Twenty Years of Convergence

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ECB Forum on Central Banking, Sintra 18-19 June 2019

Convergence

- Convergence in GDP:
    - Optimal Currency Area
    - Catch-up and shrinking regional differences

- Convergence in Consumption:
    - Financial Integration and Risk Sharing
    - (In)Equality

- Convergence in Employment growth, labor productivity, …

Convergence

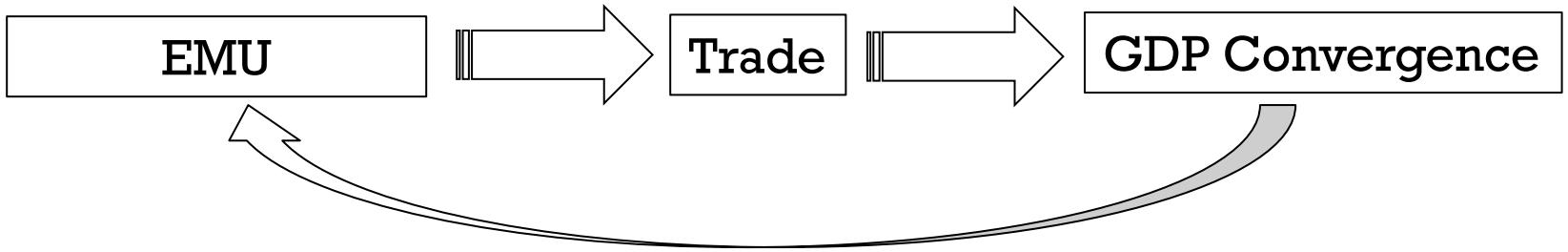
Bilateral Absolute Differences in growth rates for all countries i,j:

$$\textbf{AbsdiffY} = -\left|gy_{it} - gy_{jt}\right|, \textbf{AbsdiffC} = -\left|gc_{it} - gc_{jt}\right|$$

	Trends in Convergence in EMU		
Convergence in	1999-2018	1999-2006	2007-2018
GDP growth	0.018*** (0.006)	0.114*** (0.030)	0.058*** (0.015)
Consumption growth	0.048*** (0.008)	0.092*** (0.025)	0.106*** (0.012)

