Topic 8: Financial Frictions and Shocks

Part1: Asset holding developments

- The relaxation of capital account restrictions in many countries over the last two decades has produced dramatic increases in international asset flows,
- with a temporary slowdown during financial crisis.
- The accumulation of large foreign asset positions have implications for theories studied earlier in this course.
- Integrated financial markets provides channel of international transmission of financial shocks, as in Global Financial Crisis of 2007-9.

a) Observations (Lane and Milesi Ferretti papers)

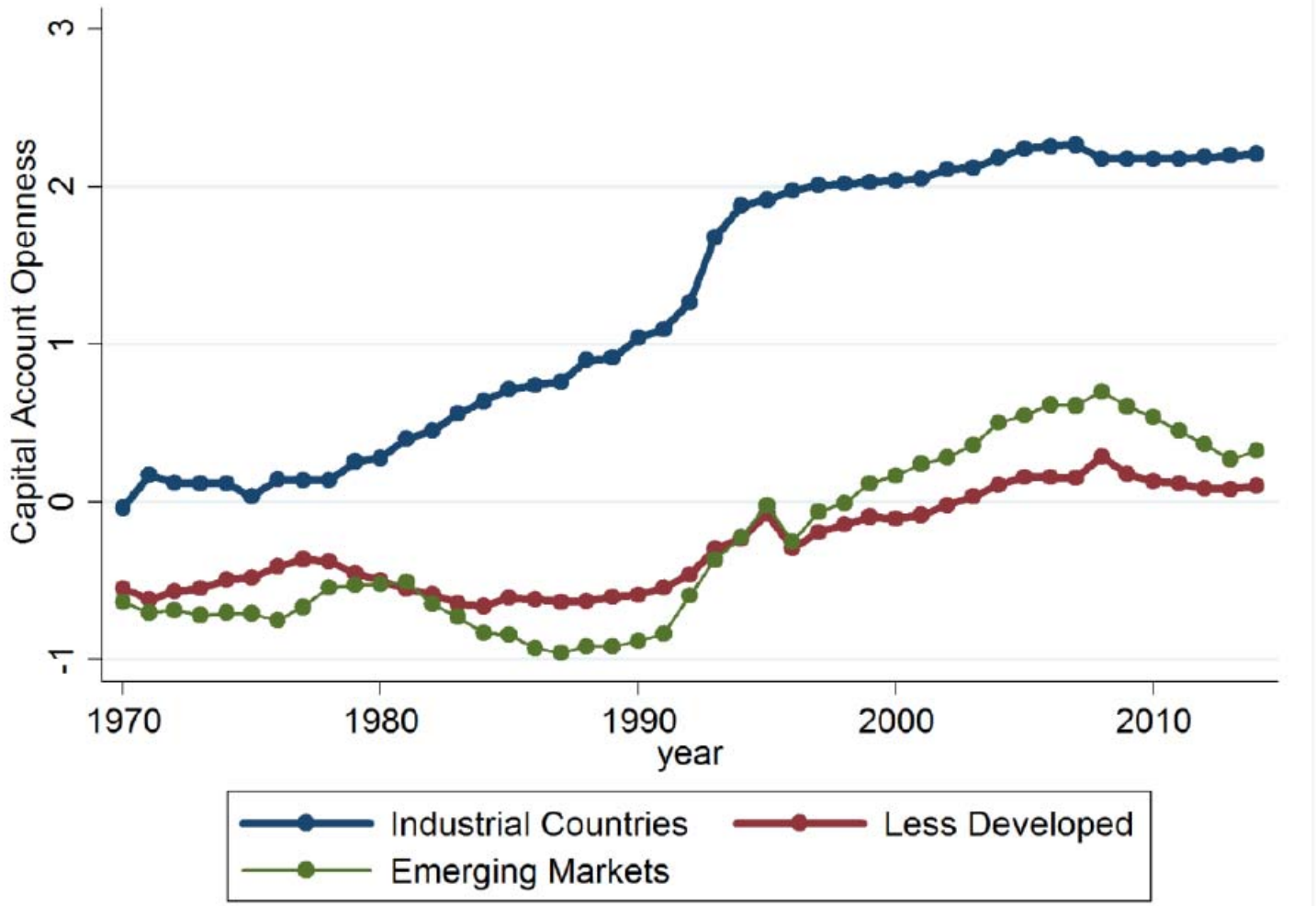
- The sum of assets plus liabilities has grown much, especially in the late 1990s.

- Financial integration has grown faster than goods trade integration.

- Gross holdings (assets plus liabilities) has grown much more than net holdings (assets minus liabilities).

- Returns on US assets abroad have tended to be higher than US liabilities. This explains why US net interest income was positive until recently, even though it has been a net debtor since 1989.

Figure 1: Development of *KAOPEN* for Different Income Groups, 1970 – 2014



Chinn-Ito index of caitgal account openness ranges -2.5 to 2.5

Figure 2. Composition of International Portfolio, Industrial Countries
(Sum of Assets and Liabilities as a Ratio of GDP, 1980–2003)

