# Business Cycles in the Euro Area

Domenico Giannone, European Central Bank, ECARES and CEPR
Michele Lenza, European Central Bank
Lucrezia Reichlin, European Central Bank and CEPR

August 14, 2008

**Abstract**

In those countries of the EMU which started from similar initial conditions in terms of real activity in the seventies, business cycles are very similar and no significant change can be detected since 1999. For the other countries, there is a lot of uncertainty and not much can be said. No clear change since the EMU can be identified in either group. As for euro area business cycle, euro area capita GDP growth since 1999 has been lower than what could have been predicted on the basis of historical experience and US observed developments. The gap between US and euro area GDP per capita level has been 30% on average since 1970 and there is no sign of catching up or of further widening.

**JEL Classification**: E32, E33, C5, F2, F43.

**Keywords**: Euro Area, International Business Cycle, European Monetary Union, European Integration.

* We would like to thank the editors Alberto Alsesina and Francesco Giavazzi, the seminar participants at the conference on "The Euro Area, the Euro and the World Business Cycle" in Aix-en-Provence and our discussant Benoit Mojon. The opinions in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank. Please address any comments to Domenico Giannone (domenico.giannon@ecb.int); Michele Lenza (michele.lenza@ecb.int); or Lucrezia Reichlin (lucrezia.reichlin@ecb.int).

# 1 Introduction

When asked in the 1960s about what, in his opinion, had been the impact of the French revolution, the Chinese premiere Zhou Enlai famously said: "it's too early to tell".

This might be what will be said about the effect of the European Monetary Union (EMU) on euro area business cycles in two hundred and fifty years. It is clearly quite a risky endeavor to study this question with seven years of data only, but this is the question we were asked to analyze for this volume celebrating the tenth anniversary of the single currency and this is therefore what we do in the paper.

A lot has been written on this issue and results in the literature are far from be consensual (in the next Section we review the findings). Moreover, very little is known about the historical characteristics of national and aggregate business cycles in the euro area. One of our objectives is to describe the basic characteristics of real economic activity in the area as a whole and in member countries as well as the dynamic relations between national cycles over the last forty years. Having formed a view on these features for a sufficiently long historical period (our sample starts in 1970), we then address the question of changes related to the EMU.

We adopt a very conservative and narrow approach. Since we are looking for robust results on a topic where there is little consensus about descriptive statistics, we analyze annual data, which are less affected by measurement error than quarterly statistics and are available for all countries for a relatively long time period. Moreover, we look at real data only, since the well documented changes in nominal variables and the convergence of inflation and interest rates that have taken place since the early nineties, if of significance, should be reflected in visible changes in the output structure over time. In a way, the establishment of the EMU helps identify broader economic relations without having to define a complex model. Finally, amongst real variables, we focus on GDP per capita only, disregarding other real indicators, such as, for example, labor market or consumption data. This choice is partly motivated by lack of reliable comparative statistics, but also because, unless the omitted real variables have a predictive power for output, output dynamics should reflect changes in different sectors of the real economy.

We first analyze asymmetries in levels of economic activities and then look at growth rates to try to identify patterns across countries and over time in the evolution of gaps between each member's growth

rate and the euro wide average.

Then we study the dynamic relationship between growth rates. We base our analysis on two simple models, one which characterizes the joint output dynamic of the euro area countries and one which studies the euro area aggregate cycle in relation to that of the US, the other large common currency area in the world.

We first look at the relation between countries' output dynamics and average euro area growth. Precisely, we ask whether, based on the economic structure prevailing before 1999 and conditioning on the observed path of euro area growth before and after 1999, we would have observed, in each country, the realized growth observed during the EMU years. We then focus on the euro area aggregate cycle and ask the question of whether the observed growth path in the EMU years could have been expected on the basis of the past distribution and conditioning on external developments. To capture external development we use, as a conditioning variable, the observed path of US GDP growth. The choice of US output as a conditioning variable is motivated by the finding in Giannone and Reichlin (2005) and Giannone and Reichlin (2006) and some additional results which we report here which show that the dynamic correlation between US and euro area growth is robust and has been stable over time.

