Diversification through Trade

Francesco Caselli, Miklos Koren, Milan Lisicky, and Silvana Tenreyro

Very preliminary

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   - emergence of new trading partners (e.g. China and India)
3. Fast transmission of the current crisis, with the near collapse of trade

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- Implicit assumption: sector-specific shocks are the prevalent source of volatility.
  - But in volatility accounting, country-specific shocks (affecting all sectors) account for a large part of overall volatility.
  - Openness to trade may lead to sectoral specialization, but it may also help diversify country-specific shocks (both on the demand and supply sides).

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- Increased trade openness also means that a large shock to a particular country (e.g. US), can have a larger impact on other countries through stronger demand linkages.
  - Trade can mitigate the shock's impact on the GDP of the country hit by the shock.

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- Next step: A quantitative exercise

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  - "Big crisis hits large country"
- Next step: A quantitative exercise
  - How have actual changes in trade barriers affected volatility patterns across countries? China? Crisis?

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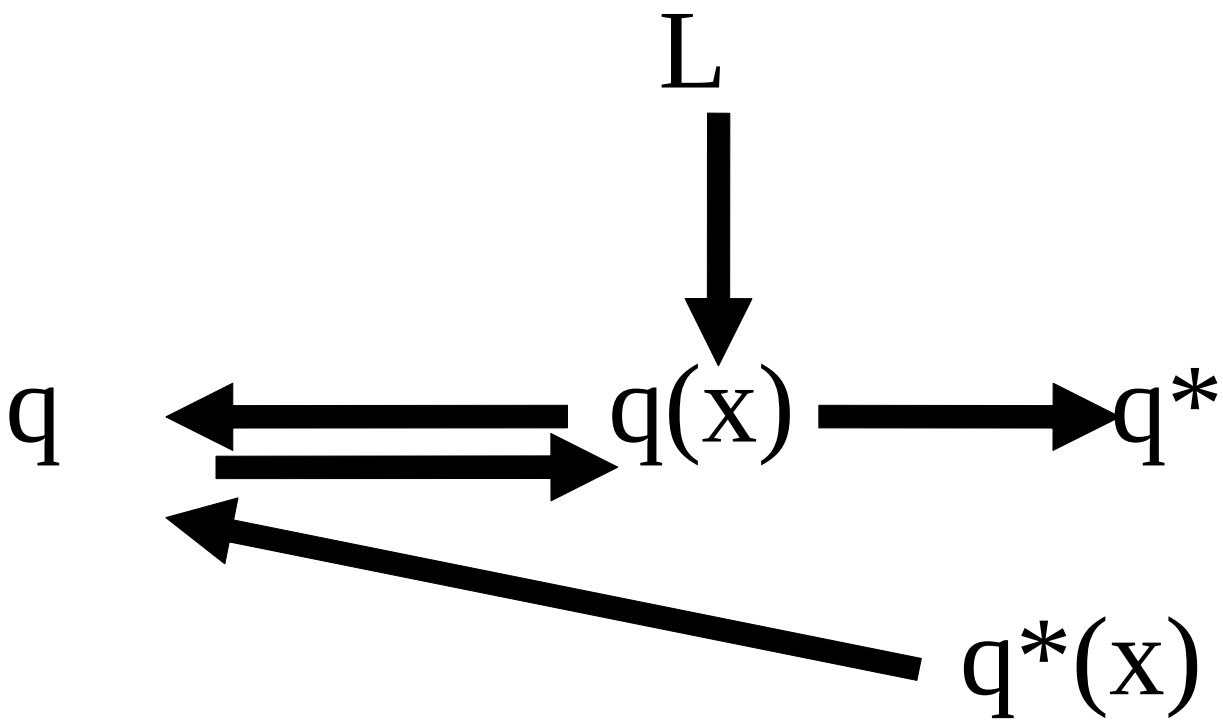
- Add country-specific shocks, which shift the distribution of efficiencies in a country
  - Output in a country becomes stochastic.

Productive structure EK-AL



Autarky

- Buyers purchase individual goods $q(x)$ to maximize the CES:

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  - Price of individual goods

$$p(x) = B x^{\theta} w^{\beta} p^{1-\beta}$$

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- Draws independent across countries.
- Delivering a tradable good from country j to country i results in $0 < \kappa_{ij} \leq 1$ arriving at j ($=$ if $i = j$); $\kappa_{ij} \geq \kappa_{ik}\kappa_{kj} \nabla i, k, j$

Production

- The total output for use as input or consumption in country i.