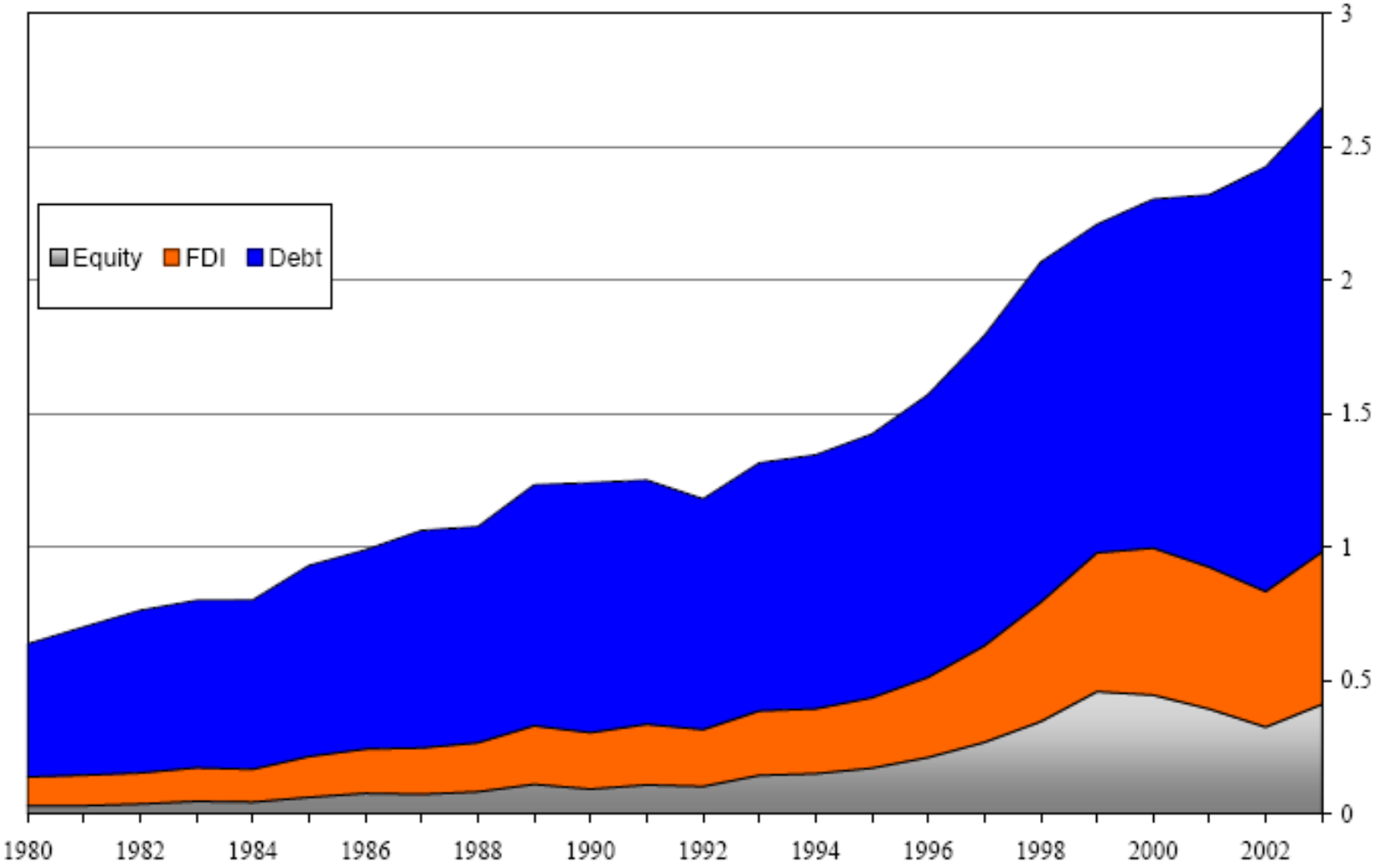


Figure 4. International Integration: Finance versus Trade

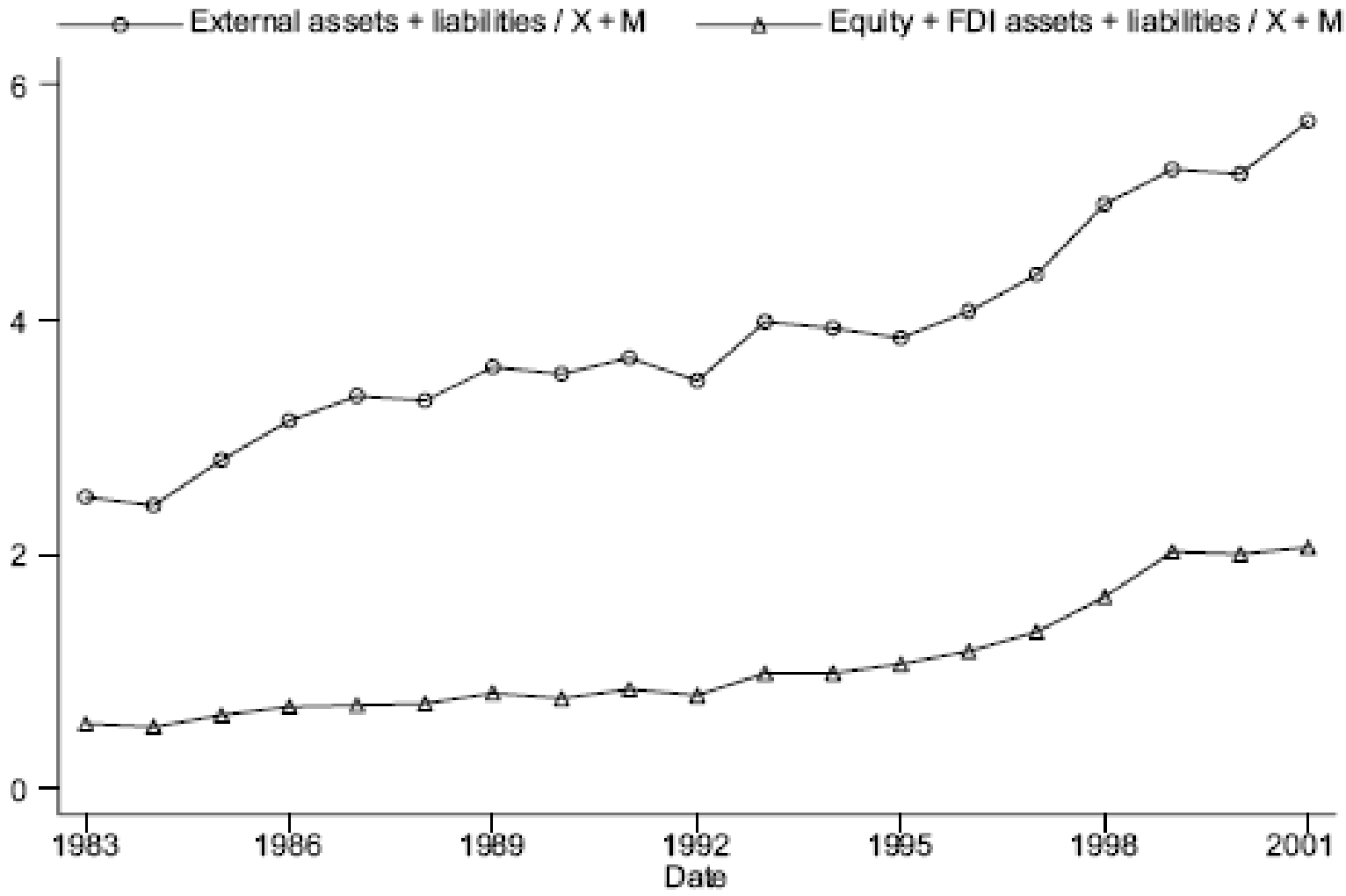
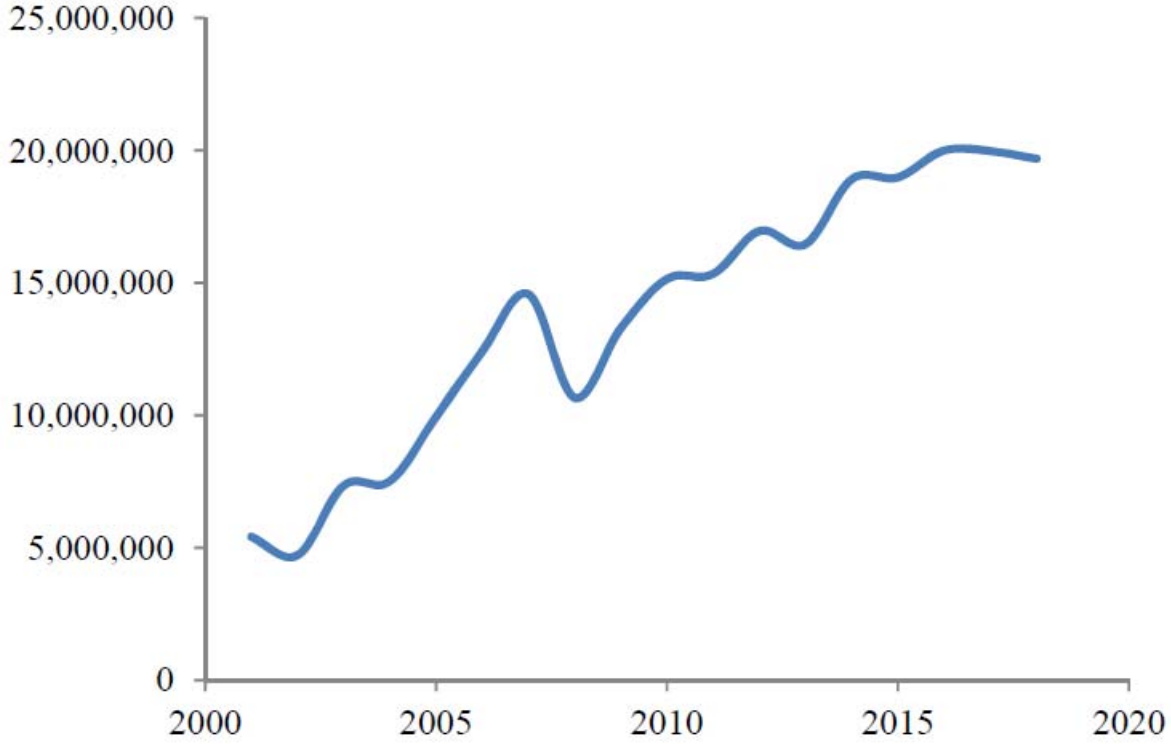
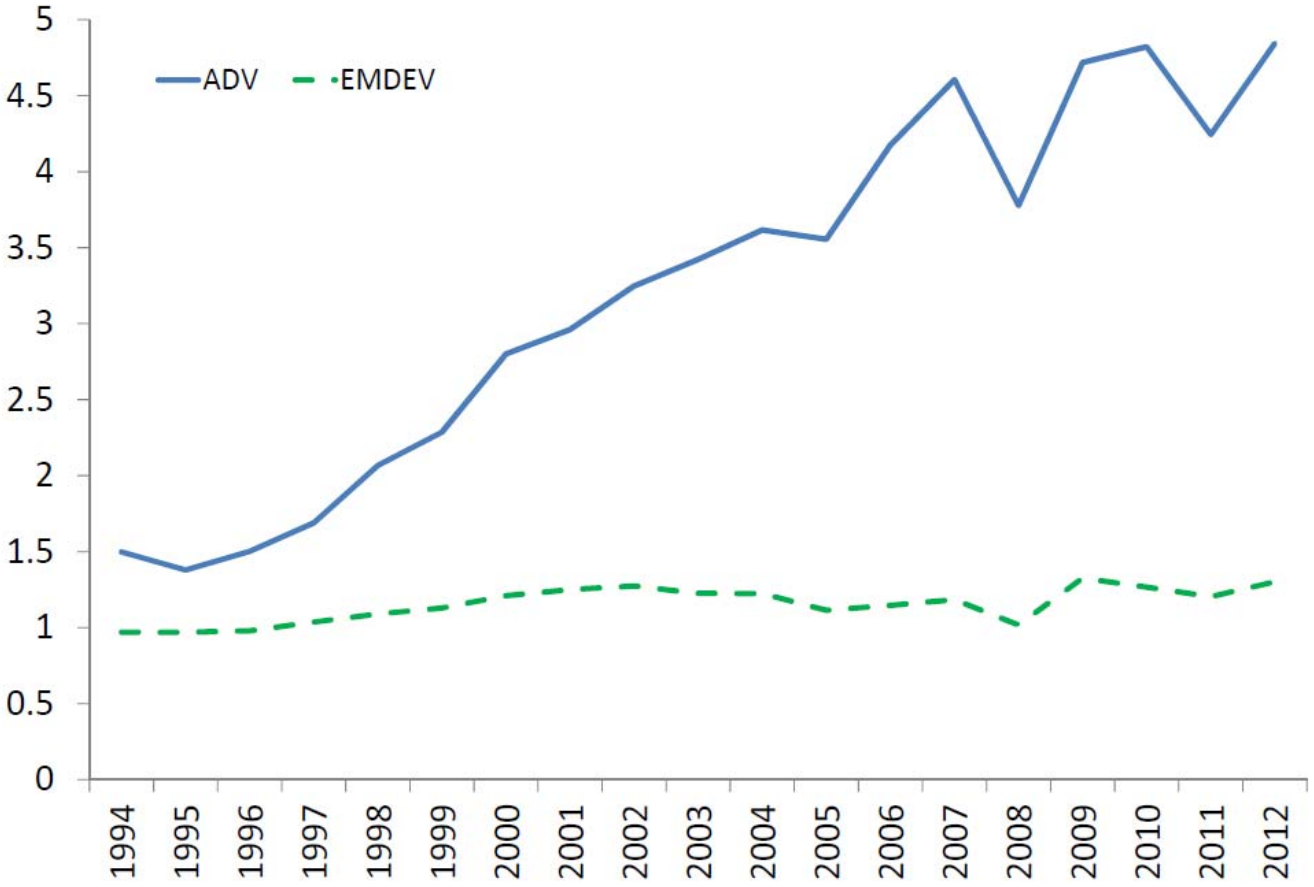


Fig. 3. US bilateral portfolio investment with the world (mil. $)



Source: Coordinated Investment Portfolio Survey, IMF. Quarterly real GDP, 1980:1-2016:3.

Figure 2: International Financial Integration

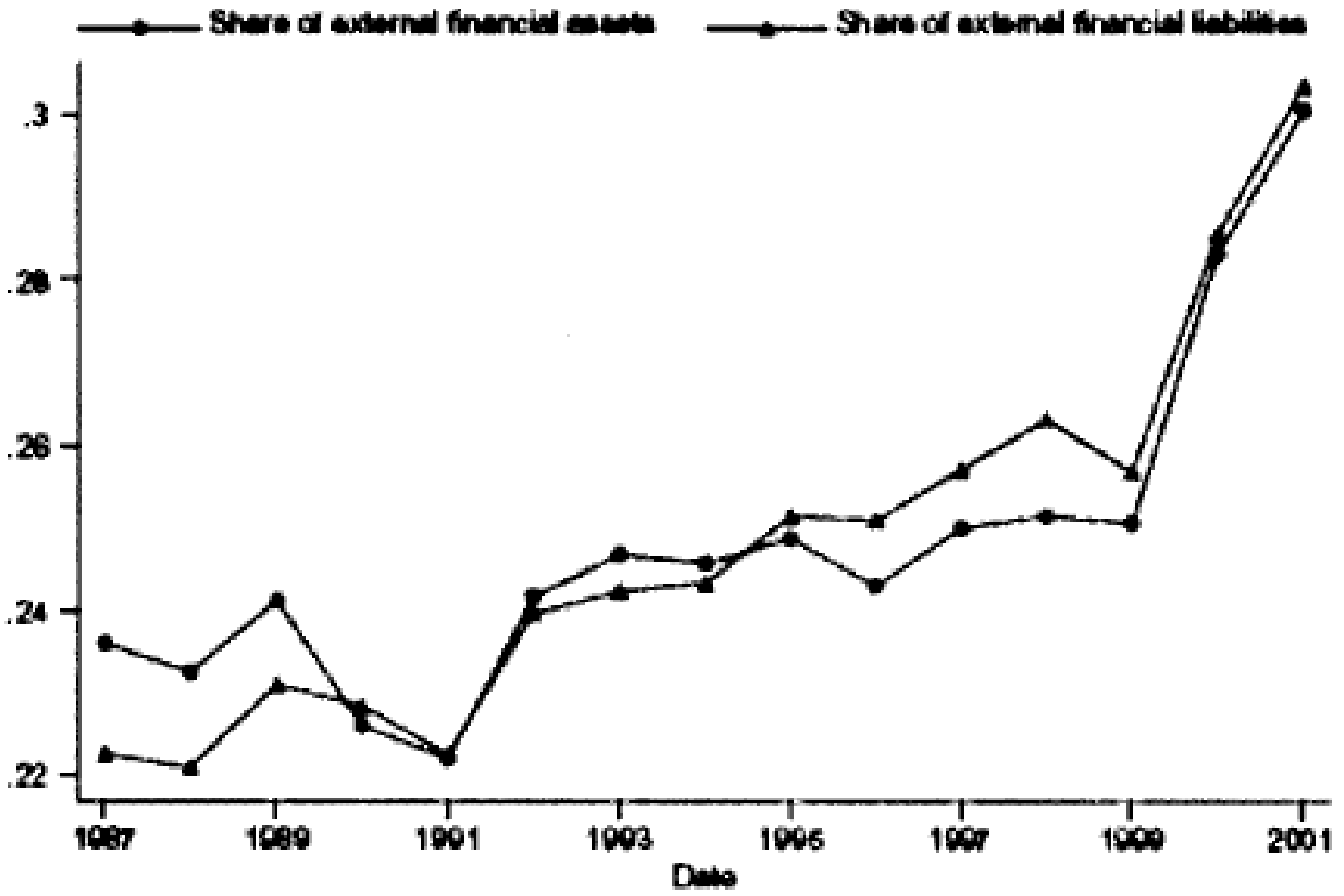


Note: This figure reports the median of the International Financial Integration (IFI) index for 22 advanced (ADV) countries and for 95 emerging/developing (EMDEV) economies. $IFI_{it} = (A_{it} + L_{it})/GDP_{it}$ is defined as the sum of foreign assets (A_{it}) plus foreign liabilities (L_{it}) scaled by GDP.

source: Benertrix, Lane, Shambaugh (2015)

Figure 6. External versus Total Financial Holdings

United Kingdom, 1987–2001



Source: Office of National Statistics.

b) the US portfolio is special:

- While US gross assets are primarily in foreign currency, its liabilities are largely in US dollars.

- While the US is a net creditor in foreign currency assets (50% of US GDP in 2004) it is net debtor in dollar assets (72% of GDP). Overall, net debt position of 22% of GDP.

- This implies that a change in the nominal exchange rate affects the value of the net asset position: a 10% depreciation of dollar transfers 5% of US GDP.

- Implications of this fact will be developed in a theoretical model in the third section of this lecture.

Table 1: Currency composition of selected asset categories

Assets, $ billions (2004)

	Total	FDI	Equity	FDI+equity	Other
Total	9,973	3,287	2,520	5,807	4,165
U.S. dollar	3,476	14	22	35	3,441
Foreign currencies	6,497	3,274	2,498	5,772	725

Liabilities, $ billions

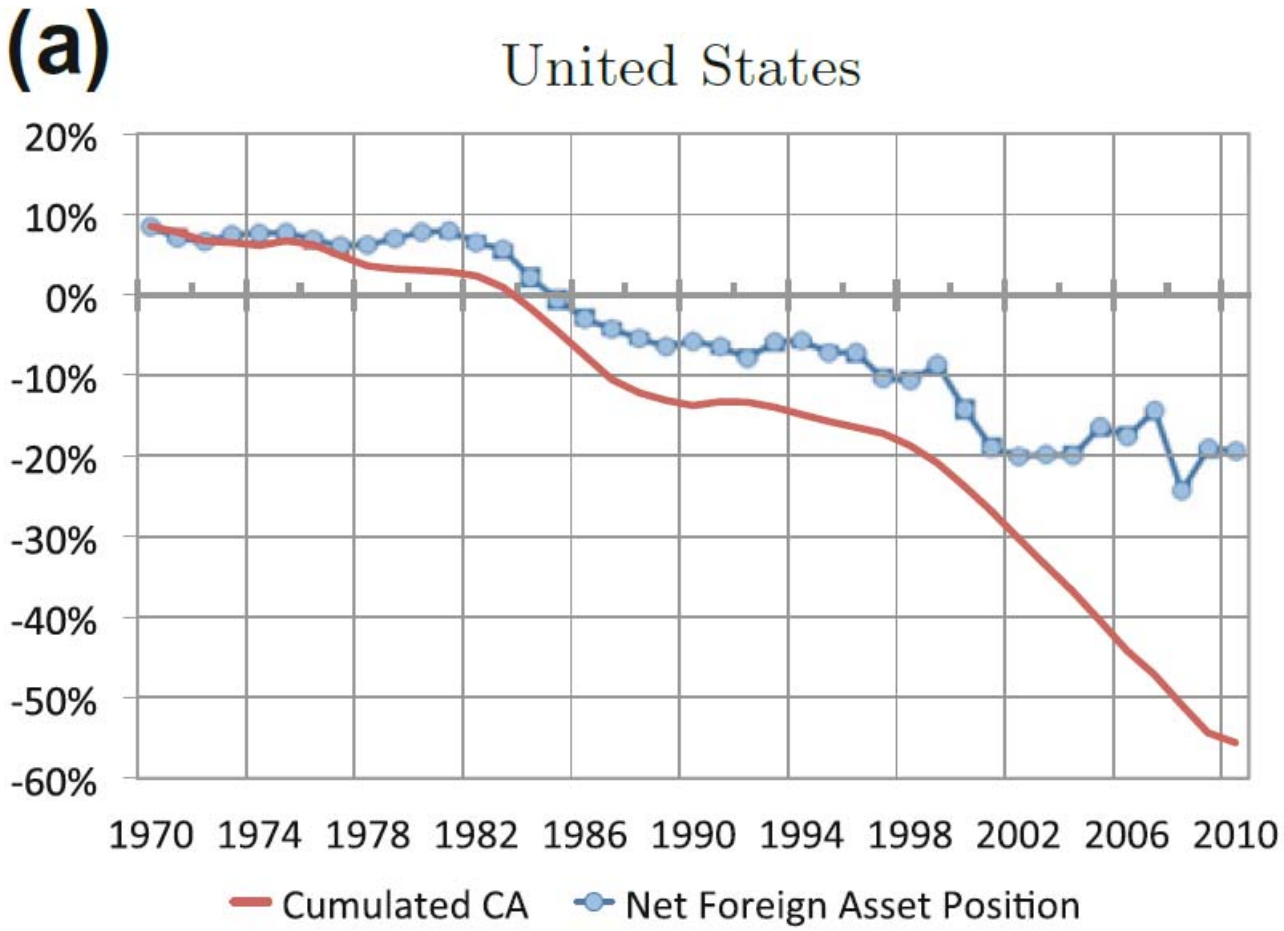
	Total	FDI	Equity	FDI+equity	Other
Total	12,515	2,687	1,929	4,615	7,900
U.S. dollar	11,869	2,687	1,929	4,615	7,254
Foreign currencies	646	0	0	0	646

