CEMLA
CENTER FOR LATIN AMERICAN MONETARY STUDIES

The Transmission of US Shocks to Emerging Markets

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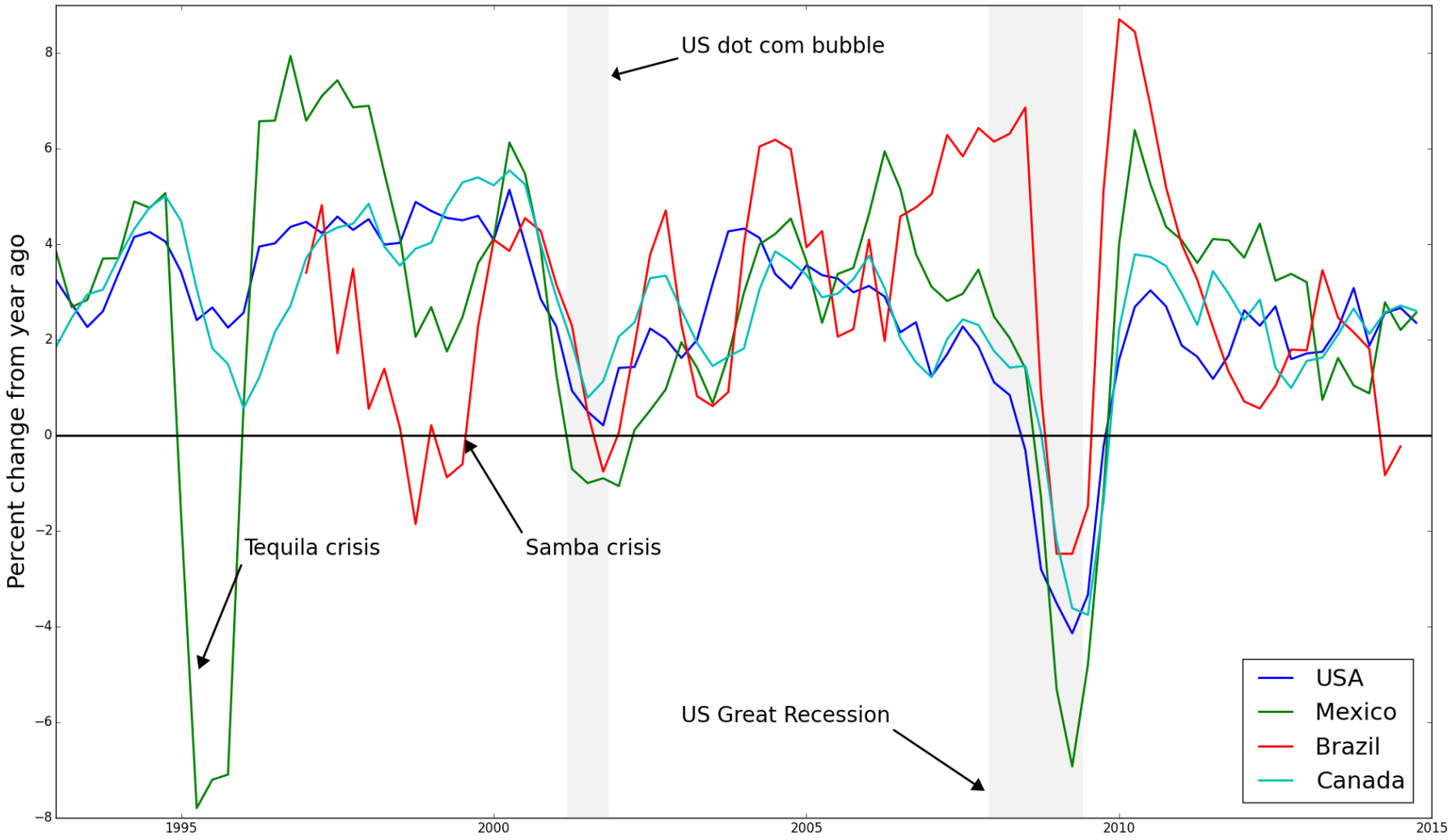
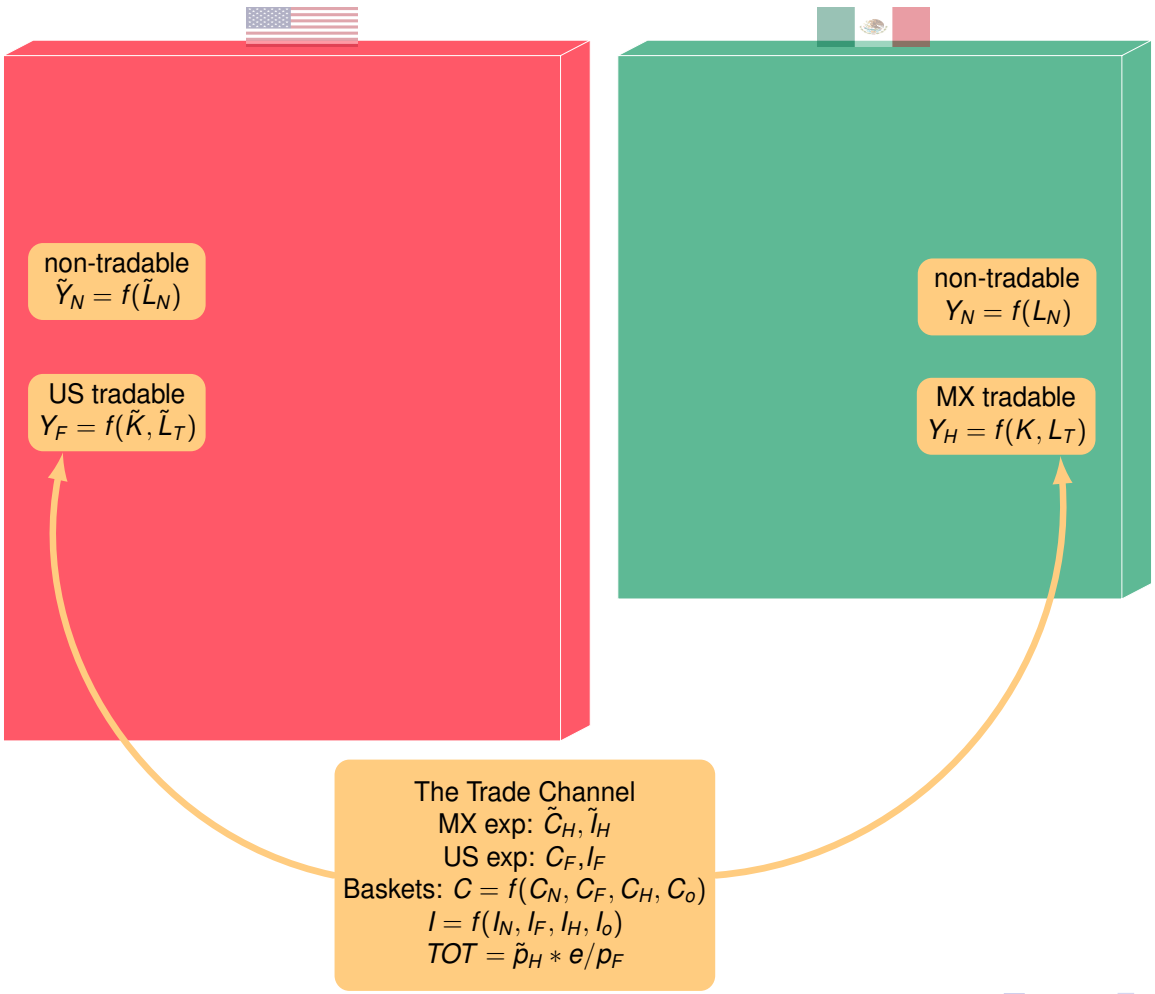
Co-movement of the US & EMEs Business Cycles



Previous Empirical and Theoretical Studies

- Empirical studies have used VARs to document the transmission of US shocks to emerging markets.
  - Canova (2005); Mackowiak(2007)
- Theoretical studies show that international business cycles with standard and "enriched" trade linkages have a difficult generating transmission.
  - Schmitt-Grohe(1998); Justiniano and Preston (2010)
- Another strand of the literature focuses on interest rate shocks and financial linkages to analyze the vulnerability of emerging markets to external shocks.
  - Neumeyer and Perri (2005); Uribe and Yue (2006); Garcia-Cicco, Pancrazi and Uribe (2010), Chang and Fernandez (2010)

Our approach: endogenous trade and financial linkages



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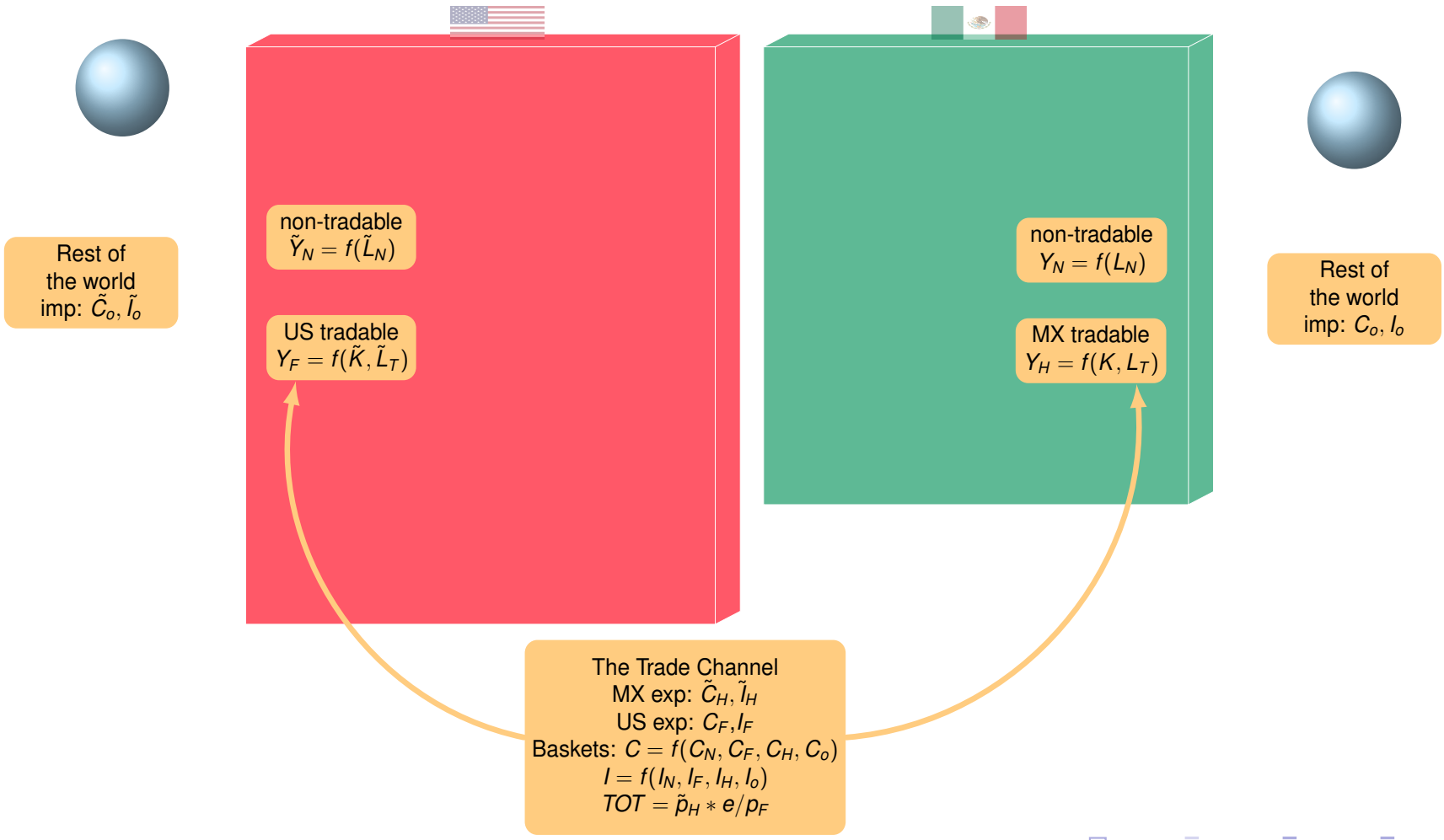