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- Price

$$p_i = AB \left(\sum_{j=1}^{N} \left(\frac{w_j^{\beta} {p_j}^{1-\beta}}{\kappa_{ij}} \right)^{-1/\theta} \lambda_j \right)^{-\theta}$$

Simple Version of the Model: Summary

1. $p_i(w) = AB\left(\sum_{j=1}^{N}\left(\frac{w_j^{\beta}p_j(w)^{1-\beta}}{\kappa_{ij}}\right)^{-1/\theta}\lambda_j\right)^{-\theta}$
2. $d_{ij}(w) = (AB)^{-1/\theta}\left(\frac{w_j^{\beta}p_j(w)^{1-\beta}}{p_i(w)\kappa_{ij}}\right)^{-1/\theta}\lambda_j;$
   $\sum_{j=1} d_{ij} = 1$
3. $L_i p_i q_i = \sum_{j=1}^{N} L_j p_j q_j d_{ji}(w)$

$$Y_i = \frac{L_i w_i}{p_i} = \text{real } GDP$$

Adding country-specific shocks

- In EKAL, $\lambda_j's$ are deterministic, so GDP per capita is a deterministic constant for each country j.
- Assume now that $\lambda_j's$ are subject to shocks
  - Higher realization of λ_j leads to stochastically lower costs x in country j and higher GDP_j
  - Stochasticity in λ_j imparts stochasticity in GDP_j.

Some Simple Analytical Results

Level and volatility of GDP in Autarky

- GDP:

$$Y_i = (AB)^{-1/\beta} Z_i$$

$$Z_i \equiv \lambda_i^{\theta/\beta_i} L_i$$

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- Volatility

$$Var(\hat{Y}_i) = Var(\hat{Z}_i)$$

$$\hat{x} \equiv \frac{\Delta \ln x}{\Delta t}$$

Level and volatility of GDP in costless trade

- GDP

$$Y_i = (AB)^{-1/\beta} Z_i^{\frac{\beta}{\beta+\theta}} \left(\sum_{j=1}^{N} Z_j^{\frac{\beta}{\theta+\beta}} \right)^{\theta/\beta}$$

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- Volatility:

$$Var(\hat{Y}_i) = \left\{ \begin{array}{c} \left(\frac{\beta+\theta\gamma_i}{\beta+\theta} \right)^2 Var(\hat{Z}_i) + \\ \left[\frac{\theta}{\beta+\theta} \right]^2 \sum_{j \neq i}^{N} \gamma_j^2 Var(\hat{Z}_j) + \\ 2\theta \frac{\beta+\theta\gamma_i}{(\beta+\theta)^2} \sum_{j \neq i}^{N} \gamma_j Cov(\hat{Z}_j, \hat{Z}_i) \end{array} \right\}$$

$$\gamma_j = \frac{\bar{Z}_j^{\frac{\beta}{\theta+\beta}}}{\sum_{j=1}^{N} \bar{Z}_j^{\frac{\beta}{\theta+\beta}}}$$

Costless trade versus autarky

- Productivity gain:

$$\frac{Y_i^T}{Y_i^A} = \frac{Z_i^{\frac{\beta}{\beta+\theta}} \left(\sum_{j=1}^{N} Z_j^{\frac{\beta}{\theta+\beta}} \right)^{\theta/\beta}}{Z_i} = \left[1 + Z_i^{\frac{-\beta}{\beta+\theta}} \sum_{j \neq i}^{N} Z_j^{\frac{\beta}{\theta+\beta}} \right]^{\theta/\beta} > 1$$

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- Gain higher

  i) the smaller the country $Z_i^{\frac{-\beta}{\beta+\theta}} \sum Z_j^{\frac{\beta}{\theta+\beta}}$
  ii) the higher the importance of tradeables in production $(1-\beta)$, and
  iii) the higher the scope for comparative advantage θ.

Change in variance (costless trade versus autarky)

.

- If $Var(\hat{Z}_i) = \sigma$ and $Cov(\hat{Z}_i; \hat{Z}_j) = 0$

$$Var(\hat{Y}_i^T) = \sigma \left\{ \left(\frac{\beta + \theta\gamma_i}{\beta + \theta} \right)^2 + \left[\frac{\theta}{\beta + \theta} \right]^2 \sum_{j \neq i}^{N} \gamma_j^2 \right\}$$

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- Results can be reversed if covariance are high and/or the volatility of other countries is high.

Intermediate Levels of Trading Costs

Qualitative exercise

- Each period, draw $\lambda = (\lambda_1 ... \lambda_N)$ from a log-normal distribution with fixed mean and std deviation
- Choose A,B,θ, α, β as in AL
- Time series, volatility and covariance:

country/period	1	2	3	...	T	*vol*	*cov*
country 1	y_{1_1}	y_{1_2}	y_{1_3}	...	y_{1_T}	σ_{y_1}	$\sigma_{y_1,W}$
country 2	y_{2_1}	y_{2_2}	y_{2_3}	...	y_{2_T}	σ_{y_2}	$\sigma_{y_2,W}$
...	...	...	...	...	...	...	...
country n	y_{N_1}	y_{N_2}	y_{N_3}	...	y_{N_T}	σ_{y_N}	$\sigma_{y_N,W}$