Overall, the results of the paper should reassure the early critics of the EMU. If conditioning appropriately, the level of heterogeneity that we have observed over the last ten years are in line with historical experience. Differences between countries are small and the transmission of common shocks rather homogeneous.

On a more pessimistic tone, one of our findings is that the average growth experienced by the euro area as a whole from 1999 to 2006 has been slightly lower than what we would have expected based on its historical relation with the US. We do not try to establish any causal connection between common monetary policy and aggregate growth and there is no reason to believe that there should be one. However, if the euro area payed a price for the common monetary policy, this affected all countries and did not induce, as was expected by its critics, large asymmetries. If we exclude small countries, which started from different levels of income per capita with respect to the average, the adjustment to common shocks was rather homogeneous before the start of the EMU and it has not changed during the EMU years. The causes of slow growth are therefore not related to the factors emphasized in the discussion that took place ten years ago. One implication of our results is that the effect of exchange

rates on real economic performance is rather small.

## 2 What do we know about the euro area business cycles?

There is a large empirical literature which describes the characteristics of business cycles and their evolution in OECD countries. Most papers, however, don't analyze the total sample of euro area member countries and focus either on large European countries (including also non euro area nations), the G7 or a larger number of OECD economies. What we have learned about the euro area business cycles comes from this literature. Below we summarize the results.

Papers have addressed different questions.

At the beginning of the EMU, there was an effort to collect data on the aggregate euro area economy (Fagan, Henry, and Mestre, 2001). With these data, some studies, in the first years of the EMU, have tried to characterize the euro area aggregate business cycle, both for what concerns the dating of recessions and expansions of levels of economic activity (the so-called classical cycle) and the growth cycle.

Other studies have focused on countries' heterogeneity and look at synchronization of recessions or use growth rates and filtered data to identify the cross-country pattern of co-movements between some components of output or industrial production data. A popular approach has been to identify the relative importance of a common world component in major OECD countries, a European (and/or euro area) component and, in some papers, a regional component. Few of these studies, however, are recent enough to be sufficiently informative on the EMU regime's "facts".

Many papers have focused on the issue of structural change. Here authors have asked whether the degree of synchronization has changed in relation to the ERM, the Maastricht Treaty and the EMU. Some studies, have looked backward and estimated the degree of heterogeneity of the response to common euro area, European or world shocks before the inception of the EMU, to infer, on that basis, what would have happened as a consequence of the single currency and evaluate its potential costs.

Finally, some studies have used a variety of methods to characterize the synchronization of turning points of classical cycles focusing on growth rather than on recession episodes.

Since the set of countries, the time period and the variables used are different across these studies, it is

quite difficult to report results in a synthetic way. Below is a review of the findings.

*Characteristics of the euro area aggregate business cycle: recessions and expansions*

The first attempt to look at the euro area as a single economy and date the turning points of its "classical" cycle has been pursued by the CEPR dating committee on the basis of judgemental criteria (www.CEPR.org) and with data from 1970 to 2003. Artis, Marcellino, and Proietti (2005) reproduce these data using more formal techniques. The result of these studies is that the timing of euro area recessions is similar to that of US recessions as classified by the NBER (see wwww.nber.org), although euro area turning points lag US ones (see Giannone and Reichlin (2005) for a documentation of this point). None of these studies, however, analyze recent data and in the euro area sample no classical recession has so far been identified.

Turning points have also been established on the basis of a cyclical component extracted from many economic activity indicators. This component, the EUROCOIN index of the euro area business cycle, corresponds to a growth cycle concept and is regularly updated by the CEPR (see www.CEPR.org and Altissimo, Bassanetti, Cristadoro, Forni, Hallin, Lippi, and Reichlin (2001)).

*Characteristics of the national business cycles*

The literature seems to agree that the timing of classical recessions is very synchronized across euro area countries (Artis, Marcellino, and Proietti, 2005; Harding and Pagan, 2006), although there is no comprehensive analysis of all euro area economies including recent years.