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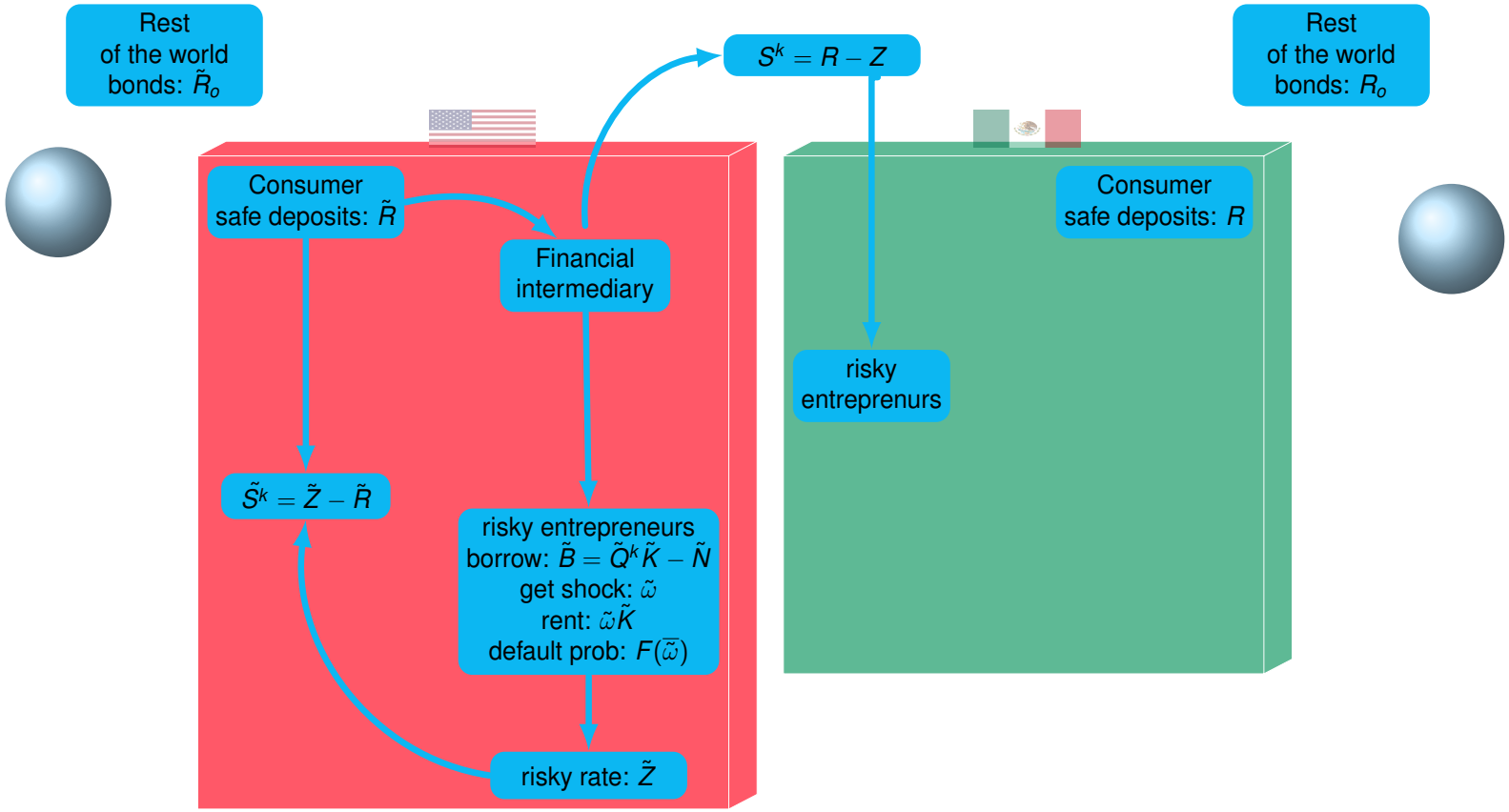

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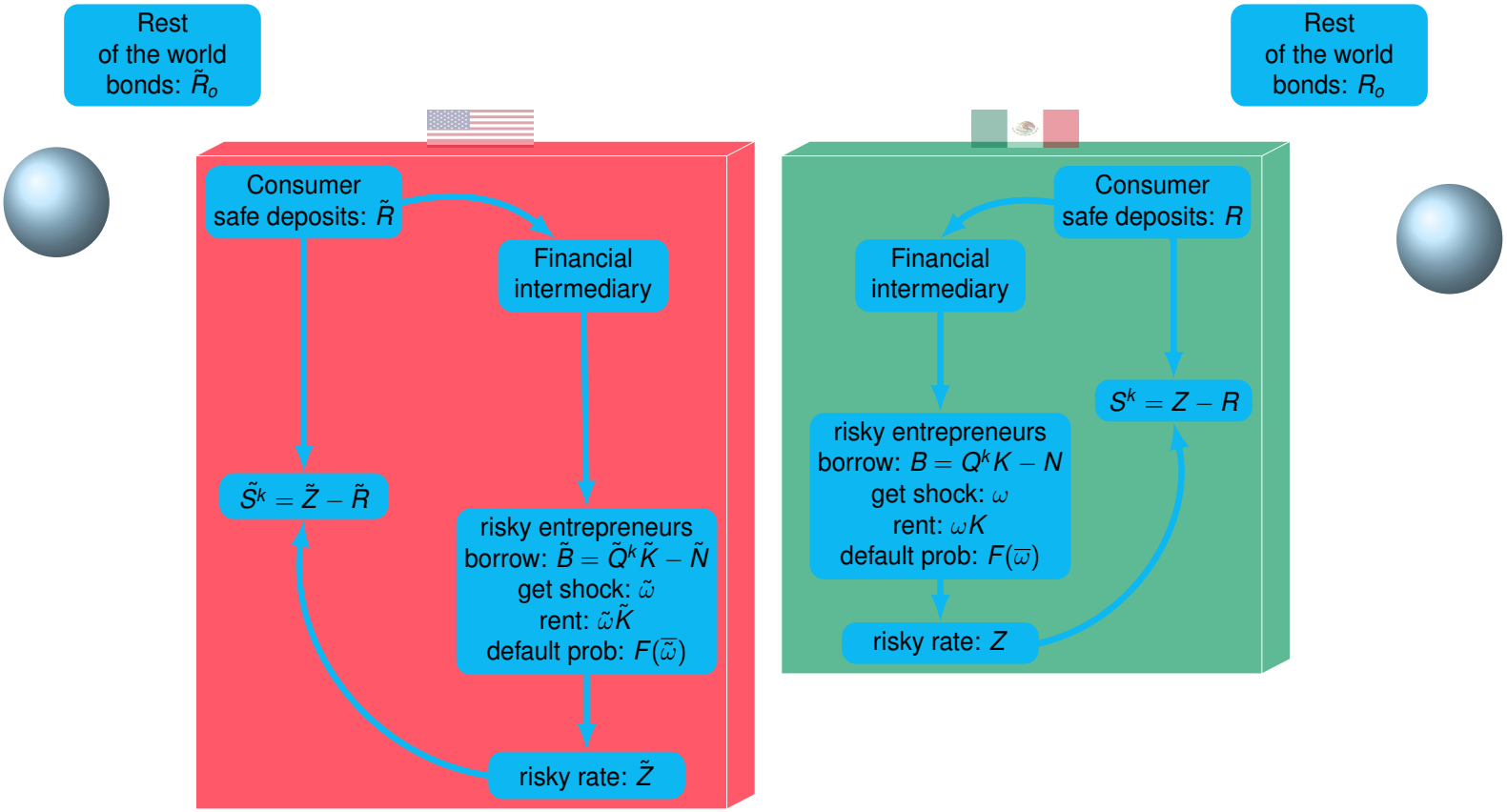