Convergence in GDP

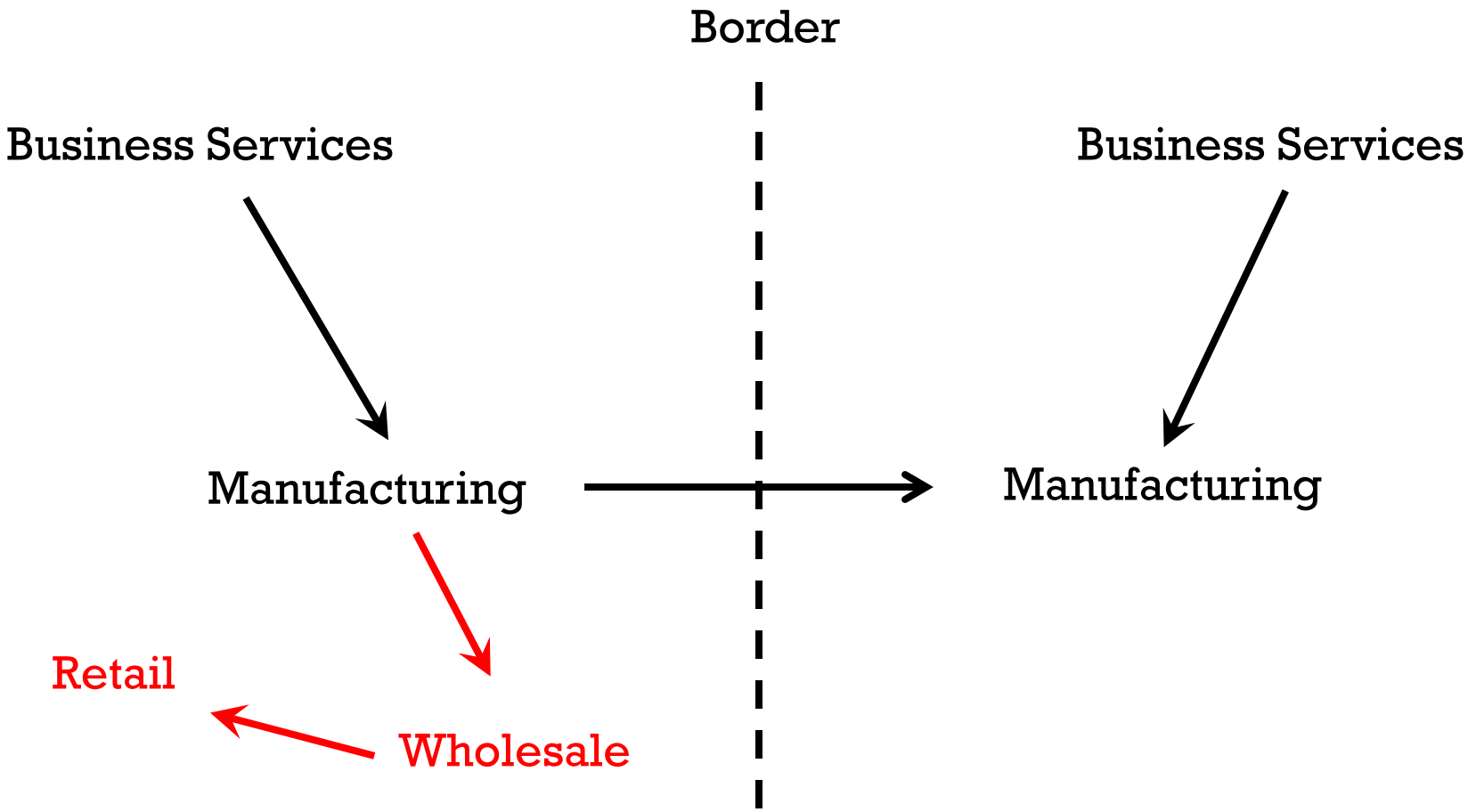
- Synchronized growth key to Optimal Currency Area.



- Little question that EMU encourages trade (some question about how much).
- Little question that trade synchronizes GDP. Famous result (Frankel-Rose 1999), based on observed trade, i.e. on activities that actually trade with each other.
- But there is much more than just direct trade. Many services are still largely non-traded, yet they supply trading sectors. Deep integration happens precisely when non-traded sectors cater for trading activities.

Measuring connection without trade data

Want to measure the international proximity between two sectors even if they do not trade directly – but trade via downstream linkages



Decomposing the Value Chain

Decompose gross output into value chain components that are purely domestic vs. those that cross border.

Define Y_i^r gross output in country i and sector r :

$$Y_i^r = \left[\sum_{j\neq i} F_{ij}^r + \sum_s \sum_{j\neq i} \left(a_{ij}^{rs} F_j^s + a_{ii}^{rs} F_{ij}^s\right) + \sum_t \sum_s \sum_{j\neq i} \left(a_{ij}^{rs} a_{jj}^{st} F_j^t + a_{ii}^{rs} a_{ij}^{st} F_j^t + a_{ij}^{rs} \sum_k a_{jk}^{st} F_k^t\right) + \cdots\right]$$

$$+ \left[F_{ii}^r + \sum_s a_{ii}^{rs} F_{ii}^s + \sum_s a_{ii}^{rs} a_{ii}^{st} F_i^t + \cdots\right]$$

where F_{ij}^s denotes final demand for good s produced in country i arising from country j, and a_{ij}^{rs} is entry in (world) input-output table.

Decomposing the Value Chain

Hard to compute, even with values for a and F.

