DEUTSCHE BUNDESBANK
EUROSYSTEM

Workshop on

“The Costs and Benefits of International Banking”

Eltville, 18 October 2010

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Federal Reserve Board

Presentation to

“International banks and the cross-border transmission of business cycles“

International Banks and the Cross-Border Transmission of Business Cycles[1]

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Federal Reserve Board

Workshop on "The Cost and Benefits of International Banking"
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[1] These slides and associated remarks represent only the authors' current opinions, not those of the Board of Governors or the Federal Reserve System.

Motivation

- Disruptions in credit markets in 2007 led the Fed and other central banks to implement non-conventional policies (for example, the Term Auction Facility).
- Important involvement of large U.S. and European banks – global banks.
- Relevant role of funding via the interbank market and cross-border intrabank transactions through foreign bank branches.
- Foreign bank branches: 20 percent of all assets held by commercial banks in the United States in 2008.

Objective

Objectives:

- Study the link between the cross-border funding activities of global banks and the international transmission of business cycles.
- Highlight the effects of regulatory changes on global banks' ability to transform domestic deposits into loans abroad.

Methodology:

1. **Empirical analysis**
   - Cyclical behavior of net positions between the U.S.-based branches of foreign banks (Western Europe, emerging Asia) and their parent banks (novel dataset).
   - The pattern of lending by U.S.-based subsidiaries of foreign banks to large and small U.S. firms.
2. **Model**
   - Two-country DSGE framework with global banks (that can transform foreign deposits into local loans) and heterogeneous firms.

Related Literature

- **Bank funding and liquidity management**: CGFS (2010), Canales-Kriljenko, Coulibaly and Kamil (2010), McGuire and von Peter (2009), Cetorelli and Goldberg (2011)
- **DSGE models with banks**: Brunnermeier and Sannikov (2010), De Blas and Russ (2010), Gertler and Kiyotaki (2010), Iacoviello (2011), Kalemli-Ozcan, Papaioannou, and Perri (2011), Kollman, Enders, and Muller (2011), Stebunovs (2006)
- **DSGE models with heterogeneous agents:** Ghironi and Melitz (2005)
- **Firm financing**: Neumeyer and Perri (2005), Russ and Valderrama (2009)

Data

- Branches of foreign banks in the United States: FFIEC 002 report.
- Subsidiaries of foreign banks in the United States: FFIEC 031 report.
- Macro data:
  - INTL/CEIC (real GDP growth);
  - Federal Reserve System (effective FF rate);
  - International Financial Statistics.
- **"Net due to"** position relative to related depository institutions (for example, relative to the parent bank) =

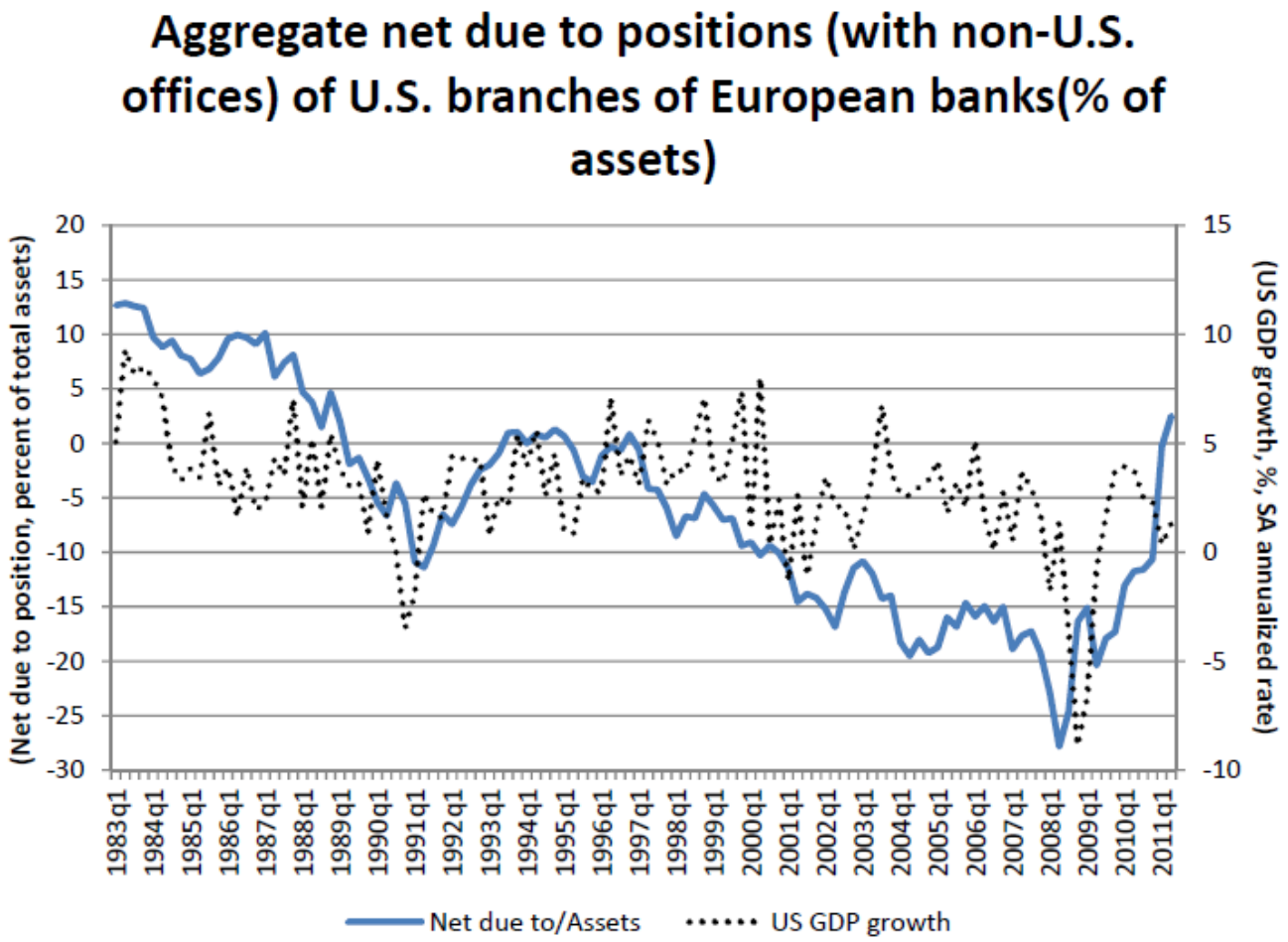
= Gross due to related depository institutions (liability of the branch) –

– Gross due from related depository institutions (asset of the branch)