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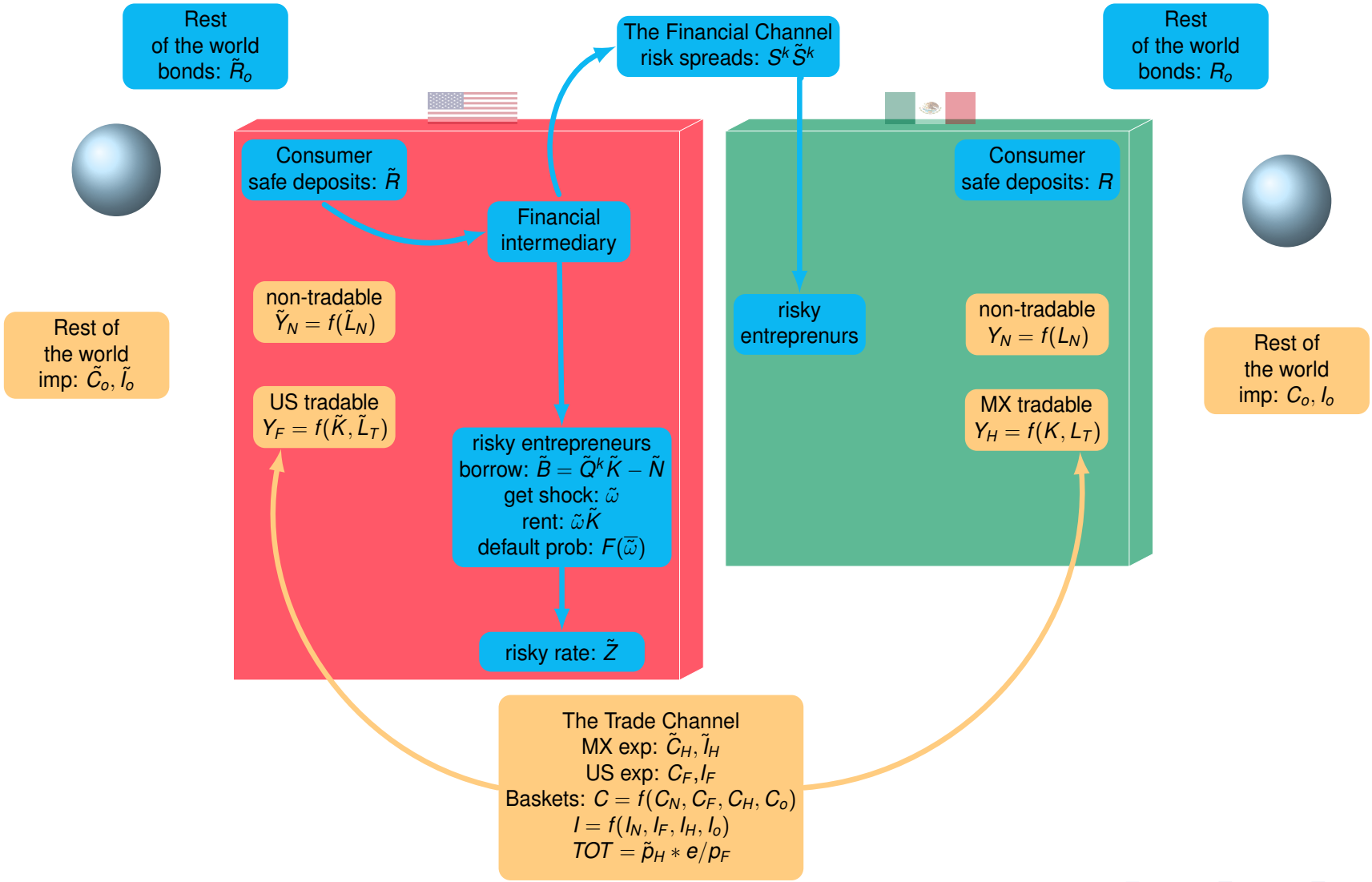


Our approach

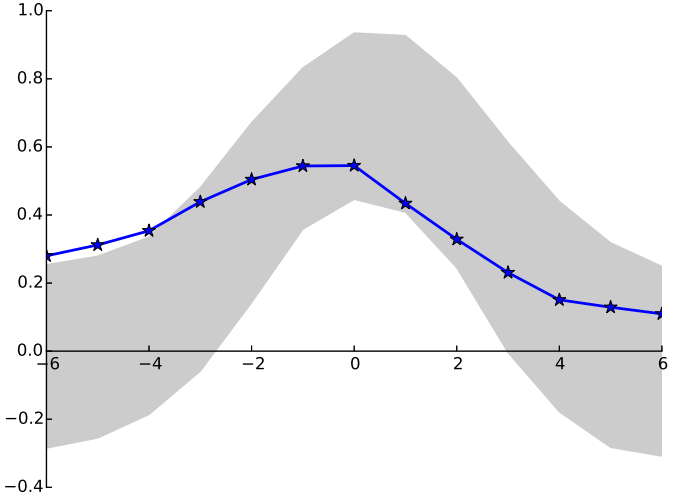
- Using 16 quarterly series for Mexico and the US from 1994 to 2012, we estimate the model using Bayesian techniques.
- We use the estimated model to address three questions:
  - What are the driving forces of the Mexican business cycle?
  - What is the historical impact of US shocks on the Mexican economy?
  - What are the roles of trade linkages and financial market distortions in exposing the Mexican economy to the US shocks?

Econometric findings

- The model predicts cross-country correlations consistent with the data

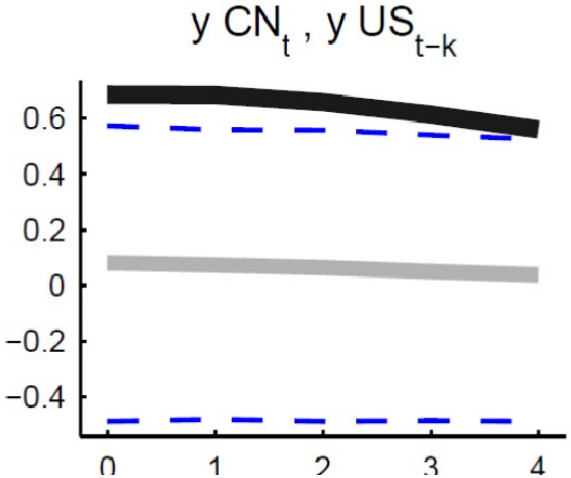
This paper

$corr(\Delta Y_t^{mx}, \Delta Y_{t-j}^{us})$



Justiniano and Preston (JIE, 2010)

$corr(Y_t^{can}, Y_{t-j}^{us})$



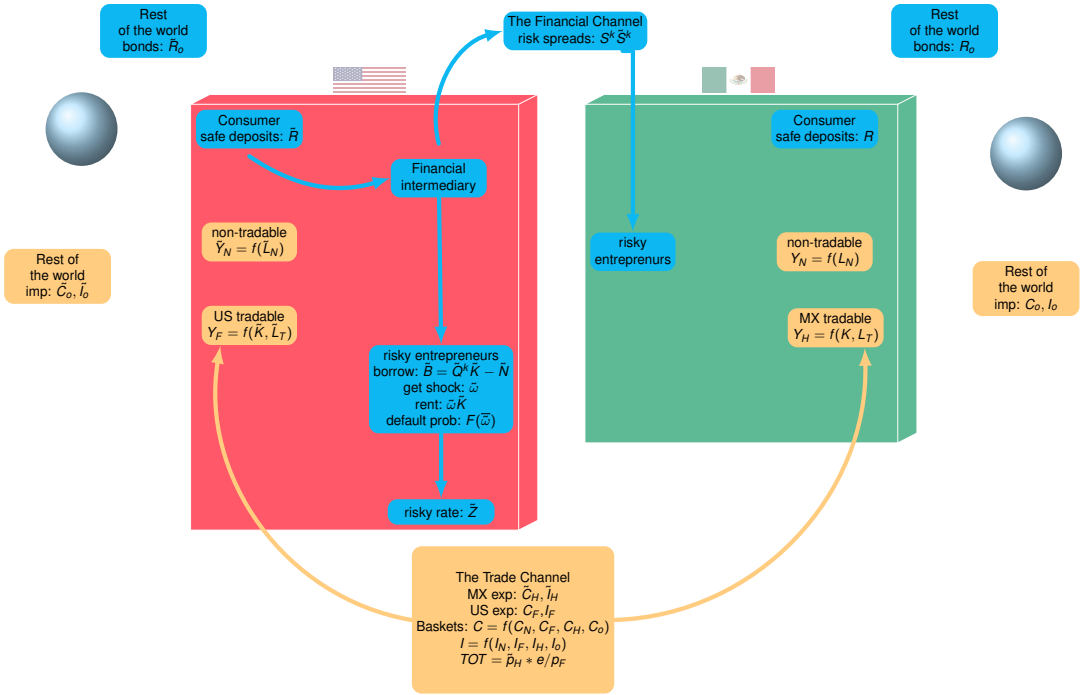
- The estimation endogenously delivers the "Small Open Economy" assumption needed in structural VARs estimations.

Economic findings

- We find that US shocks explain around 70% of the variation in Mexico's GDP growth rate. This is the largest source of fluctuations.
  - This finding is confirmed by an estimated structural VAR using our dataset.
  - For Mexico's GDP variance, Mackowiak (JME, 2007) finds that external shocks explain 50% and Canova (JAE, 2005) finds that external shocks explain 92%.
- The transmission of shocks occurs through out the business cycles in the sample. Interestingly, during the Tequila crisis (1994-1995) US shocks play a minor role.
- While Mexico's growth substantially benefited from the US expansion in the second part of the 1990s, it was adversely hit by the US recessions in 2001 and 2008.
- Counter-factual experiments show that spill-overs from the US are more sensitive to the changes in financial frictions than to the changes in the volume of bilateral trade.

Our approach: endogenous trade and financial linkages

- International business cycle features (e.g., Stockman and Tesar (1995), Heathcote and Perri (2002))
- Financial aspects (BGG (1999), Christiano, Motto and Rostagno (AER, 2014))



- Consumer
- Final good producer
- Capital producer
- Entrepreneur
- Financial intermediary
- Exporter
- Government

Consumer's Problem

- The household's preferences are a modified version of GHH (AER, 1988) preferences to allow for habit in consumption

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\xi_{C,t}\left[C_t - \varphi C_{t-1} - \frac{\psi}{1+\eta} L_t^{1+\eta}\right]^{1-\sigma} - 1}{1-\sigma}, \tag{1}$$

  - C: consumption basket
  - L: labor composite
  - φ: habit parameter
  - ξ_C: preference shock
  - β: discount factor
  - σ: inter-temporal elasticity
  - η: aggregate labor-wage elasticity
  - ψ: scale parameter

- Labor composite

$$L_t = \left[\left(L_{N,t}\right)^{1+\chi} + \left(L_{T,t}\right)^{1+\chi} \right]^{1/(1+\chi)} \tag{2}$$

  - L_N: labor in non-traded sector
  - L_T: labor in traded sector
  - $\frac{1}{\chi}$: elasticity of substitution

- Consumption composite

$$C_t = \left[a^{\frac{1}{\theta}} C_{T,t}^{\frac{\theta-1}{\theta}} + (1-a)^{\frac{1}{\theta}} C_{N,t}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{3}$$