In general, evidence on growth rates points to the importance of the world component in the European business cycle (Canova, Ciccarelli, and Ortega, 2005; Kose, Otrok, and Whiteman, 2003; Monfort, Renne, Rffer, and Vitale, 2004). Others have emphasized the strong link between the US and the euro area business cycle (Agresti and Mojon, 2001; Canova, Ciccarelli, and Ortega, 2005; Negro and Otrok, 2008; Giannone and Reichlin, 2005, 2006).

Papers are less consensual on the identification of a specific euro area or European business cycle over a longer sample. Some studies identify the emergence of a European cycle in the nineties, some date it back to the seventies, while other don't find it at all (see the review below).

A different approach has been to look at the relative importance of regional, national and euro wide

cycles. Forni and Reichlin (2001) and Croux, Forni, and Reichlin (2001) have shown, on the basis of data including only a couple of years of the EMU sample, that a regional component, orthogonal to the national one, explains a large component of national European cycles (around 30 %).

Finally, recently, the European Central Bank, has published a report on output growth differentials since 1990 in euro area countries and found that they are small (and comparable with those of US states), but persistent (Bank, 2007). The same message comes from a more analytical study by Giannone and Reichlin (2006).

*Changes since the ERM, Maastricht and the EMU*

Evidence on changes of the characteristics of euro area cycles is less consensual. Clearly with many institutional changes clustered around the early nineties and a short sample covering the EMU regime, it is hard to come up with robust findings. Artis and Zhang (1997), analyzing cycles before and after 1979 (the beginning of the first ERM) find increased synchronicity since the ERM for countries belonging to the ERM. However Artis (2003) revisits these findings using data up to 2001 and concludes, on a sample of twenty-three countries, that there is no evidence of a European cycle. This again contrasts with the results of Lumsdaine and Prasad (2003), based on seventeen OECD countries (of which ten belong to the euro area and 13 to Europe) between 1963 and 1994. They find that, especially after 1973, there is a clear European business cycle. Helbling and Bayoumi (2003), on the other hand, find little synchronization between G7 growth cycles from 1973 to 2001 and estimate that Germany was more synchronized with anglo-saxon countries than with France in that period, although they also find instability over time of cross-country correlations. Focusing on slowdowns episodes, however, they point to strong cross-country correlations during recessions.

Two papers use more recent data. On the basis of data up to 2007, seven euro area and three European non euro area countries, Canova, Ciccarelli, and Ortega (2008) find that a European Union (EU) cycle emerges in the 1990s, but this is common to EMU and non EMU countries. The same authors find that a European cycle was absent until the mid-eighties. Negro and Otrok (2008), with data from 1970 to 2005, find no change in average cross-country correlation of euro area business cycles and for the larger set of European countries while they detect a decline in G7 average correlations.

*Shocks and propagations*

Few studies have tried to assess the propagation of US, German or world shocks across countries on the basis of semi-structural or structural models.

Before the establishment of the EMU, Bayoumi and Eichengreen (1992), with a sample of twelve members of the EU from 1960 to 1988, identify demand and supply shocks on the basis of countries's VARs on output growth and inflation. They identify a core group (Germany, France, Belgium, the Netherlands and Denmark) whose supply shocks are both smaller and more correlated across neighboring countries and a periphery (the UK, Italy, Spain, Portugal, Ireland and Greece) with large and weakly correlated shocks.

Giannone and Reichlin (2006) study the response of output growth of euro area countries to a euro area wide shock, on the basis of the 1970-2005 sample. They find that a large part of countries' business cycle is due to common (area wide) shocks while idiosyncratic fluctuations are limited, but persistent.

Different results, on the other hand, are found by Canova, Ciccarelli, and Ortega (2008). With quarterly data from 1970 to 1993, these authors find no positive spillovers of German shocks to other EMU countries while, with information up to the ECB creation at the end of 1998, they find a lot of commonalities in the response of EMU countries to German shocks. The same result, according to the authors, holds for the longer term sample, including the first four year of the EMU.