Stylized Fact 1 - Balance Sheet of U.S. branches of European banks

Assets	Q4 2006	Q4 2008	Q2 2011	Liabilities	Q4 2006	Q4 2008	Q2 2011
Cash	4%	11%	39%	Deposits	53%	52%	52%
Fed Funds Sold	1%	0%	0%	Fed Funds Purchased	6%	1%	2%
Resale Agreements	15%	3%	5%	Repurchase Agreements	8%	3%	5%
U.S. Gov. Securities	2%	2%	4%	Trading Liabilities	6%	9%	5%
Other Securities	21%	25%	13%	Other Liabilities	18%	30%	17%
Loans	24%	27%	22%				
Other Assets	2%	2%	2%				
Total Claims on Non-Related Parties	69%	70%	85%	***Total Liabilities to Non-Related Parties***	91%	95%	81%
Net Due from Related Depository Institutions	31%	30%	15%	Net Due to Related Depository Institutions	9%	5%	19%
Total Assets ($ millions)	1,193,532	1,402,416	1,328,310	***Total Liabilities ($ millions)***	1,193,532	1,402,416	1,328,310

Stylized Fact 1 - Net positions and macro factors (U.S. branches of European banks)



Stylized Fact 1 - Net positions and macro factors (U.S. branches of European banks)

$$\frac{NDT_{ijt}}{TA_{ijt}} = \alpha + \beta_1 \text{US GDP Growth}_t + \beta_2 \text{Foreign GDP Growth}_t + \\ + \beta_3 \text{Real Interest Rate Differential}_t + \beta_4 \text{Log Assets}_{ijt} + \\ + \theta_{ij} + \mu_q + \varphi_t + \epsilon_{ijt}$$

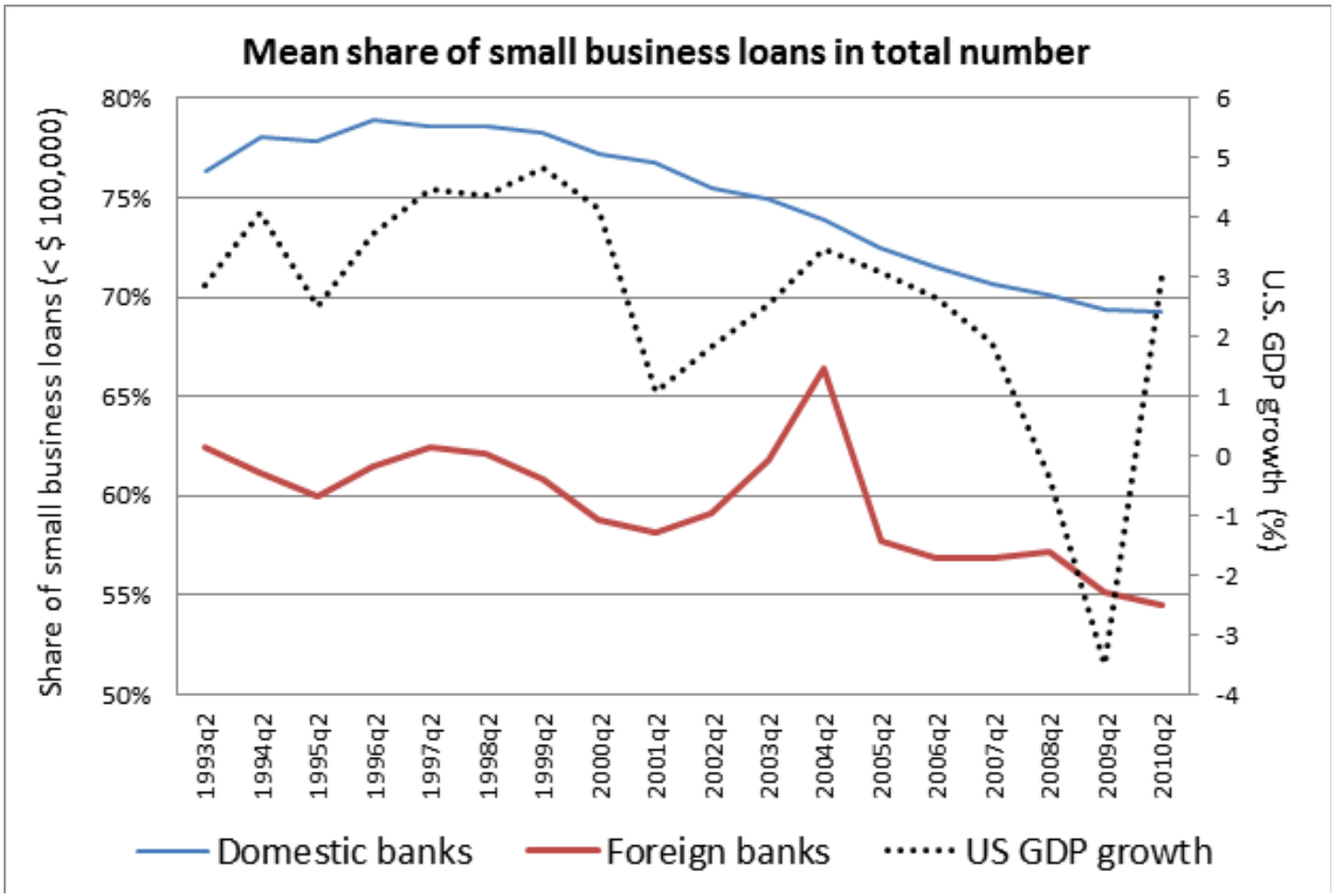
- Bank branch i, country of origin j;
- μ_q = seasonal quarterly dummy;
- θ_{ij} = bank fixed effect
- φ_t = time fixed effect

Stylized Fact 1 - Net positions and macro factors (U.S. branches of European banks)

Dependent variable:	*Net due to / Assets* (1)	*Gross due to /Assets* (2)	*Gross due from / Assets* (3)
U.S. GDP Growth	1.167**	-0.106	-1.273***
	[0.536]	[0.326]	[0.342]
Foreign GDP Growth	0.029	0.024	-0.005
	[0.124]	[0.073]	[0.083]
Real Interest Rate Differential	-1.377	-1.218*	0.159
	[1.019]	[0.662]	[0.557]
Log of Claims on Nonrelated Parties	3.852	-2.106	-5.958***
	[2.443]	[1.416]	[1.281]
Constant	-41.740**	50.994***	92.734***
	[20.651]	[12.018]	[10.844]
Branch Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Quarterly Dummies	Yes	Yes	Yes
Observations	4,514	4,514	4,514
Number of Branches	136	136	136