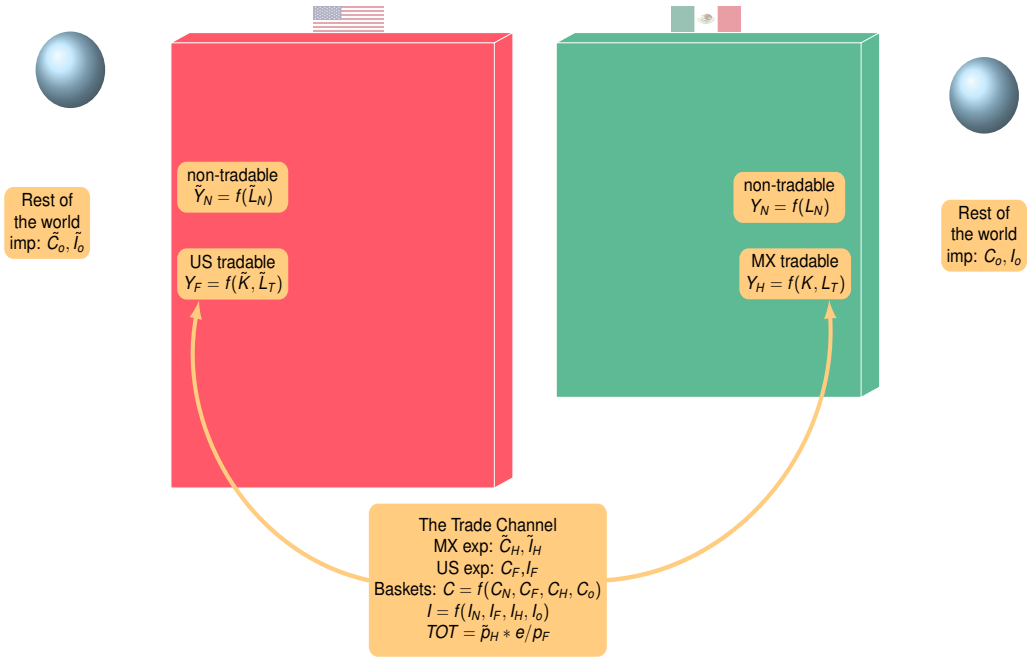
  - C_T: traded consumption basket
  - C_N: non-traded good
  - θ: elasticity of substitution
  - a: share parameter

Our approach: endogenous trade and financial linkages

- The traded consumption basket:

$$C_{T,t} = \left[m_H^{\frac{1}{\omega}} C_{H,t}^{\frac{\omega-1}{\omega}} + m_F^{\frac{1}{\omega}} C_{F,t}^{\frac{\omega-1}{\omega}} + m_O^{\frac{1}{\omega}} C_{O,t}^{\frac{\omega-1}{\omega}} \right]^{\frac{\omega}{\omega-1}} \quad (4)$$

  - C_H: traded good produced in Mexico (**H**ome country)
  - C_F: traded good produced in US (**F**oreign country)
  - C_O: traded produced elsewhere (**O**ther country)
  - ω_c: elasticity of substitution within traded goods
  - m's: shares



- The household's budget constraint (in units of the domestic consumption basket) is given by

$$e_t B_{o,t} = -\left[w^*_{H,t} L_{H,t} + w^*_{N,t} L_{N,t} + \Pi_t\right] + \left[C_t + T_t\right] + e_t R_{t-1} B_{o,t-1} + e_t \frac{\pi}{2}\left(B_{o,t} - \bar{B}_o\right)^2 \tag{5}$$

- The lump-sum transfers Π_t include: transfers from the firms, from the capital producers and from the entrepreneurs.

U.S. households

- U.S. households save in a portfolio of three risk-free bonds: $\tilde{B}_t$, B_t and $\tilde{B}^o_t$.
- The funds of $\tilde{B}_t$ and B_t finance the domestic and foreign branches—correspondingly—of a mutual fund described below.
- By law, the mutual fund cannot divert funds from the domestic branch to the foreign branch and vice-versa. The third bond $\tilde{B}^o_t$ is traded with the rest of the world.
- The budget constraint is

$$\tilde{C}_t + \tilde{B}_t + nB_t + \tilde{B}^o_t + \tilde{T}_t = \tilde{w}_{Tt}\tilde{L}_{Tt} + \tilde{w}_{Nt}\tilde{L}_{Nt}$$
$$+ \tilde{R}_{t-1}\tilde{B}_{t-1} + nR_{t-1}B_{t-1} + \tilde{R}^o_{t-1}\tilde{B}^o_{t-1} + \frac{\tilde{\pi}}{2}(\tilde{TB}_t - \bar{T}B)^2 + \tilde{\Pi}_t$$

where $\tilde{TB}_t = \tilde{B}_t + nB_t + \tilde{B}^o_t$ and n is the inverse of the relative size of MX.

Final good producer

- Production functions with input adjustment costs (e.g. Basu and Shapiro (2001), Ireland and Schuh (RED, 2008))

$$Y_N = \left[A_{N,t} L_{N,t}\right]\left[\frac{\phi_L}{2}\left(\frac{L_{N,t}}{L_{N,t-1}} - 1\right)^2\right] \tag{6}$$

$$Y_{H,t} = \left[A_{T,t} K_{t-1}^{\alpha} L_{T,t}^{1-\alpha}\right]\left[\frac{\phi_L}{2}\left(\frac{L_{T,t}}{L_{T,t-1}} - 1\right)^2\right]\left[\frac{\phi_K}{2}\left(\frac{K_{T,t-1}}{K_{T,t-2}} - 1\right)^2\right] \tag{7}$$

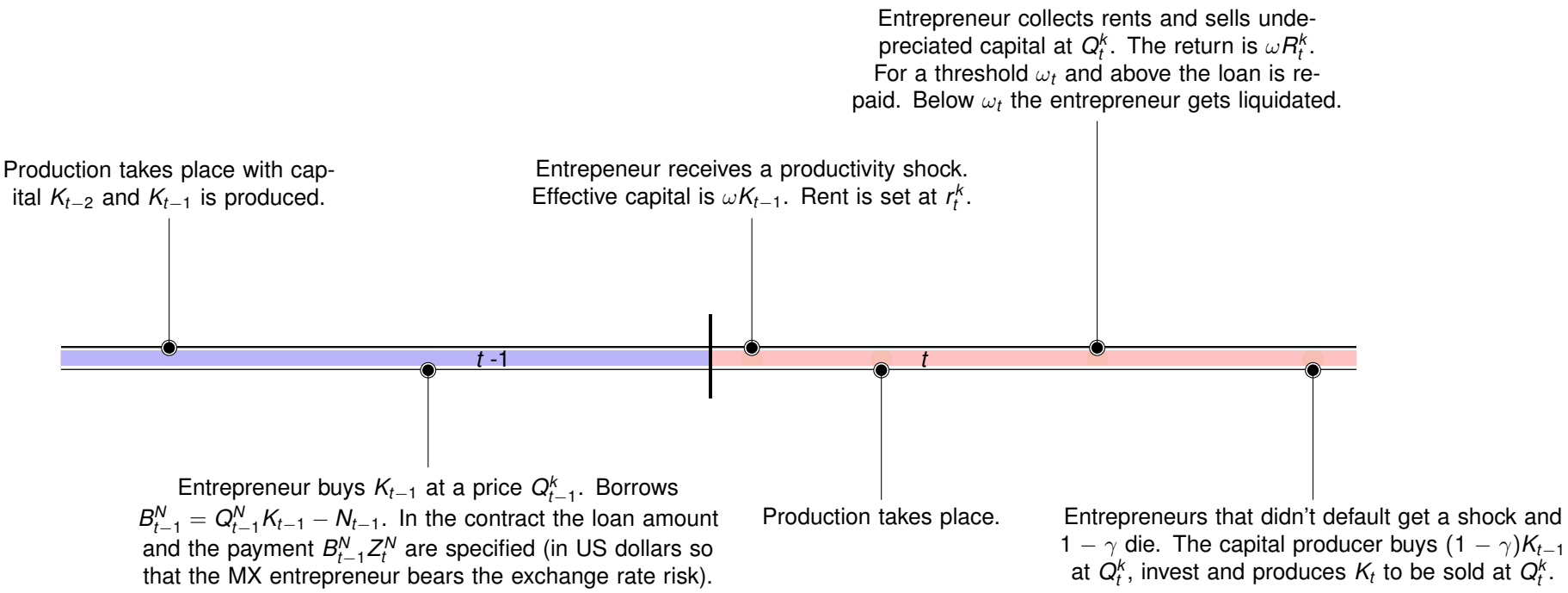
- Working capital constraint in total production revenues, thus

$$\frac{[1 - \kappa_j(R_t^o - 1)]}{1 - \tau_j} p_{j,t} Y_{j,t} \tag{8}$$

is the net revenue, with $j = N, H$

Capital production, entrepreneurs & financial intermediation

We follow Christiano, Motto and Rostagno (AER, 2014) closely, and adapt it to a two-country setting.



Capital producer

- To produce new capital, the capital producer purchases the un-depreciated capital $(1-\delta)K_{t-1}$ used in period t at a price Q_t^k and I_t units of investment to produce K_t. Then, the newly produced raw capital is sold to the entrepreneur at a price Q_t^k.
- The capital producer combines the un-depreciated capital and investment goods to produce the new capital with the following technology:

$$K_t = (1-\delta)K_{t-1} + \xi_{I,t} I_t \left[1 - \frac{\phi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2\right], \tag{9}$$

where $\xi_{I,t}$ is a shock to the marginal efficiency of investment in producing capital, and ϕ_I determines the cost of adjustment.

