Jean Monnet Conference
ECONOMIC PROSPECTS FOR THE EUROPEAN UNION - CHALLENGES FOR ECONOMIC POLICY UNTIL THE END OF THE DECADE
23-24 September 2016

Core-Periphery in the EMU: A New Simple Theory-Driven Metrics

Nauro F Campos
Brunel University London,
ETH-Zurich and IZA-Bonn

Corrado Macchiarelli
Brunel University London and
London School of Economics

Motivation

The Flexible Euro Stiglitz recently proposed is his plan for a Northern Euro and a Southern Euro, i.e. the typical ‘two-tier’ integration approach.

Stiglitz claims the Southern Euroit is to be "less core"

Does anybody know (or ever asked) how much "less core" should it be?

Motivation

Beyond complete disintegration, one can thus see two alternatives for euro:

"Controlled" disintegration: e.g. two-tier currency union

Deepening integration (i.e. 5 Presidents Report)

That's what we explore empirically in this paper using a simple test.

This paper

A simple question:

We replicate Bayoumi and Eichengreen's results for 1989-2015 and ask whether the EMU strengthened or weakened the core-periphery pattern

The paper uses the same:

- ✓ Methodology (+ extension to a 'core-periphery' metrics)
- ✓ Sample of EU countries
- ✓ Time window (25 years)

Tooling up

Optimal Currency Area (OCA; Cf. Mundell)

The main research question regards the costs and benefits of sharing a common currency (Alesina and Barro, 2002).

Main cost is the loss of monetary policy autonomy, which increases on the degree of asymmetry of shocks.

Benefits are mostly in terms of reduction of transaction costs and exchange rate uncertainty, and of increasing price transparency and competition.

Still, recent econometric evidence reporting "no substantive reliable and robust effect" of currency unions on trade challenges some of these benefits (Glick and Rose, 2016).

Is it all about costs then?

Tooling up (cont'd)

The original OCA formulation stressed as key criteria

- ✓ labour mobility,
- ✓ product diversification
- ✓ trade openness

Possible endogeneity of currency unions: i.e. criteria do not have to be met *ex ante* but rather will be achieved *ex post*.

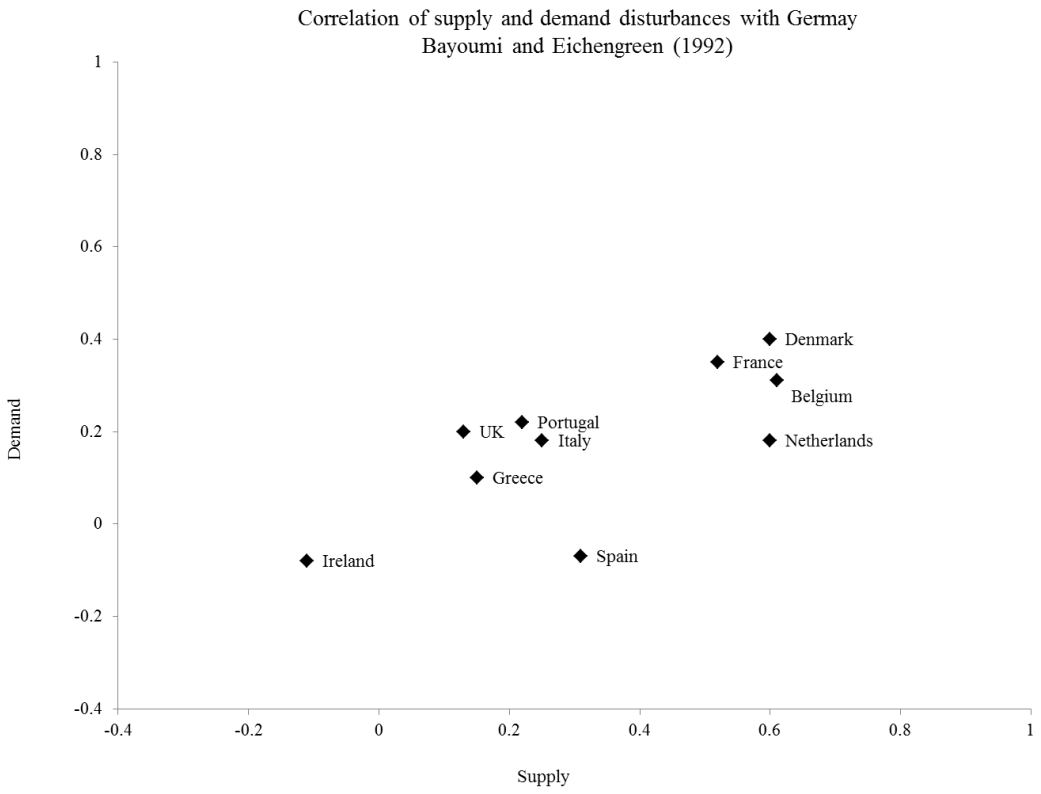
Recent work calls attention to credibility shocks. If there are varying degrees of commitment, countries with dissimilar credibility shocks, which exacerbate time inconsistency problems, should join in currency unions (Chari et al 2015).

Another important recent strand highlights situations when OCA criteria are interdependent and focus on interactions between openness and mobility (Farhi and Werning, 2015).

Synchronizing is hard to do

An important additional consideration regards differences between supply and demand shocks (Ramey, forthcoming).

As for the degree of synchronization of supply shocks across countries before the EMU, Bayoumi and Eichengreen (1993) argue that the evidence supports the idea of a "core" (Germany, France, Denmark and Benelux) where shocks are highly correlated and a "periphery" where synchronisation is lower.



Synchronizing is hard to do (cont'd)

The EMU may have eliminated independent national monetary policies as a source of idiosyncratic demand shocks, but national fiscal policies remained independent so the cross-country correlation in movements in demand may well persist.

Hence we decided to up-date this influential Bayoumi and Eichengreen (1993) exercise to assess to what extent the EMU has reinforced the core-periphery pattern they identified in the data for up to 1988.

- ✓ We use same methodology, window and sample (25 years later).
- ✓ We also offer a new (and straightforward) test for classifying countries into core and periphery.

To preview the main result of the paper, we find the EMU weakened the original core-periphery pattern.

Estimation

The methodology used by Bayoumi and Eichengreen (1993) is an extension of the Blanchard and Quah (1989) procedure for decomposing permanent and temporary shocks. Consider a system where the true model is represented by an infinite moving average of a (vector) of variables, X_t, and shocks, ϵ_t. Using the lag operator L, a bi-variate VAR featuring real GDP and its deflator (Source: Annual Data, OECD National Accounts) can be written as an infinite moving average representation of demand and supply disturbances:

$$X_t = A_0\epsilon_t + A_1\epsilon_{t-1} + A_2\epsilon_{t-2} + A_3\epsilon_{t-3} + \cdots = \sum_{i=0}^{\infty} L^i A_i \epsilon_t$$

where $X_t = [\Delta y_t, \Delta p_t]$ and the matrices A represent the impulse response functions of the shocks to the elements of X. It follows that

$$\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \epsilon_{dt} \\ \epsilon_{st} \end{bmatrix}$$

where $y_t$and p_t represent the logarithm of output and prices and ϵ_t are $i.i.d.$ disurbances, which identify supply and demand shocks (Ramey, forthcoming). For the i-th country, a_{11i} represents element a_{11}, in matrix A_i.