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

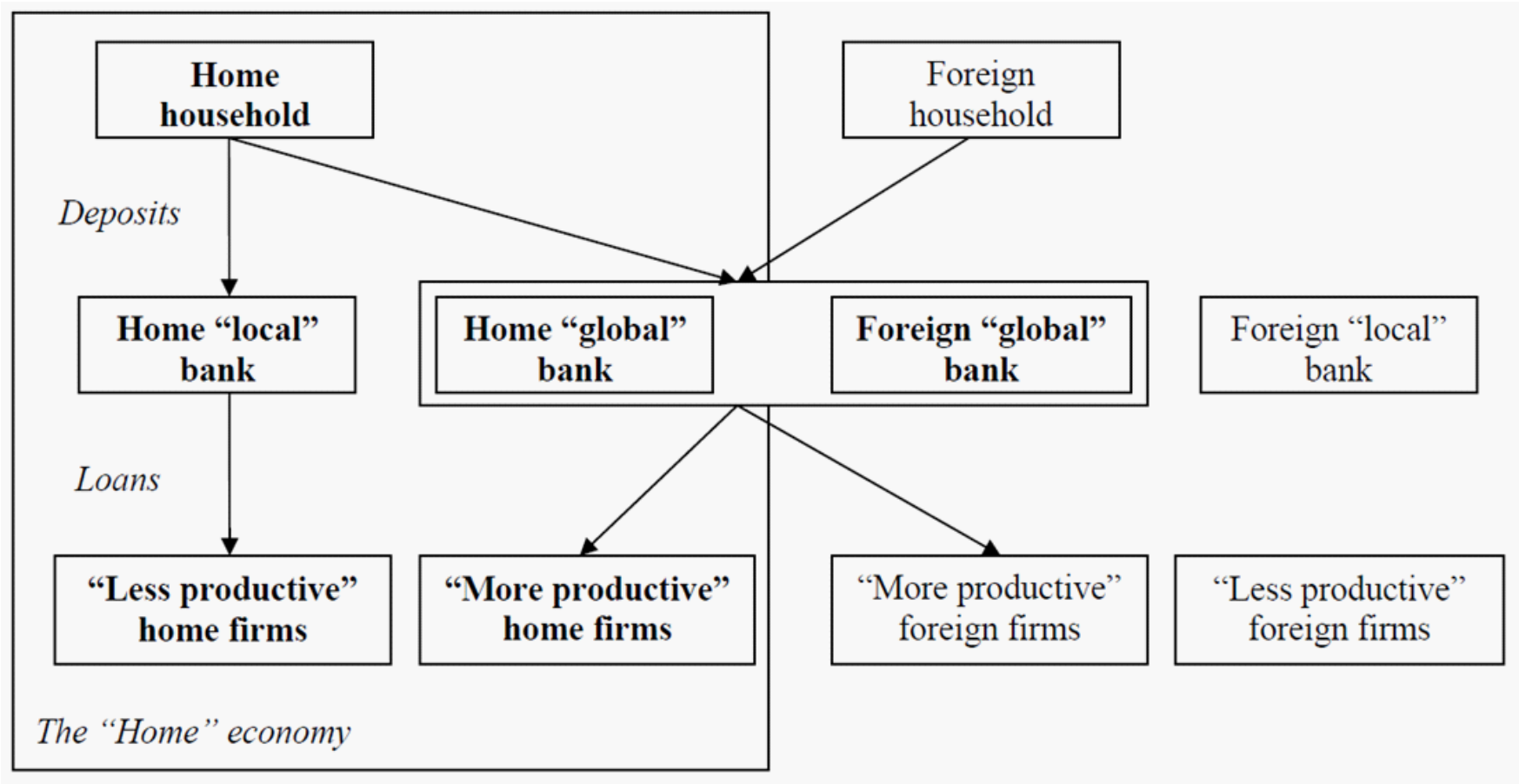
Stylized Fact 2 - Firm size and bank lending – Domestic vs. foreign banks



Model Assumptions

- Two-country (Home and Foreign), RBC model with:
  - (1) One representative household that provides bank deposits.
  - (2) Continuum of monopolistically-competitive firms, heterogeneous in productivity, borrow working capital from banks.
  - (3) Two types of banks in each country: local and global.
- The global bank, in addition to domestic operations, also collects foreign deposits and issues loans to foreign firms.
- Production by heterogeneous firms:
  - function of labor, country-specific, and firm-specific productivity.
- Each firm can borrow either from the local or from the global banks:
  - Borrowing from the global banks has the advantage of a lower interest rate, but requires a per-period fixed cost.
  - Only the larger, more productive firms access international loans; their fraction changes over time.

Model Assumptions



Representative household

- Maximize expected lifetime utility:

$$\max_{\{D_t,\, x_t\}} \left[E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma} \right],$$

- subject to:

$$(\widetilde{v}_t+\widetilde{\pi}_t)N_t x_{t-1}+(1+r_t)D_{t-1}+w_t L \geq \widetilde{v}_t(N_t+N_{E,t})x_t+D_t+\frac{\xi}{2}(D_t)^2+C_t$$

- FOCs:

$$1+\xi D_t = \beta E_t \left[(1+r_{t+1}) \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \right],$$
$$\widetilde{v}_t = \beta(1-\delta) E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} (\widetilde{v}_{t+1}+\widetilde{\pi}_{t+1}) \right].$$

- Consumption basket C_t is a CES aggregate of country-specific goods (described later).

Firms: production

- Following entry, each firm draws productivity factor z from a common distribution $G(z)$ with support on $[z_{min}, \infty)$;
- Production:

$$y_t(z) = Z_t z n_t(z), \text{ with unit cost} \frac{w_t}{Z_t z}$$

- Firms must pay fraction ϕ of the wage bill before producing.
- Need working capital - two choices:
  - (1) Borrow from the local bank;
  - (2) Use an aggregate loan provided by the global banks (home and foreign).