- Investment baskets

$$I_t = \left[a^{\frac{1}{\theta}} I_{T,t}^{\frac{\theta-1}{\theta}} + (1-a)^{\frac{1}{\theta}} I_{N,t}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{10}$$

with

$$I_{T,t} = \left[m_H^{\frac{1}{\nu}} I_{H,t}^{\frac{\nu-1}{\nu}} + m_F^{\frac{1}{\nu}} I_{F,t}^{\frac{\nu-1}{\nu}} + m_O^{\frac{1}{\nu}} I_{O,t}^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}}, \tag{11}$$

- Note that investment plays a direct role in the trade channel (is traded) and also in the financial channel (capital is the collateral)

Entrepreneur

The timing of events is as follows

- (t-1):
  - K_{t-1} is produced
  - Entrepreneur N buys K^N_{t-1} at a price Q^k_{t-1}. Borrows $e_{t-1}B^N_{t-1} = Q^N_{t-1}K^N_{t-1} - N_{t-1}$. In the contract the loan amount and the payment $B^N_{t-1}Z^N_t$ are specified (in US dollars so that the MX entrepreneur bears the exchange rate risk).
- (t):
  - Productivity shock is realized. Effective capital is ωK^N_{t-1}. Rent is set at r^k_t.
  - Production takes place
  - Entrepreneur collects rents and sells undepreciated capital at Q^k_t. The return is ωR^k_t, where:

$$R^k_t = \frac{r^k_t + (1-\delta)Q^k_t}{Q^k_{t-1}}$$

Entrepreneur

- For a threshold ω_t and above the loan is repaid, below ω_t the entrepreneur gets liquidated. We can write the solvency condition as

$$e_{t-1} B^N_{t-1} Z^N_t \leq \omega_t R^k_t Q^k_{t-1} K_{t-1} \tag{12}$$

- A bankrupt entrepreneur is monitored by the bank, which seizes the entrepreneur's assets after paying a monitoring cost μ.
- The shock ω is such that

$$\ln(\omega) \sim \mathcal{N}(0, \sigma_t) \tag{13}$$

where σ_t is a "risk shock"

Optimal debt contract

- The profit for the emerging market section of the bank is given by

$$\pi_t^{bank,em} = \int_{\omega_t}^{\infty} B_{t-1}^N Z_t^N dF(\omega) + (1-\mu) \int_0^{\omega_t} \frac{1}{e_t} R_t^k \omega_t Q_{t-1}^k K_{t-1}^N dF(\omega) - R_{t-1} B_{t-1}^N \tag{14}$$

- The expected net worth of the entrepreneur is (in units of the US consumption basket)

$$E_t V_{t+1}^N = E_t \Big\{ \int_{\omega_t}^{\infty} \frac{1}{e_{t+1}} R_{t+1}^k \omega Q_t^k K_t^N - Z_{t+1}^N B_t^N dF(\omega) \Big\} \tag{15}$$

- The optimal debt contract (specified at the end of period t) for type N entrepreneur sets Z and B to maximize $E_t V_{t+1}^N$ subject to a zero profit condition of the bank.

International Pricing: Exporters

- There are intermediary firms that buy the traded good, H, and export it to the US. The exporting firms face a similar working-capital constraint as the producers.
- The representative exporter maximizes

$$\frac{\left[1-\kappa_E(R_t-1)\right]}{1-\tau_E}\tilde{p}_{H,t}\xi_{tot,t}\tilde{Q}_{H,t}-\frac{p_{H,t}}{e_t}\tilde{Q}_{H,t}$$

  - $\tilde{Q}_{H,t}=n\left[\tilde{C}_{H,t}+\tilde{X}_{FH,t}\right]$: total exports to the US.
- The pricing equation for the H good:

$$\tilde{p}_{H,t}=\frac{p_{H,t}}{e_t}\frac{1-\tau_E}{\left[1-\kappa(R_t-1)\right]}\frac{1}{\xi_{tot,t}}$$

  - ξ_{tot}: terms of trade shock

Closing the model

- Government
  - Government finances expenditures with lump-sum taxes: $T_t = p_{G,t} G_t$
  - and adjusts spending according to:

$$G_t = (G)\left(\frac{Y_t}{Y_{t-1}}\right)^{\psi_{G,Y}} \xi_{G,t}$$

- Other net imports
  - Imports from the rest of the world, $p_{o,t}[C_{o,t} + X_{No,t} + X_{Ho,t}]$, follows an autoregressive process:

$$ONMY_t = (ONMY)^{1-\rho_{onm}} \left(ONMY_{t-1}\right)^{\rho_{onm}} \left(\frac{Y_t}{Y_{t-1}}\right)^{\psi_{onm,y}} \epsilon_{onm,t}$$

Structural Shock Processes

- The fourteen structural shocks in the model follow AR(1) processes:

$$\widehat{\xi}_t = \rho_\xi \widehat{\xi}_{t-1} + \widehat{\epsilon}_{\xi,t}$$

where $\xi = \left\{\xi_C, \tilde{\xi}_C, \xi_I, \tilde{\xi}_I, \xi_{A_T}, \tilde{\xi}_{A_T}, \xi_{A_N}, \tilde{\xi}_{A_N}, \xi_\sigma, \tilde{\xi}_\sigma, \xi_{tot}, \xi_{onm}, \tilde{\xi}_{onm}, \xi_G, \tilde{\xi}_G, \tilde{\xi}_{Lt}\right\}$. We allow for $\widehat{\epsilon}_{A_T,t}$ and $\widehat{\epsilon}_{A_N,t}$ to be positively correlated within countries but not across countries and all other shocks $\widehat{\epsilon}_{\xi,t}$ are i.i.d.

Estimation: RWMH

- The solution of the model and its relation to the data take the state-space form:

$$X_t = \Gamma X_{t-1} + \Xi \epsilon_t$$
$$D_t = \Theta X_{t-1} + \epsilon_t^{me}$$

- We estimate
  - parameters of the shock processes;
  - parameters that determine the real rigidities (e.g., degree of the financial market imperfection, investment adjustment costs).
- We calibrate
  - parameters that are commonly used in the literature (e.g., coefficient of risk-aversion);
  - parameters that are difficult to identify with our data-set (e.g., elasticity of substitution between home and foreign goods).

Steady-state values and ratios

Variable	Description	MX & US
β	Subjective discount factor	0.994
σ	Intertemporal elastacity of substitution	4
η	Curvature on disutility of labor	1
χ	Labor elasticity of substitution	2
$\bar{\xi}_L$	Steady state wage markup	1.15
θ	Elasticity of substitution between tradable and non-tradable	0.7
ν	Elasticity of substitution among tradables	1.5
δ	Capital depreciation rate	0.025
α	Power on capital in production function	0.4
a	Share of tradables in consumption and investment baskets	0.7

Variable	description	data	model
Financial variables			
$\tilde{R}$	US interest rate	1.0245	1.0242
$\tilde{S}^k$	US risk spread	1.0241	1.0242
S^k	MX risk spread	1.0351	1.0353
Bilateral Trade			
exp/Y	MX exports / MX GDP	0.1927	0.1927
imp/Y	MX imports / MX GDP	0.1446	0.1446
US			
$\tilde{C}/\tilde{Y}$	Consumption / GDP	0.6619	0.6619
$\tilde{I}/\tilde{Y}$	Investment / GDP	0.1676	0.1676
$\tilde{G}/\tilde{Y}$	Government spending / GDP	0.2061	0.2061
MX			
C/Y	Consumption / GDP	0.6429	0.6429
I/Y	Investment / GDP	0.2026	0.2026
G/Y	Government spending / GDP	0.1152	0.1152
$Y/\tilde{Y}$	MX GDP / US GDP	0.0645	0.0645

Data: 16 time series

Our data (D) covers 1994Q1–2012Q4.

- GDP growth for Mexico and the US
- Consumption growth for Mexico and the US
- Investment for growth Mexico and the US
- Bilateral imports growth for Mexico
- Bilateral exports growth for Mexico
- Real exchange rate depreciation
- Government spending growth for Mexico and the US
- Non-bilateral trade/ GDP for Mexico and the US
- J.P. Morgan EMBI+ Spread Mexico
- Spread between BAA and 10-year Treasury for the US
- Growth in per capita work hours US

Priors and Posteriors of Estimated Parameters

Param.	Prior Dist.	Prior mean	Prior s.d.	Mexico Posterior mean	Mexico Posterior 5%	Mexico Posterior 95%	US Posterior mean	US Posterior 5%	US Posterior 95%
Preference Shocks									
ρ_{ξ_c}	β	0.500	0.100	0.394	0.269	0.525	0.327	0.230	0.455
σ_{ξ_c}	Γ^{-1}	0.020	0.100	0.149	0.107	0.201	1.226	0.797	1.750
Wage Markup Shock									
$\tilde{\rho}_{\xi_L}$	β	0.500	0.100				0.451	0.262	0.630
$\tilde{\sigma}_{\xi_L}$	Γ^{-1}	0.020	0.100				0.048	0.007	0.098
Technology Shocks									
ρ_{ξ_i}	β	0.500	0.100	0.653	0.555	0.749	0.597	0.448	0.745
σ_{ξ_i}	Γ^{-1}	0.020	0.100	0.193	0.140	0.271	0.070	0.046	0.100
ρ_{AT}	β	0.500	0.100	0.436	0.305	0.566	0.938	0.915	0.957
σ_{AT}	Γ^{-1}	0.020	0.100	0.014	0.008	0.020	0.032	0.024	0.040
σ_{AN}	Γ^{-1}	0.020	0.100	0.007	0.003	0.013	0.015	0.013	0.018
$corr(A_N, A_T)$	β	0.500	0.141	0.467	0.233	0.706	0.182	0.084	0.300
Terms of Trade Shock									
$\rho_{\xi_{tot}}$	β	0.500	0.100	0.236	0.145	0.344			
σ_{tot}	Γ^{-1}	0.020	0.100	0.092	0.073	0.115			
Measurement Errors									
$\sigma_{\Delta Y}$	$\mathcal{U}$	0.002	0.000	0.004	0.004	0.004	0.002	0.002	0.002
$\sigma_{\Delta C}$	$\mathcal{U}$	0.003	0.000	0.005	0.004	0.005	0.001	0.001	0.002
$\sigma_{\Delta I}$	$\mathcal{U}$	0.008	0.000	0.016	0.015	0.016	0.009	0.007	0.010
$\sigma_{\Delta G}$	$\mathcal{U}$	0.002	0.000	0.003	0.000	0.005	0.001	0.000	0.002
$\sigma_{\Delta L}$	$\mathcal{U}$	0.001	0.000				0.002	0.001	0.002
$\sigma_{\Delta imp}$	$\mathcal{U}$	0.008	0.000	0.016	0.016	0.016			
$\sigma_{\Delta exp}$	$\mathcal{U}$	0.007	0.000	0.013	0.011	0.014			
$\sigma_{\Delta onmy}$	$\mathcal{U}$	0.001	0.000	0.001	0.000	0.003	0.000	0.000	0.001
$\sigma_{\Delta spread}$	$\mathcal{U}$	0.002	0.000	0.002	0.000	0.004	0.001	0.000	0.001
$\sigma_{\Delta e}$	$\mathcal{U}$	0.011	0.000	0.015	0.002	0.022			

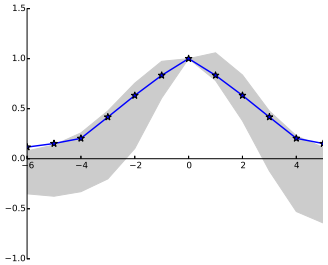
- Our prior elicitation presumes that both countries face symmetrically volatile shocks and let the data speak