Antras and Chor (2013) introduce weights for each order of the value chain:

$$U_i^r = \left[1\sum_{j\neq i} F_{ij}^r + 2\sum_s\sum_{j\neq i}\left(a_{ij}^{rs}F_j^s + a_{ii}^{rs}F_{ij}^s\right) + 3\sum_t\sum_s\sum_{j\neq i}\left(a_{ij}^{rs}a_{jj}^{st}F_j^t + a_{ii}^{rs}a_{ij}^{st}F_j^t + a_{ij}^{rs}\sum_k a_{jk}^{st}F_k^t\right) + \cdots\right]$$

$$+\left[1F_{ii}^r + 2\sum_s a_{ii}^{rs}F_{ii}^s + 3\sum_s a_{ii}^{rs}a_{ii}^{st}F_i^t + \cdots\right]$$

U_i^r can be computed as $[\boldsymbol{I} - \boldsymbol{A}]^{-2}\boldsymbol{F}$, where $\boldsymbol{A}$ direct requirement input-output matrix and $\boldsymbol{F}$ vector of final demand.

By analogy domestic component can be computed as $[\boldsymbol{I} - A^{DOM}]^{-2}\boldsymbol{F^{DOM}}$

Export Intensity

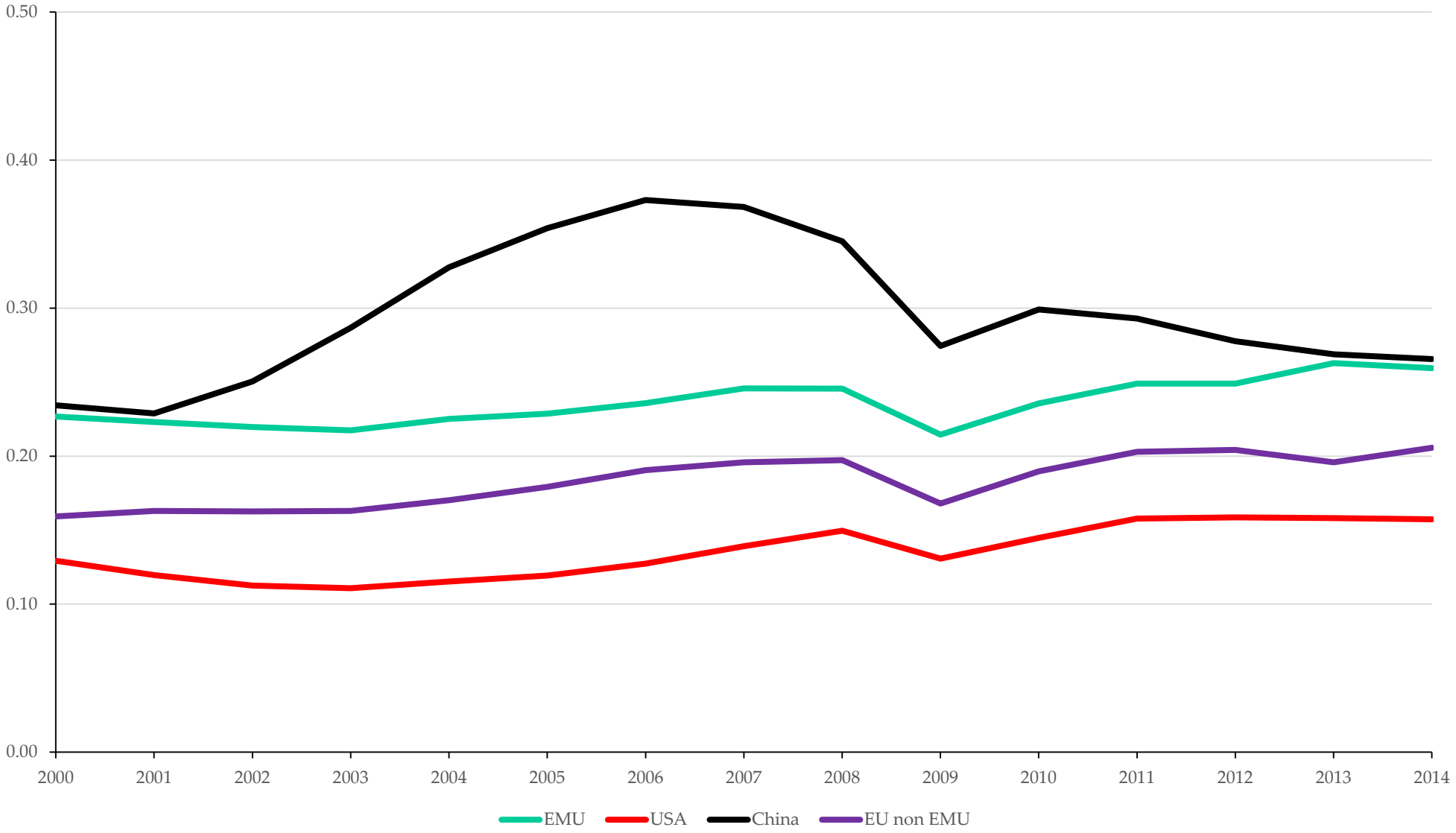
$$[\boldsymbol{I} - \boldsymbol{A}]^{-2}\boldsymbol{F} - \left[\boldsymbol{I} - \boldsymbol{A}^{\boldsymbol{DOM}}\right]^{-2}\boldsymbol{F}^{\boldsymbol{DOM}}$$