Firms: prices and profits

(1) Firms borrowing from local banks

- Profit maximization:

$$\pi_{L,t}(z) = \underbrace{p_{L,t}(z)y_t(z)}_{\text{revenue}} - \underbrace{w_t n_t(z)}_{\text{wage bill}} - \underbrace{r_{L,t} l_t(z)}_{\text{borrowing cost}}$$

- subject to:

$$y_t(z) = p_{L,t}(z)^{-\theta} C_t,$$
$$l_t(z) \geq \phi \frac{w_t}{Z_t z} y_t(z).$$

- Equilibrium price and profit:

$$p_{L,t}(z) = \frac{\theta}{\theta - 1} \frac{w_t}{Z_t z}(1 + \phi r_{L,t});$$
$$\pi_{L,t}(z) = \frac{1}{\theta} p_{L,t}(z)^{1-\theta} C_t.$$

Firms: prices and profits

(2) Firms borrowing from global banks

- Profit maximization:

$$\pi_{G,t}(z) = p_t(z)y_t(z) - w_t n_t(z) - r_{S,t} l_t(z) - f_G \frac{w_t}{Z_t}.$$

- subject to:

$$y_t(z) = p_{G,t}(z)^{-\theta} C_t,$$
$$l_t(z) \geq \phi \frac{w_t}{Z_t z} y_t(z).$$

- Equilibrium price and profit:

$$p_{G,t}(z) = \frac{\theta}{\theta - 1} \frac{w_t}{Z_t z}(1 + \phi r_{S,t}).$$
$$\pi_{G,t}(z) = \frac{1}{\theta} p_{G,t}(z)^{1-\theta} C_t - f_G \frac{w_t}{Z_t}.$$

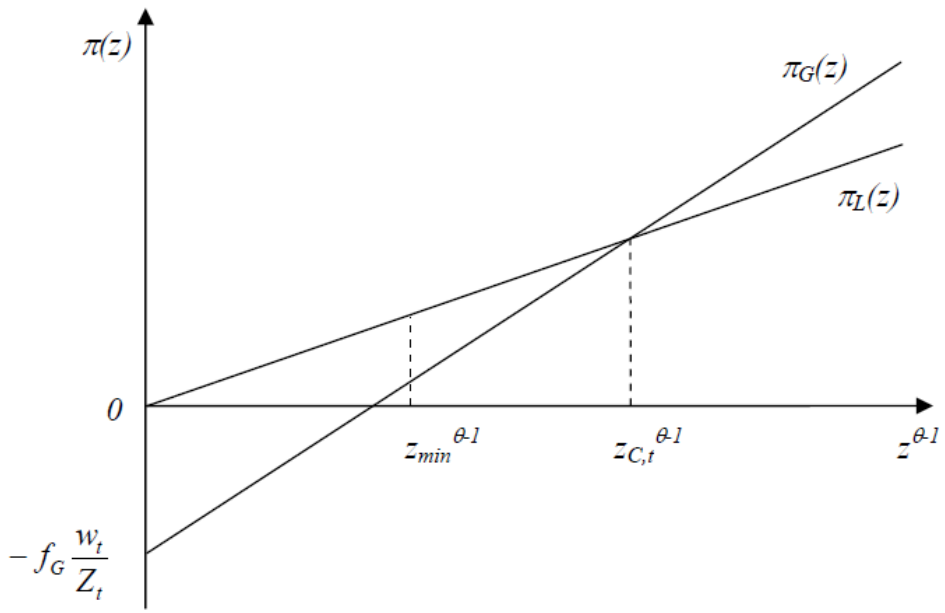
Firms: endogenous productivity cutoff

- Write the firm profits as functions of productivity factor $z^{\theta-1}$:

$$\pi_{L,t}(z) = \frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}(1+\phi r_{L,t})\right]^{1-\theta} C_t z^{\theta-1};$$

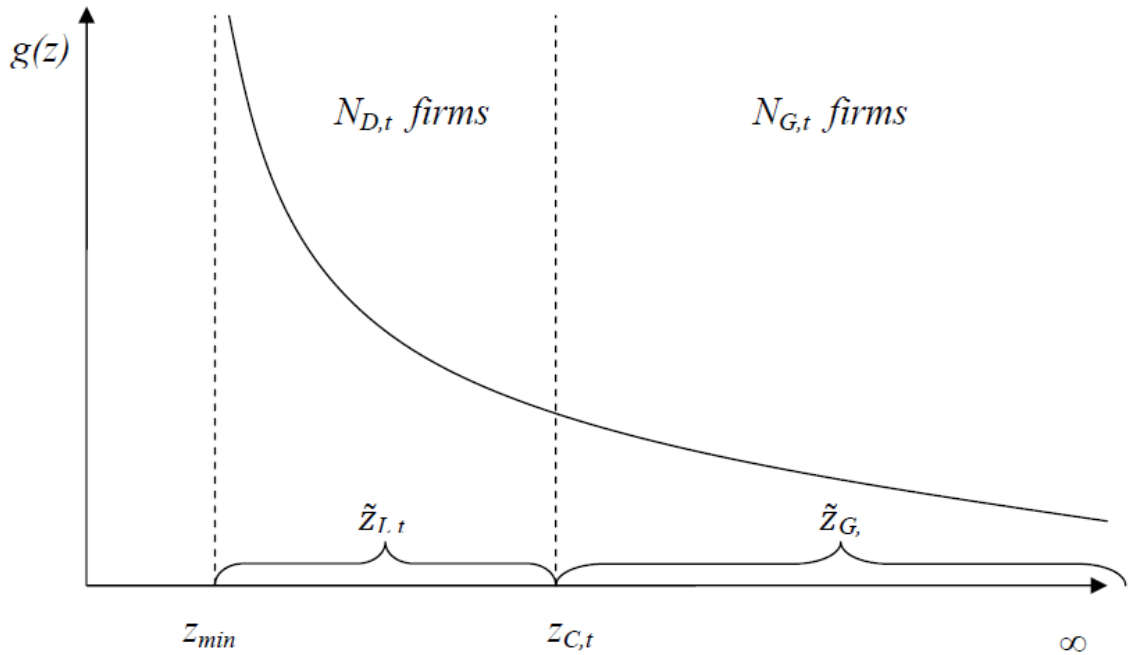
$$\pi_{G,t}(z) = \underbrace{\frac{1}{\theta}\left[\frac{\theta}{\theta-1}\frac{w_t}{Z_t}(1+\phi r_{S,t})\right]^{1-\theta} C_t}_{\text{slope}} z^{\theta-1} - \underbrace{f_G\frac{w_t}{Z_t}}_{\text{intercept}}.$$

- For $r_{S,t} < r_{L,t}$, define cutoff $z_{C,t} = \{z \mid \pi_{L,t}(z) = \pi_{G,t}(z)\}$.



Firms: aggregation

- Define average labor productivity for local borrowers ($\widetilde{z}_{L,t}$) and global borrowers ($\widetilde{z}_{G,t}$):



- Every period, $N_{L,t}$ firms borrow locally ($z < z_{C,t}$), and $N_{G,t}$ firms borrow from the global banks ($z > z_{C,t}$);
- So that $N_{L,t} + N_{G,t} = N_t$.