Estimation (cont'd)

Start from VAR

$$X_t = B_1 X_{t-1} + B_2 X_{t-2} + \cdots + B_n X_{t-n} + e_t$$
$$= \left(I - B(L)\right)^{-1} e_t$$

where e_t represents the residuals from the VAR equations. In order to convert MA into the model in previous slide, the residuals from the VAR, e_t, are transformed into demand and supply shocks by writing $e_t = C\epsilon_t$.

Each country, exact identification requires 4 restrictions. Two are normalizations, which define the variance of the shocks ϵ_{dt} and ϵ_{st}. The third restriction is from assuming that demand and supply shocks are orthogonal to each other. The fourth that demand shocks have only temporary effects on output (Bayoumi and Eichengreen 1993).

Estimation (cont'd)

The 4th restriction implies cumulative effect of demand shocks on the change in output must be zero:

$\sum_{i=0}^{\infty} a_{11i} = 0$

Thus far this is standard.

The standard AD-AS model implies that demand shocks should raise prices in both the short and long run, while supply shocks should lower prices and increase demand. In order to achieve that we need to impose an additional over-identifying restriction. We need to impose this restriction in our sample for the demand and supply shocks to be theory-consistent.

This differs from Bayoumi and Eichengreen (1993) because they do not impose this last restriction, which leaves the model exactly identified.

Imposing $\sum_{i=0}^{\infty} a_{12i} = 1$ is an over-identifying restriction. Under the latter assumption, demand across each country is restricted to respond qualitative in the same way to supply shocks. In terms of the structural VAR analysis this implies:

$$\sum_{i=1}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & \gamma \\ . & . \end{bmatrix}$$

with γ>0

Estimation (cont'd)

In order to retrieve demand and supply disturbances, we follow Campos and Macchiarelli (2016) and estimate the above VAR model consistent with Bayoumi and Eichengreen (1993) (2 lags no constant). Differently from the latter, we bootstrap the original VAR residuals in a *i.i.d.* fashion and generate 10.000 data sets.

At each time VAR parameters are re-calculated we follow the structural identification explained above: we impose the 4 identifying restrictions + the 5th over-identifying restriction.

We count the number the latter restriction is rejected at each bootstrap replication.

<u>In details</u>

K = 10.000 data sets. For each of the k-*th* samples we test for the over-identifying restriction based on a LR-test. We record the number of rejections of the over-identifying restriction test at each bootstrap replication, and calculate

$$NoR_i = 100 \times \frac{\sum_{k=1}^{K} \left\{ NoR = 1 \middle| -2(L_r - L_u) > \chi^2_{q-\left(\frac{n^2-n}{2}\right)} \right\}_{i,k}}{K}$$

where n is the VAR-dimension (in this case $n = 2$) and q is the number of long-run restrictions.

Median values of structural disturbances are then considered.

Test for over-identifying restrictions

	# of rejections (percent of bootstrap replications) $\gamma = 0.1$	# of rejections (percent of bootstrap replications) $\gamma = 0.5$	# of rejections (percent of bootstrap replications) $\gamma = 1$	# of rejections (percent of bootstrap replications) $\gamma = 1.5$	# of rejections (percent of bootstrap replications) $\gamma = 2$
BE	99.99	97.0	17.4	19.0	46.0
DE	99.96	99.96	24.7	19.0	30.0
DK	100.0	100.0	34.6	25.0	11.0
ES	99.96	99.96	72.7	76.0	60.0
FR	99.99	95.00	20.2	19.0	45.0
GR	99.96	99.96	91.8	99.0	91.0
IE	100.0	100.0	98.3	96.0	91.0
IT	100.0	100.0	14.6	35.0	22.0
NL	100.0	99.00	19.7	53.0	37.0
PT	100.0	100.0	88.2	80.0	51.0
UK	99.94	99.00	49.1	17.0	17.0
Total largest 3	100.0	98.0	21.5	30.3	37.3
Total largest 5	100.0	98.8	30.4	40.4	38.8
Total EZ9	100.0	99.0	49.7	55.1	52.6

Note: We bootstrap the original VAR residuals in a i.i.d. fashion and generate 10.000 data sets. For each of the 10.000 samples we recalculate the VAR parameters. At each replication we impose the over-identifying restriction and count the number of rejections. Cut off value is that of a $\chi 2(1)$ with probability 0.999 (10.828). The results are fairly robust if this probability is reduced to 0.99 (6.635). The countries for which this restriction is rejected on average more than in 55% of cases are the ones for which the over-identifying restriction is relaxed.

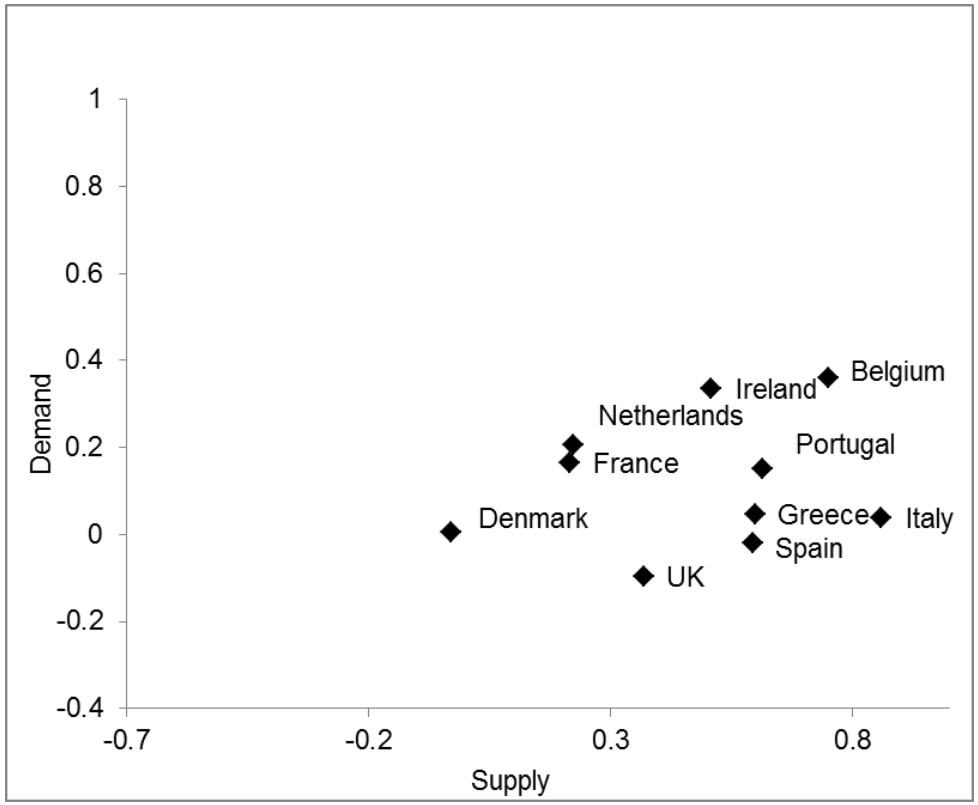
Test for over-identifying restrictions

	# of rejections (percent of bootstrap replications)
BE	17.4
DE	24.7
DK	34.6
ES	72.7
FR	20.2
GR	91.8
IE	98.3
IT	14.6
NL	19.7
PT	88.2
UK	49.1