Priors and Posteriors of Estimated Parameters

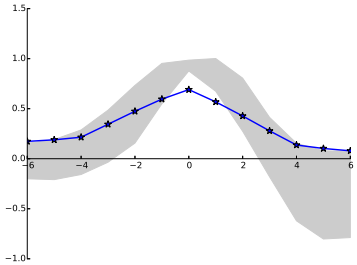
Param.	Prior Dist.	Prior mean	Prior s.d.	Mexico Posterior mean	Mexico Posterior 5%	Mexico Posterior 95%	US Posterior mean	US Posterior 5%	US Posterior 95%
Working Capital Constraint									
κ_N	β	0.250	0.100	0.237	0.096	0.410			
κ_T	β	0.250	0.100	0.172	0.066	0.308			
κ_E	β	0.250	0.100	0.632	0.509	0.750	0.161	0.078	0.258
Financial Parameters & Shocks									
$\bar{\sigma}$	Γ	2.000	0.500	0.920	0.709	1.099	0.504	0.435	0.589
ρ_τ	β	0.500	0.100	0.368	0.245	0.505	0.361	0.260	0.465
σ_τ	Γ^{-1}	0.020	0.100	0.021	0.013	0.034	0.016	0.012	0.020
Preference Parameters									
φ	β	0.200	0.100	0.095	0.047	0.148			
$\tilde{\varphi}$	β	0.850	0.063				0.922	0.904	0.937
Capital Technology									
σ_A	β	0.500	0.100	0.517	0.354	0.683	0.483	0.334	0.645
ϕ_I	Γ	2.000	0.500	2.561	1.811	3.473	1.810	1.385	2.337
ϕ_K	Γ	2.000	0.500	2.033	1.245	2.954	1.990	1.230	2.908
ϕ_L	Γ	2.000	0.500	2.125	1.338	3.148	3.390	2.630	4.237
Government Spending									
$\psi_{G,Y}$	$\mathcal{N}$	0.000	0.100	-0.063	-0.181	0.058	0.070	-0.044	0.183
ρ_G	β	0.500	0.100	0.380	0.256	0.508	0.316	0.207	0.438
σ_G	Γ^{-1}	0.020	0.100	0.028	0.022	0.037	0.012	0.009	0.015
Non-bilateral Trade									
ρ_{onm}	β	0.500	0.100	0.637	0.538	0.735	0.806	0.741	0.869
$\phi_{onm,y}$	$\mathcal{N}$	0.000	0.100	0.015	-0.058	0.082	0.042	-0.001	0.085
σ_{onm}	Γ^{-1}	0.020	0.100	0.011	0.009	0.014	0.003	0.003	0.004

Model Fit: Key Second Moments

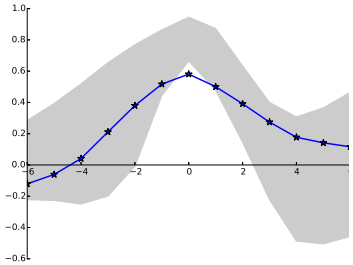
$\text{Corr}(\Delta Y, \Delta Y_{t-j})$



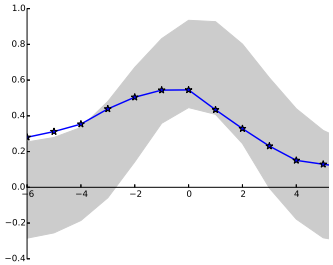
$\text{Corr}(\Delta Y, \Delta C_{t-j})$



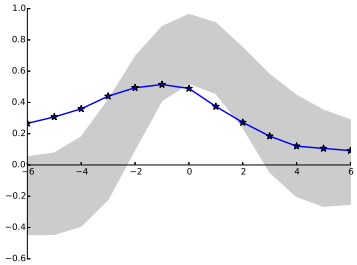
$\text{Corr}(\Delta Y, \Delta I_{t-j})$



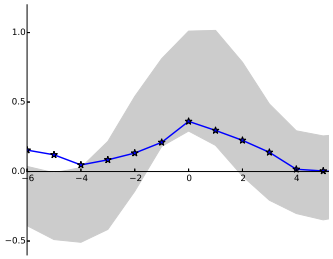
$\text{Corr}(\Delta Y, \Delta \tilde{Y}_{t-j})$



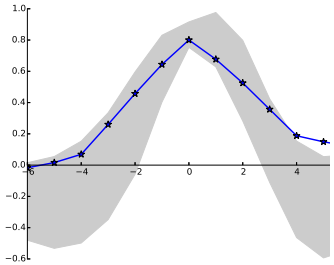
$\text{Corr}(\Delta Y, \Delta \tilde{I}_{t-j})$



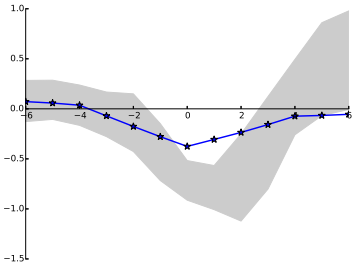
$\text{Corr}(\Delta Y, \Delta exp_{t-j})$



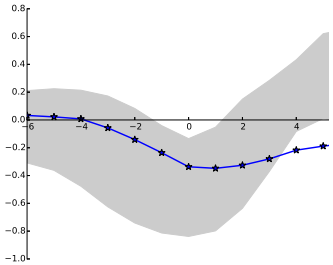
$\text{Corr}(\Delta Y, \Delta imp_{t-j})$



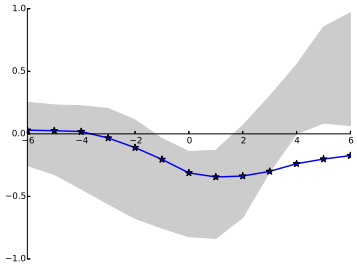
$\text{Corr}(\Delta Y, \Delta e_{t-j})$



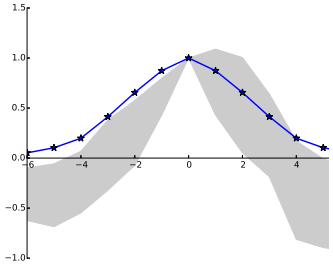
$\text{Corr}(\Delta \tilde{Y}, \Delta e_{t-j})$



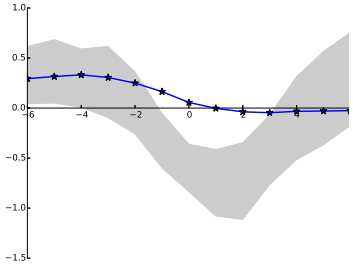
$\text{Corr}(\Delta \tilde{I}, \Delta e_{t-j})$



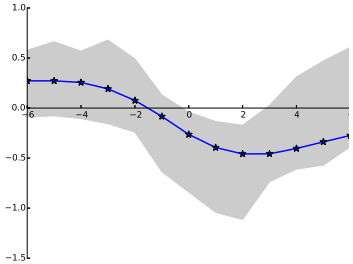
$\text{Corr}(\Delta S^k, \Delta S^k_{t-j})$



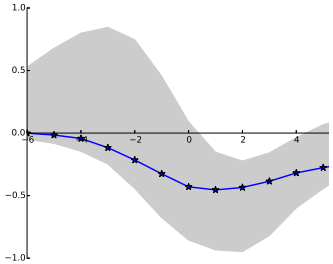
$\text{Corr}(\Delta Y, S^k_{t-j})$



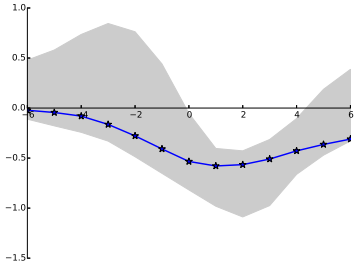
$\text{Corr}(\Delta I, S^k_{t-j})$



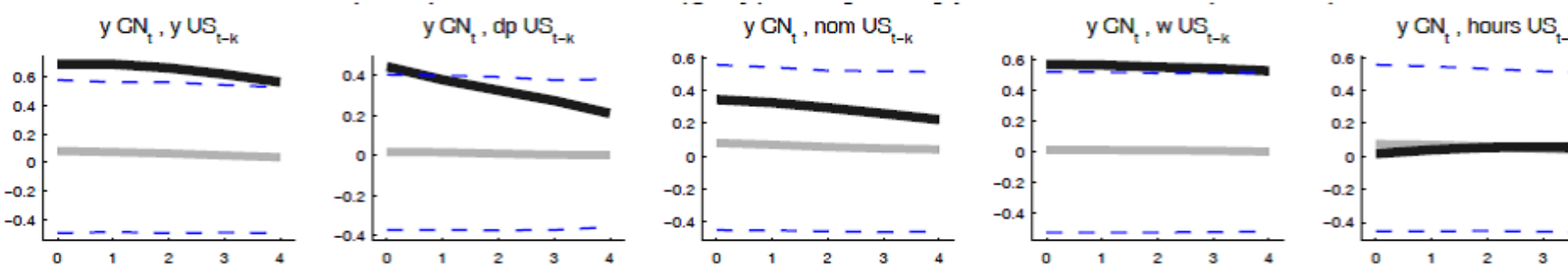
$\text{Corr}(\Delta \tilde{Y}, \Delta \tilde{S}^k_{t-j})$



$\text{Corr}(\Delta \tilde{I}, \Delta \tilde{S}^k_{t-j})$



Comparing to Justiniano & Preston 2010 JIE



Variance Decomposition

	Mexico				Bilateral			US				
	ΔY	ΔC	ΔI	ΔS^k	Δimp	Δexp	Δe	$\Delta \tilde{Y}$	$\Delta \tilde{C}$	$\Delta \tilde{I}$	$\Delta \tilde{L}$	$\Delta \tilde{S}^k$
ξ_τ	1.3	1.2	9.9	75.6	1.1	1.7	0.3	0.0	0.0	0.1	0.0	0.0
ξ_C	0.2	28.9	0.4	0.1	2.3	11.5	1.2	0.0	0.1	0.2	0.1	0.0
ξ_I	2.6	1.4	45.3	11.1	5.7	15.5	3.5	0.0	0.1	0.3	0.2	0.0
ξ_{A_T}, ξ_{A_N}	12.3	0.8	0.3	0.1	0.1	15.9	1.2	0.1	0.1	0.2	0.1	0.0
ξ_{TOT}	2.7	5.7	2.1	1.0	4.2	2.6	43.9	0.0	0.0	0.3	0.1	0.1
$\tilde{\xi}_\tau$	0.3	0.3	0.5	0.3	0.3	0.5	0.2	15.4	9.9	14.8	15.7	59.3
$\tilde{\xi}_C$	1.8	2.1	1.2	0.4	2.0	0.7	1.0	4.1	59.3	6.5	13.4	3.1
$\tilde{\xi}_I$	1.6	1.6	3.2	1.0	2.1	0.9	1.2	14.6	9.4	15.0	27.7	2.5
$\tilde{\xi}_L$	1.3	1.2	1.7	0.4	1.6	0.3	0.9	5.7	2.1	6.4	14.1	1.1
$\tilde{\xi}_{A_T}, \tilde{\xi}_{A_N}$	69.0	49.3	29.4	7.7	70.7	43.3	41.5	53.6	13.1	48.7	21.4	31.2
m.e.	4.6	6.0	5.1	2.0	7.6	4.4	3.9	5.9	5.4	4.4	6.5	2.2