for given κ

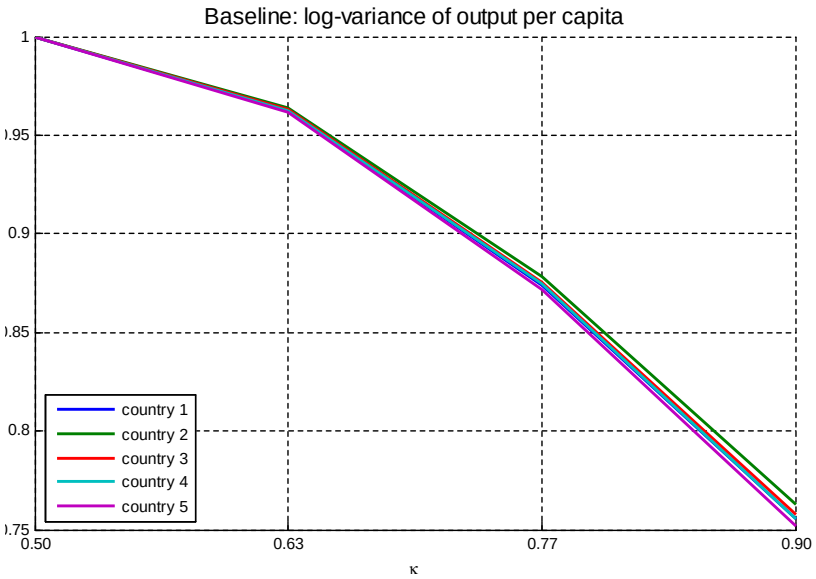
Some simple (qualitative) experiments

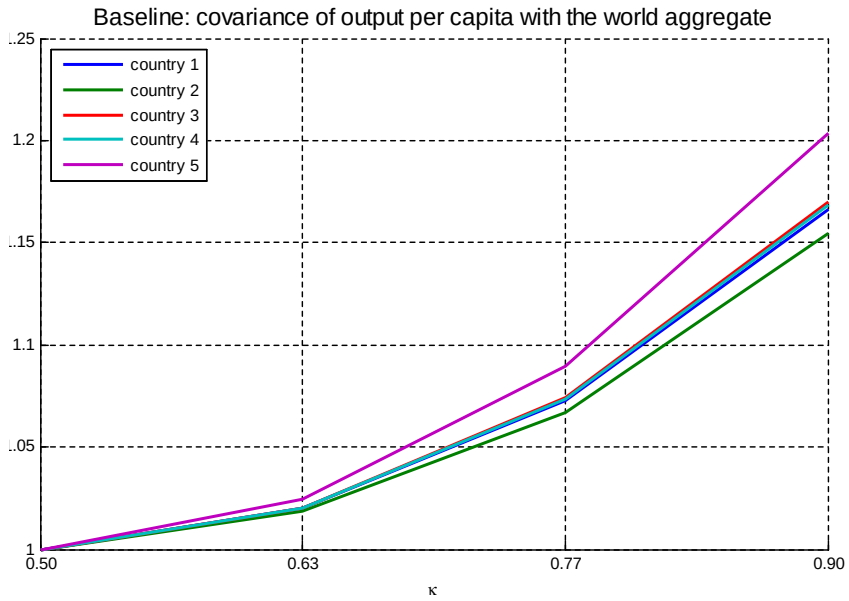
1. Widespread decrease in international trade barriers
2. China joins the World
3. Crisis hits big country

Calibration

- "Barriers decrease"
  - $L_N = \mathbf{1}$; $\kappa_{ijt} = \kappa_t$ increases over time for $i \neq j$ and $\kappa_{iit} = 1$.
  - Same, but $L_N = (1, 1, 1, 3, 3)$.
- "China joins": Same, but $L_N = (1, 1, 1, 3, 3)$; and $\kappa_{i5t} = \kappa_{5jt}$ smaller at $t = 1$
- "Crisis hits": low λ for a big country; $L_N = (1, 1, 1, 3, 3)$.