For these countries the over-identifying restriction is rejected most of the time

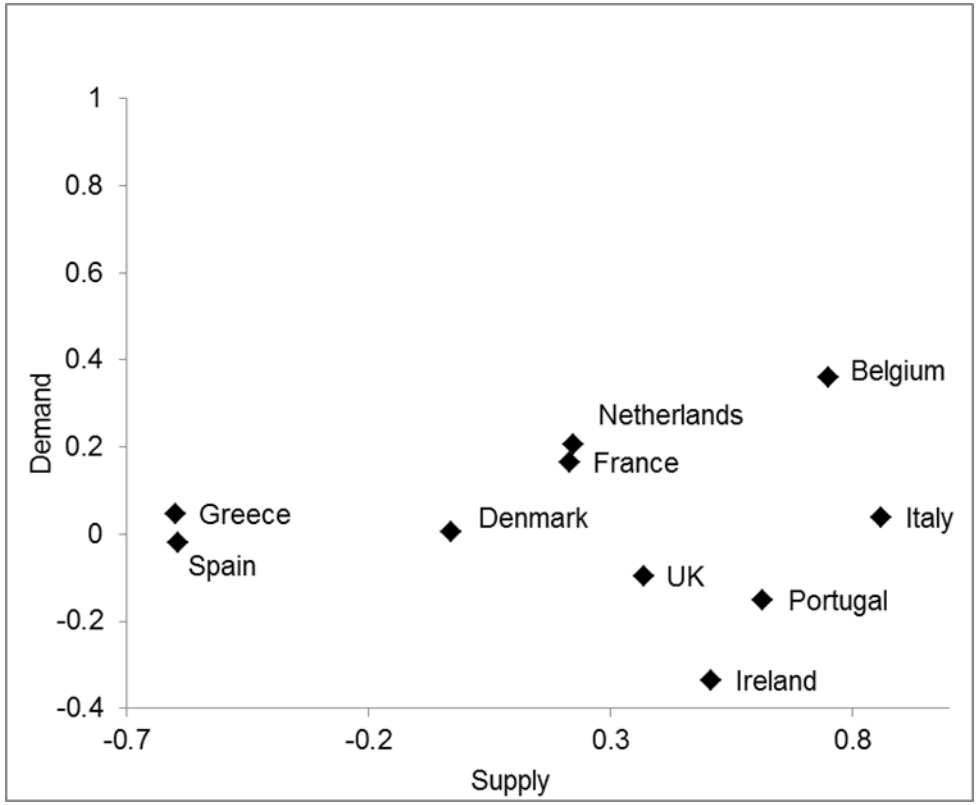
Note: We bootstrap the original VAR residuals in a i.i.d. fashion and generate 10.000 data sets. For each of the 10.000 samples we recalculate the VAR parameters. At each replication we impose the over-identifying restriction and count the number of rejections. Cut off value is that of a $\chi 2(1)$ with probability 0.999 (10.828). The results are fairly robust if this probability is reduced to 0.99 (6.635). The countries for which this restriction is rejected on average more than in 55% of cases are the ones for which the over-identifying restriction is relaxed.

Correlation of supply and demand disturbances imposing the "one-size-fits-all" restriction (bootstrapped residuals – median values)



Note: This figure reports median bootstrapped residuals based on 10.000 VAR replications. Structural residuals are retrieved from a SVAR where the over-identifying restriction above is imposed for all countries. The sample for this SVAR is 1989–2015, with two lags for all countries and no constant as in Bayoumi and Eichengreen (1993). The demand and supply disturbances correlation coefficients are vis-à-vis Germany.

Correlation of supply and demand disturbances (bootstrapped residuals – median values) relaxing the "one-size-fits-all" restriction