How much sectors in country i serve downstream sectors that are across the border.

Hold length of value chain (U_i^r) constant to obtain export intensity EI_i^r.

This is multilateral export intensity: how export intensive sectors are in country i, towards other partners.

Export Intensities for EMU, EU, US, China



Bilateral Export Intensity

$$[\boldsymbol{I} - \boldsymbol{A}]^{-2}\boldsymbol{F} - \left[\boldsymbol{I} - \boldsymbol{A}^{\boldsymbol{DOM}}\right]^{-2}\boldsymbol{F}^{\boldsymbol{DOM}}$$

Easy to specialize with bilateral versions of matrices $\boldsymbol{A_{ij}}$, $\boldsymbol{A_{ij}^{DOM}}$, $\boldsymbol{F_{ij}}$, $\boldsymbol{F_{ij}^{DOM}}$.

EI_{ij}^{r} : How much sectors in country i serve downstream sectors **in country j**.

Finally, bilateral intensity $BI_{ij}^{rs} = EI_{ij}^{r} \times EI_{ji}^{s}$.

Two sectors (r,s) in countries (i,j) tend to be close to each other if sector r in country i has high export intensity with country j, and sector s in country j has high export intensity with country i.

(NB: $BI_{ij}^{rs} \neq BI_{ij}^{sr}$)

Bilateral Export Intensity by sector (x1,000)

(EMU red, US blue, China black)

	AGR	Light MFG	Heavy MFG	Retail/Whole	Bus. Serv.
AGR	6.906	6.195	7.550	3.481	3.944
	2.172	2.009	2.371	1.455	1.486
	0.927	0.945	1.384	0.923	0.816
Light MFG	7.037	6.387	7.980	3.562	3.968
	1.725	1.585	1.948	1.173	1.198
	1.031	1.036	1.529	1.004	0.877
Heavy MFG	7.950	7.335	9.132	4.100	4.580
	2.473	2.272	2.790	1.677	1.711
	1.157	1.182	1.728	1.153	1.028
Retail/Whole	3.733	3.393	4.228	1.896	2.154
	0.718	0.668	0.831	0.491	0.519
	1.005	1.023	1.501	0.994	0.883
Bus. Serv.	4.219	3.942	4.864	2.358	2.792
	0.993	0.937	1.192	0.688	0.760
	0.950	0.968	1.428	0.937	0.836

Bilateral Export Intensity and Convergence in GDP

$$-\left|gy_{it}^{r} - gy_{jt}^{s}\right| = \alpha_{ij}^{rs} + \beta BI_{ij,t}^{rs} + \gamma Trade_{ij,t}^{rs} + \eta_{ij,t}^{rs}$$

Estimated within country-sector pair.

Augmented with directly observed measure of (intermediate) trade:

$$Trade_{ij,t}^{rs} = \frac{Z_{ij,t}^{rs} + Z_{ji,t}^{rs}}{VA_{i,t}^{r} + VA_{j,t}^{s}}$$

$VA_{i,t}^{r}$ denotes value added in sector r of country i,
$Z_{ij,t}^{rs}$ is intermediate input use of sector r output in country i by sector s in country j.