Firms: aggregation

Pareto-distributed firm productivity

- Firm-specific labor productivity z is Pareto-distributed:

$$g(z) = kz_{min}/z^{k+1}$$
$$G(z) = 1 - (z_{min}/z)^k.$$

- Under the Pareto assumption, the firm productivity averages are:

$$\widetilde{z}_{L,t} = \left[\frac{1}{G(z_{C,t})}\int_{z_{\min}}^{z_{C,t}} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_{\min} z_{C,t}\left[\frac{z_{C,t}^{k-(\theta-1)} - z_{\min}^{k-(\theta-1)}}{z_{C,t}^{k} - z_{\min}^{k}}\right]^{\frac{1}{\theta-1}},$$

$$\widetilde{z}_{G,t} = \left[\frac{1}{1-G(z_{C,t})}\int_{z_{C,t}}^{\infty} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_{C,t}.$$

Firms: aggregation

- Average prices:

$$\widetilde{p}_{L,t} = \frac{\theta}{\theta-1}\frac{w_t}{Z_t \widetilde{z}_{L,t}}(1+\phi r_{L,t}) \quad \text{(local borrowing)}$$
$$\widetilde{p}_{G,t} = \frac{\theta}{\theta-1}\frac{w_t}{Z_t \widetilde{z}_{G,t}}(1+\phi r_{S,t}) \quad \text{(global borrowing)}$$

- Average profits:

$$\widetilde{\pi}_{L,t} = \frac{1}{\theta}\left(\widetilde{p}_{L,t}\right)^{1-\theta} C_t \quad \text{(local borrowing)}$$
$$\widetilde{\pi}_{G,t} = \frac{1}{\theta}\left(\widetilde{p}_{G,t}\right)^{1-\theta} C_t - f_G \frac{w_t}{Z_t} \quad \text{(global borrowing)}$$

- Price index:

$$1 = N_{L,t}\left(\widetilde{p}_{L,t}\right)^{1-\theta} + N_{G,t}\left(\widetilde{p}_{G,t}\right)^{1-\theta}$$
$$1 = N^*_{L,t}\left(\widetilde{p}^*_{L,t}\right)^{1-\theta} + N^*_{G,t}\left(\widetilde{p}^*_{G,t}\right)^{1-\theta}$$

- Total profits:

$$N_t \widetilde{\pi}_t = N_{L,t}\widetilde{\pi}_{L,t} + N_{G,t}\widetilde{\pi}_{G,t}$$
$$N^*_t \widetilde{\pi}^*_t = N^*_{L,t}\widetilde{\pi}^*_{L,t} + N^*_{G,t}\widetilde{\pi}^*_{G,t}$$

Country-specific goods and trade

Production

- Each firm produces variety $y_t(\omega)$.
- All varieties ω available at period t form the country-specific good:

$$\widehat{Y}_{h,t} = \left[\int_{\omega \in \Omega} y_t(\omega)^{\frac{\theta-1}{\theta}} d\omega \right]^{\frac{\theta}{\theta-1}},$$

where $\theta > 1$ is the elasticity of substitution across varieties.

Trade

- The home-specific good $\widehat{Y}_{h,t}$ can be consumed domestically $(Y_{h,t})$ or exported $(Y^*_{h,t})$, so that $\widehat{Y}_{h,t} = Y_{h,t} + Y^*_{h,t}$.

Prices

- The home consumption basket C_t is a CES aggregate of the home and foreign-specific goods, set as the numeraire $(P_t = 1)$:

$$C_t = \left[(\lambda_y)^{\frac{1}{\epsilon_y}} (Y_{h,t})^{\frac{\epsilon_y - 1}{\epsilon_y}} + (1-\lambda_y)^{\frac{1}{\epsilon_y}} (Y_{f,t})^{\frac{\epsilon_y - 1}{\epsilon_y}} \right]^{\frac{\epsilon_y}{\epsilon_y - 1}}.$$

Banks

- In each economy, two types of banks (local and global) transform deposits into loans, as in de Blas and Russ (2010):

$$L_{j,t} = \frac{D_{j,t}}{c_j}, \text{ where } c_j \geq 1 \text{ and } j \in \{L, G\}.$$

- The global bank is more productive ($c^G < c^L$), so that $r^G < r^L$.

(1) The local bank

- Profit: $\Omega_{L,t} = \underbrace{r_{L,t}(1-\delta)L_{L,t}}_{\text{interest received for good loans}} - \underbrace{\mu\delta L_{L,t}}_{\text{monitoring cost for non-performing loans}} - \underbrace{r_t D_{L,t-1}}_{\text{interest paid on deposits}} = 0.$

- The cost c and firm exit δ introduce a wedge between r_t and $r_{L,t}$:

$$r_{L,t} = \frac{c^L}{1-\delta} r_t + \frac{\mu\delta}{1-\delta}.$$

- Loan clearing: $L_{L,t} = N_{L,t}\widetilde{l}_{L,t}$, where $\widetilde{l}_{L,t} = \frac{\phi w_t}{Z_t \widetilde{z}_{L,t}} \left(\frac{\widetilde{p}_{L,t}}{p_{h,t}}\right)^{-\theta} \left(Y_{h,t} + Y^*_{h,t}\right).$

Banks

(2) The global bank

- Interest charged for loans is a weighted average of the cost of home and foreign deposits:

$$r_{G,t}=\frac{D_{H,t-1}}{D_{H,t-1}+D^*_{H,t-1}Q_t}\left(\frac{c_G r_t+\mu\delta}{1-\delta}\right)+\frac{D^*_{H,t-1}Q_t}{D_{H,t-1}+D^*_{H,t-1}Q_t}\left(\frac{c_G r^*_t Q_t+\mu\delta}{1-\delta}\right)$$

- Market clearing for the global loans:

$$L_{S,t}=\left[\lambda^{\frac{1}{\epsilon}}L_{H,t}^{\frac{\epsilon-1}{\epsilon}}+(1-\lambda)^{\frac{1}{\epsilon}}L_{F,t}^{\frac{\epsilon-1}{\epsilon}}\right]^{\frac{\epsilon}{\epsilon-1}}=N_{G,t}\widetilde{l}_{G,t}.$$

Allocation of deposits

- Home deposits D_{t-1} are allocated in fixed shares across the home local, home global, and foreign global banks: $S_L+S_H+S_F=1$.