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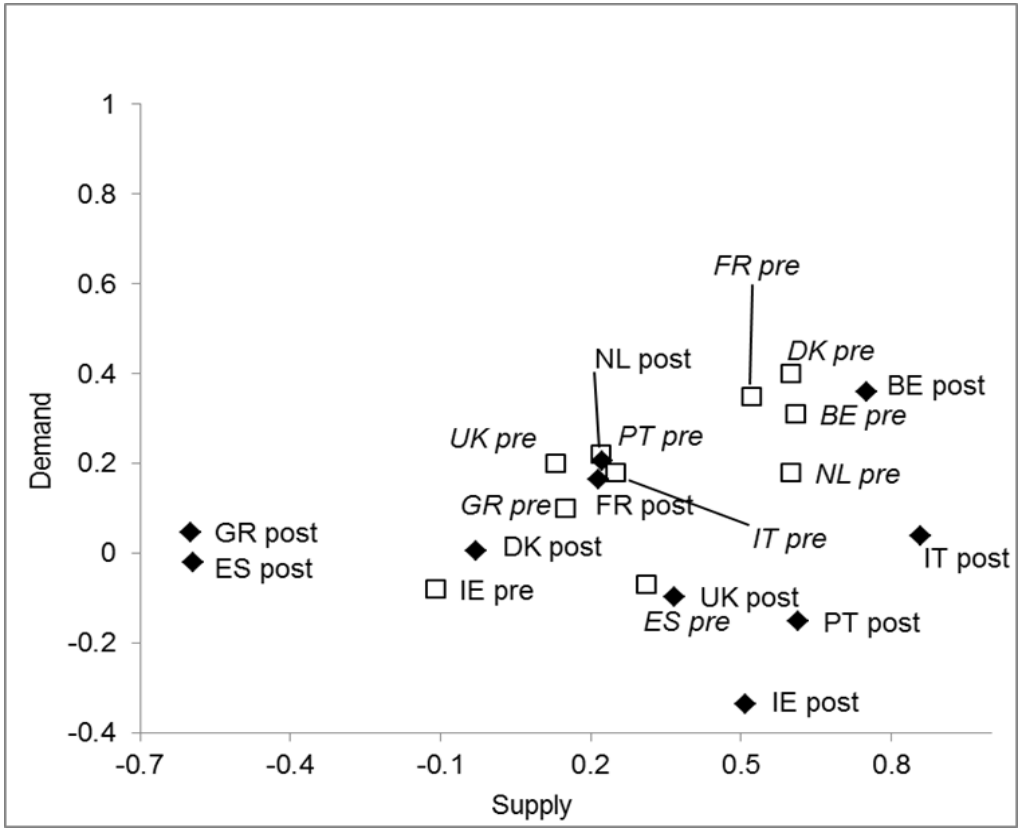
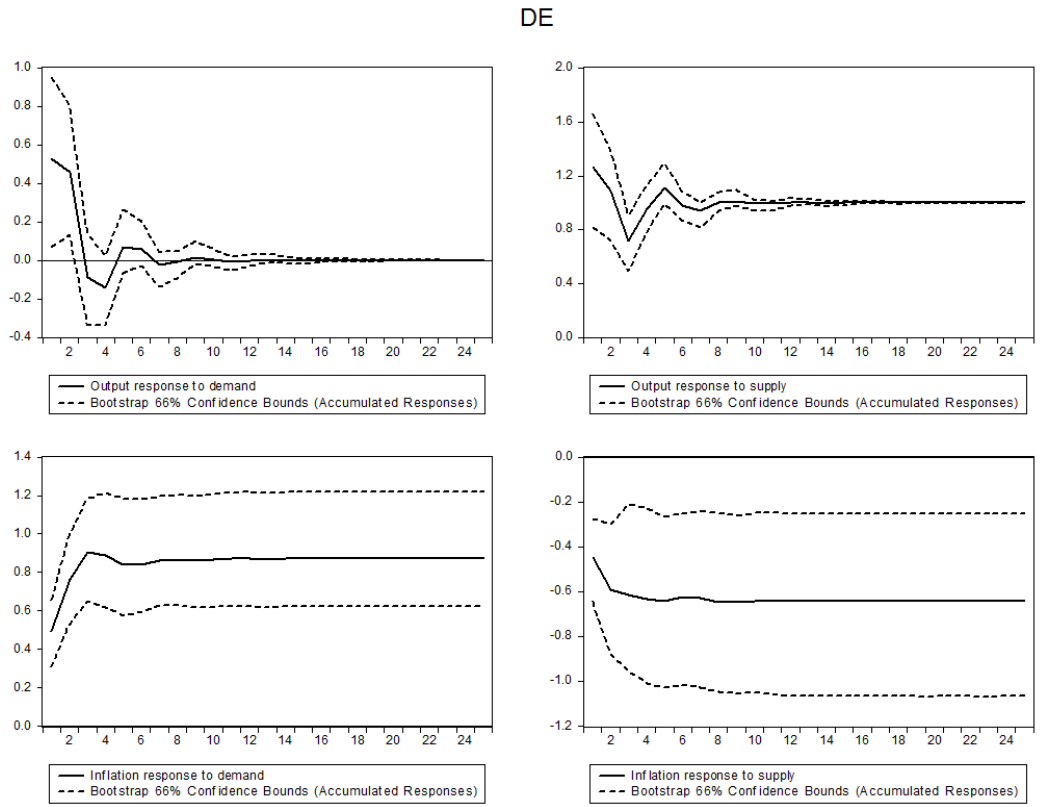
Correlation of supply and demand disturbances vis-à-vis Germany, pre and post EMU



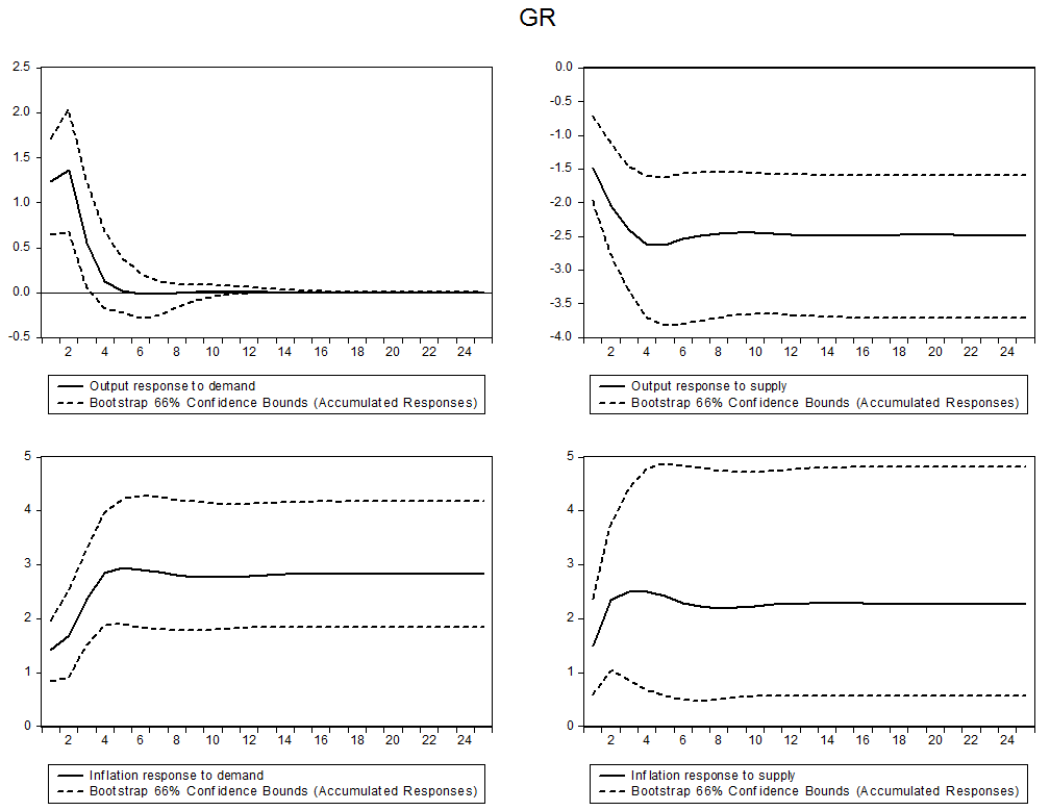
Note: The figure compares estimates from pre-Maastricht based on Bayoumi and Eichengreen (1993), covering the period 1963-1988, with our equivalent estimates for the period 1989-2015 ('post'). For each country, we estimate a bi-variate SVAR using (log) real GDP and the (log) deflator, both in first differences. The structural identification of the shocks for our sample relaxes the over-identifying restriction as discussed previously.

SVAR Impulse Response Functions - Germany



Note: IRFs report based on 10.000 VAR replications. The black line denotes the median IRF, whereas the dotted lines denote its 66% confidence interval. Structural residuals are retrieved from a SVAR where the over-identifying restriction described in Section 3 is imposed for all countries, with the exception of Ireland, Spain, Greece and Portugal. The sample is 1989 – 2015, with the SVAR being solved using 2 lags and no constant as in Bayoumi and Eichengreen (1993).