Uniform decrease in trade barriers



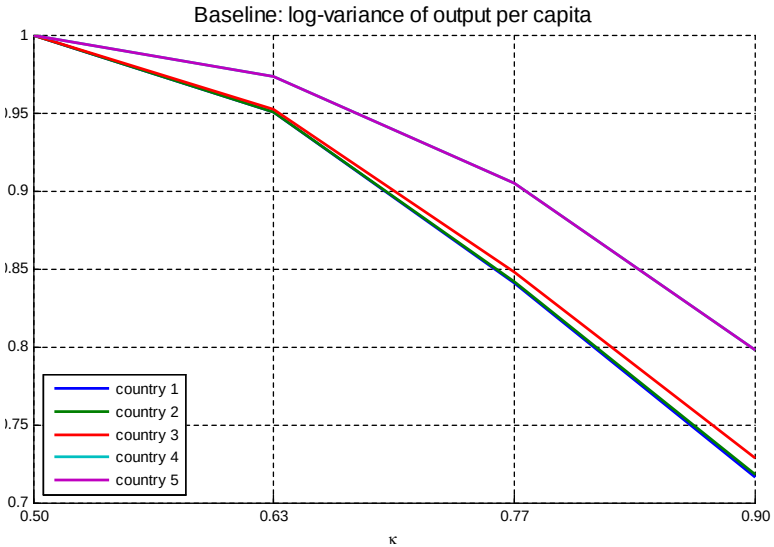


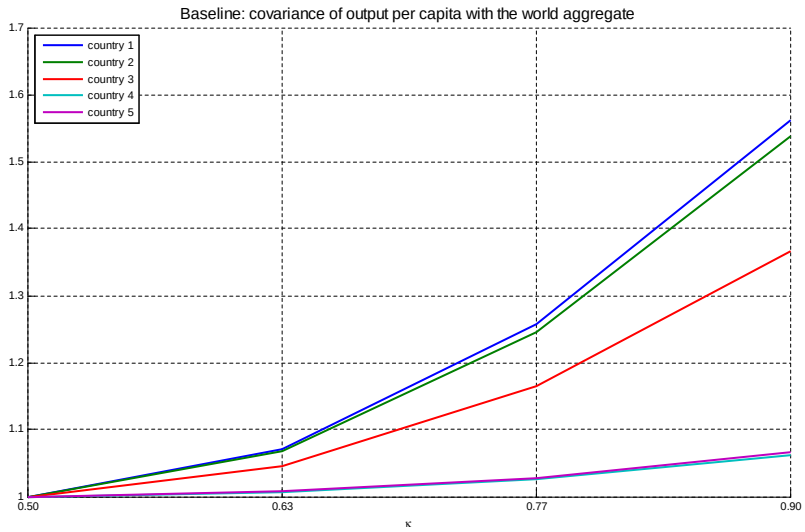
Volatility change

Covariance change

$L_N = \mathbf{1}$; κ_{ij} increases uniformly over time from 0.5 to 0.9 ($\kappa_{iit} = 1$)

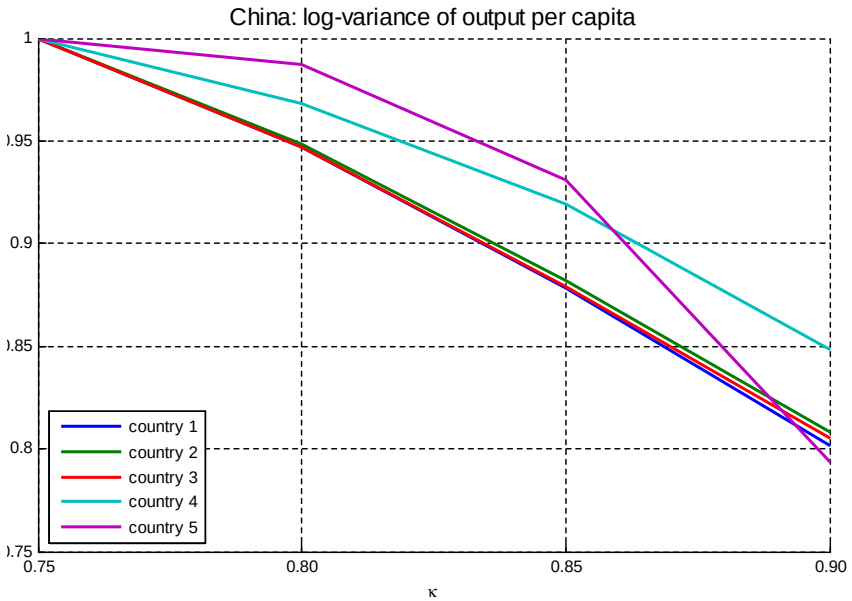
Uniform decrease in trade barriers, with some big countries

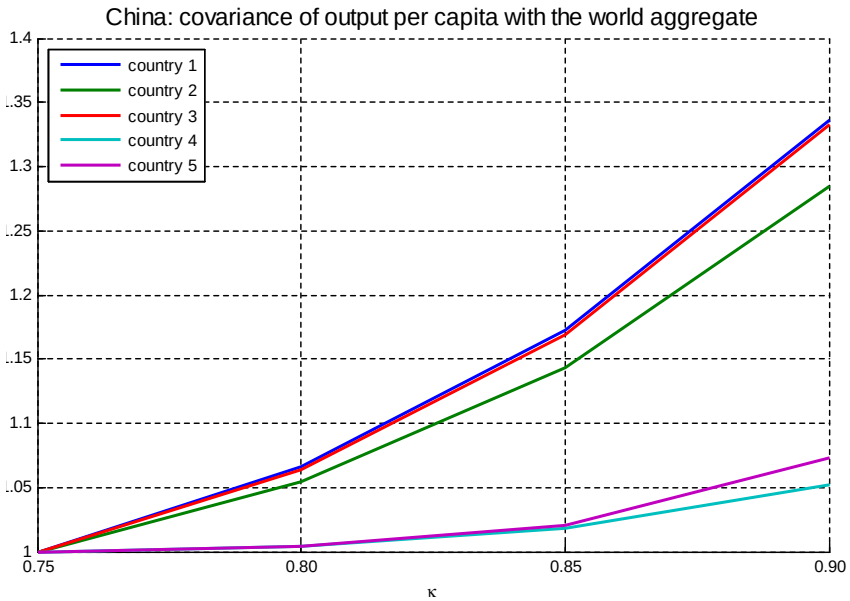




κ_{ij} increases uniformly over time from 0.5 to 0.9 L=(1,1,1,3,3)