Bank lending constraints

$$L_{H,t}+L^*_{H,t}Q_t=\frac{S_H D_{t-1}+S^*_H D^*_{t-1}Q_t}{c_G}\text{ and }L^*_{F,t}+\frac{L_{F,t}}{Q_t}=\frac{S^*_F D^*_{t-1}+S_F D_{t-1}/Q_t}{c^*_G}.$$

Closing the model

- Net lending (Net Due To Position) by foreign branches in Home:

$$NDTP_t^* = \frac{1}{Q_t}\left[L_{F,t} - \frac{S_F D_{t-1}}{c_G^*}\right].$$

- Net lending by home branches abroad:

$$NDTP_t = Q_t\left[L_{H,t}^* - \frac{S_H^* D_{t-1}^*}{c_G}\right].$$

- The balance of payments equation:

$$\underbrace{p_{h,t}Y_{h,t}^* - p_{f,t}Q_t Y_{f,t}}_{\text{net exports}} + \underbrace{r_t S_F D_{t-1} - r_t^* S_H^* D_{t-1}^* Q_t}_{\text{net interest payments}}$$
$$= \underbrace{S_F\left(D_t - D_{t-1}\right) - S_H^*\left(D_t^* - D_{t-1}^*\right)}_{\text{change in stock of foreign assets}}.$$

Calibration

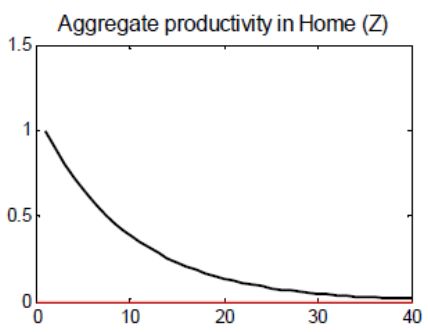
- Standard quarterly calibration:

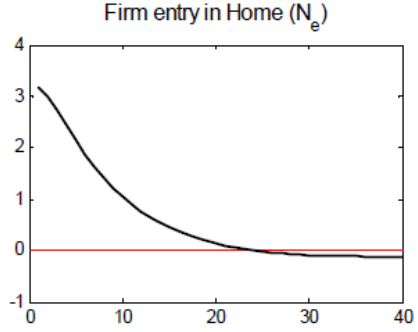
$\beta = 0.99$	Discount factor
$\gamma = 2$	CRRA coefficient
$\theta = 3.8$	Intra-temporal elasticity of substitution
$f_E = 1$	Firm's sunk entry cost
$k = 3.4$	Pareto distribution parameter
$\delta = 0.025$	Probability of firm exit
$\phi = 0.5$	Share of wage bill to be financed
$f_G = 0.0002$	Firms' fixed cost for global loans
$C_L = 1.05, C_G = 1.01$	Cost parameter, local and global bank
$S_L = 0.4, S_H = 0.3, S_F = 0.3$	Share of home deposits
$\mu = 0.01$	Banks' monitoring cost
$\varepsilon_\lambda = 1.4$	Substitution, home and foreign loans
$\lambda = 0.5$	Share of home global bank in syndicate

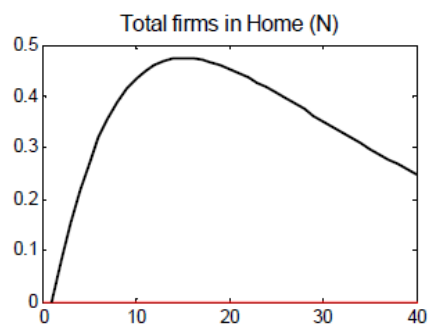
- Steady states: 1% of firms borrow globally, account for 9% of total borrowing; foreign banks provide 5% of total lending.

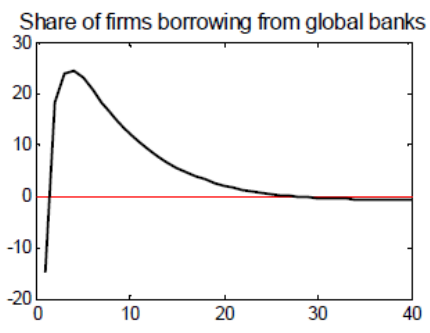
Impulse responses

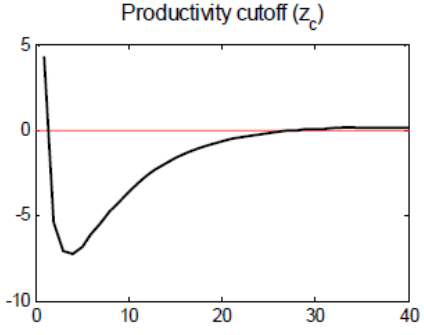
- % deviations from steady state, (+) TFP shock in Home ($\rho = 0.9$):