SVAR Impulse Response Functions - Greece



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Robustness check

One important concern is that the relationship between demand and supply may have changed over time and/or the nature of shocks has been altered by the EMU itself.

Focus on the role of oil shocks: one could argue that the increase in correlation in supply disturbances is due to a larger role for oil price shocks in the sample.

Net Oil Price Increase (NOPI) measure from Hamilton (2003). Let s_t denote the nominal price of oil in logs, then

$$NOPI_t = \begin{cases} I_t = s_t - \max(s_{t-1}, s_{t-37}) & if \quad I_t > 0 \\ 0 & otherwise \end{cases}$$

The net oil price increase is a censored predictor that assigns zero weight to net oil price decreases and singles out oil prices peaks in a 36-month (or shorter) window.

When conditioning the SVAR on NOPI:

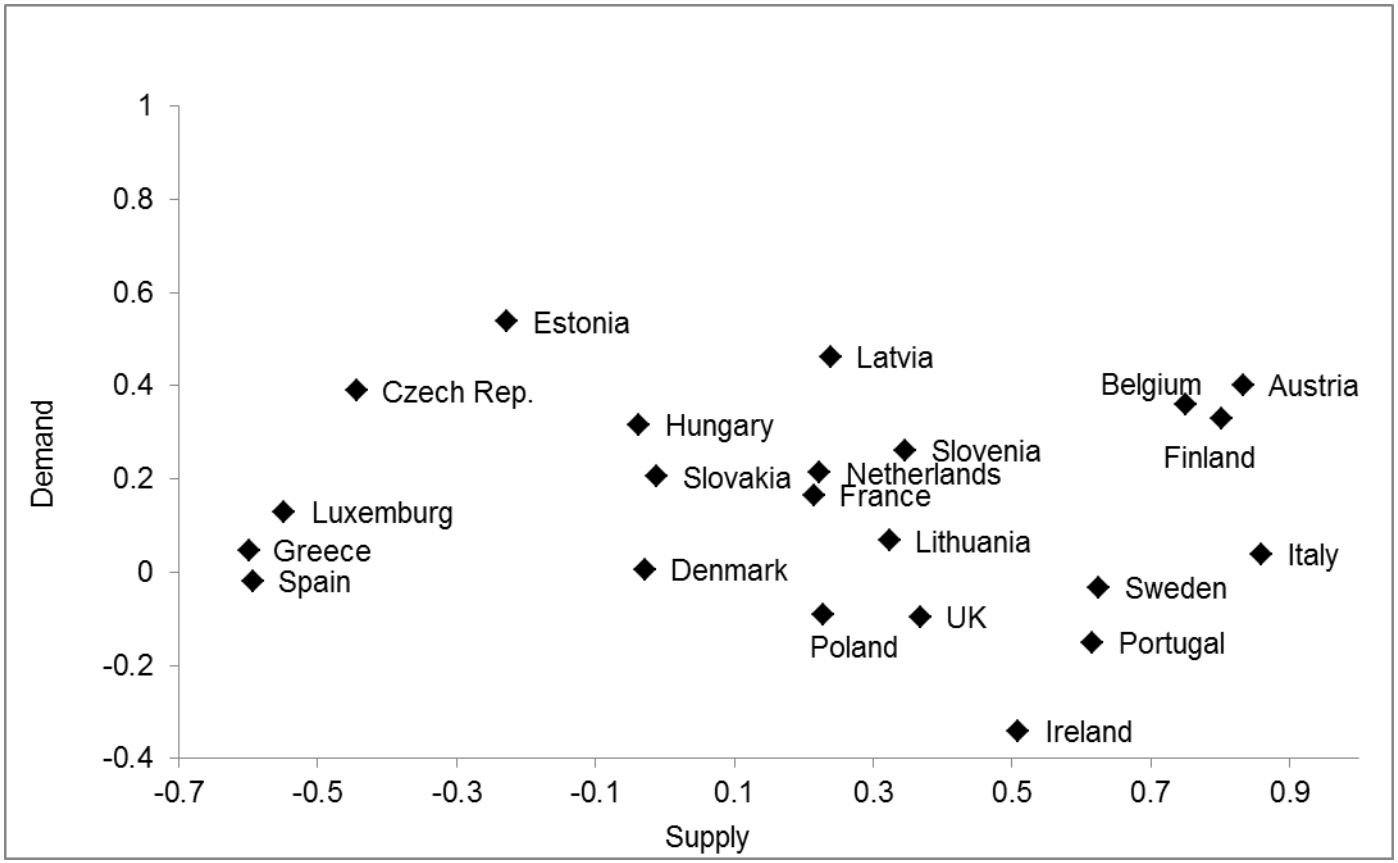
No evidence that the responses of real GDP and inflation to demand and supply innovations are largely driven by the real price of oil.

Extension: EU28

	# of rejections (percent of bootstrap replications)
AT	21.0
BE	17.4
CZ	96.0
DE	24.7
DK	34.6
EE	97.0
ES	72.7
EU28 Aggregate	18.0
FI	74.0
FR	20.2
GR	91.8
HU	74.0
IE	98.3
IT	14.6
LT	97.0
LU	96.0
LV	99.0
NL	19.7
PT	88.2
SE	44.0
SI	18.0
SK	88.0
UK	49.1

