility and Trade

- Intuition using a one-sector EK model
- In autarky :

$$Var(\hat{Y}^a_{nt}) = \frac{1}{(\gamma\theta)^2} Var(\hat{Z}_{nt})$$

where $\hat{x}_t \equiv d \ln x_t$

- In the costless equilibrium :

$$Var(\hat{Y}_{nt}) = \frac{1}{(\gamma\theta)^2} \left[\underbrace{\left(\frac{s_n + \gamma\theta}{1+\gamma\theta} \right)^2 Var(\hat{Z}_{nt})}_{\textit{domestic exposure}} \right.$$

$$\left. + \underbrace{\left(\frac{1}{1+\gamma\theta} \right)^2 \sum_{m \neq n} s_m^2 Var(\hat{Z}_{mt})}_{\textit{foreign exposure}} + \underbrace{2 \frac{s_n + \gamma\theta}{1+\gamma\theta} \frac{1}{1+\gamma\theta} \sum_{m \neq n} Cov(\hat{Z}_{nt}, \hat{Z}_{mt})}_{\textit{Covariances}} \right]$$

where s_n is the relative size of country n, at the mean Z_{nt}

Volatility and Trade (2)

- With uncorrelated shocks and constant variances :

$$\begin{aligned} Var(\hat{Y}_{nt}) &= \frac{1}{(\gamma\theta)^2}\left[\left(\frac{s_n+\gamma\theta}{1+\gamma\theta}\right)^2\sigma^2+\left(\frac{1}{1+\gamma\theta}\right)^2\sum_{m\neq n}s_m^2\sigma^2\right] \\ &< Var(\hat{Y}_{nt}^a) \end{aligned}$$

$\Rightarrow$ Diversification of risk across countries

- In general, impact of trade on volatility depends on :
  1. Extent of diversification towards low volatile, uncorrelated countries
  2. Volatility of comparative advantaged sectors

Empirical strategy

- Calibration of the observed parameters :
  - $\{\alpha_n^k\}$ and $\{\gamma_n^k\}$ fitted to data on sectoral absorption, value added and output
  - θ and σ calibrated ($\theta \in [2, 8]$, $\sigma = 2$)
  - $\{d_{nmt}^k\}$ calibrated based on bilateral trade data (assuming $d_{nmt}^k = d_{mnt}^k$) :

$$d_{nmt}^k = \left(\frac{\pi_{nmt}^k \pi_{mnt}^k}{\pi_{nnt}^k \pi_{mmt}^k} \right)^{1/2\theta}$$

  - $\{Z_{nt}^k\}$ calibrated using the (inverse of the) formula for π_{nmt}^k, then filtered to remove the LR component and finally decomposed into sector- vs country-specific components using a factor model

Counterfactual analysis

i. Quantify the impact that changes in tariffs between 1972 and 2007 have had on the volatility of countries' GDP

ii. Counterfactual volatility muting either the country- or the sector-specific sources of TFP shocks

Impact of tariff reductions on volatility

Table 1: Baseline and counterfactual change in volatility (measured as variance) under free trade. Baseline calibration with $\theta = 4$.