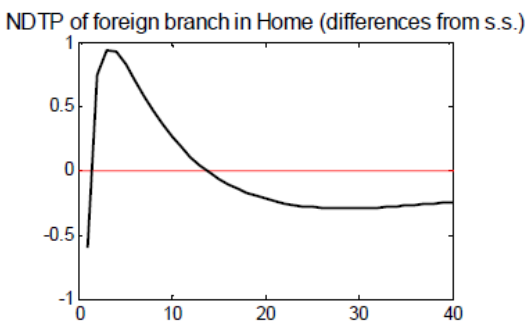


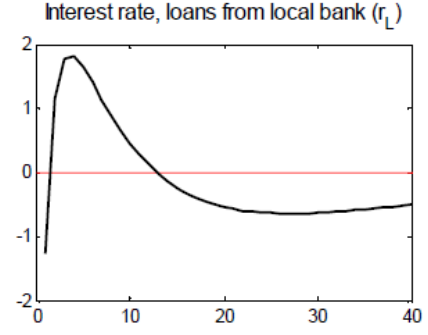


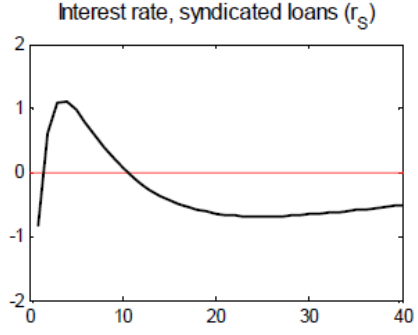


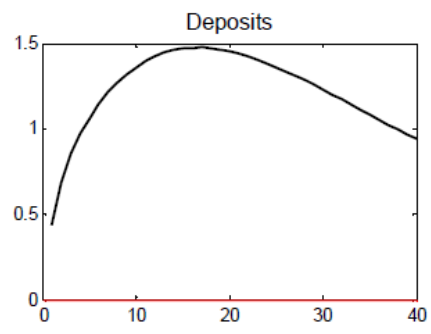










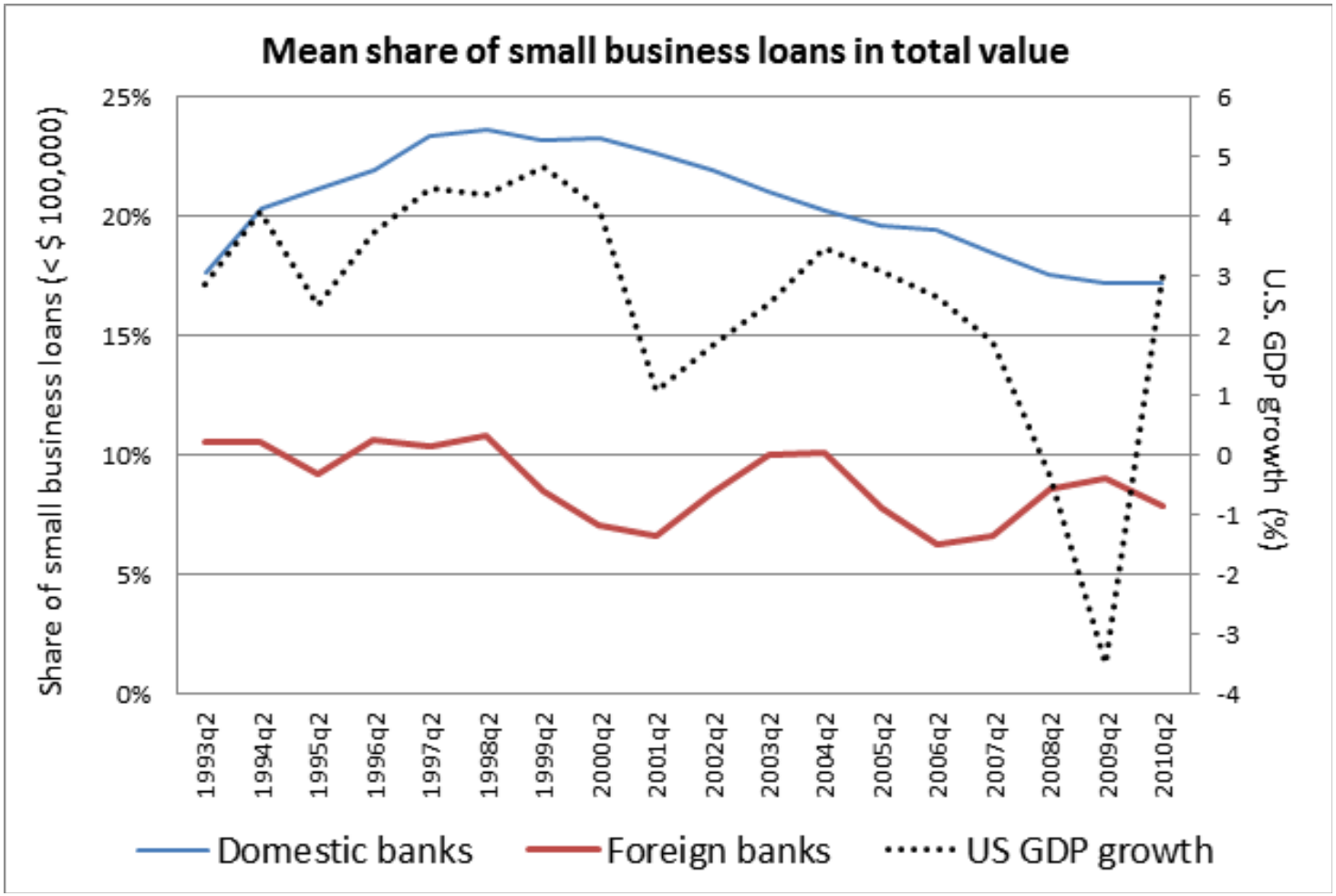


Further work

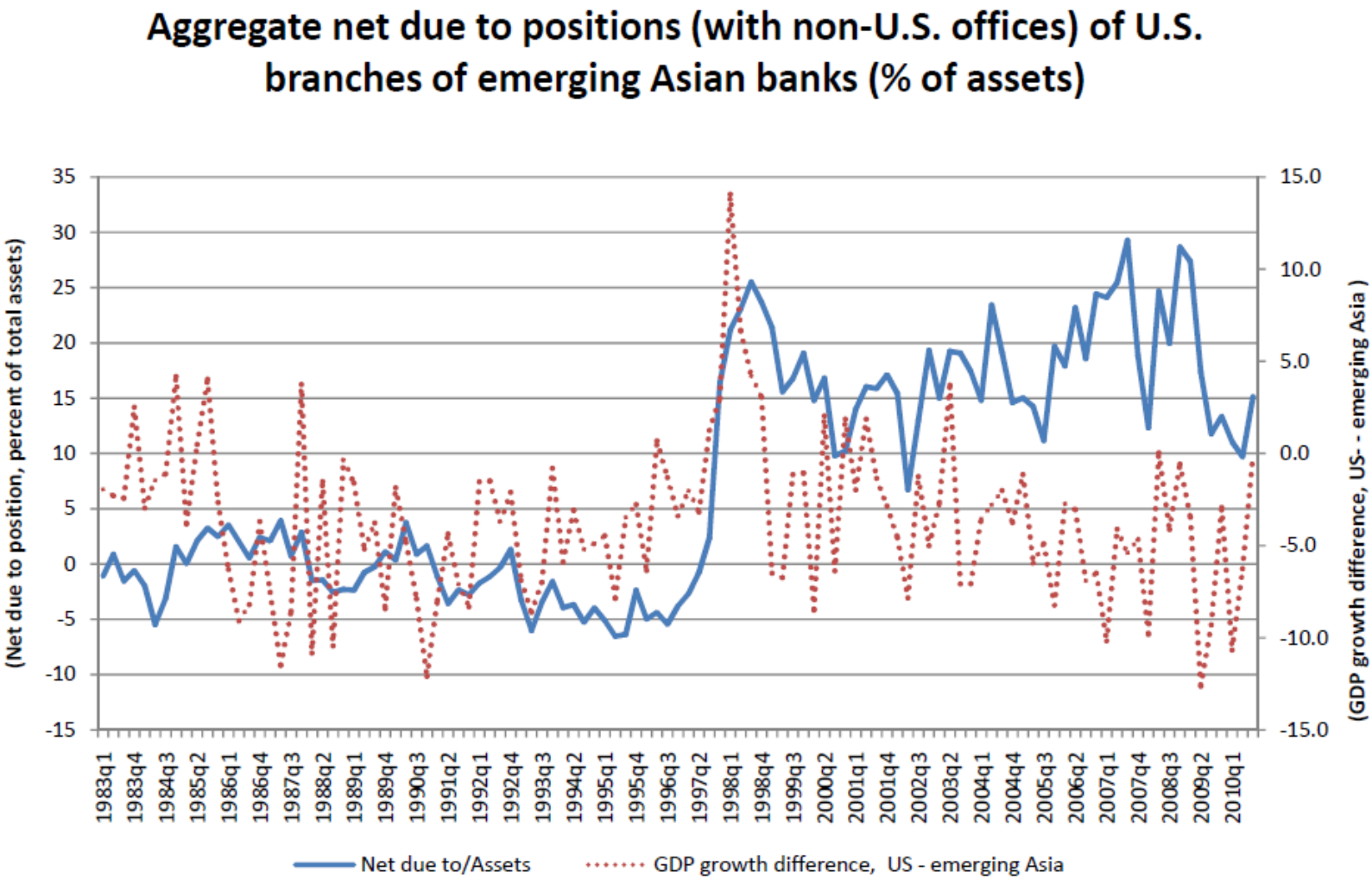
- Study the model dynamics in response to shocks:
  - A positive TFP shock in Home:
    $\longrightarrow$ firms' ability to access foreign deposits amplifies the expansion;
    $\longrightarrow$ as more of the small firms gain acess to international loans $\longrightarrow$ further amplification.
  - A negative TFP shock in Home:
    $\longrightarrow$ international bank lending exacerbates the contraction.