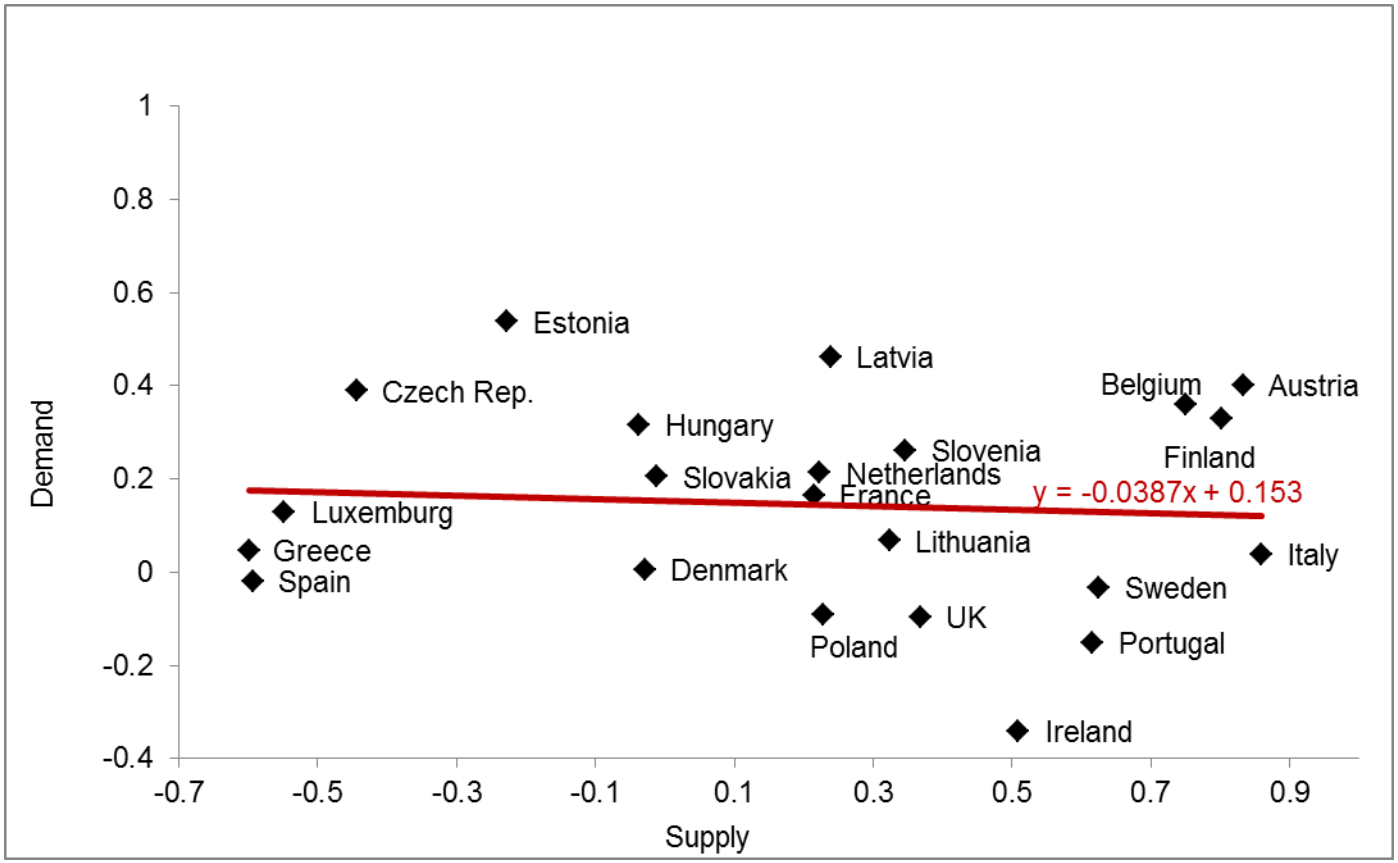
Note: We bootstrap the original VAR residuals in a i.i.d. fashion and generate 10.000 data sets. For each of the 10.000 samples we recalculate the VAR parameters. At each replication we impose the over-identifying restriction and count the number of rejections. Cut off value is that of a $\chi 2(1)$ with probability 0.999 (10.828). The results are fairly robust if this probability is reduced to 0.99 (6.635). The countries for which this restriction is rejected on average more than in 55% of cases are the ones for which the over-identifying restriction is relaxed. Data for Bulgaria, Croatia, Cyprus, Malta and Romania are not part of the OECD Annual Accounts.

Extension: Correlation of supply and demand disturbances (bootstrapped residuals – median values) relaxing the "one-size-fits-all" restriction – EU28



Note: This figure reports median bootstrapped residuals based on 10.000 VAR replications. Structural residuals are retrieved from a SVAR where the over-identifying restriction above is imposed for all countries, with the exception of the countries for which the number of rejections in Table 1 exceeds 55%. The sample for this SVAR is 1989–2015, with two lags for all countries and no constant as in Bayoumi and Eichengreen (1993).

Extension: Correlation of supply and demand disturbances (bootstrapped residuals – median values) relaxing the "one-size-fits-all" restriction – EU28



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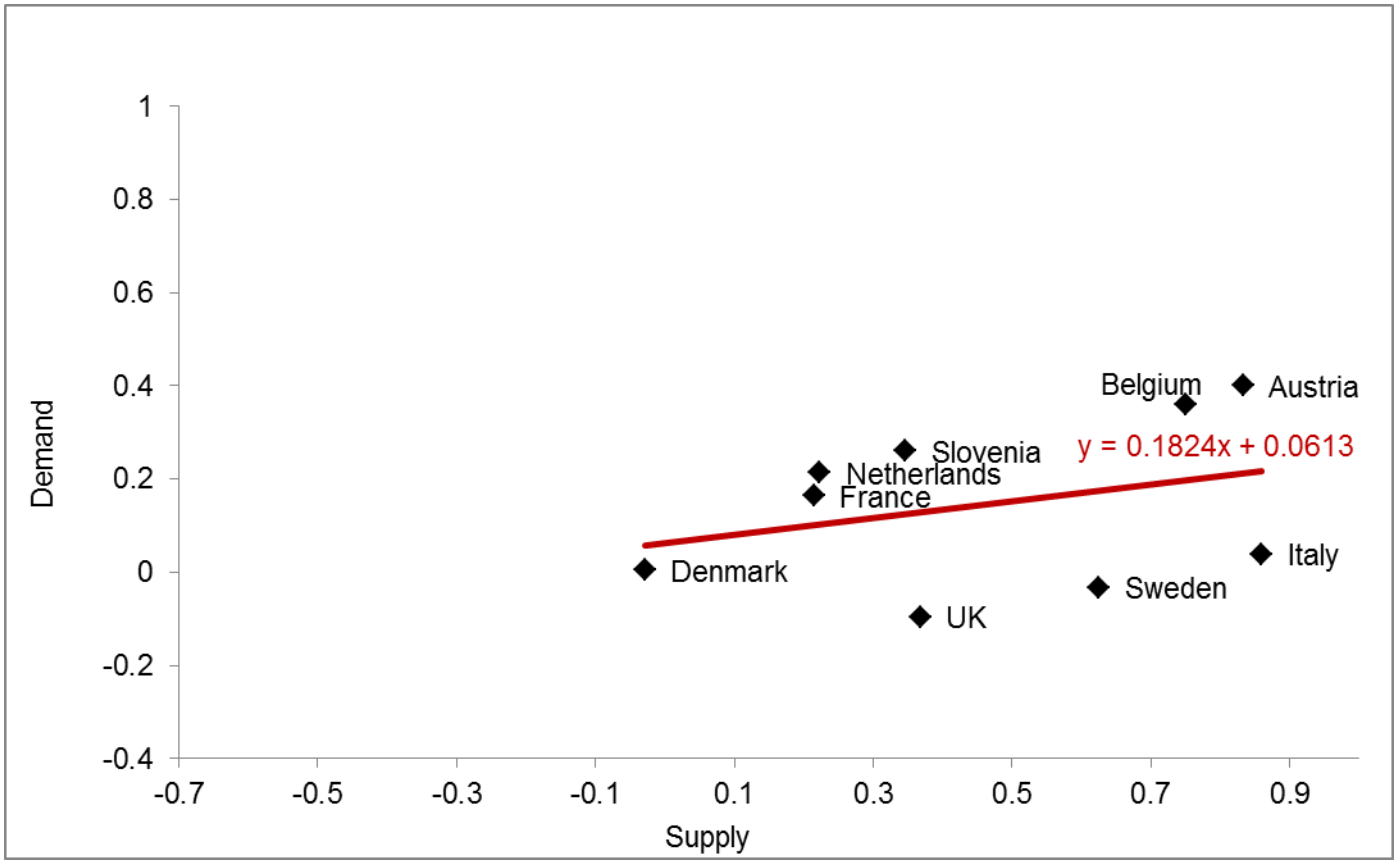
Extension: Correlation of supply and demand disturbances (bootstrapped residuals – median values) "core" countries



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NoR metrics

Thus far we considered the analysis of a univariate time series NOR for each country i over a sample from $t = 1, \ldots., T$.