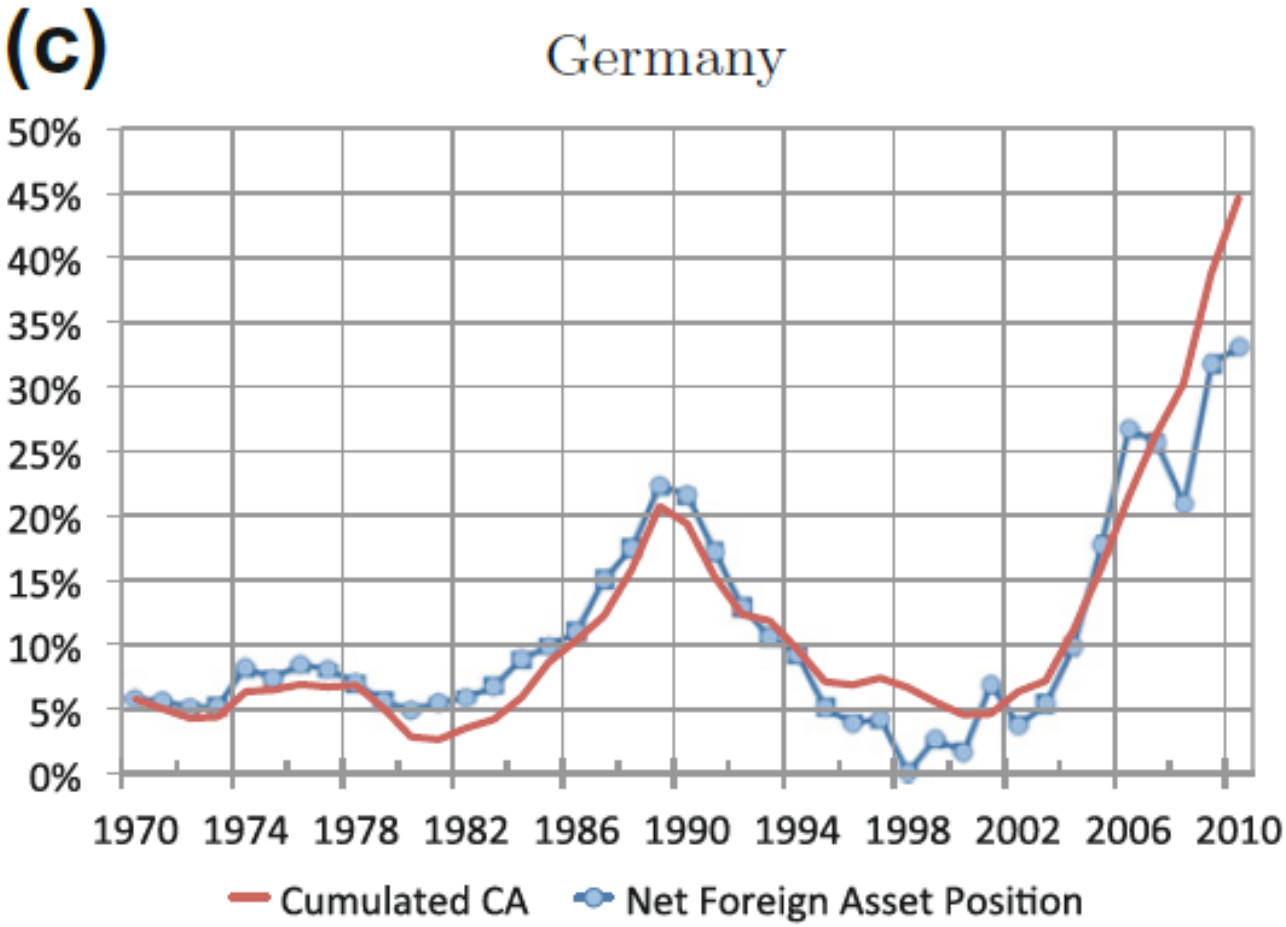
Net assets, $ billions

	Total	FDI	Equity	FDI+equity	Other
Total	-2,542	600	592	1,192	-3,734
U.S. dollar	-8,393	-2,673	-1,907	-4,580	-3,813
Foreign currencies	5,851	3,274	2,498	5,772	79

Net assets, percent of GDP

	Total	FDI	Equity	FDI+equity	Other
Total	-22%	5%	5%	10%	-32%
U.S. dollar	-72%	-23%	-16%	-39%	-32%
Foreign currencies	50%	28%	21%	49%	1%


(a)
United States
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
-60%
1970 1974 1978 1982 1986 1990 1994 1998 2002 2006 2010
Cumulated CA
Net Foreign Asset Position


(c)
Germany
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
1970 1974 1978 1982 1986 1990 1994 1998 2002 2006 2010
Cumulated CA
Net Foreign Asset Position

Part2: Financial Adjustment: Gourinchas and Rey

- This paper studies how capital gains on gross external assets provide an alternative channel for international BOP adjustment to the familiar channel via trade flows.
- We have seen in our intertemporal models that a country running a current account deficit to smooth over a shock needs to finance this by trade surpluses in future periods.
- An alternative way of satisfying the budget constraint would be for the valuation of foreign holdings of home assets to drop.
- A likely way that this would occur would be through exchange rate depreciation.

a) Theory

- The theory is analogous to that used for the Present Value tests of Campbell, used to test the intertemporal approach to the current account used in this course.
- The authors refer to their approach as an "intertemporal approach to the Financial account."
- Begin with a rewriting of the BOP (budget) constraint:

$$NA_{t+1} = R_{t+1}\left(NA_t\right) + NX_t$$

Where

- NA is defined as the difference between gross foreign assets (*A*) and gross foreign liabilities (*L*).
- NX is net exports, exports (*X*) minus imports (*M*).
- *R* is total return on net foreign asset portfolio.

- As in the earlier present value tests, linearize this budget constraint:

$$\Delta na_{t+1} = r_{t+1} + \left(\frac{1}{\rho} - 1 \right) \left(nx_t + na_t \right)$$

Where $\rho - 1$ is the steady state ratio of net exports to net assets (NX /NA).

- The <u>total rate of return on the net foreign asset portfolio can be approximated</u> as a weighted combination of the rates of return on the countries external assets and that on the country's external liabilities (which can differ)

$$r_{t+1} \approx \left| \mu_a \right| r^a{}_{t+1} - \left| \mu_l \right| r^l{}_{t+1}$$

- For reference later, define a linear combination of net exports and net assets:

$$nxa_t = nx_t + na_t = |\mu_x| x_t - |\mu_m| m_t + |\mu_a| a_t - |\mu_l| l^l{}_t$$

Which can be interpreted as the deviation from trend of the ratio of net exports to net foreign assets (NX /NA).

- The intertemporal budget constraint implies a condition analogous to the test condition from the present value CA literature:

$$\Delta nxa_t = -\sum_{j=1}^{\infty} \rho^j E_t \left[r_{t+j} + \Delta nx_{t+j} \right]$$

(key PV condition)

- This shows that movements in the trade balance and the net foreign asset position must forecast either future portfolio returns, or future net exports growth, or both.

- So there are two channels of adjustment to a net export imbalance: the usual trade channel, and an asset valuation channel.

- Note that the latter, represented in r, can take place by changes in the nominal exchange rate, if the gross asset positions for assets and liabilities tend to be denominated in different currencies.

b) Empirical Implementation and Results

Data: The authors must work quite hard to collect the data needed to compute the series for total returns, r, as this requires estimates on weights for different categories of assets and their returns.

Present value test:

- The authors follow Campbell methodology in testing the PV condition above.

- They use a VAR to generate forecasts for the expected discounted sums of r and NX above.

- They then can use the equation above to compute a model-consistent forecast of Δnxa, which then can compare to the data using a Wald test.

- They find a chi-squared statistic of 0.325, and with three restrictions, the p-value is 0.955. So they cannot reject the restriction of the Present value condition above.

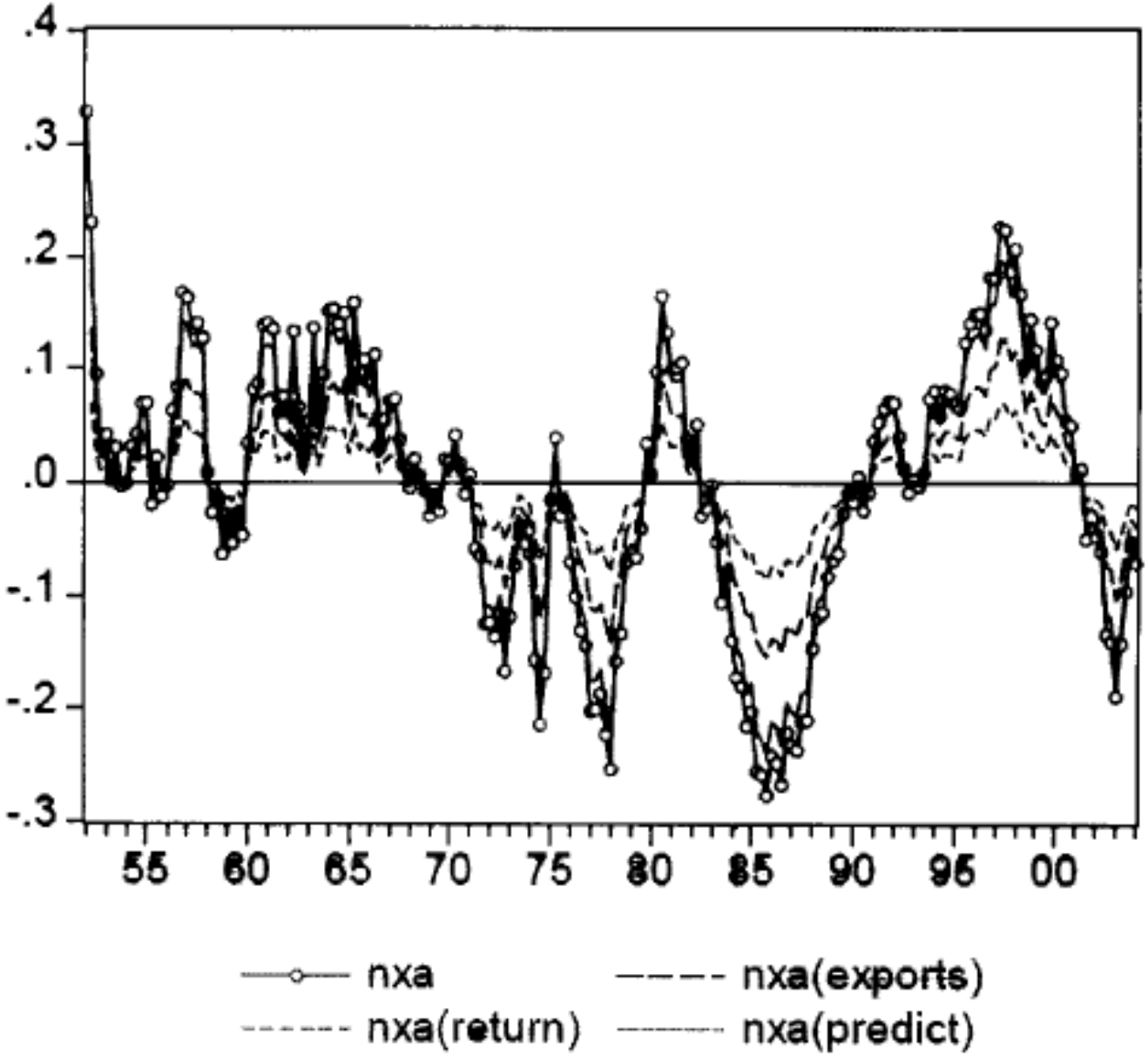
Decomposition:

The authors decompose Δnxa into the two channels implied by the PV condition: $\Delta nxa_t = -\sum_{j=1}^{\infty} \rho^j E_t \left[r_{t+j} + \Delta nx_{t+j} \right]$

- the trade channel ($\sum_{j=1}^{\infty} \rho^j E_t \left[\Delta nx_{t+j} \right]$)

-and the valuation channel ($\sum_{j=1}^{\infty} \rho^j E_t \left[r_{t+j} \right]$).

- The valuation channel plays an important role, accounting for 31% of overall external adjustment.
- They conclude that the valuation channel does not replace the need for the US to generate net exports in the future, but it does significantly reduce the magnitude of adjustment needed along the trade channel.


.4
.3
.2
.1
.0
-.1
-.2
-.3
55
60
65
70
75
80
85
90
95
00
nxa
nxa(exports)
nxa(return)
nxa(predict)

Gourinchas and Rey (2005)

		Discount factor ρ		
#	percent	0.96	0.95	0.94
1	$\beta_{\Delta nx}$	64.91	56.13	45.77
2	β_r	28.97	30.87	31.59
	of which:			
3	β_a	28.79	28.94	27.51
4	β_l	0.28	2.02	4.17
5	Total (lines 1+2)	93.88	87.00	77.36
6	μ_a	6.77	8.24	10.16

Part 3: Implications for monetary policy models: Tille

a) **Model**:

- Two country model sticky price model like OR (1995), but with new asset market features.