Many observations. E.g. 12 core EMU countries, 50 sectors, 15 years:

12 x 11/2 x 50 x 50 x 15 = 2,475,000 observations

Bilateral Export Intensity and Convergence in EMU

	(1)	(2)	(3)	(4)	(5)	(6)
BI_{ijrs}	0.20***	0.20***	0.10***	0.12***	0.16***	0.15***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
$Trade_{ij}^{rs}$		0.23***	0.24***	-0.0048	0.0073	0.012
		(0.08)	(0.07)	(0.03)	(0.04)	(0.04)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects			Yes			
Yr-Cntry-Sector				Yes		
Yr-Cntry					Yes	
Yr-Cntry-Pair						Yes
N	2292400	2292391	2292391	2128492	2128492	2128492
R2	0.00018	0.00018	0.053	0.34	0.035	0.051

Convergence between specific sector categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	AGR-AGR	AGR-MFG	AGR-SER	MFG-AGR	MFG-MFG	MFG-SER	SER-AGR	SER-MFG	SER-SER
BI_{ij}	0.04	-0.01	0.18***	0.02	0.13***	0.26***	0.23***	0.41***	0.57***
	(0.06)	(0.04)	(0.05)	(0.03)	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)
$Trade_{ij}$	-1.86	0.34***	-8.48	-3.05	0.26*	-1.87***	7.28	2.08***	-1.42***
	(2.05)	(0.11)	(5.72)	(2.76)	(0.14)	(0.45)	(6.63)	(0.49)	(0.32)
N	14168	80183	84220	78428	443828	466108	82078	464470	487784
$R2$	0.0001	0.0001	0.0002	0.00003	0.0001	0.0003	0.00047	0.0004	0.0007

How much does Bilateral Intensity explain ***aggregate*** convergence:

Absolute differences do not aggregate up easily. Use instead quasi-correlation coefficients:

$$q_{ij,t}^{rs} = \frac{(g_{it}^{r} - \bar{g}_{i}^{r})(g_{jt}^{s} - \bar{g}_{j}^{s})}{\sigma_{i}^{r}\sigma_{j}^{s}}$$

Aggregate version:

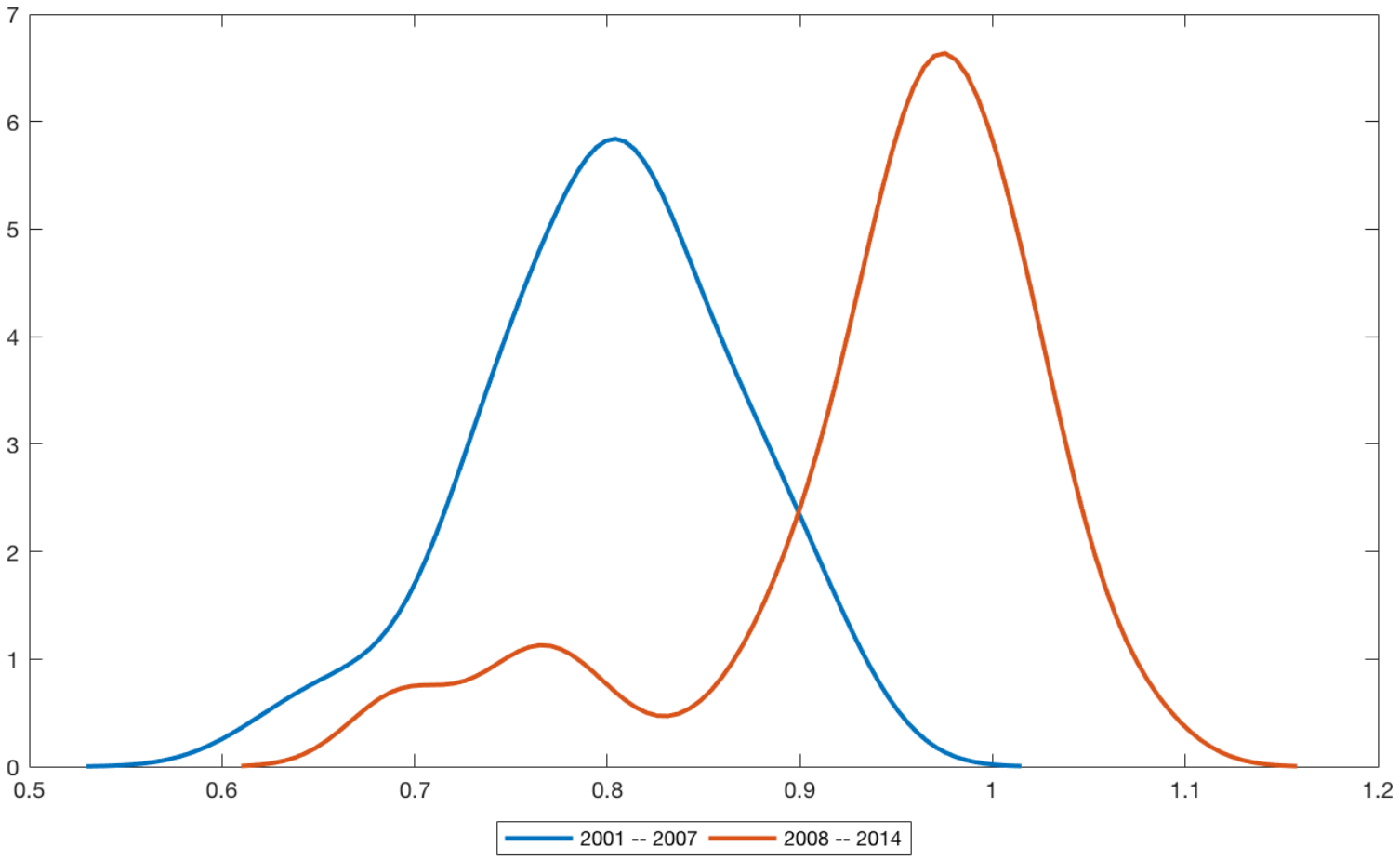
$$q_{ij,t} = \frac{(g_{it} - g_{i}^{*})(g_{jt} - g_{j}^{*})}{\sigma_{i}\sigma_{j}}$$

After some algebra:

$$q_{ij,t} = \sum_{r}\sum_{s} W_{ij}^{rs} q_{ij,t}^{rs}$$

with $W_{ij}^{rs} = \frac{\omega_{i}^{r}\omega_{j}^{s}\sigma_{i}^{r}\sigma_{j}^{s}}{\sigma_{i}\sigma_{j}}$

Convergence in quasi-correlations in GDP - EMU



Explaining aggregate convergence up from sector level

Estimate

$$q_{ij,t}^{rs} = \alpha_{ij}^{rs} + \beta BI_{ij,t}^{rs} + \gamma Trade_{ij,t}^{rs} + \eta_{ij,t}^{rs}$$

Obtain fitted values for quasi correlations $\hat{q}_{ij}^{rs}(BI)$ and $\hat{q}_{ij}^{rs}(Trade)$.

Compute

$$\hat{q}_{ij}(BI) = \sum_r \sum_s W_{ij}^{rs} \hat{q}_{ij}^{rs}(BI)$$

$$\hat{q}_{ij}(Trade) = \sum_r \sum_s W_{ij}^{rs} \hat{q}_{ij}^{rs}(Trade)$$

Regress actual q_{ij} on $\hat{q}_{ij}(BI)$ and $\hat{q}_{ij}(Trade)$.