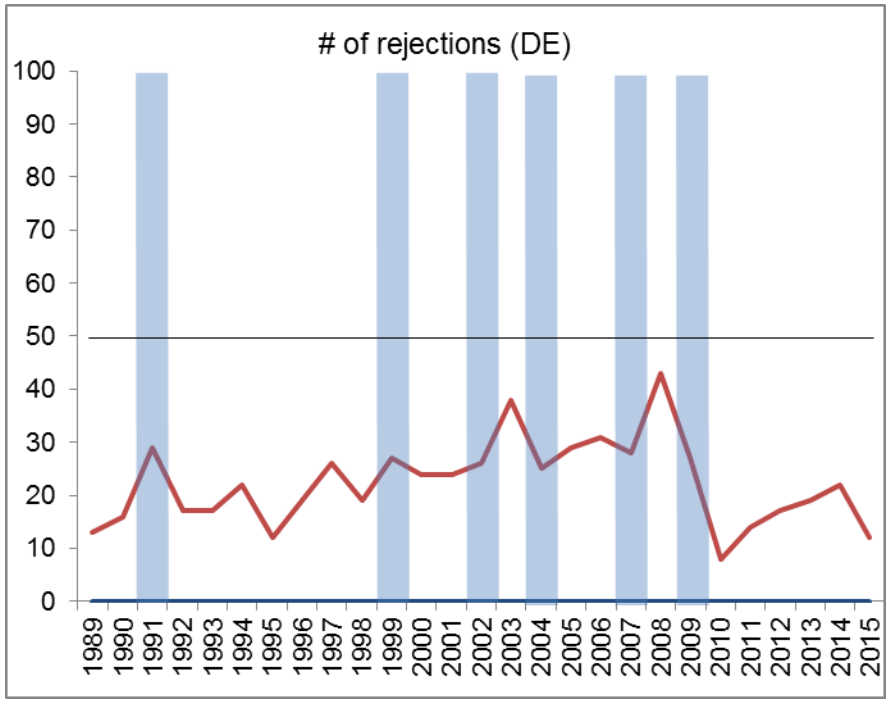
NOR_{i} was constant over the entire sample.

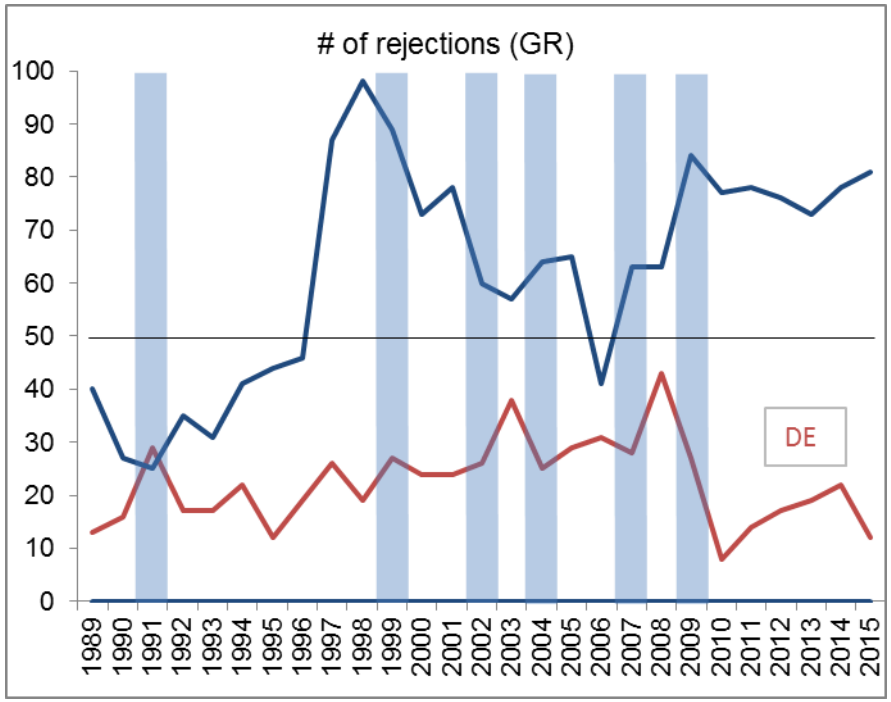
To assess parameter constancy, let T be larger than before (55 years, i.e. 1960-2015) and τ denote the width of a sub-sample (25 years) or window and define the rolling sample 'metrics'

$$NOR_{\mathrm{t_i}}(\tau) = \frac{1}{\tau - 1} \sum_{j=0}^{\tau-1} NOR_{(t-j)_i}(\tau)$$

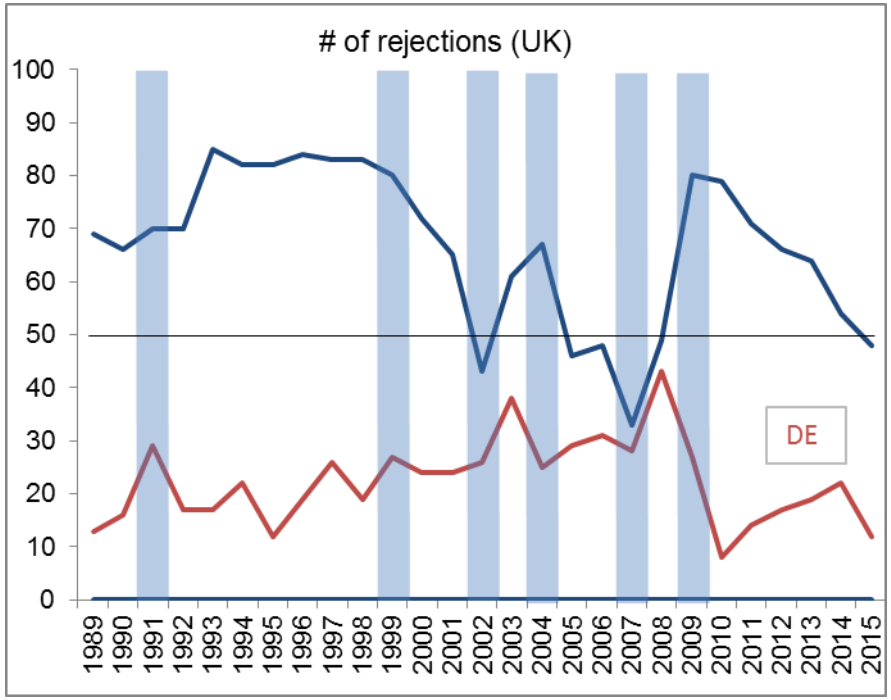
The windows are rolled through the sample one observation at a time, so there will be $T - \tau + 1$ rolling estimates of each parameter.