Variance Decomposition

	Mexico				Bilateral			US				
	ΔY	ΔC	ΔI	ΔS^k	Δimp	Δexp	Δe	$\Delta \tilde{Y}$	$\Delta \tilde{C}$	$\Delta \tilde{I}$	$\Delta \tilde{L}$	$\Delta \tilde{S}^k$
ξ_τ	1.3	1.2	9.9	75.6	1.1	1.7	0.3	0.0	0.0	0.1	0.0	0.0
ξ_C	0.2	28.9	0.4	0.1	2.3	11.5	1.2	0.0	0.1	0.2	0.1	0.0
ξ_I	2.6	1.4	45.3	11.1	5.7	15.5	3.5	0.0	0.1	0.3	0.2	0.0
ξ_{A_T}, ξ_{A_N}	12.3	0.8	0.3	0.1	0.1	15.9	1.2	0.1	0.1	0.2	0.1	0.0
ξ_{TOT}	2.7	5.7	2.1	1.0	4.2	2.6	43.9	0.0	0.0	0.3	0.1	0.1
$\tilde{\xi}_\tau$	0.3	0.3	0.5	0.3	0.3	0.5	0.2	15.4	9.9	14.8	15.7	59.3
$\tilde{\xi}_C$	1.8	2.1	1.2	0.4	2.0	0.7	1.0	4.1	59.3	6.5	13.4	3.1
$\tilde{\xi}_I$	1.6	1.6	3.2	1.0	2.1	0.9	1.2	14.6	9.4	15.0	27.7	2.5
$\tilde{\xi}_L$	1.3	1.2	1.7	0.4	1.6	0.3	0.9	5.7	2.1	6.4	14.1	1.1
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m.e.	4.6	6.0	5.1	2.0	7.6	4.4	3.9	5.9	5.4	4.4	6.5	2.2

Variance Decomposition

	Mexico				Bilateral			US				
	ΔY	ΔC	ΔI	ΔS^k	Δimp	Δexp	Δe	$\Delta \tilde{Y}$	$\Delta \tilde{C}$	$\Delta \tilde{I}$	$\Delta \tilde{L}$	$\Delta \tilde{S}^k$
ξ_τ	1.3	1.2	9.9	75.6	1.1	1.7	0.3	0.0	0.0	0.1	0.0	0.0
ξ_C	0.2	28.9	0.4	0.1	2.3	11.5	1.2	0.0	0.1	0.2	0.1	0.0
ξ_I	2.6	1.4	45.3	11.1	5.7	15.5	3.5	0.0	0.1	0.3	0.2	0.0
ξ_{A_T}, ξ_{A_N}	12.3	0.8	0.3	0.1	0.1	15.9	1.2	0.1	0.1	0.2	0.1	0.0
ξ_{TOT}	2.7	5.7	2.1	1.0	4.2	2.6	43.9	0.0	0.0	0.3	0.1	0.1
$\tilde{\xi}_\tau$	0.3	0.3	0.5	0.3	0.3	0.5	0.2	15.4	9.9	14.8	15.7	59.3
$\tilde{\xi}_C$	1.8	2.1	1.2	0.4	2.0	0.7	1.0	4.1	59.3	6.5	13.4	3.1
$\tilde{\xi}_I$	1.6	1.6	3.2	1.0	2.1	0.9	1.2	14.6	9.4	15.0	27.7	2.5
$\tilde{\xi}_L$	1.3	1.2	1.7	0.4	1.6	0.3	0.9	5.7	2.1	6.4	14.1	1.1
$\tilde{\xi}_{A_T}, \tilde{\xi}_{A_N}$	69.0	49.3	29.4	7.7	70.7	43.3	41.5	53.6	13.1	48.7	21.4	31.2
m.e.	4.6	6.0	5.1	2.0	7.6	4.4	3.9	5.9	5.4	4.4	6.5	2.2

Structural BVAR estimation

Partitioning the observables y_t into U.S., Mexican variables and, exchange rate and spreads: Y_t^{US}, Y_t^{MX}, y_t^e, y_t^s, and $y_t^{\tilde{s}}$ respectively, the five blocks are given by

$$\begin{bmatrix} I_{1x1} & A_e^s & A_e^{MX} & A_e^{\tilde{s}} & A_e^{US} \\ 0 & I_{1x1} & A_s^{MX} & A_s^{\tilde{s}} & A_s^{US} \\ 0 & 0 & I_{nxn} & 0 & 0 \\ 0 & 0 & 0 & I_{1x1} & A_{\tilde{s}}^{US} \\ 0 & 0 & 0 & 0 & I_{nxn} \end{bmatrix} \begin{pmatrix} y_t^e \\ y_t^s \\ Y_t^{MX} \\ y_t^{\tilde{s}} \\ Y_t^{US} \end{pmatrix} = \begin{bmatrix} B_e^e & B_e^s & B_e^{MX} & B_e^{\tilde{s}} & B_e^{US} \\ B_s^e & B_s^s & B_s^{MX} & B_s^{\tilde{s}} & B_s^{US} \\ B_{MX}^e & B_{MX}^s & B_{MX}^{MX} & B_{MX}^{\tilde{s}} & B_{MX}^{US} \\ 0 & 0 & 0 & B_{\tilde{s}}^{\tilde{s}} & B_{\tilde{s}}^{US} \\ 0 & 0 & 0 & B_{US}^{\tilde{s}} & B_{US}^{US} \end{bmatrix} \begin{pmatrix} y_{t-\ell}^e \\ y_{t-\ell}^s \\ Y_{t-\ell}^{MX} \\ y_{t-\ell}^{\tilde{s}} \\ Y_{t-\ell}^{US} \end{pmatrix} + \begin{pmatrix} \epsilon_t^e \\ \epsilon_t^s \\ \epsilon_t^{MX} \\ \epsilon_t^{\tilde{s}} \\ \epsilon_t^{US} \end{pmatrix}$$

The structural errors $[\epsilon_t^{'US}, \epsilon_t^{'MX}, \epsilon_t^{'e}, \epsilon_t^{'s}, \epsilon_t^{'\tilde{s}}]'$ are orthogonal with unit variance.

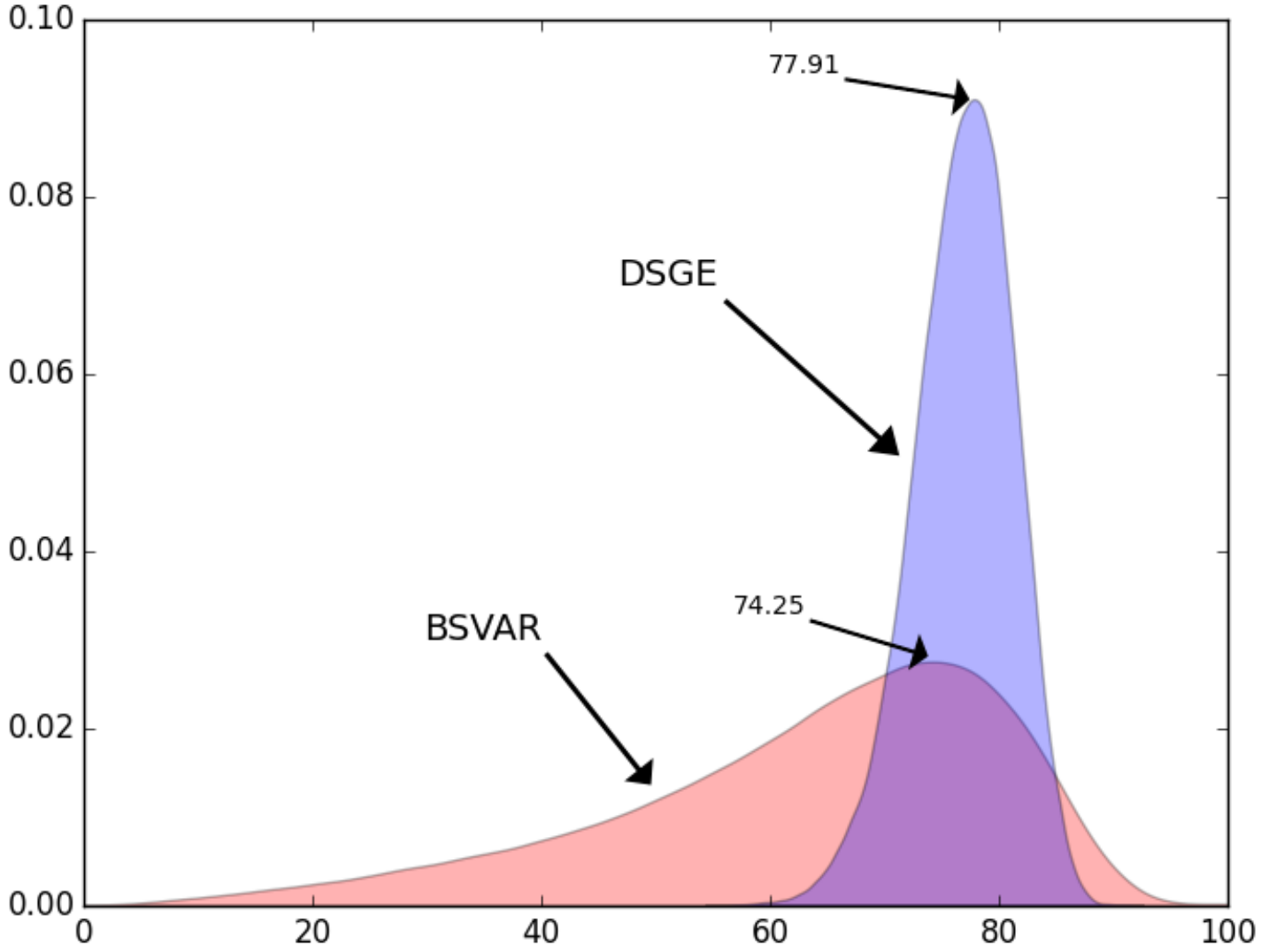
Structural BVAR estimation

Partitioning the observables y_t into U.S., Mexican variables and, exchange rate and spreads: Y_t^{US}, Y_t^{MX}, y_t^e, y_t^s, and $y_t^{\tilde{s}}$ respectively, the five blocks are given by