BI and quasi-correlation at sector level

	(1)	(2)	(3)	(4)	(5)	(6)
BI_{ij}	4.15***	4.08***	2.10***	2.15***	2.32***	2.18***
	(0.11)	(0.11)	(0.11)	(0.10)	(0.11)	(0.12)
$Trade_{ij}^{rs}$		3.81***	3.32***	2.53***	4.15***	3.82***
		(0.74)	(0.72)	(0.26)	(0.31)	(0.31)
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects			Yes			
Yr-Cntry-Sector				Yes		
Yr-Cntry					Yes	
Yr-Cntry-Pair						Yes
N	325600	325600	325600	325600	325600	325600
R2	0.0089	0.0091	0.054	0.33	0.013	0.03

Estimates of $q_{ij,t} = \alpha_{ij} + \beta \hat{q}_{ij}(BI) + \varepsilon_{ij,t}$

and $q_{ij,t} = \alpha_{ij} + \beta \hat{q}_{ij}(Trade) + \varepsilon_{ij,t}$

	(i)	(ii)	(iii)
Export Intensity	2.722*** (0.675)		2.221* (1.240)
Trade		48.753*** (13.375)	12.756 (24.020)
N. Obs	132	132	132
Within R2	0.206	0.169	0.209
Pair FE	Yes	Yes	Yes

Convergence in Consumption in EMU

- Consumption growth rates converged, sometimes faster than GDP growth rates.
- Outcome could be delivered by financial integration.
- Conventional test:

$$gc_{i,t} = \gamma_t + \beta gy_{i,t} + \epsilon_{i,t}$$

Pattern of consumption in country i unaffected by (idiosyncratic) income shocks there: β=0.

- Do estimates of β depend on financial integration?

$$gc_{i,t} = \gamma_t + \beta_1 gy_{i,t} + \beta_2 gy_{i,t} \times \varphi_{i,t} + \epsilon_{i,t}$$

- $\varphi_{i,t}$ measures number of Financial Services Action Plan (FSAP) directives adopted by country i at time t. β_2<0

Convergence in Consumption in EMU

- New test:

$$|gc_{i,t} - gc_{j,t}| = \alpha_{ij} + \delta|gy_{i,t} - gy_{j,t}| + \varepsilon_{ij,t}$$

Convergence in consumption between countries i and j uncorrelated with convergence in (idiosyncratic) income shocks: δ=0.

- Do estimates of δ depend on financial integration?

$$|gc_{i,t} - gc_{j,t}| = \alpha_{ij} + \delta_1|gy_{i,t} - gy_{j,t}| + \delta_2|gy_{i,t} - gy_{j,t}| \times \varphi_{ij,t} + \varepsilon_{ij,t}$$

- $\varphi_{ij,t}$ measures number of ***common*** FSAP directives adopted by countries i and j at time t. δ_2<0

Conventional Approach

	1999-2014	1999-2014	1999-2006	1999-2006	2007-2014	2007-2014
GDP Growth	0.716*** (0.031)	0.710*** (0.054)	0.728*** (0.044)	0.821*** (0.055)	0.707*** (0.044)	-0.531* (0.82)
Interaction with FSAP		0.000 (0.002)		-0.017*** (0.006)		0.034*** (0.008)
FSAP		0.065 (0.045)		0.106** (0.054)		0.113 (0.078)

Bilateral Approach

	1999-2014	1999-2014	1999-2006	1999-2006	2007-2014	2007-2014
GDP Growth	0.135*** (0.027)	0.362*** (0.069)	0.193*** (0.043)	0.824*** (0.105)	0.078** (0.035)	-0.169 (0.161)
Interaction with FSAP		-0.010*** (0.003)		-0.043*** (0.007)		0.009* (0.005)
FSAP		-0.009 (0.008)		-0.012 (0.022)		0.047** (0.024)

Conclusion

- A new determinant of convergence / synchronization in GDP growth: bilateral export intensity, measuring connection between two sectors across borders, via input-output linkages. Distinct from direct trade.
- Explains convergence in value added growth at sector level, including non-traded services.
- Explains 20% of aggregate synchronization in GDP – at least on par with observed trade.

- A standard determinant of convergence / synchronization in Consumption growth: financial integration (i.e. harmonization in EMU)
- Risk sharing apparent pre-2007. Broke down after GFC probably because integration via bank lending vs. other financial markets. Not a new result.

Thank you