‘Coreness Index’





‘Coreness Index’



NoR metrics at high(er) frequency

Can we move at higher frequency? Yes, but not straightforward.

Using Q data:

1) We need to be more careful in treating outliers, i.e. *dummy saturation* approach (IIS); Hendry et al. (2008) and Johansen and Nielsen (2009)

2) Quarterly series are much more volatile and there are a lot of changes in regime in the sample, which are smoothed out an annual frequency.

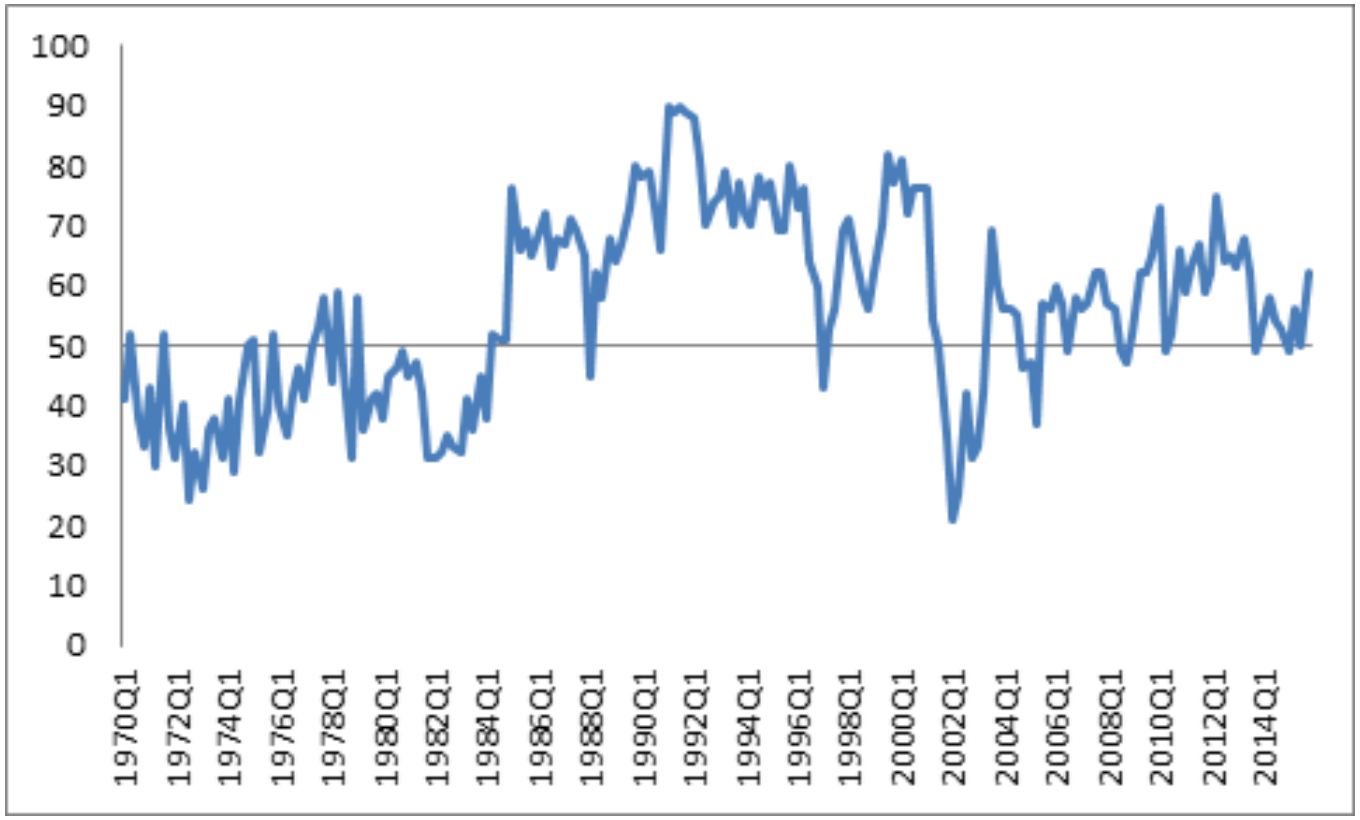
Coreness

We have estimated the average cyclical length for the series (GDP growth and inflation) over the whole sample: which is 20-23 quarters, or 5 to 5.7 years. Good news is that this is consistent with the average duration of business cycle provided by NBER.

We have crunched those series in the SVAR. Estimation is 1960Q1 to 2015Q4 with a window τ of variable duration. This duration is (for now) equal to the number of cycles.

Alternative would be using a TVP-VAR.

Figure - UK Coreness Index (CI) (avg duration: 2 cycles)



Conclusion

Our results suggest the EMU has significantly weakened the original pattern described in Bayoumi and Eichengreen, in that we find, based on demand and supply shocks, substantial changes in the clustering of countries. Overall, a new, smaller, periphery has emerged.

From an OCA / convergence perspective, dynamic effects and **how core-periphery has shifted over time is an important avenue for research.**

And more on

Synchronicity (i.e. weakening of periphery), trade openness and labour mobility since 1999 is likely to have generated substantial benefits.

However, two caveats are in order.

- ✓ One is that these benefits are far from entrenched or irreversible: policy inconsistencies, delays and mistakes can diminish them (and one can argue that this has indeed happened since 2010). Despite the weakening of the "core-periphery" pattern we observe, irreversibility cannot be taken for granted (recall that here this was examined for only one of the three aspects of the OCA Trinity).
- ✓ The second caveat is that this process of rooting of an endogenous OCA, that our results seem to support the possibility of substantial economic costs in the case of exit, above and beyond the (maybe symmetric) loss of benefits. The results suggest euro-outs have also become much more entrenched even without using the euro as their currency (e.g. UK is an example - it turns out to be **boarder line though**). The costs of leaving the European Union, even for euro-outs, have risen considerably since the introduction of the EMU.

Open questions

There are various other important features that also deserve close scrutiny, empirically, such as the interactions among trade openness, labour mobility and business cycle synchronisation.

Moreover, these should be carried out acknowledging that the EMU has changed and will continue to do so. The construction of a Genuine EMU is on-going and a crucial element of this debate (Begg 2015).