- Can hold home and foreign bonds and equities. Nominal bonds in H and F currency (one period and perpetuity bonds that pay a fixed nominal interest rate for all future periods).

- Equities share in firm in H and F, which are mutual fund claim to other countries nominal profits.

- assume steady state with zero net foreign asset position, so can get closed form solution.

- Nonetheless, there are nonzero gross holdings in each currency.

- Calibration: representative of US case. Foreign currency - assets represent 50% of home GDP (either bonds, equities, or combination of the two).

Four cases for asset market in each table:

1) no international asset positions
2) bonds only economy
3) equities only
4) mixture of bonds and equities matching US case.

b) Findings (sticky price version of model)

With no financial integration (column 1), get something close to the basic Obstfeld-Rogoff (1995) story: Increase money supply raises production and consumption.

Bonds only economy: (Column 2)

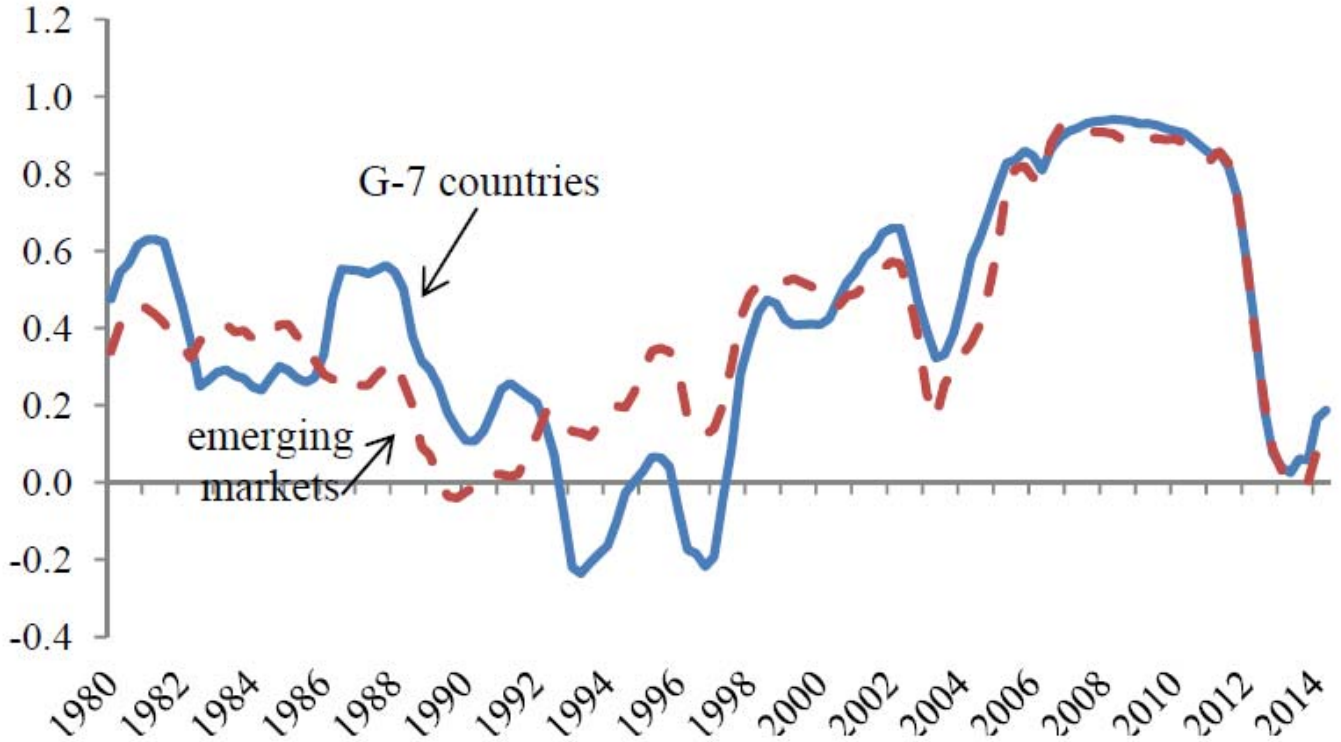
- We see evidence of a wealth transfer.
- May appear that the asset valuation effect has little impact on consumption
- But note the fall in home long-run output.
- It is also very clear in the effect on home welfare, which rises 5.8 times larger than in the no asset case.

Short run differentials	Consumption	0.04	0.04	0.03	0.04
	Output	7.72	7.68	7.72	7.71
	Profits	7.72	7.68	7.72	7.71
Long run differentials	Consumption	0.04	0.04	0.03	0.04
	Output	-0.28	-0.32	-0.28	-0.29
	Profits	0.72	0.68	0.72	0.71
Total differential	Consumption	1	1.00	1	0.90
	Output	1	0.00	1	0.82
	Profits	25	24	25	25
Asset prices	Exchange rate	0.97	0.96	0.97	0.96
	Home equity	0.86	0.84	0.86	0.86
	Foreign equity	0.14	0.16	0.14	0.14
Net asset positions	Total	3.36	3.84	3.34	3.45
	- financial flows	3.36	3.36	3.22	3.23
	- exchange rate	0	0.48	0.48	0.48
	- asset prices	0	0	-0.36	-0.27
Welfare	Differential	0.04	1	0.01	0.21
	Home	0.10	0.58	0.09	0.19
	Foreign	0.06	-0.42	0.08	-0.02

Part 4: International transmission of financial shocks and Global Financial Crisis

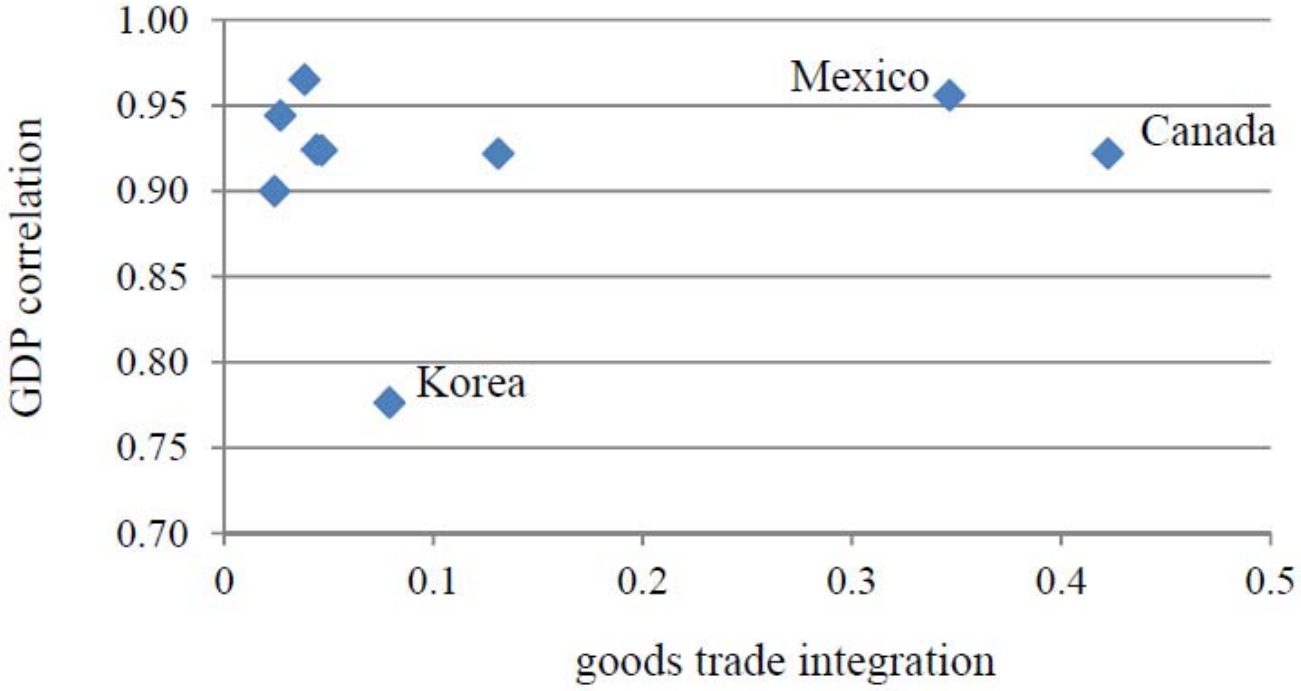
- International comovement was particularly strong during recent financial crisis.
- But was temporary, associated with particular financial shock.
- Countries with greater financial linkages to US tended to experience US Great Recession more strongly.

Fig. 1. Correlation of GDP with US in rolling 5 year window



Solid line represents average among G7 countries (excluding US), which includes Canada, France, Germany, Italy, Japan, United Kingdom. Dashed line represents average among emerging markets countries in our sample, which includes China, Korea, Mexico. Source: International Financial Statistics, IMF. Quarterly real GDP, 1980:1-2016:3. Seasonally adjusted, logged and HP filtered.

Fig. 4. Bilateral GDP correlation with US in 2009 plotted against bilateral trade volume with US in 2006 as share of country's GDP

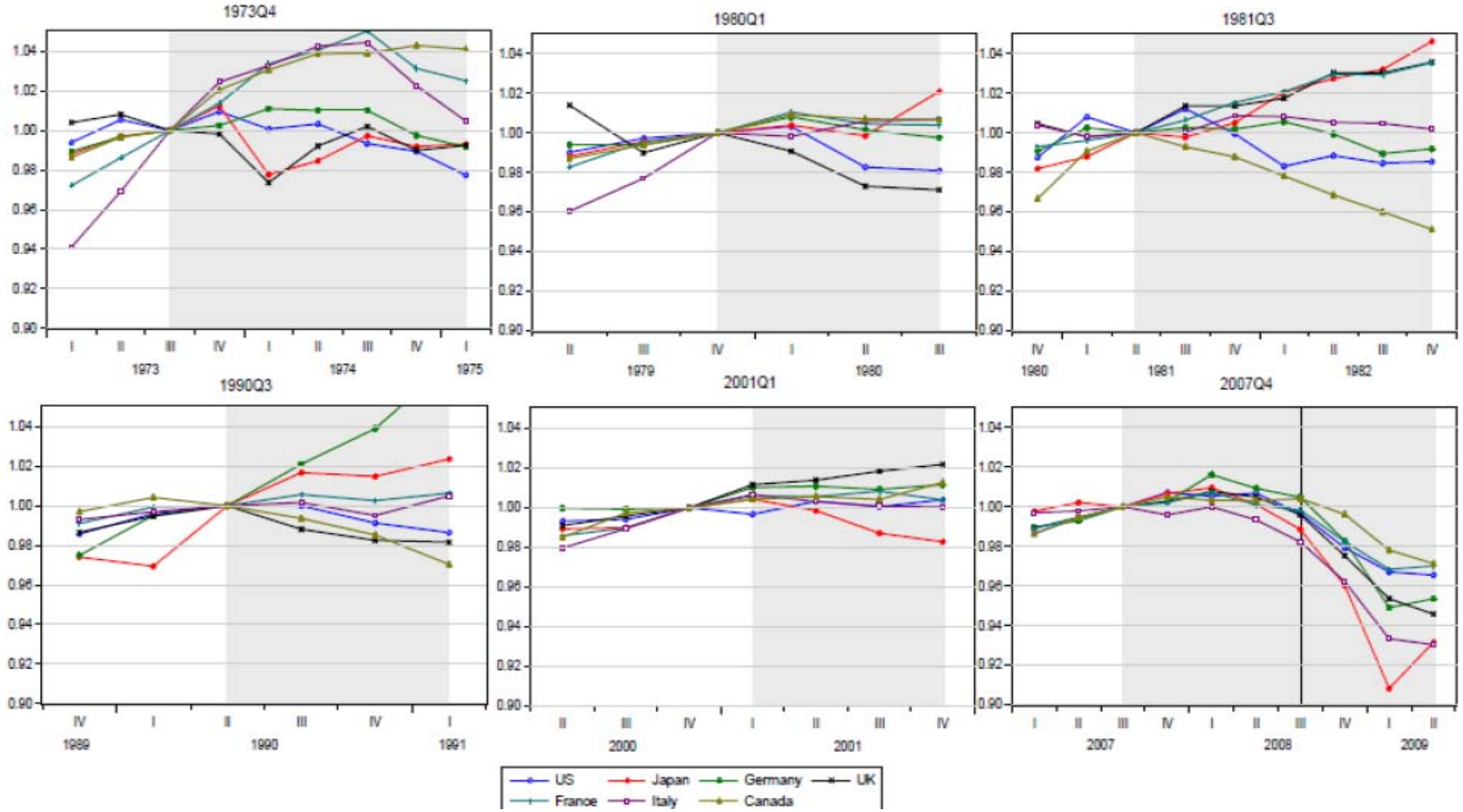


a) **International Recession** (Perri and Quadrini, 2016)

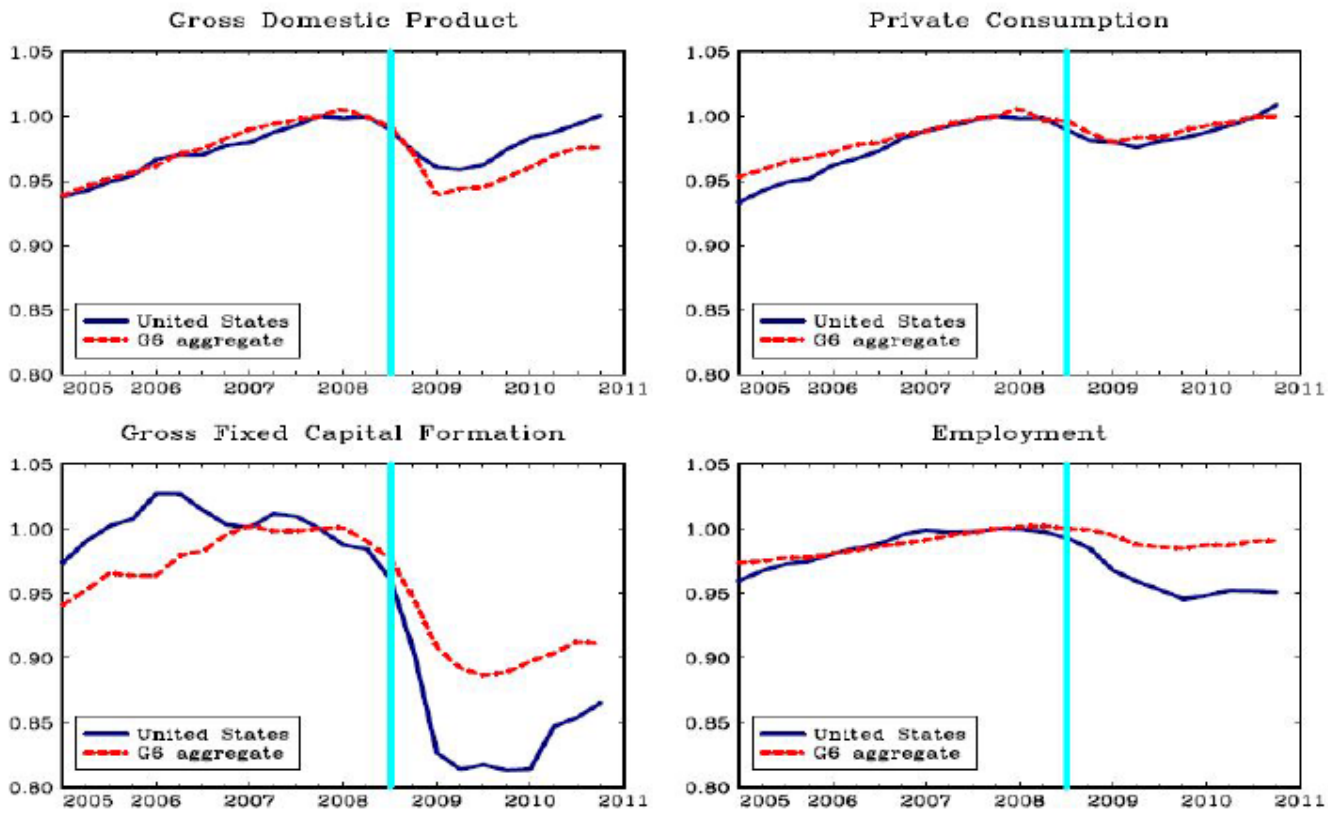
(slides from Angsoka Y. Paundralingga)

High degree of real and financial co-movement in industrialized countries.

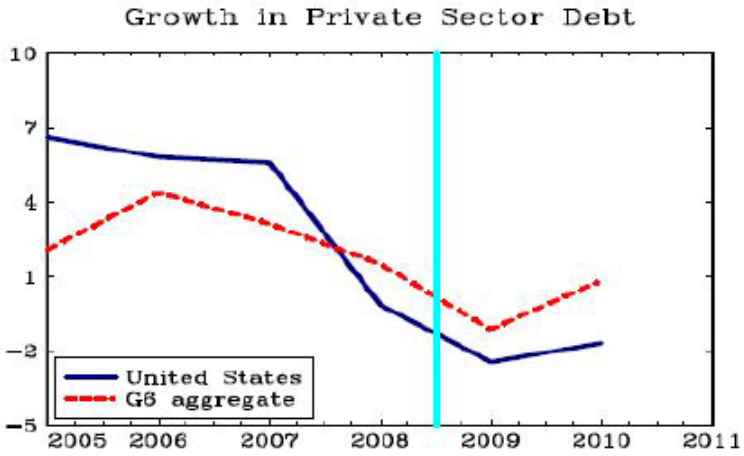
GDP during past recessions:

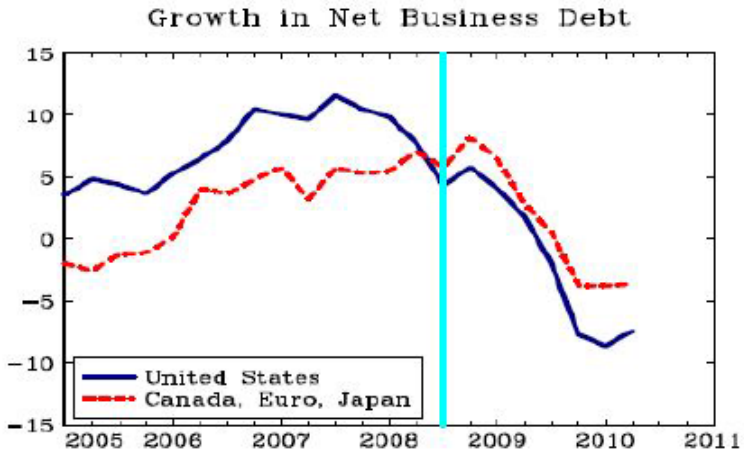


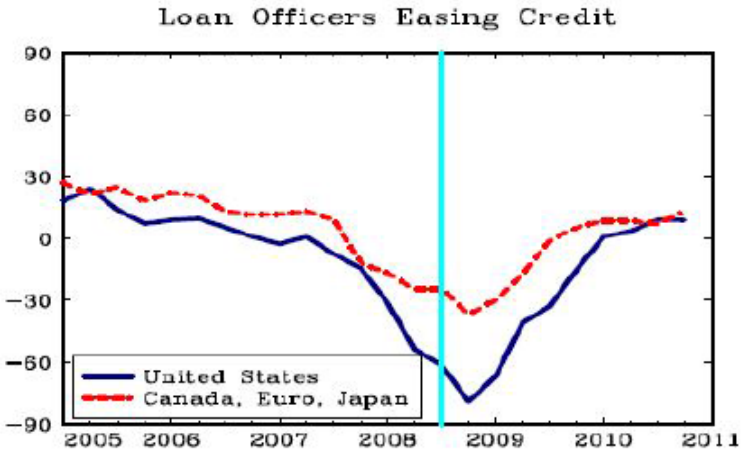
High degree of international co-movement in real variables



High degree of international co-movement in financial variables
Asymmetry between pre-crisis phase and the crisis phase







This Paper

- MAIN OBJECTIVE :

  provide an explanation for these two features of the crisis: the international dimension (both real and financial) and its depth.

- HYPOTHESIS :

  Multiple self-fulfilling equilibria in credit markets can explain these features.

- STRATEGY :

  - A transmission channel for credit shocks but does not deal with the more fundamental question of what causes a credit shock.
  - Provide an 'endogenous' mechanism for the credit tightening $\Rightarrow$ tighter/looser credit constraints can emerge endogenously as multiple self-fulling equilibria.

Multiple Equilibria?

- 'BAD' equilibria,
  1. Markets expect low resale prices for the assets of defaulting firms.
  2. Firms face low credit capacity and are liquidity constrained
  3. Liquidity constrained firms $\Rightarrow$ no firms that have the ability to purchase the assets of liquidated firms.
  4. The resale price of their assets is low

  This rationalizes prior expectation of low prices.

  These equilibria are characterized by depressed economic activity, financial intermediation and asset prices.

Multiple Equilibria?

- 'GOOD' equilibria,
  1. Markets expect high resale prices of firms' assets which
  2. Firms get higher debt
  3. High borrowing capacity $\Rightarrow$ firms are unconstrained.
  4. There are firms with the required liquidity to purchase the assets of liquidated firms $\Rightarrow$ keeps prices high.

  This rationalizes prior expectation of high prices.

  These equilibria are characterized by sustained levels of economic activity, financial intermediation and asset prices.

What do Perri-Quadrini do?

Perri-Quadrini propose a two-country model where

- Credit expansions and contractions are generated by self-fulfilling expectations (multiple equilibria).
- Multiple equilibria arise because of occasionally binding constraints.
- Credit contractions generate sharp recessions while the macroeconomic impact of credit expansions is more gradual (asymmetry).
- Recessions are more severe after long periods of credit and macroeconomic expansions (history dependence).
- The model generates large movements in asset prices.

Model with Segmented Markets

- Two types of agents (sectors):
  - Investors: They are the shareholders of firms and consume dividend
$$\max \mathrm{E} \sum_{t=0}^{\infty} \beta^t u(d_t)$$
  - Workers: Supply labor and lend funds to firms with bonds.
$$\max \mathrm{E} \sum_{t=0}^{\infty} \delta^t U(c_t, h_t)$$
- Different discount factors: $\beta < \delta$.

Firms

- There is unit mass of firms owned by investors.
- 'Concave' production function $F(\bar{k}, h_t)$. Fixed capital for the moment.
- Budget constraint: $b_t + d_t = \frac{b_{t+1}}{R_t} + F(h_t) - w_t h_t$.
- Discount factor: $m_{t+1} = \frac{\beta u_c(d_{t+1})}{u_c(d_t)}$
- Also borrow intra-temporally for working capital $l_t = F(h_t)$
- Limited enforcement: $\xi_t \cdot \bar{k} \geq \frac{b_{t+1}}{R_t} + l_t$.

Remarks on the Constraints of the Firms' Maximization Problem

$$
\begin{aligned}
b_t + d_t &= \frac{b_{t+1}}{R_t} + F(h_t) - w_t h_t \\
\xi_t \cdot \bar{k} &\geq \frac{b_{t+1}}{R_t} + F(h_t)
\end{aligned}
$$

1. Start the period with intertemporal debt b_t.
2. Before producing $\rightarrow$ choosing labor input h_t, dividends d_t, and next period debt b_{t+1}.
3. Before receiving the revenues $\rightarrow$ pay wages, $w_t h_t$, dividends, d_t, and current debt net of the new issue, $b_t$and b_{t+1}/R_t
4. Thus the firm faces a cash flow mismatch during the period : $w_t h_t + d_t + b_t - b_{t+1}/R_t$
5. To cover the cash flow mismatch, the firm contracts the intra-period loan l_t to be repaid at the end of the period, after the realization of revenues

Remarks on Modelling Default

- Intra-period loan, l_t, is liquid funds that can be easily diverted in the event of default.
- AT DEFAULT
  - Debt contracts are not perfectly enforceable as the firm can default.
  - Takes place at the end of the period before repaying l_t.
  - The firm holds the revenues $F(h_t) = l_t$.
  - The lender has the right to liquidate the firm's assets.
  - THUS the only remaining asset is the physical capital k.
- Let the liquidation value of capital is $\xi_t \cdot \bar{k}$, with ξ_t is stochastic.
  - The total liabilities of the firm at the end are $l_t + b_{t+1}/R_t$.
  - To ensure that the firm does not default, the total liabilities are subject to the enforcement constraint

Remarks on Modelling Self-Fulfilling Expectations

- Enforcement constraint on intratemporal loans l_t in fixed-capital model is

$$\xi_t \cdot \bar{k} \geq l_t + \frac{b_{t+1}}{R_t}$$

- ξ_t is known at the time that l_t is set.
- In version with endogenous ξ, it can take two values $\bar{\xi}$ and $\underline{\xi}$
- Self-fulfilling expectations equilibria:
  - Firms borrow up to limit, $\xi = \bar{\xi}$
  - Firms don't borrow up to the limit, $\xi = \underline{\xi}$
- Fluctuations in ξ_t affect the ability to borrow $\Rightarrow$ generate pro-cyclical movements in real and financial variables

Remarks on The Role of Fluctuations of ξ_t (ξ_t decreases)

SETUP: A pre-shock equilibrium in which the enforcement constraint is binding

- FIRST OPTION : the firm is unwilling to change the input of labor

  1. $F(h_t) = l_t$, the intra-period loan, does not change.
  2. reducing the intertemporal debt b_{t+1} (enforcement const)
  3. reduction in $b_{t+1} \Rightarrow$ a reduction in dividends.
  4. the firm is forced to substitute debt with equities.

- SECOND OPTION : the firm keep the dividend payments unchanged

  1. reducing the intra-period loan $l_t = F(h_t)$ (enforcement const)
  2. reduction in the input of labor

The firm faces a trade-off: paying lower dividends AND/OR cutting employment. The optimal choice depends on the relative cost of changing these two margins which depends on the stochastic discount factor for investors
$m_{t+1} = \beta u_c(d_{t+1})/u_c(d_t)$

Recursive Problem for the Firm

$$V(s;b) = \max_{d,h,b'} \left[d + Em'V(s';b') \right]$$

subject to

$$b + d = \frac{b'}{R} + F(h) - wh$$

$$\xi_t \cdot \bar{k} \geq \frac{b'}{R} + F(h)$$

First Order Conditions

$$\begin{aligned} F_h(h) &= w \cdot \left(\frac{1}{1-\mu} \right) \\ REm' &= 1-\mu \end{aligned}$$

- INTERPRETATION of μ
  - Multiplier for the enforcement constraint
  - If $(\mu > 0) \Rightarrow$ the enforcement constraint is binding
  - There is a wedge in the demand for labor

Enforcement Constraint and The Labor Wedge

- Labor Wedge?
  - The input of labor needs to be financed.
  - Part of the financing has to come from equity (through lower payment of dividends).
  - IF the cost of equity, $1/Em$, is greater than the cost of debt, R, $\Rightarrow$ expanding the input of labor is costly in the margin because the firm needs to substitute debt with equity.
- The equity premium $1/Em - R$ determines the labor wedge
- The wedge is strictly increasing in μ and disappears when $\mu = 0$, i.e. the enforcement constraint is not binding.

SETUP : Open Economy

- Two symmetric countries.
- Households borrow and lend internationally. They own domestic bonds, b_t, and foreign bonds, n_t.
- Investors are allowed to hold shares of domestic and foreign firms. The implication is full diversification.

SETUP : Open Economy

- Because of investors' diversification, the common discount factor is:

$$m_{t+1} = \frac{\beta u_c(d^1_{t+1} + d^2_{t+1})}{u_c(d^1_t + d^2_t)}$$

- Back to first order conditions of firms:

$$F_h(h^1) = w^1 \cdot \left(\frac{1}{1-\mu^1}\right) \qquad REm' = 1-\mu^1$$

$$F_h(h^2) = w^2 \cdot \left(\frac{1}{1-\mu^2}\right) \qquad REm' = 1-\mu^2$$

Property with Exogenous ξ_t

Proposition

An unexpected change in ξ_t (domestic credit shock) has the same impact on employment and output of domestic and foreign countries.

HOWEVER
Unless shocks are internationally correlated, the model does not generate co-movement in financial flows.

Endogenous ξ_t

- The enforcement constraint is occasionally binding

$$\xi_t \cdot \bar{k} \geq \frac{b'}{R} + F(h)$$

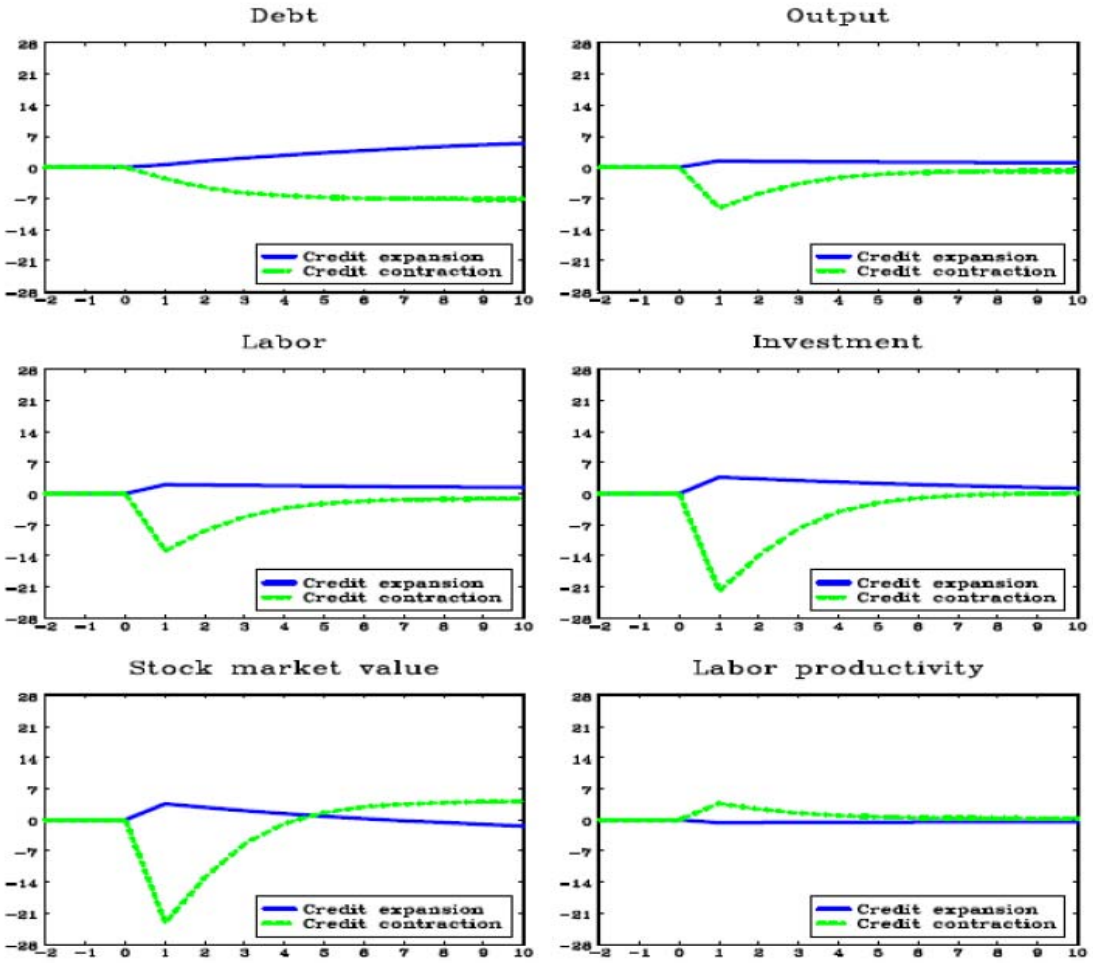
- Capital can be sold to households at price $\xi_t = \underline{\xi}_t$
- Alternatively, capital can be sold to firms at price $\xi_t = \bar{\xi}_t$.
- However, firms can make the purchase only if they have liquidity.
- Multiple equilibria:
  - If the market expects $\xi_t = \bar{\xi}_t$, firms will not borrow up to the limit and the ex-post price of the liquidated capital is $\xi_t = \bar{\xi}_t$.
  - If the market expects $\xi_t = \underline{\xi}_t$, firms will borrow up to the limit and the ex-post price of the liquidated capital is $\xi_t = \underline{\xi}_t$.

Property with Endogenous ξ_t

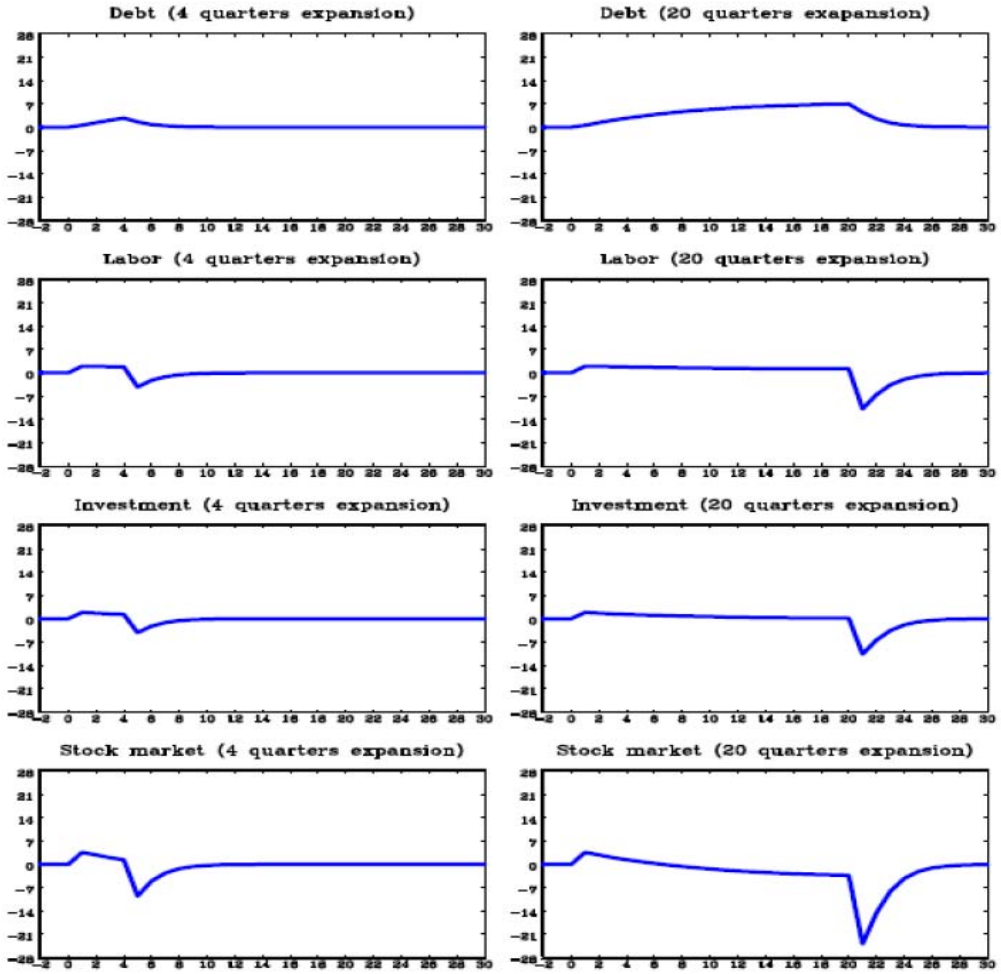
Proposition

A credit contraction in the domestic country (decline in ξ_t) is always associated with a credit contraction in the foreign country (decline in ξ_t^*). Thus, both countries experience the same responses in macroeconomic and financial variables.

Result 1: Asymmetry: Credit contractions have larger macroeconomic and asset price effects than expansions



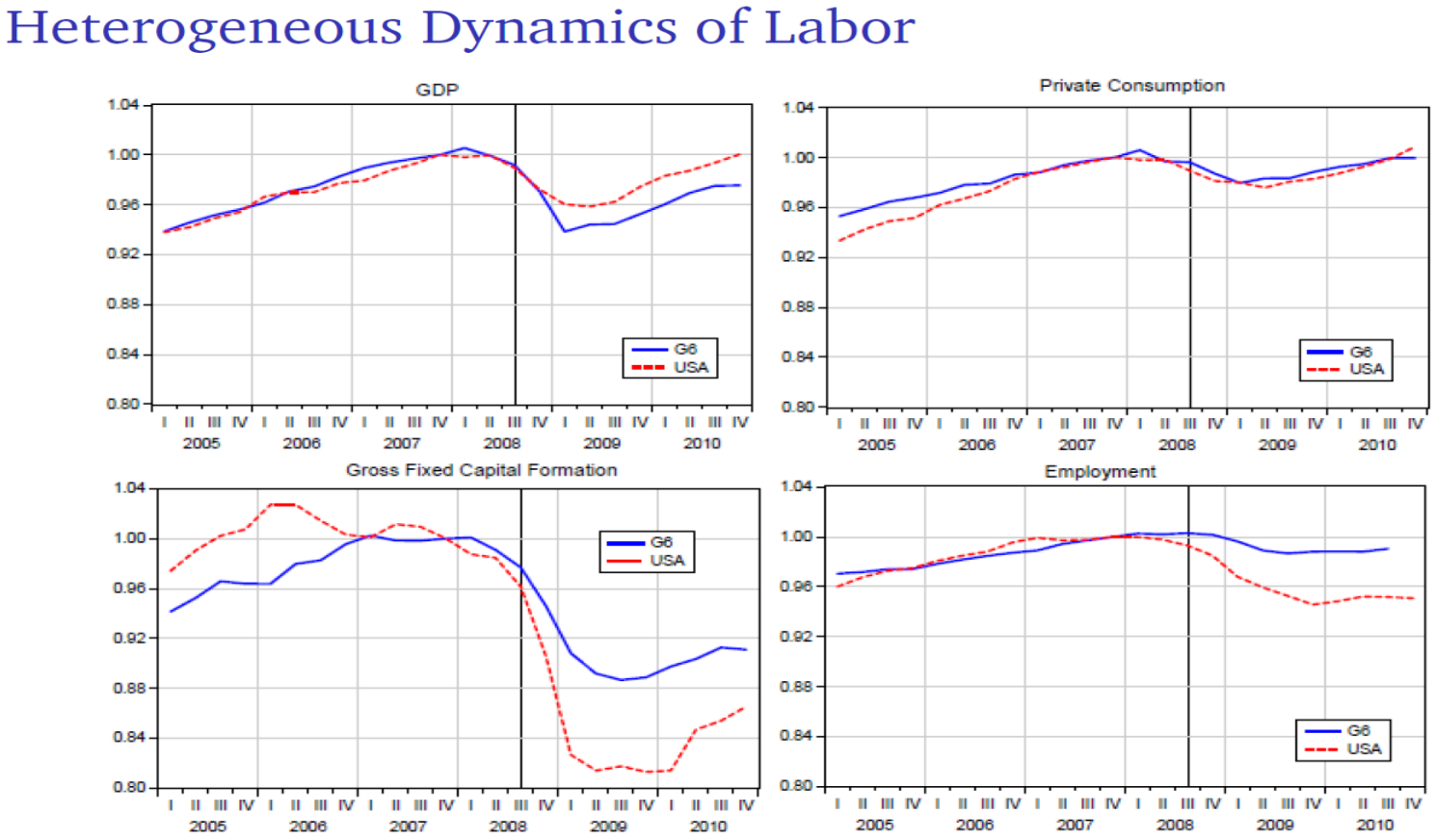
Result 2: Recessions Led by Credit Booms: The severity of crises increases with the duration of the credit expansion

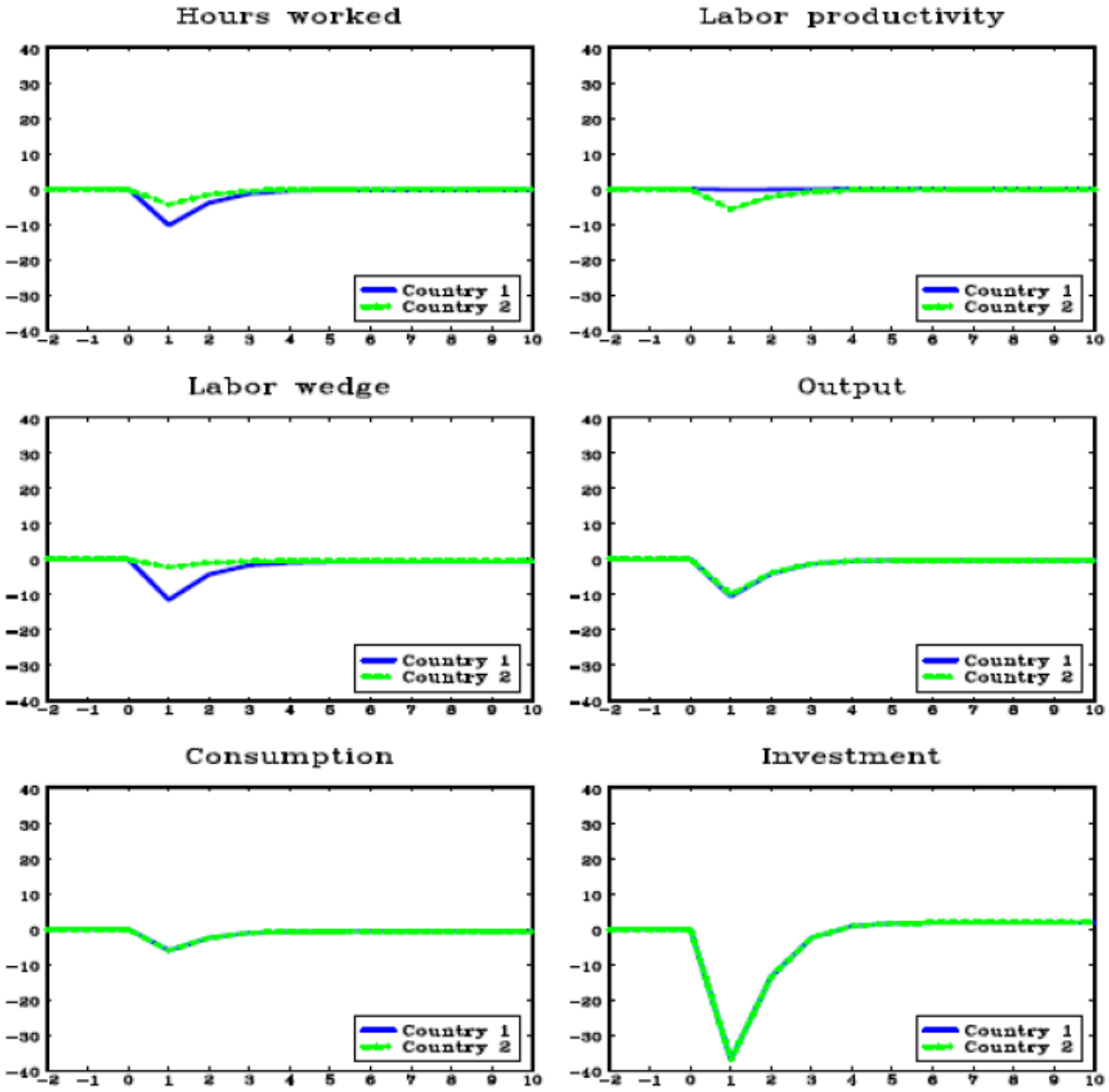


Result 3: Employment and Asset Price Volatility: Credit shocks generate large fluctuations in employment and asset prices

	Credit shocks only	Productivity shocks only	Both shocks
	Standard deviations		
Output	0.88	0.76	1.16
Consumption	0.68	0.44	0.77
Labor	1.26	0.26	1.26
Investment	2.27	0.77	2.36
Tobin's q	1.14	0.38	1.18
Stock market value	2.46	0.54	2.45
Interest rate	0.48	0.25	0.48
Return on equity	5.82	0.37	5.82
	Expected returns (% annualized)		
Interest rate	1.40	1.56	1.40
Return on equity	6.96	5.62	6.96
Equity risk premium	1.56	0.06	1.56
Nonbinding constraints, %	96.44	99.99	96.04

Result 4: Heterogeneous Responses of Labor:Heterogeneous response of employment but similar responses of financial variables and other real variables




Hours worked
Labor productivity
Labor wedge
Output
Consumption
Investment
Country 1
Country 2

Conclusions:

- In a financially integrated world, time-varying borrowing constraints can generate output fluctuations that are perfectly synchronized across countries.
- If borrowing constraints are only occasionally binding, they can generate multiple equilibria with different levels of market prices of collateral.
- Effects of shocks are asymmetric depending on whether borrowing constraints are binding.

- Credit shocks are an important source of business cycle fluctuations:
  - the credit shock is modelled as a shock to the access of firms to (cheap) external finance
  - firms react to the shock by reducing their output and employment
- in the context of internationally integrated financial markets, these credit shocks can generate a powerful transmission mechanism across countries:
  - a credit shock in the home country reduces credit access in the foreign economy as well and generates strong international co-movement
  - the real impact of a credit shock is smaller in an integrated economy
  - the credit constraint does not generate co-movement for other shocks

- "Usually co-movement is explained as the result of synchronized disturbances (global or common shocks) and/or as the result of country-specific shocks that spill over to other countries (international transmission of country-specific shocks)."
- Quadrini and Perri (2011) offers us an alternative interpretation:
  - They show that under certain conditions, two countries are financially integrated and the shadow cost of credit is equalized across countries → provides an endogenous mechanism for synchronization of real and financial variables in response to global credit disturbances.
  - They also show in this framework that global (perfectly correlated) credit disturbances may emerge endogenously as multiple self-fulfilling equilibria in the model.

b) Devereux and Yetman: Leverage Constraints and the International Transmission of Shocks

Slides courtesy of Luca Macedoni

How does financial integration propagates shocks?

Balance sheet channel for the international transmission of shocks

1. Suppose a negative shock reduces the price of home equity
2. In the balance sheet of Foreign and Home investors the value of assets will decline
3. If investors are constrained by the maximum amount of leverage, they will sell assets, contracting their balance sheet
4. This will further reduce the price of home equity
5. As a result the capital available to firms will reduce, depressing output in both economies

Why do we need the financial friction?

1. Suppose we have perfect financial markets
2. Consider a negative productivity shock in the home country
3. The fall in income will make home agents increase their borrowing (consumption smoothing)
4. Home consumption will decrease as well as the foreigner one
5. But foreign output will remain the same

The Model

- Infinite horizon
- Two countries: Home and Foreign
- One world good
- The population in each country is normalized to unity
- Labor is supplied inelastically
- No capital accumulation
- Two types of households: Investors and Savers
  - Investors have a lower discount factor than Savers
  - In each country, n is the share of Investors and $1 - n$ of Savers
- Two assets: noncontingent bonds and a fixed asset (equity, normalized to unity)
- Partial financial integration: assume (for now) that only equity can be traded across countries

The role of equity

- k^i_{jt} is the portfolio holdings of the fixed asset (equity) in country j, by home agent of type i. Asterisks will denote foreign holdings
- **Savers**
  - Cannot hold foreign shares of the fixed asset
  - Can sell their shares of fixed asset to home investors (for a price q_{jt})
  - Holding the fixed asset provides $G(k^s_1)$ units of domestic production
- **Investors**
  - Can hold shares of the foreign fixed asset (portfolio linkages)
  - The fixed asset owned by investors is used by firms and provides a return R^i_{jt}
  - Investors can borrow from savers to purchase the fixed asset
  - Leverage constraint: the ratio between investors' debt and their assets cannot exceed a value κ

Investors

Investors maximize the following utility

$$E_t \sum_{t=s}^{\infty} \theta_t^I U(C_t^I) \tag{1}$$

subject to the budget constraint

$$C_t^I + q_{1t} k_{1t}^I + q_{2t} k_{2t}^I = W_t^I + k_{1t-1}^I + (q_{2t} + R_{2t}) k_{2t-1}^I + B_t^I - R_{t-1} B_{t-1}^I \tag{2}$$

and the leverage constraint

$$B_t^I \leq \kappa (q_{1t} k_{1t}^I + q_{2t} k_{2t}^I) \tag{3}$$

Savers

Savers maximize the following utility

$$E_t \sum_{t=s}^{\infty} \theta_t^S U(C_t^S) \tag{7}$$

subject to the budget constraint

$$C_t^S + q_{1t} k_{1t}^S = W_t^S + q_{1t} k_{1t-1}^S + G(k_1^s) + B_t^S - R_{t-1} B_{t-1}^S \tag{8}$$

Production

Firms are competitive and produce

$$Y_t = A_t F(L_t, K_{t-1}) \tag{9}$$

where

$$K_{t-1} = n(\hat{k}_{1t-1}) = n(k^I_{1t-1} + k^{*I}_{1t-1}) \tag{10}$$

Profit maximization implies

$$W_t = A_t F_1(L_t, K_{t-1}) \tag{11}$$

$$R_{1K,t} = A_t F_2(L_t, K_{t-1}) \tag{12}$$

Market clearing

Bond market clearing

$$nB_t^I + (1-n)B_t^S = 0 \tag{13}$$

Equilibrium of the fixed asset for the home economy

$$nk_{1t}^I + nk_{1t}^{*I} + (1-n)k_{1t}^I = 1 \tag{14}$$

World market clearing

$$n(C_t^I + C_t^{*I}) + (1-n)(C_t^S + C_t^{*S}) = Y_t + Y_t^* + (1-n)(G(k_{1t-1}^S + G(k_{2t-1}^{*S}) \tag{15}$$

Solution

- The model is log linearized around the steady state.
- Using a first order approximation, it is possible to uniquely determine how much capital is employed by the final good sector and by the home sector.
- But the **ownership** of the final good sector capital would be indetermined
- Solution: second order approximation of the portfolio selection equation
- We also add transactions costs of international financial trade (home bias)

Portfolio Choice

To understand the transmission mechanism it is convenient to rewrite the model in terms of **Net Foreign Assets** (NFA) and the **ex post excess return** on the portfolio r_{xt}.

$$NFA_t = q_{2t} k_{2t}^{I} - q_{1t} k_{1t}^{*I} \tag{16}$$

$$r_{xt} = r_{1t} - r_{2t} = \frac{(q_{1t} + R_{1t})}{q_{1t-1}} - \frac{(q_{2t} + R_{2t})}{q_{2t-1}} \tag{17}$$

Portfolio Choice

We can rewrite the budget constraint of the Investor as

$$C_t^I + \mathbf{NFA_t} = W_t^I + R_{1Kt}\hat{k}_{1t-1}^I - q_{1t}(\hat{k}_{1t} - \hat{k}_{1t-1}) + r_{2t}NFA_{t-1} - \mathbf{r_{xt}}q_{1t-1}k_{1t}^{*I} + B_t^I - R_{t-1}B_{t-1}^I$$

If the ex post return falls (because home return falls), the NFA will rise.
We can also rewrite the leverage constraint:

$$B_t^I \leq \kappa(NFA_t + q_{1t}\hat{k}_{1t-1}^I)$$

Note that

$$NFA_t + NFA_t^* = 0$$

NFA is the **transmission channel**

Figure 2: Calibration parameters

CALIBRATION

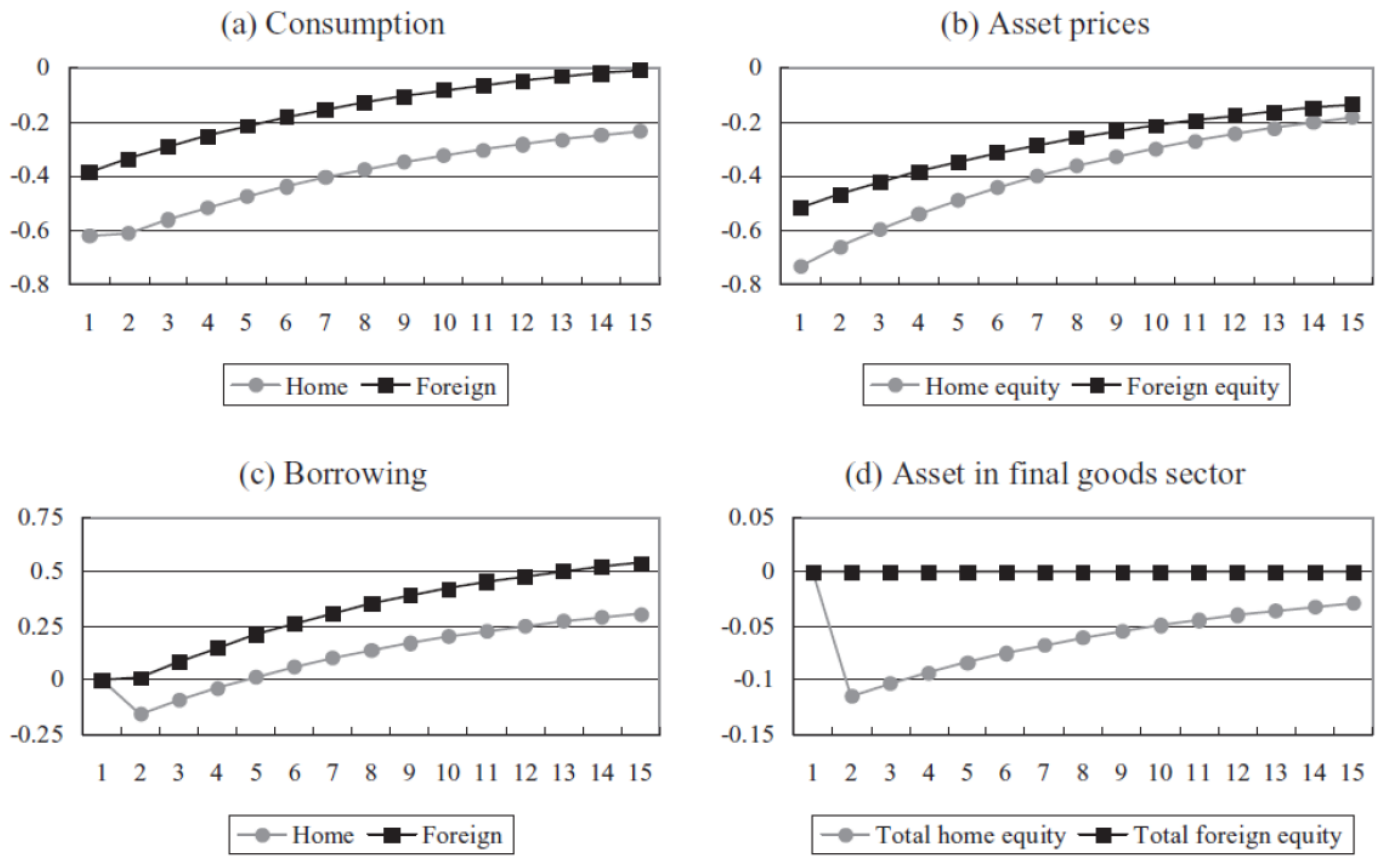
Parameter		Value	Parameter		Value
n	Proportion of investors	0.5	ε	Capital share in final goods production	0.36
η	Discount function	0.022	ω	Capital share in home production	0.1
ζ	Discount function	See text	σ	Coefficient of relative risk aversion	2
κ	Leverage	0.5, 0.75	ρ	Productivity shock persistence	0.9