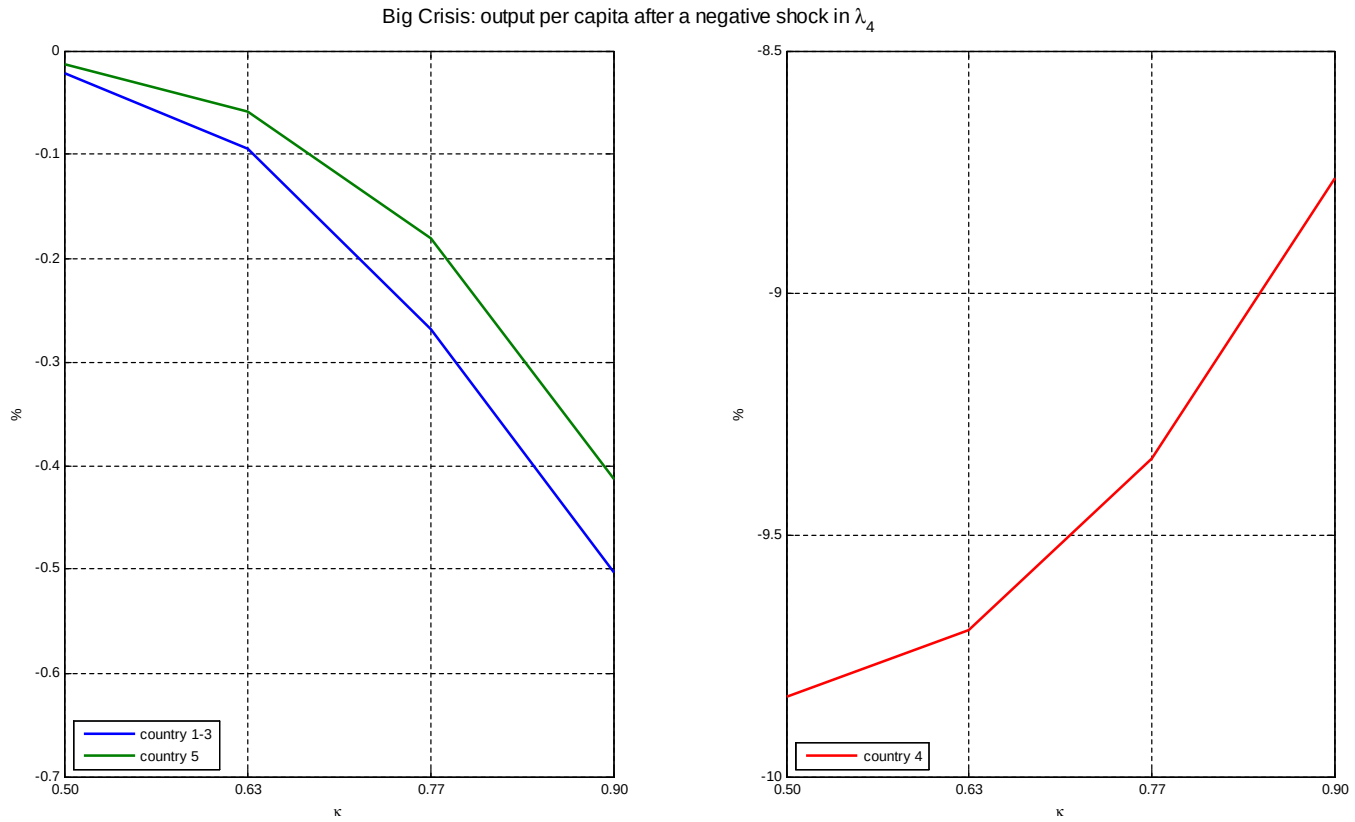
China joins the World





κ_{ij} increases uniformly but for a big country it increases more rapidly:1-4 = 0.75->0.9, for the 5th moves 0.4->0.9L=(1,1,1,3,3)
Correlation among the "old" partners (say US-Europe) can actually decrease with the rise of China. Key what is defined as world

Shock to Big country



$L(1,1,1,3,3)$; shock to λ_4.

Next Steps

- Use data on bilateral trade, gross output, GDP to back out the λs and κs.
- Study how much of the changes in volatility and comovement patterns can be accounted for by changes in κ, the process generating λ, the growth of China.