	Average volatility				Changes in average volatility due to measured changes in trade barriers		
	Benchmark volatility (1)	Volatility absent sectoral shocks (2)	Volatility at 1972s trade barriers (3)	Volatility absent sectoral shocks, at 1972s trade barriers (4)	Volatility change due to change in trade barriers (5)	Volatility change due to specialization (6)	Volatility change due to diversification (7)
Australia	0.00085	0.00081	0.00090	0.00090	-5.6%	4.8%	-10.4%
Austria	0.00023	0.00020	0.00037	0.00033	-37.5%	-3.5%	-34.0%
Belgium and Luxembourg	0.00035	0.00019	0.00465	0.00426	-92.4%	-4.8%	-87.5%
Canada	0.00019	0.00014	0.00040	0.00037	-53.0%	4.2%	-57.2%
China	0.00631	0.00581	0.00630	0.00582	0.2%	0.3%	-0.1%
Colombia	0.00113	0.00089	0.00106	0.00084	6.2%	1.3%	4.9%
Denmark	0.00031	0.00013	0.00049	0.00032	-35.5%	5.5%	-41.0%
Finland	0.00038	0.00034	0.00046	0.00045	-16.3%	7.2%	-23.5%
France	0.00022	0.00012	0.00023	0.00014	-7.5%	4.1%	-11.6%
Germany	0.00028	0.00014	0.00029	0.00018	-5.3%	6.0%	-11.3%
Greece	0.00032	0.00023	0.00028	0.00022	13.9%	10.4%	3.5%
India	0.00087	0.00082	0.00159	0.00150	-45.7%	-2.9%	-42.7%
Ireland	0.00078	0.00055	0.06890	0.06919	-98.9%	0.8%	-99.6%
Italy	0.00017	0.00009	0.00015	0.00010	12.4%	19.5%	-7.1%
Japan	0.00027	0.00011	0.00025	0.00011	8.2%	7.4%	0.8%
Mexico	0.00066	0.00076	0.00186	0.00202	-64.3%	3.3%	-67.6%
Netherlands	0.00021	0.00012	0.00239	0.00260	-91.4%	12.1%	-103.5%
Norway	0.00055	0.00046	0.01116	0.01078	-95.1%	-2.7%	-92.4%
Portugal	0.00115	0.00082	0.00193	0.00170	-40.3%	5.4%	-45.6%
ROW	0.00164	0.00173	0.00163	0.00173	0.6%	0.8%	-0.2%
South Korea	0.00094	0.00069	0.00097	0.00072	-3.3%	-0.9%	-2.4%
Spain	0.00018	0.00015	0.00017	0.00016	9.3%	14.7%	-5.4%
Sweden	0.00020	0.00020	0.00030	0.00029	-32.7%	-2.1%	-30.6%
United Kingdom	0.00020	0.00016	0.00020	0.00018	0.4%	9.2%	-8.8%
United States	0.00028	0.00017	0.00027	0.00018	2.1%	3.2%	-1.1%
Average	0.00075	0.00063	0.00429	0.00420	-26.8%	4.1%	-31.0%

Note: Column (1) shows the average volatility in the baseline model using the calibrated kappas and shocks from 1972-2007. Column (2) is the volatility in (1) after removing common sectoral shocks. Column (3) shows the average volatility using the calibrated shocks from 1972-2007 under the assumption that trading costs in manufacturing and agriculture remain at their 1970 levels. Column (4) is similar to (3), after removing common sectoral shocks. Column (5) shows the percent change in average volatility as economies lowered their trading costs (move from (3) to (1)). Column (6) shows the contribution of specialization to the change in volatility in (5). Column (7) shows the contribution of diversification to the change in volatility in (5).

Impact of tariff reductions on volatility (2)

- Two thirds of the countries experienced a $\downarrow$ in volatility (>90% for Bel-Lux, IRL, NLD, NOR)
- Diversification channel contributes to reducing Var in 90% of countries
- Specialization channel contributes to increasing Var in 2/3 of countries
- Limits :
  - Mixed evidence that trade indeed reduces volatility
  - Quantitative analysis circumvent the problem of causal identification...
  - ... But is strongly dependent on the underlying assumptions
  - eg does not take into account granularity effects (di Giovanni and Levchenko, 2012)

Conclusion

- EK model can be used to run counterfactuals on various questions :
  - Spillover effects of China's growth on the RoW (Hsieh & Ossa, 2011, di Giovanni et al, 2014)
  - Impact of trade with emerging countries on labour markets (Levchenko and Zhang, 2013)
  - Impact of trade on the skill premium (Burstein & Vogel, 2012 and Parro, 2013)
  - ...
- Some of these topics will be studied in the second semester's course

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