$$\begin{bmatrix} I_{1x1} & A_e^s & A_e^{MX} & A_e^{\tilde{s}} & A_e^{US} \\ 0 & I_{1x1} & A_s^{MX} & A_s^{\tilde{s}} & A_s^{US} \\ 0 & 0 & I_{nxn} & \boxed{0 \quad 0} \\ 0 & 0 & 0 & I_{1x1} & A_{\tilde{s}}^{US} \\ 0 & 0 & 0 & 0 & I_{nxn} \end{bmatrix} \begin{pmatrix} y_t^e \\ y_t^s \\ Y_t^{MX} \\ y_t^{\tilde{s}} \\ Y_t^{US} \end{pmatrix} = \begin{bmatrix} B_e^e & B_e^s & B_e^{MX} & B_e^{\tilde{s}} & B_e^{US} \\ B_s^e & B_s^s & B_s^{MX} & B_s^{\tilde{s}} & B_s^{US} \\ B_{MX}^e & B_{MX}^s & B_{MX}^{MX} & \boxed{B_{MX}^{\tilde{s}} \quad B_{MX}^{US}} \\ 0 & 0 & 0 & B_{\tilde{s}}^{\tilde{s}} & B_{\tilde{s}}^{US} \\ 0 & 0 & 0 & B_{US}^{\tilde{s}} & B_{US}^{US} \end{bmatrix} \begin{pmatrix} y_{t-\ell}^e \\ y_{t-\ell}^s \\ Y_{t-\ell}^{MX} \\ y_{t-\ell}^{\tilde{s}} \\ Y_{t-\ell}^{US} \end{pmatrix} + \begin{pmatrix} \epsilon_t^e \\ \epsilon_t^s \\ \epsilon_t^{MX} \\ \epsilon_t^{\tilde{s}} \\ \epsilon_t^{US} \end{pmatrix}$$

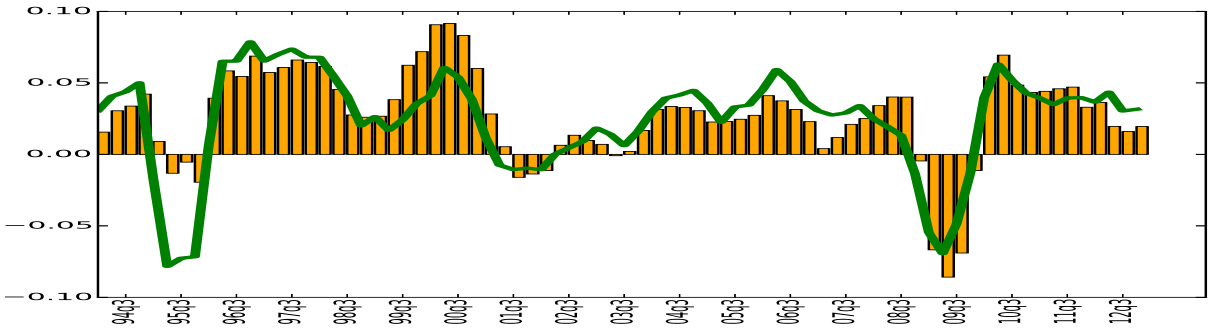
The structural errors $[\epsilon_t^{'US}, \epsilon_t^{'MX}, \epsilon_t^{'e}, \epsilon_t^{'s}, \epsilon_t^{'\tilde{s}}]'$ are orthogonal with unit variance.

Estimated Spill-overs from the US to Mexico

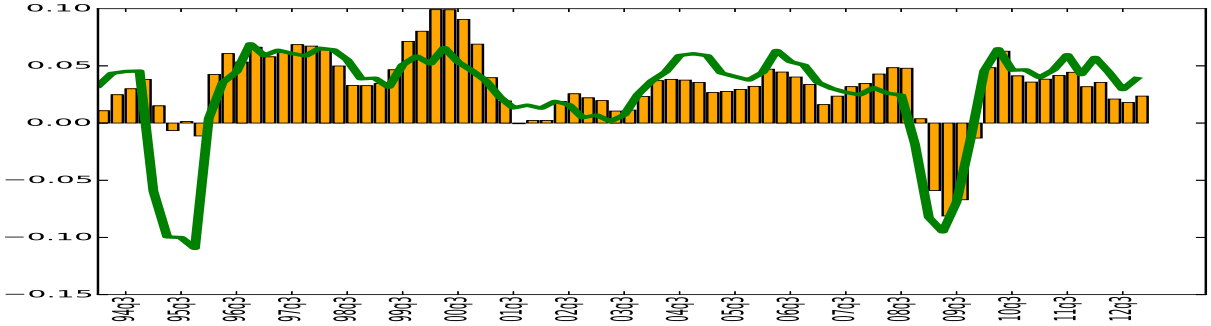


Historical Contribution of US Shocks in Mexico: When the US sneezes . . .

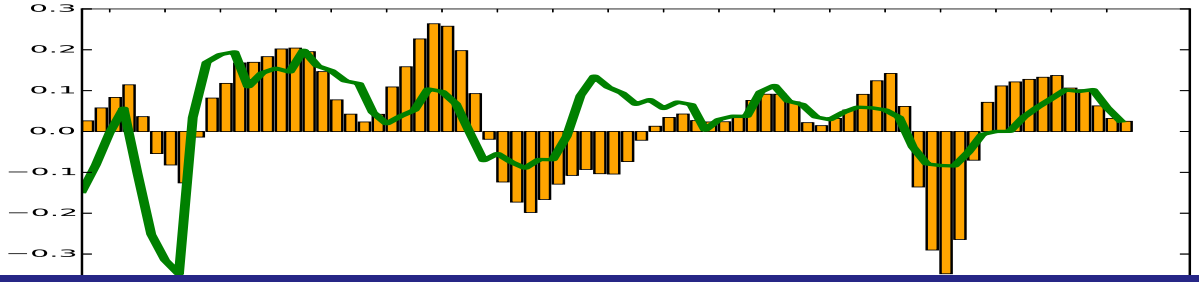
GDP



Consumption

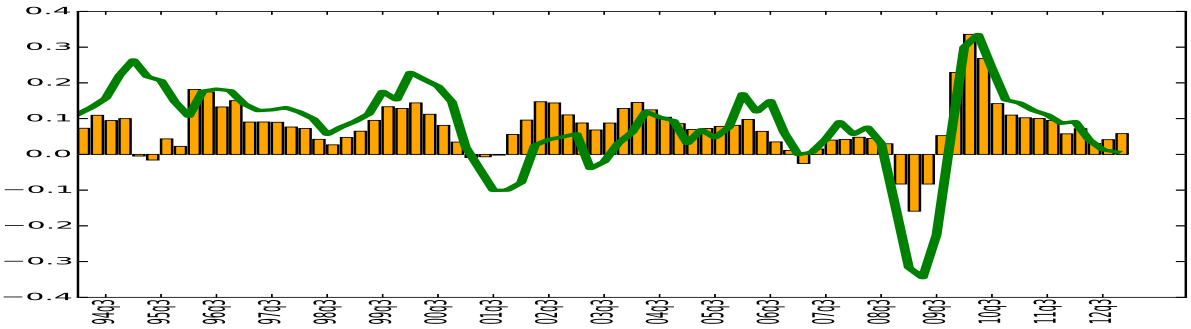


Investment

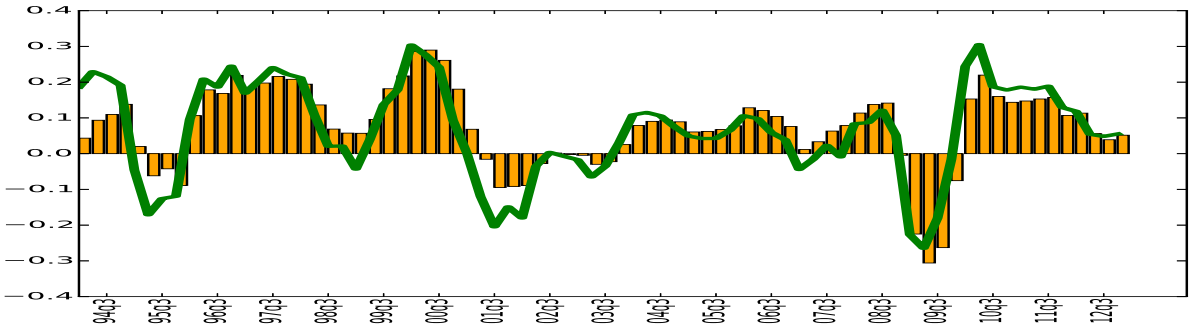


Historical Contribution of US Shocks in Mexico

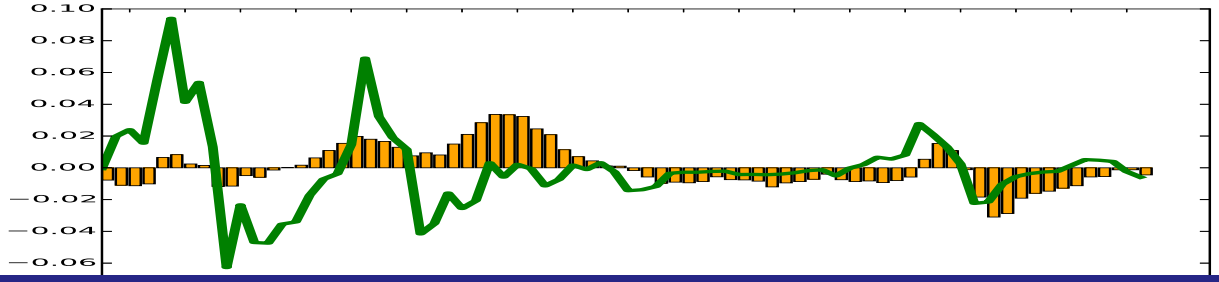
Exports



Imports



Risk spread



Conclusions

- The econometric estimation of the model
  - Predicts cross-country correlations consistent with the data
  - Delivers without extraneous assumptions the Small Open Economy characteristic of Mexico
- We find that US shocks explain 70% of the variation in Mexico's GDP growth rate, constituting the most important source of fluctuations for Mexico's economy.
- Historical decompositions show that the US expansions during the 1990s contributed to Mexico's growth by 1 percentage points on average. On the other hand, the 2001 US recession led to a reduction of 3 percentage points in Mexico's GDP growth in that year, whereas the 2008 crisis lead to a reduction of 10 percentage points.
- We also find that the financial frictions are the most important features that allow the model to capture the cross-country correlations and spill-overs in the data.
- . . . future work . . .