Minimalist Counterfactual

- Spending on goods from j as a share of $i's$ spending:

$$d_{ij} = \frac{I_{ij}}{L_i p_i q_i} = \frac{I_{ij}}{GNO_i - S_i}$$

- Spending share on domestic goods:

$$d_{ii} = 1 - \sum_{j \neq i} d_{ij}$$

- Real aggregate GDP:

$$\frac{w_i L_i}{p_i} = \text{const} \cdot L_i \left(\frac{\lambda_i}{d_{ii}} \right)^{\theta / \beta_i}.$$

Minimalist Counterfactual (continued)

- Real aggregate GDP:

$$\frac{w_i L_i}{p_i} = \text{const} \cdot L_i \left(\frac{\lambda_i}{d_{ii}} \right)^{\theta/\beta_i}.$$

Call z_{it} the combination L_i andλ_i

$$z_{it} = \ln L_{it} + \frac{\theta}{\beta_i} \ln \lambda_{it}.$$

z_{it} can be recovered from:

$$y_{it} = \text{const'} + z_{it} - \frac{\theta}{\beta_i} \ln d_{ii,t},$$

- We can then decompose GDP volatility as

$$\text{Var}(\tilde{y}_i) = \text{Var}(\tilde{z}_i) + \left(\frac{\theta}{\beta_i} \right)^2 \text{Var}(\ln \tilde{d}_{ii}) - \frac{2\theta}{\beta_i} \text{Cov}(\tilde{z}_i, \ln \tilde{d}_{ii}).$$

Change in Variance from 70-84 to 85-2006

Country	Percent Change in Standard Deviation (1)	Absolute Difference in Variance (2)	Absolute Difference in Var(Z) (3)	Absolute Difference in Var(dii) (4)	Absolute Difference in the Covariance (5)	Percent Share of difference (2) accounted for by (4) and (5)
Australia	45.79	4.65	4.97	-0.33	0.01	-6.89
Austria	-36.28	-8.07	-2.48	2.03	-7.61	69.22
Belgiumplus	-45.38	-13.09	-4.37	13.37	-22.10	66.64
Canada	-4.02	-1.44	12.16	2.55	-16.15	943.79
China,P.R.: Mainland	-15.43	-12.29	-9.42	1.62	-4.48	23.34
Denmark	-7.89	-1.54	-8.94	1.47	5.93	-480.04
Finland	54.87	33.69	48.85	0.43	-15.58	-44.97
Franceplus	-28.48	-7.37	-8.27	0.68	0.21	-12.18
Germany	0.69	0.18	2.16	2.97	-4.94	-1121.14
Greece	-47.92	-53.29	-57.64	0.60	3.76	-8.18
India	-18.19	-7.86	-13.60	0.45	5.29	-73.02
Ireland	64.02	27.38	30.38	11.24	-14.24	-10.93
Italy	-29.04	-7.78	1.78	-0.93	-8.64	122.86
Japan	24.11	9.24	10.36	-0.52	-0.60	-12.08
Korea	25.28	19.21	22.47	-2.84	-0.43	-17.00
Mexico	-36.98	-41.58	-26.29	3.86	-19.15	36.77
Netherlands	-21.98	-6.31	1.50	14.04	-21.84	123.75
Norway	7.35	1.54	-1.33	-1.12	3.99	186.63
Portugal	-14.96	-13.87	-22.40	0.48	8.05	-61.52
Spain	-43.41	-28.74	-27.25	-0.61	-0.88	5.18
Sweden	50.35	10.24	13.71	1.40	-4.87	-33.92
United Kingdom	-18.53	-6.17	-3.70	-0.95	-1.51	40.00
United States	-44.63	-14.39	-13.03	-0.17	-1.20	9.49

Next Step: Towards a more "quantitative" model

$$d_{ij} = A^{-1/\theta} \left(\frac{B_j w_j^{\beta_j} {p_j}^{1-\beta_j}}{p_i \kappa_{ij}} \right)^{-1/\theta} \lambda_j \tag{1}$$

$$p_i = A \left[\sum_{j=1}^{N} \left(\frac{B_j w_j^{\beta_j} {p_j}^{1-\beta_j}}{\kappa_{ij}} \right)^{-1/\theta} \lambda_j \right]^{-\theta} \tag{2}$$

$$L_i p_i q_i + S_i = \sum_{j=1}^{N} L_j p_j q_j d_{ji} \tag{3}$$

$$L_i w_i = \beta_i (L_i p_i q_i + S_i) \tag{4}$$

where

$$d_{ij} = \frac{I_{ij}}{L_i p_i q_i}. \tag{5}$$

$d_{ii} = 1 - \sum_{j \neq i} d_{ij}$; Big Unknowns: $L_j; \lambda_j; \kappa_{ij}$

Next: Back to the experiments

- How much can the (presumable) increase in κs account for the observed changes in volatility and comovements?
- Or was it good luck—improvements in the distribution of λ?
- Or was it the rise of China (increase in L)?
- What if, with this structure in place, the US's λ gets a bad draw?