- Analyze the implications of proposed Basel III liquidity standards that would decrease the amount of intrabank funding:
  - Limit banks' ability to use deposits from one country to make loans in another.

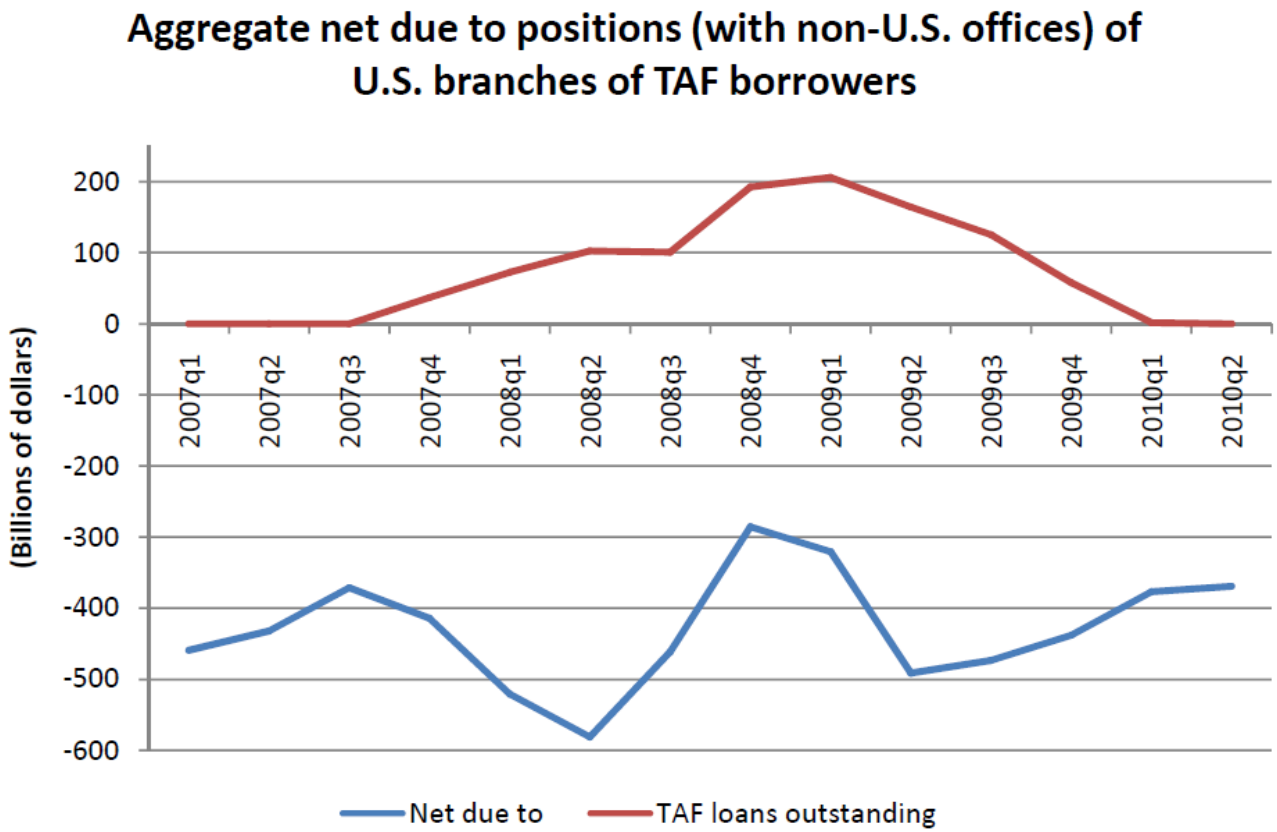
Stylized Fact 2 - Firm size and bank lending – Domestic vs. foreign banks



Stylized facts - Net positions and macro factors (U.S. branches of Asian banks)



Stylized facts - Net positions and the demand for dollar funding



Stylized facts - Net positions and the demand for dollar funding

Dependent variable:	*Net due to / Assets*	*Gross due to /Assets*	*Gross due from / Assets*	*Net due to / Assets*	*Gross due to /Assets*	*Gross due from / Assets*
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy Crisis	3.086	4.072*	0.986	3.692**	4.366***	0.674
	[2.574]	[2.367]	[1.313]	[1.489]	[1.474]	[0.663]
Dummy Europe	-23.298***	-14.067***	9.231***			
	[2.760]	[2.423]	[1.402]			
Dummy Crisis X Dummy Europe	-7.454*	-4.169	3.285*	-8.478***	-4.959**	3.519**
	[3.902]	[3.456]	[1.955]	[2.694]	[2.438]	[1.581]
Constant	26.045***	39.855***	13.810***	17.265***	34.621***	17.355***
	[1.760]	[1.671]	[0.913]	[0.616]	[0.577]	[0.332]
Branch Fixed Effects	No	No	No	Yes	Yes	Yes
Observations	1,204	1,204	1,204	1,204	1,204	1,204
R-squared	0.13	0.06	0.09	0.03	0.03	0.04

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Firm Entry with Sunk Costs

Firm entry

- Firm entry takes place untill the sunk entry cost equals the net present value of the average firm, as in Ghironi and Melitz (QJE, 2005):

$$f_E \frac{w_t}{Z_t} = \widetilde{v}_t,$$

- where:

$$\widetilde{v}_t = E_t \sum_{s=t+1}^{\infty} [\beta(1-\delta)]^{s-t} \left(\frac{C_s}{C_t}\right)^{-\gamma} \widetilde{\pi}_s.$$

- The law of motion for the number of producing firms is:

$$N_{t+1} = (1-\delta)(N_t + N_{E,t}).$$

Calibration exercise

- Vary the fixed cost f_G of international borrowing: