# Finance and Synchronization

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# Disclaimer

The views expressed in this paper are solely those of the authors and should not be taken to represent those of the Bank of England.

# This paper

- We revisit a classic question in international macro: **what is the impact of financial integration on business cycle synchronization?**

- International synchronization of cycles first-order question
  - Propagation of shocks, external constraint on macro policy, coordination,...

- Old literature: openness in general main culprit
  - Historically, trade openness [Frankel and Rose (1998); Baxter and Kouparitsas (2005)]

- Recent events shifted the focus on financial openness. Heuristically, it seems financial linkages helped propagate the great recession

# But Theory Ambiguous

- International Real Business Cycle model [Backus, Kehoe, and Kydland (1992, JPE)]
  - Idiosyncratic productivity shock leads to cross-country MPK differential
  - Because of efficient finance, resources shift where MPK is higher $\Rightarrow$ **Negatively correlated cycles**

- IRBC model with credit frictions and integrated financial markets [Allen and Gale (2000), Devereux and Yetman (2010), Dedola and Lombardo (2010)]
  - Idiosyncratic shock (not necessarily to productivity) affects tightness of the constraint at home
  - Because of financial integration, credit constraints are interdependent across countries $\Rightarrow$ **Positively correlated cycles**

- Key ingredient is idiosyncratic (ie, country-specific) shock

# Common Shocks

- Shocks common to two or more countries (but with country-specific loadings) constitute a key driver of business cycles
  - Large role of world and regional factor in developed countries (60% for US, 72% for Canada, 72% for France, 56% for Germany) [Kose, Otrok, and Whiteman (2003, 2008), Crucini, Kose, and Otrok (2011)]
- Empirically important to distinguish country-specific shocks from common shocks with country-specific loadings
- We will show this is especially important in the literature on cycle synchronization

# This paper: results

- Shows that financial linkages lowers synchronization, conditional on common shocks
- Shows that financial linkages do not lower synchronization, conditional on idiosyncratic shocks
- Explains theoretically why common shocks can create such a reversal
- Since theory builds from idiosyncratic shocks, evidence suggests credit constraints may be relevant empirically

# Plan

- Estimation & Data
- Results
- Conclude

# Empirics

- Frankel and Rose (1998, EJ), Imbs (2006, JIE):

$$\rho_{ij} = \alpha + \beta K_{ij} + \delta T_{ij} + \eta_{ij,t}$$

where $K_{ij}$ is a measure of bilateral financial linkages, $\rho_{ij}$ Pearson correlation coefficient

- Results: $\beta > 0$, $\delta > 0 \Rightarrow$ **Positively correlated cycles**.

- But if the true model is

$$\rho_{ij,t} = \alpha_{ij} + \beta K_{ij,t} + \delta T_{ij,t} + \eta_{ij,t}$$

then the between result is fallacious. Need time series to check. Pearson correlation not adapted (Forbes-Rigobon, 2002)

# Empirics (cont'd)

- Giannone, Lenza and Reichlin (2008), Morgan, Rime and Strahan (2004):

$$\mathcal{S}_{ij,t} = -\left|y_{it} - y_{jt}\right|$$
$$\mathcal{S}^{e}_{ij,t} = -\left|e_{it} - e_{jt}\right| \quad \text{where} \quad y_{it} = \alpha_i + \gamma_t + e_{it}$$

- Then can estimate

$$\mathcal{S}_{ij,t} = \alpha_{ij} + \gamma_t + \beta \cdot K_{ij,t} + \delta \cdot Z_{ij,t} + \eta_{ij,t}$$

- Kalemli-Ozcan, Papaioannou and Peydro (2013, JF): 18 OECD countries over 1978-2006 $\beta < 0 \Rightarrow$ **Negative correlated cycles**

- But common shocks pollute this estimation – if they have country-specific loadings

# Why common shocks matter

- Suppose true model is:

$$y_{i,t} = a_i^y + b_i^y \mathcal{F}_t^y + \varepsilon_{i,t}^y$$

  where $\mathcal{F}_t$ is a vector of common factors

- Then $\mathcal{S}_{ijt}$ embeds heterogeneous responses to common shocks:

$$\mathcal{S}_{ij,t} = -\left| a_i^y - a_j^y + \left( b_i^y - b_j^y \right) \mathcal{F}_t^y + \varepsilon_{i,t}^y - \varepsilon_{j,t}^y \right|$$

- True of both $\mathcal{S}_{ij,t}$ and $\mathcal{S}_{ij,t}^e$.

# Data: Sample

- Data is extension of Kalemli-Ozcan, Papaioannou, Peydro (JF, 2013)
- KPP data set covers 18 advanced economies
  - Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, UK, Ireland, Italy, Japan, Netherlands, Portugal, Sweden, and US
  - 153 country pairs
- Annual data from 1980 to 2012

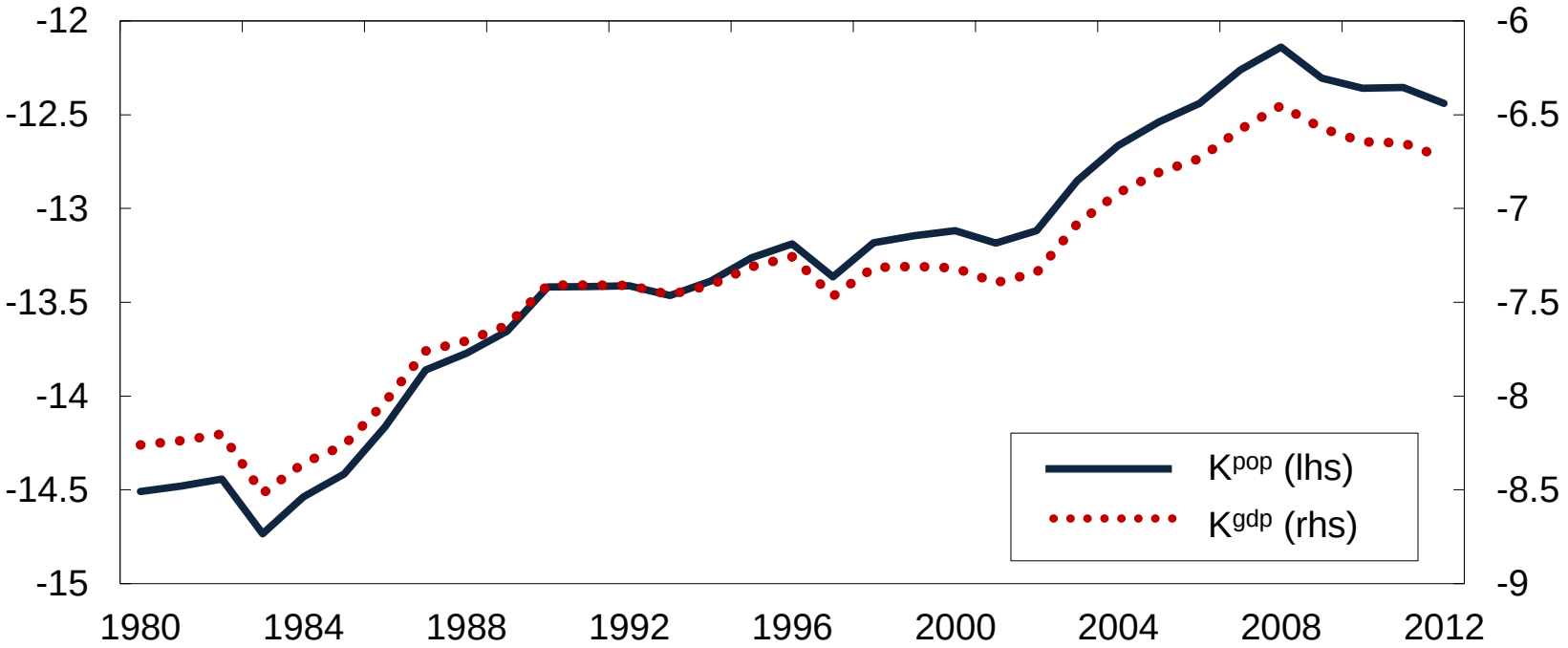
# Banking integration measures

- Virtually non existent time varying measures of international capital but for bank assets and liabilities
- "International Locational Banking Statistics Database" provided by the BIS
  - Asset ($A_{ij}$) and liability ($L_{ij}$) of banks located in $i$ (the "reporting area") held in country $j$ (the "vis-a-vis area")
- Two measures: normalized by population or by GDP

$$BANKINT1_{ij,t} = \frac{1}{4}\left[\ln\left(\frac{A_{ij,t}}{P_i+P_j}\right) + \ln\left(\frac{L_{ij,t}}{P_i+P_j}\right) + \ln\left(\frac{A_{ji,t}}{P_i+P_j}\right) + \ln\left(\frac{L_{ji,t}}{P_i+P_j}\right)\right.$$

$$BANKINT2_{ij,t} = \frac{1}{4}\left[\ln\left(\frac{A_{ij,t}}{Y_i+Y_j}\right) + \ln\left(\frac{L_{ij,t}}{Y_i+Y_j}\right) + \ln\left(\frac{A_{ji,t}}{Y_i+Y_j}\right) + \ln\left(\frac{L_{ji,t}}{Y_i+Y_j}\right)\right.$$

# Banking integration measures




The solid and dotted lines plot the evolution over time of the average value of $K_{ij,t}^{pop}$ and $K_{ij,t}^{gdp}$ for the 1980-2012 period. The average is computed across 153 country pairs (our sample spans 18 countries) for each year.

# Synchronization measures we consider

- Consider the following measures

$$\mathcal{S}_{ij,t} = -\left|a_i^y - a_j^y + \left(b_i^y - b_j^y\right)\mathcal{F}_t^y + \varepsilon_{i,t}^y - \varepsilon_{j,t}^y\right|$$
$$\mathcal{S}_{ij,t}^{\mathcal{F}} = -\left|\left(b_i^y - b_j^y\right)\mathcal{F}_t^y\right|$$
$$\mathcal{S}_{ij,t}^{\varepsilon} = -\left|\varepsilon_{i,t}^y - \varepsilon_{j,t}^y\right|$$

- $\mathcal{S}_{ij,t}^{\mathcal{F}}$ and $\mathcal{S}_{ij,t}^{\varepsilon}$ are the components of $\mathcal{S}_{ij,t}$ associated with common and idiosyncratic shocks, respectively

- Use either measure in conventional panel regression

$$\mathcal{S}_{ij,t} = \alpha_{ij} + \gamma_t + \beta \cdot K_{ij,t} + \delta \cdot Z_{ij,t} + \eta_{ij,t}$$

OLS between, then OLS within. With or without trade controls.

# How to proxy for unobserved common factors?

- Objective: compute *country-specific* decompositions of the type

$$y_{i,t} = a_i^y + b_{1,i}^y \mathcal{F}_{1,t}^y + ... + b_{n,i}^y \mathcal{F}_{n,t}^y + \nu_{it}^y,$$

- Simple methodology: extract the first $n$ principal components ($\mathcal{F}_t^n$) from the panel (28 years $\times$ 18 countries) of GDP growth rates

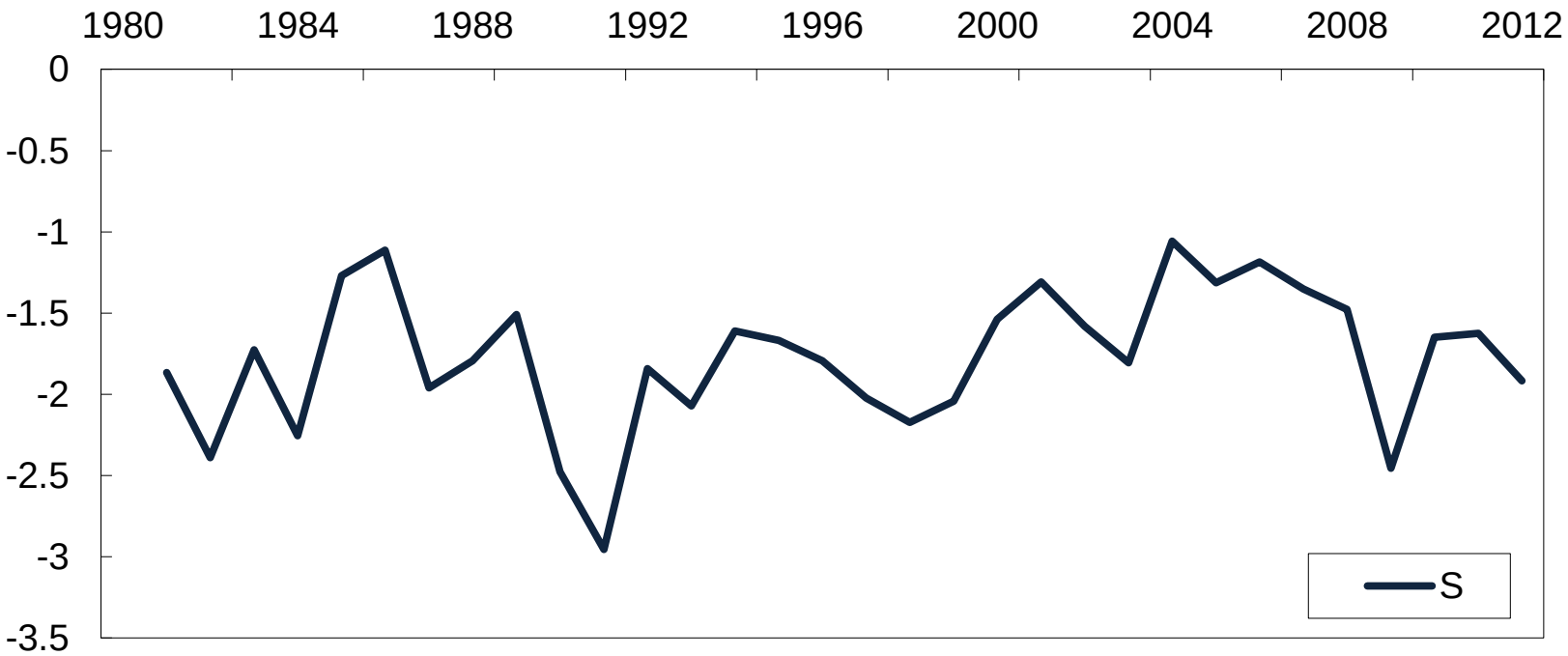
- How many principal components? Retain principal components as long as their associated eigenvalue is $> 1$

# How to proxy for unobserved common factors? Factor estimates

| | Eigenvalues | | Share of variance | | Cum. share of variance | |
|---|---|---|---|---|---|---|
| | $y_i t$ | $K_{ij,t}$ | $y_i t$ | $K_{ij,t}$ | $y_i t$ | $K_{ij,t}$ |
| $\mathcal{F}_1$ | 10.67 | 13.15 | 59% | 73% | 59% | 73% |
| $\mathcal{F}_2$ | 2.21 | 2.89 | 12% | 16% | 72% | 89% |
| $\mathcal{F}_3$ | 1.02 | 0.79 | 6% | 4% | 77% | 93% |
| $\mathcal{F}_4$ | 0.89 | 0.66 | 5% | 4% | 82% | 97% |
| $\mathcal{F}_5$ | 0.83 | 0.27 | 5% | 2% | 87% | 99% |

- Compute $\mathcal{S}^{\mathcal{F}}_{ij,t}$ using fitted values $\hat{a}_i + \hat{b}^y_{1,i}\hat{\mathcal{F}}^y_{1,t} + \hat{b}^y_{2,i}\hat{\mathcal{F}}^y_{2,t} + \hat{b}^y_{3,i}\hat{\mathcal{F}}^y_{3,t}$
- Compute $\mathcal{S}^{\varepsilon}_{ij,t}$ using residuals $\nu^y_{it}$

# How do our synchronization measures look like?




The solid line plots the evolution over time of the average value of $\mathcal{S}_{ij,t}$ for the 1980-2012 period. The average is computed across 153 country pairs (our sample spans 18 countries) for each year. The chart also reports the cross-sectional averages of the idiosyncratic component (dashed line) and the common component (dotted line) of $\mathcal{S}_{ij,t}$. $\mathcal{F}_t$ has been proxied by the first 3 principal components on the full panel of GDP growth rates. The averages are computed across 153 country pairs for each year over the 1980-2012 period.

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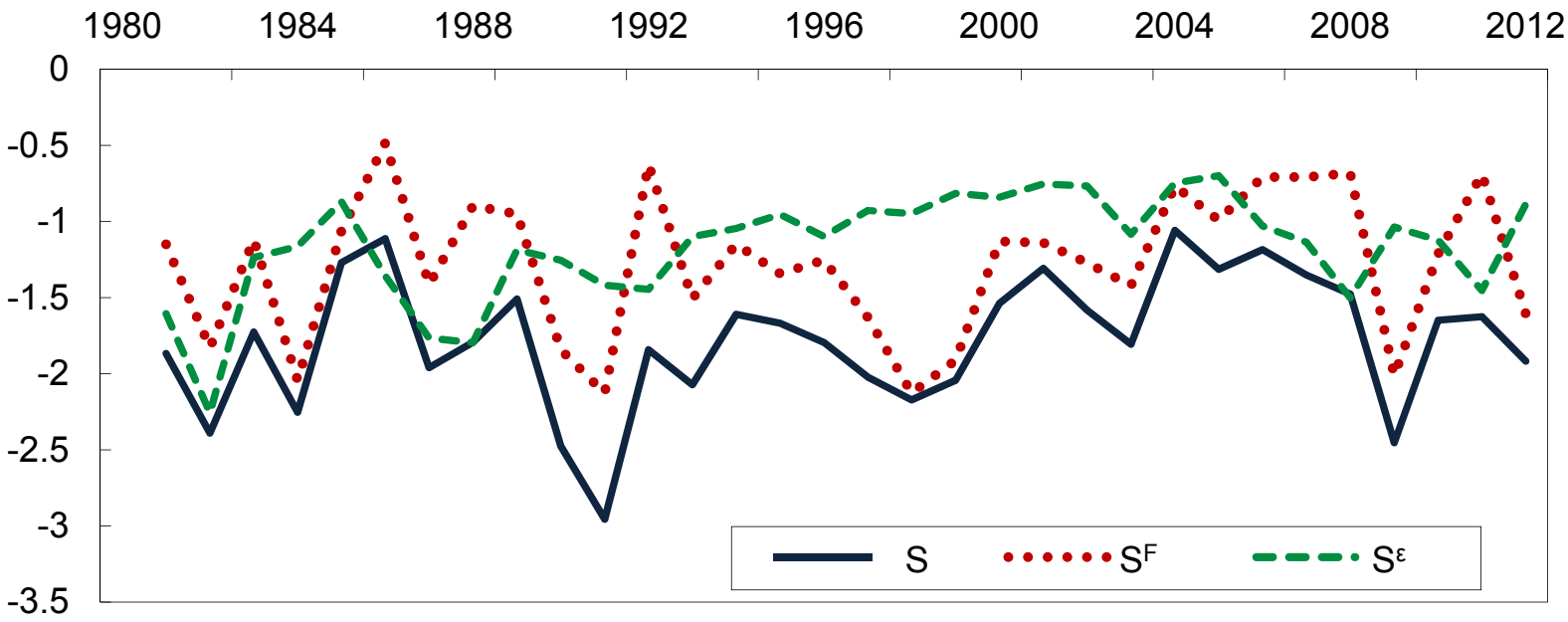


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# Plan

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# OLS "between" estimates (1980–2012)

| | $\mathcal{S}$ | $\mathcal{S}^{\mathcal{F}}$ | $\mathcal{S}^{\varepsilon}$ | $\mathcal{S}$ | $\mathcal{S}^{\mathcal{F}}$ | $\mathcal{S}^{\varepsilon}$ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Banking / Pop. ($K^{pop}$) | 0.095 | 0.106 | 0.038 | | | |
| | (0.011) | (0.008) | (0.007) | | | |
| | [8.70] | [12.85] | [5.43] | | | |
| Banking / GDP ($K^{gdp}$) | | | | 0.091 | 0.082 | 0.049 |
| | | | | (0.010) | (0.007) | (0.006) |
| | | | | [9.52] | [11.31] | [7.98] |
| Observations | 4863 | 4863 | 4863 | 4863 | 4863 | 4863 |
| $R^2$ | 0.092 | 0.176 | 0.121 | 0.095 | 0.170 | 0.127 |
| Country Pairs | 153 | 153 | 153 | 153 | 153 | 153 |

All regression specifications include a vector of year fixed effects. Estimation is performed over the 1980-2012 period.

# OLS "within" estimates (1980–2012)

| | $\mathcal{S}$ | $\mathcal{S}^{\mathcal{F}}$ | $\mathcal{S}^{\varepsilon}$ | $\mathcal{S}$ | $\mathcal{S}^{\mathcal{F}}$ | $\mathcal{S}^{\varepsilon}$ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Banking / Pop. ($K^{pop}$) | -0.144 | -0.154 | 0.075 | | | |
| | (0.040) | (0.030) | (0.021) | | | |
| | [-3.63] | [-5.05] | [3.54] | | | |
| Banking / GDP ($K^{gdp}$) | | | | -0.148 | -0.159 | 0.072 |
| | | | | (0.042) | (0.032) | (0.022) |
| | | | | [-3.56] | [-4.98] | [3.28] |
| Observations | 4863 | 4863 | 4863 | 4863 | 4863 | 4863 |
| $R^2$ | 0.099 | 0.222 | 0.133 | 0.099 | 0.222 | 0.133 |
| Country Pairs | 153 | 153 | 153 | 153 | 153 | 153 |

All regression specifications include a vector of country-pair fixed effects and a vector of year fixed effects. Estimation is performed over the 1980-2012 period. Standard errors are adjusted for country-pair-level heteroskedasticity and autocorrelation.

# OLS "within" estimates with controls (1980–2012)

| | $\mathcal{S}$ | $\mathcal{S}^{\mathcal{F}}$ | $\mathcal{S}^{\varepsilon}$ | $\mathcal{S}$ | $\mathcal{S}^{\mathcal{F}}$ | $\mathcal{S}^{\varepsilon}$ |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Banking / Pop. ($K^{pop}$) | -0.102 | -0.132 | 0.060 | | | |
| | (0.040) | (0.028) | (0.024) | | | |
| | [-2.57] | [-4.71] | [2.55] | | | |
| Banking / GDP ($K^{gdp}$) | | | | -0.106 | -0.137 | 0.056 |
| | | | | (0.041) | (0.029) | (0.024) |
| | | | | [-2.55] | [-4.65] | [2.32] |
| Trade | -0.382 | -0.198 | 0.132 | -0.386 | -0.203 | 0.141 |
| | (0.134) | (0.114) | (0.078) | (0.133) | (0.113) | (0.078) |
| | [-2.86] | [-1.75] | [1.69] | [-2.90] | [-1.79] | [1.81] |
| Observations | 4859 | 4859 | 4859 | 4859 | 4859 | 4859 |
| $R^2$ | 0.103 | 0.224 | 0.134 | 0.103 | 0.225 | 0.134 |
| Country Pairs | 153 | 153 | 153 | 153 | 153 | 153 |

All regression specifications include a vector of country-pair fixed effects and a vector of year fixed effects. Estimation is performed over the 1980-2012 period. Standard errors are adjusted for country-pair-level heteroskedasticity and autocorrelation.

# Summing up

- Sign of $\beta$ is negative for $\mathcal{S}_{ij,t}$ and $\mathcal{S}^{\mathcal{F}}_{ij,t}$, positive for $\mathcal{S}^{\varepsilon}_{ij,t}$
  - Show that reversal is due to permanent country features

- Robustness
  1. Focus on tranquil times (1980-2006)
     - $\beta$ less significant but still positive
  2. Deal with endogeneity: bilateral, time-varying IV using the instrument of KPP:
     - $\beta$ positive and significant
  3. Pairwise correlations
     - $\beta$ is not statistically different from zero
  4. Time-varying factor loadings
     - $\beta$ positive and significant

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# Appendix

# Why common factors matter? Analytical results

- Assume $K_{ij,t}$ also responds to both common and idiosyncratic shocks, i.e.:

$$K_{ij,t} = a_{ij}^K + b_{ij}^K \mathcal{F}_t^K + \varepsilon_{ij,t}^K$$

  - Forbes and Warnock (2012), Rey (2013), Bruno and Shin (2014)
  - Common shock term is general. Accounts for global cycles in financial linkages, or a potential trend in $K_{ij,t}$

- Consider our baseline regression with $\mathcal{S}_{ij,t}^{\mathcal{F}}$

$$-\left|\left(b_i^y - b_j^y\right)\mathcal{F}_t^y\right| = \alpha_{ij} + \gamma_t + \beta^{\mathcal{F}} \cdot \left[a_{ij}^K + b_{ij}^K \mathcal{F}_t^K + \varepsilon_{ij,t}^K\right] + \delta \cdot Z_{ij,t} + \eta_{ij,t}^{\mathcal{F}}$$

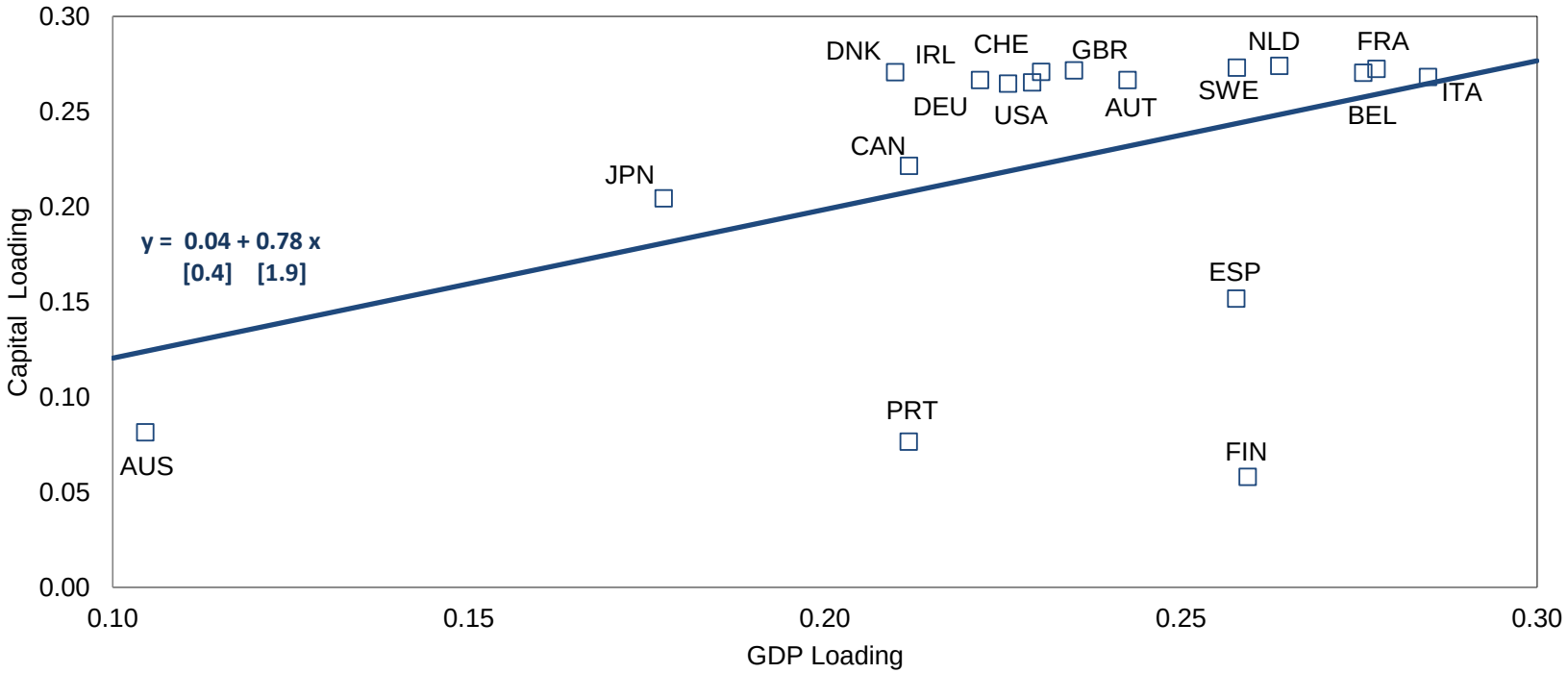
- Sign of $\beta^{\mathcal{F}}$ is given by:

$$-\left|b_i^y - b_j^y\right| \cdot b_{ij}^K \; Cov\left[\left|\mathcal{F}_t^y\right|, \mathcal{F}_t^K\right]$$

# Permanent Features?

- Suppose now a systematic positive correlation exists between $\left(b_i^y - b_j^y\right)$ and $b_{ij}^K$
  - E.g., in response to common shocks, capital intensity between $i$ and $j$ is larger in country pairs with large differences in GDP elasticity (high $b_i^y - b_j^y$)
- Then a negative correlation exists between $\mathcal{S}_{ij,t}^{\mathcal{F}}$ and $K_{ij,t}$, and it is driven by permanent features of GDP and capital flows
- Empirical question: do high $b_i$ countries also display high $b_{ij}^K$?
- Plot estimates of $\hat{b}_{1,i}$ against $\hat{b}_{1,i}^K$, where $\hat{b}_{1,i}^K = \frac{1}{J}\sum_j \hat{b}_{1,ij}^K$

# Permanent Features?




On the horizontal axis is the loading on GDP ($\hat{b}^y_{1,i}$). On the vertical axis is the loading on capital $\hat{b}^K_{1,i}$, where $\hat{b}^K_{1,i} = \frac{1}{J}\sum_j \hat{b}^K_{1,ij}$ is the average capital loading in country $i$. The slope and the constant of the fitted line are reported together with t-Statistics in square brackets.

# Permanent Features?

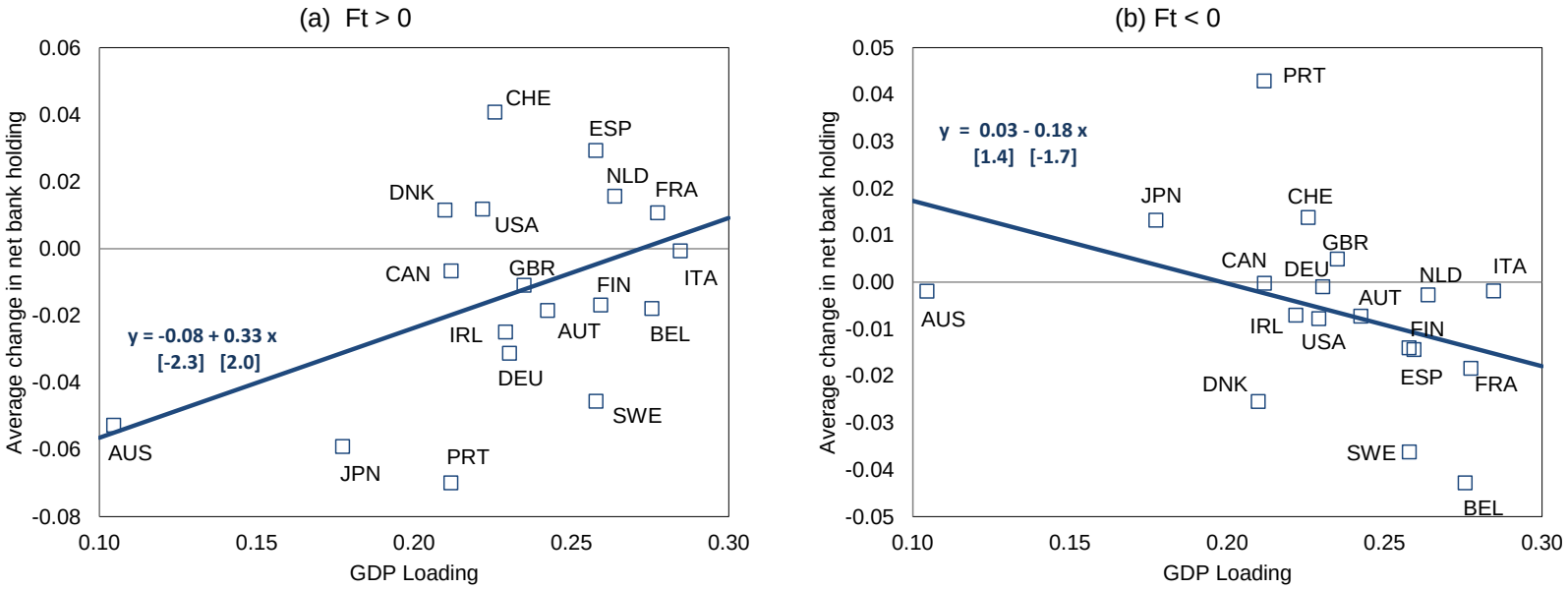
- Also implies that capital ($\hat{K}_{ij,t} = \hat{a}_{ij}^{K} + \hat{\mathfrak{b}}_{ij}^{K}\mathcal{F}_t$) should go TO countries with elastic GDP in periods of global (or regional) booms ($\mathcal{F}_t > 0$), but FROM them in years of global recession ($\mathcal{F}_t < 0$).
- Define the average change in net bank holdings, computed for positive or negative values of $\mathcal{F}_t$ :

$$KNET_i^{+} = \sum_{\mathcal{F}_t > 0} \Delta_t \left[ \sum_j \ln\left(A_{ji,t} + L_{ij,t}\right) - \ln\left(A_{ij,t} + L_{ji,t}\right) \right],$$

and:

$$KNET_i^{-} = \sum_{\mathcal{F}_t < 0} \Delta_t \left[ \sum_j \ln\left(A_{ji,t} + L_{ij,t}\right) - \ln\left(A_{ij,t} + L_{ji,t}\right) \right]$$

# Permanent Features?




On the horizontal axis is the loading on GDP ($\hat{b}^{y}_{1,i}$). On the vertical axis is the change in net bank holdings averaged over periods when $\mathcal{F}_t > 0$ ($KNET_i^{+}$), in panel (a); and when $\mathcal{F}_t < 0$ ($KNET_i^{-}$), in panel (b). The slope and the constant of the fitted line are reported together with t-Statistics in square brackets.