Calibration I

$$S_i = \sum_c E_{ci} - \sum_c M_{ic}$$

$$\begin{aligned} \beta_i &= \frac{L_i w_i}{L_i p_i q_i + S_i} \\ &= \frac{GDP_i}{GNO_i} \end{aligned}$$

Calibration II

Backing out the κ_{ji}. From

$$d_{ij} = A^{-1/\theta} \left(\frac{B_j w_j^{\beta_j} {p_j}^{1-\beta_j}}{p_i \kappa_{ij}} \right)^{-1/\theta} \lambda_j$$

And assuming $\kappa_{ji} = \kappa_{ji}$

$$\kappa_{ji} = \left(\frac{d_{ij}}{d_{jj}} \frac{d_{ji}}{d_{ii}} \right)^{\theta/2}$$

Calibration II

Backing out $\lambda_i L_i^{\beta_i/\theta} = Z_i^{\beta_i/\theta}$

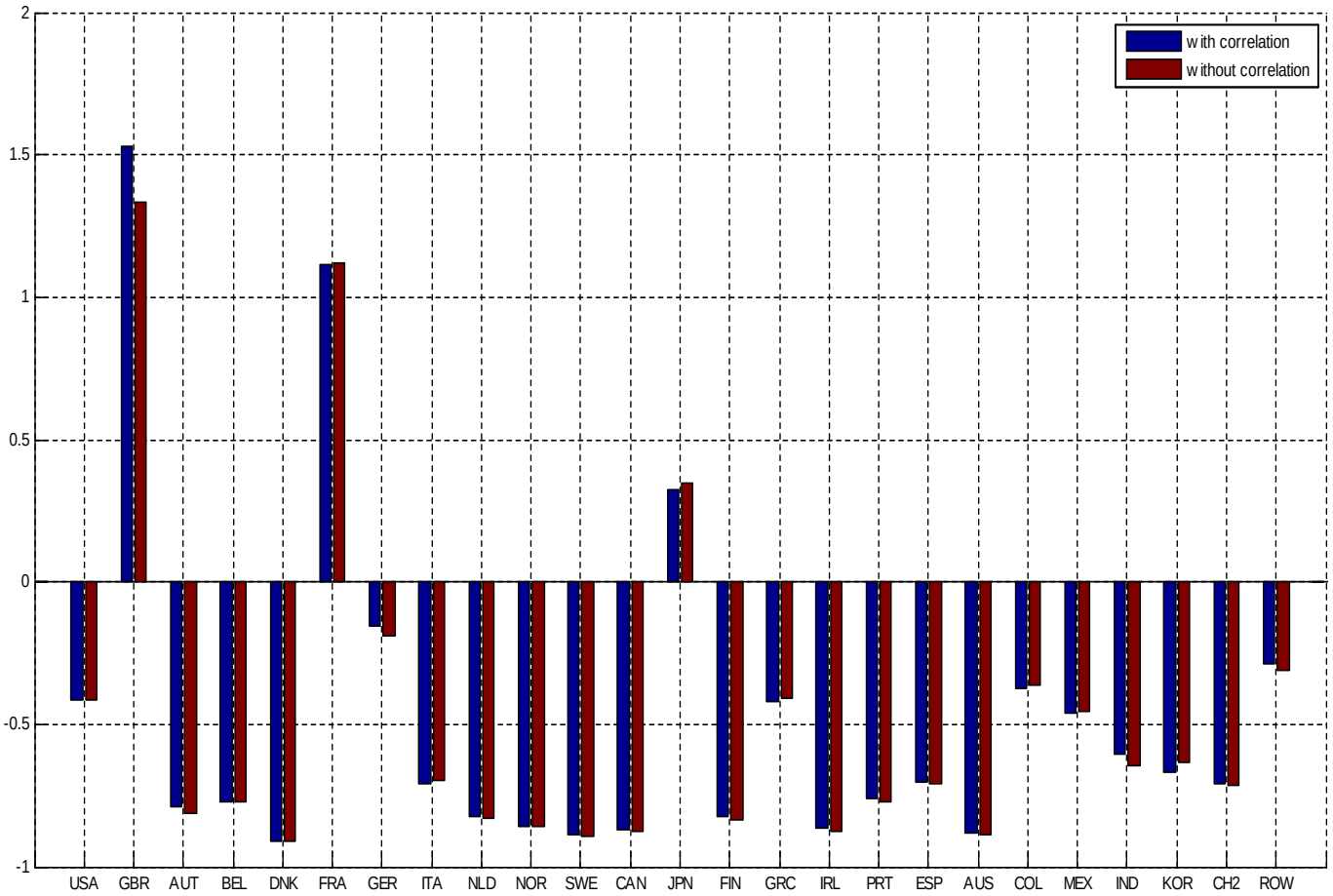
From

$$d_{ii} = A^{-1/\theta} \left(\frac{w_i}{p_i} \right)^{-\beta/\theta} \lambda_j$$

$$\lambda_i L_i^{\beta_i/\theta} = d_{ii} \left(AB_i \right)^{1/\theta} \left(\frac{w_i L_i}{p_i} \right)^{\beta_i/\theta}$$