Let us consider a negative productivity shock in the home country

1. **Only equity** markets are integrated, **no leverage** constraints
2. **Only equity** markets are integrated, **leverage** constraints bind
3. **Only bond** markets are integrated, **leverage** constraints bind
4. **Full integration**, **leverage** constraints bind

Partial integration (equity), no leverage

Figure 3: No leverage constraints

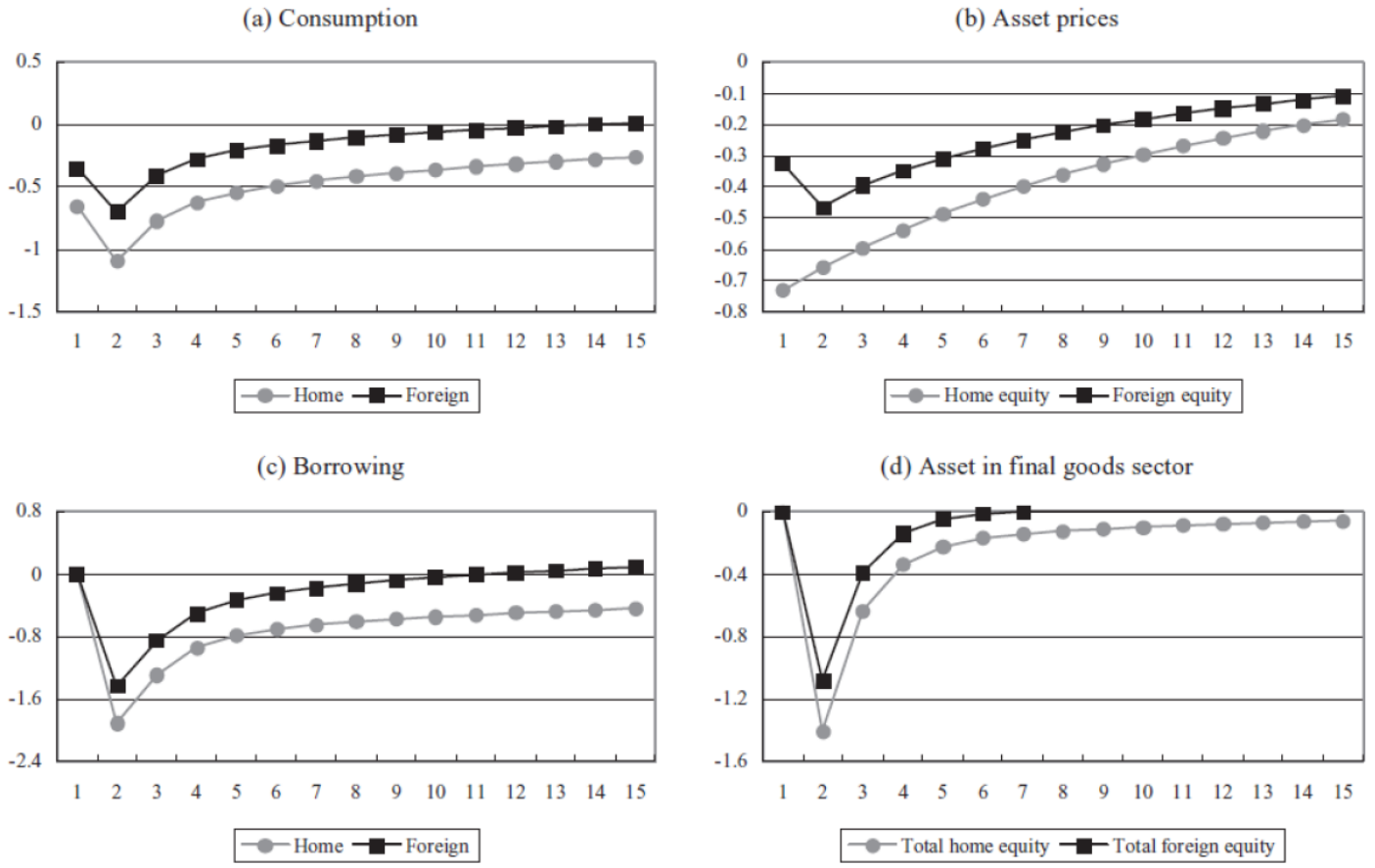


Partial integration (equity), binding leverage constraints

1. Negative home technological shock (A_t falls)
2. Home equity price falls (q_{1t}) along with its return R_{1Kt}
3. This leads to a tightening of the leverage constraints for both the home and foreign investors
4. Home investors reduce their borrowing and sell home assets
5. The ex post asset return falls as well (r_{xt}), improving the *NFA* of home investors
6. This leads to a negative movement in foreign *NFA*, which cause a tightening in the leverage constraint and a reduction in borrowing
7. Reduction in investment in final goods in both countries

Partial integration (equity), binding leverage constrain

Figure 4: Leverage constraints

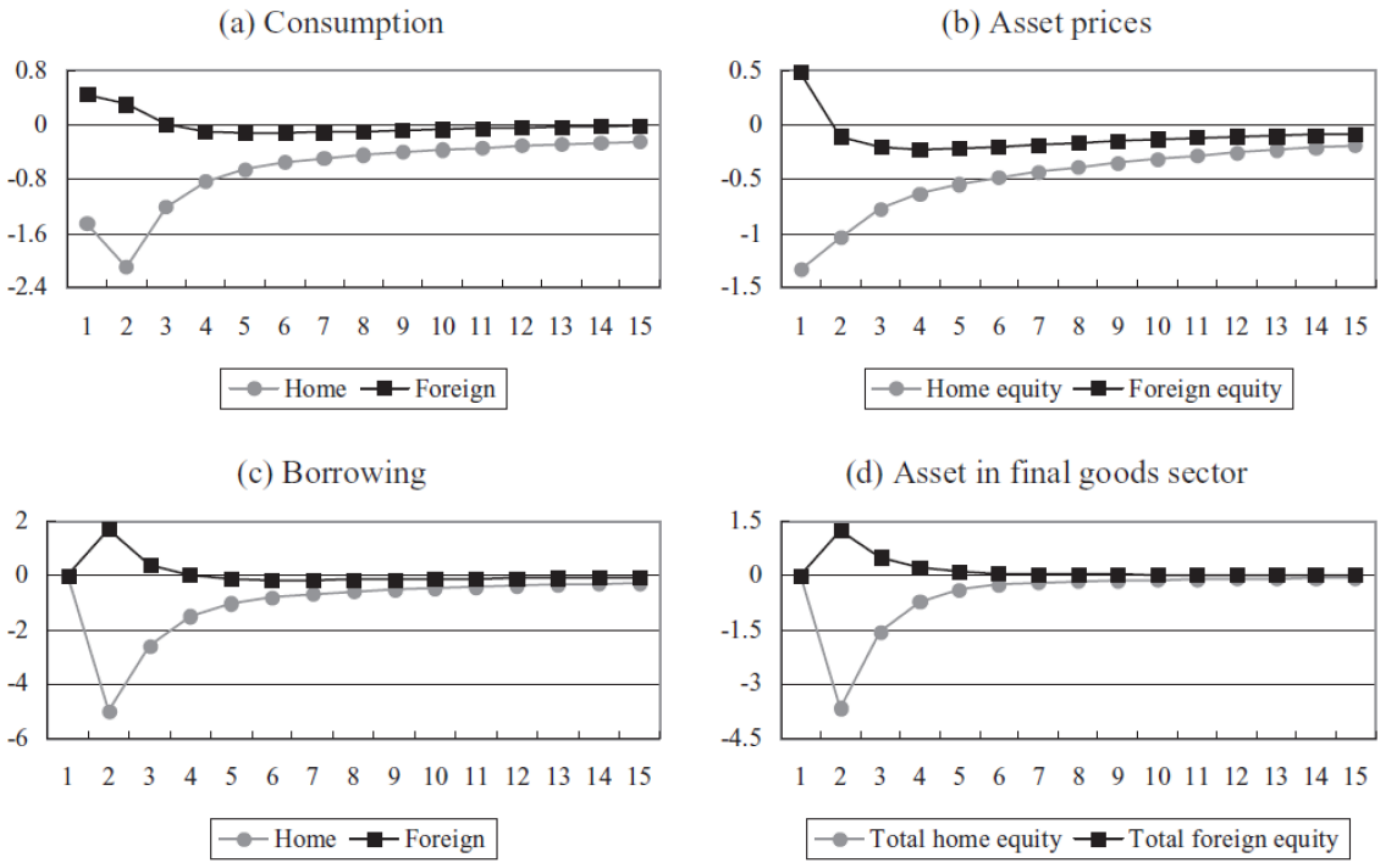


Partial integration (bonds), binding leverage constraints

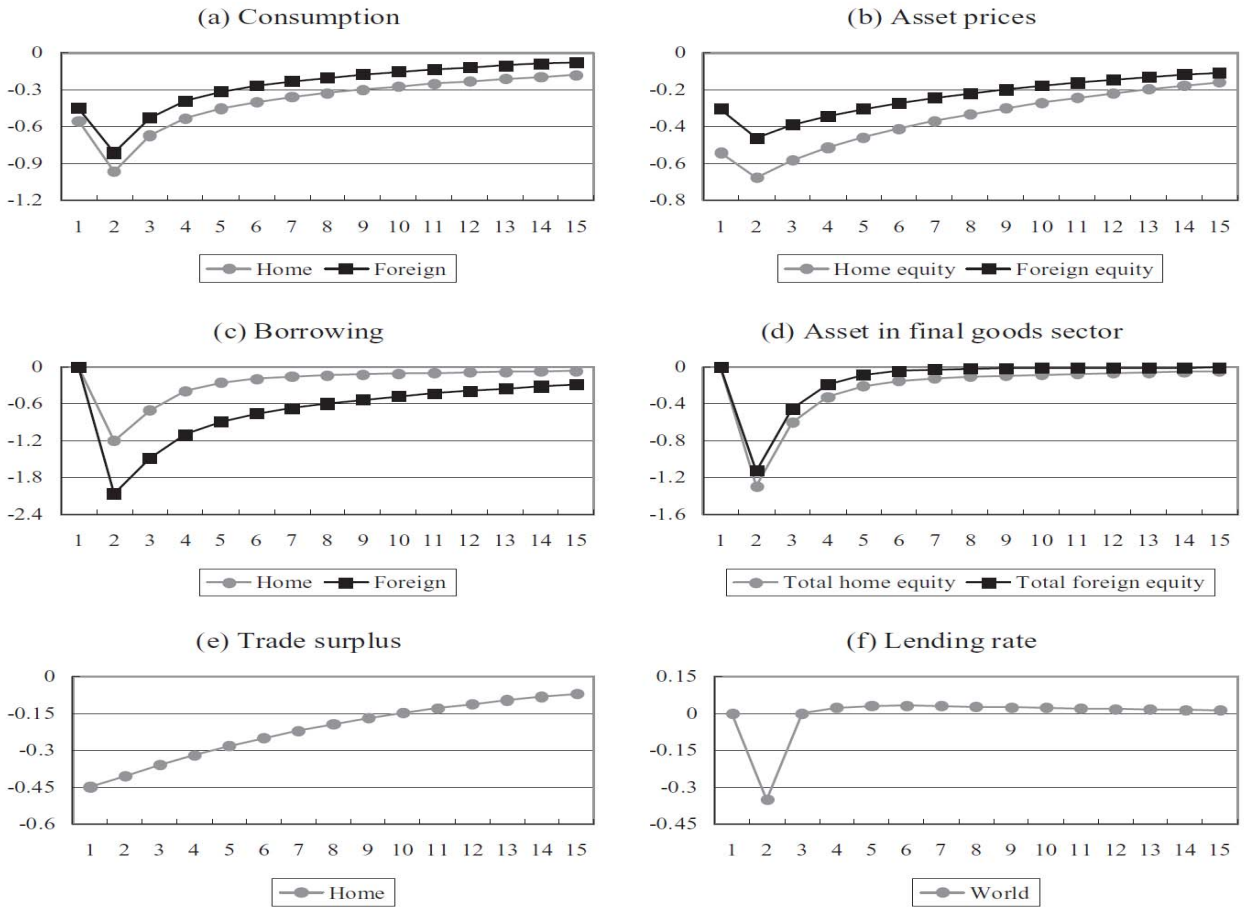
1. Negative home technological shock (A_t falls)
2. Home equity price falls (q_{1t}) along with its return R_{1Kt}
3. This leads to a tightening of the leverage constraints for both the home investors, which will reduce their borrowing
4. The world interest rate is now lower
5. Foreign investor will **increase** their borrowing
6. Hence final good investment will fall in the home country but increase in the foreign country
7. The sign of the international transmission of the shock is **negative**

Partial integration (bonds), binding leverage constrain

Figure 5: Leverage constraints



Full integration, leverage constraints bind



Full integration, **leverage** constraints bind

- There is a clear positive comovement across countries.
- Qualitatively, the transmission is similar to Figs 5 and 6, except now there is a single world debt market.
- Shock leads to a fall in the price of the home asset and, from arbitrage condition (8), the foreign asset price also falls.
- Given the hedged portfolio position of the home country, the fall in the return on the home asset leads to an increase in home NFA due to valuation effects.
- For the foreign country these valuation effects are negative, leading to tightening of foreign leverage constraint.

Summary

- The paper showed the relevance of portfolio interdependence and capital constraints on the propagation of financial shocks
- Countries would prefer to have integrated equity markets relative to bond market integration to diversify their risk
- But leverage constraint amplify the transmission of an international shock (contagion effect)
- The higher the diversification the higher the magnification of the shock