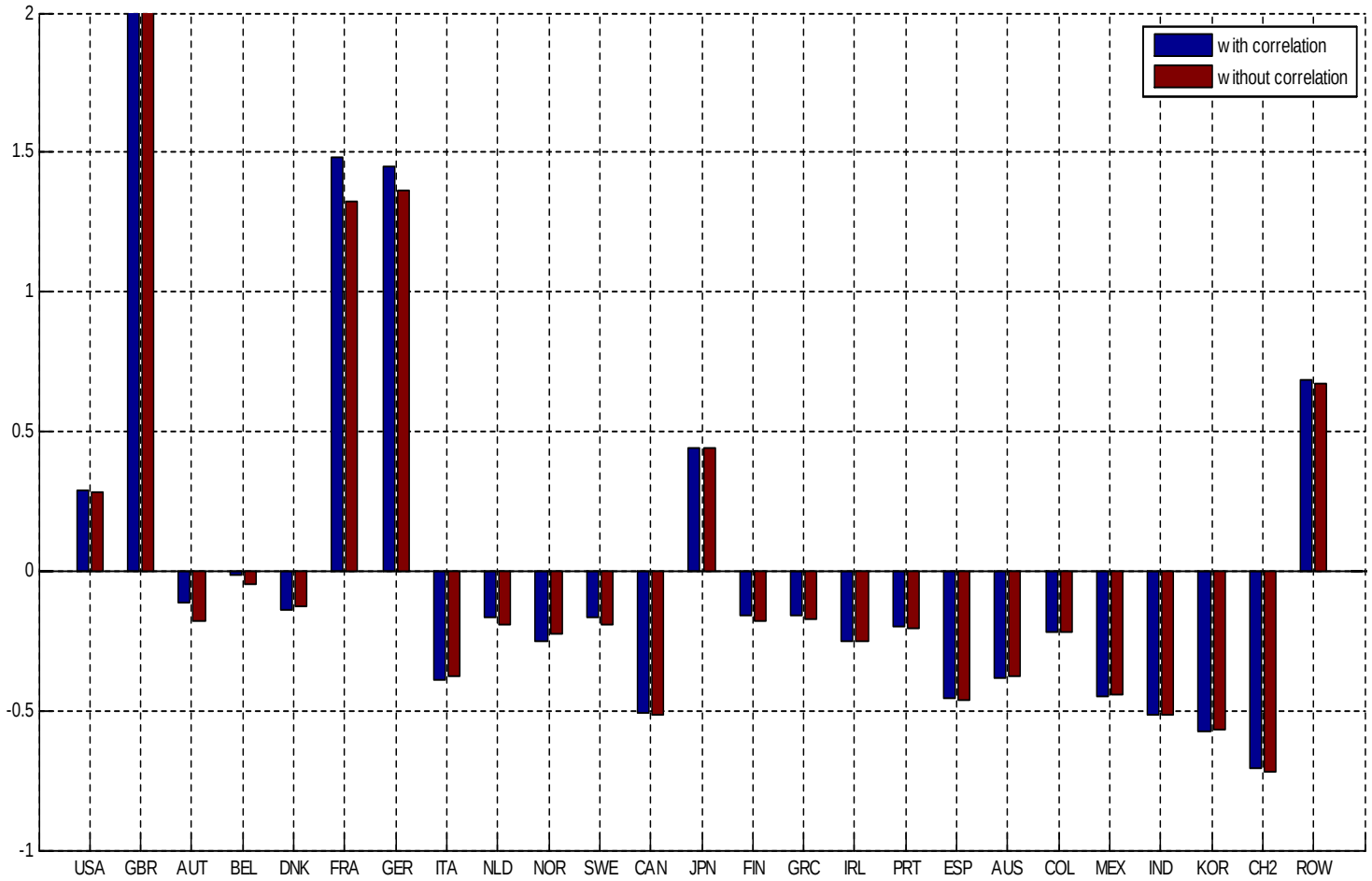
Some Very Preliminary Results from Counterfactuals

Effect of Openness if Shocks had been as in 1970-84



actual κ and shocks from 70-84

Effect of Openness if Shocks had been as in post 85.



actual κ and shocks from 87-2006

Some Conclusions

- When country-specific shocks are imperfectly correlated, trade can lead to lower volatility, particularly when
  i) a country is small
  ii) the share of tradeables in the economy is big
  iii) trading partners are less volatile or the correlations are small.

Some Conclusions

- When country-specific shocks are imperfectly correlated, trade can lead to lower volatility, particularly when
  i) a country is small
  ii) the share of tradeables in the economy is big
  iii) trading partners are less volatile or the correlations are small.
- The introduction of new trading partners:
  i) increases the correlation of growth rates with the new partners
  ii) can decrease bilateral correlations among members of the "old" group (US-Europe)

Some More Tentative Conclusions

- Trade seems to have contributed to lower volatility in the majority of countries analyzed
- For the US, if the process of shocks had been the same as in the 1970-84, openness would have contributed to lower volatility.
  - But it appears that the process of shocks in the US became significantly less volatile post 84; thus, openness exposed it to the shocks of its more volatile partners.
  - A very tentative conclusion is that in the US trade actually contributed to higher volatility.