This review shows that, although there is a broad consensus on synchronization of recessions and expansions on the basis of data on the level of economic activity, the literature is not at all in agreement on the "facts" on growth cycles, that is the facts based on either growth rates or filtered data capturing some longer moving average of growth rates. Results differ depending on the sample, the method, the data or the data transformation. These differences in opinions about what are essentially descriptive statistics are surprising. They are partly explained by poor data quality, short samples for the policy regimes of interest and lack of robustness with respect to data filtering and statistical methods.

The attempt of our paper is to re-evaluate some of the "facts", trying to emphasize robustness. We aim to characterize the feature of the euro area cycle for member countries and for the aggregate since 1970 and to compare these characteristics with those of the US cycle. Although our analysis is limited because it mainly focuses on GDP per capita, it covers all euro area countries and a relatively long time span. In the next Section we describe our data set and discuss measurement issues.

# 3 Data

Business cycle analysis is typically performed with quarterly data. However, to avoid measurement issues and since our aim is to cover all euro area countries for a period of time including few full business cycles, we have made the choice of using annual data. Although we may lose information on short term dynamics, we consider that annual data are more reliable for the purpose of establishing robust facts on real economic activity.

The quality of quarterly historical data for the euro area is still poor. Moreover, quarterly data are not available for all countries for a sufficiently long sample (they are harmonized only since 1991). For some countries, even if available, quarterly data are constructed artificially from annual data.

A way to assess the importance of measurement error is to look at the spectral density of quarterly GDP growth at different frequencies. A series for which measurement error explains a large component of the total volatility, should have the bulk of variance concentrated at high frequencies. For the US, where quarterly data are of relative good quality, quarterly GDP growth exhibits a peak at business cycle frequency and the bulk of the variance at low frequencies. It is interesting to look at Germany for comparison.

Figure 1 below plots the spectral density for Germany and the US quarterly GDP, for the sample 1970-1989[1].

INSERT FIGURE 1 OVER HERE

Clearly, German and US quarterly GDP show a very different frequency decomposition of the variance which indicates large measurement error in the case of Germany. Large concentration of volatility is at frequencies higher than the year which suggest that by using yearly data the problem of measurement might be mitigated.

We consider real GDP per capita PPP adjusted because this facilitates international comparisons on the levels of economic activity. Data are PPP adjusted using 2000 weights. The sample is 1970-2006[2].

[1]The estimates use a Bartlett lag window of eight lags. The source is IMF International Statistics for GDP volume, 2000=100.

[2]The source is OECD, National Accounts. Data are constructed using national series for GDP in volume at the prices of a common base year (2000) and then deflating them by PPP for a fixed year (2000). We follow the OECD recommendation of deflating the GDP per head series by the PPP of a fixed year instead of using the "current" PPP

We consider the twelve countries that composed the euro area until December 2006, before the inclusion of Malta, Cyprus and Slovenia.

# 4 Euro area economic activity: 1970-2006

We begin from descriptive statistics on the level of economic activity. We start from 1970 to form a view on the level of heterogeneity as it was almost forty years ago, well before the introduction of common EU policies throughout the nineties and the establishment of the euro in 1999.

Define $y_{i,t}, 1 = 1, ..., 12$ as the log of real GDP per head (times 100) for country i.

Table (1) reports the percentage difference between the real GDP of each country and the euro area aggregate in different years and sub-periods.

This corresponds to the last term of the expression:

$$y_{i,t} = y_{ea,t} + (y_{i,t} - y_{ea,t})$$

where $y_{ea,t}$ refers to the euro area.

The last column reports the population weights.

Clearly, the size of the gaps are sensitive to the time period and depends on the level of aggregate economic activity which, in turn, depends on the phase of the cycle.

Looking at starting conditions in the seventies, we can heuristically identify two groups of countries. A core group with level of output per capita close to the average. The core is composed of Italy (IT), Germany (GE), France (FR), Belgium (BE), Austria (AT), the Netherlands (NE) and Finland (FI). In the periphery we have Portugal (PT), Luxembourg (LU), Greece (GR), Ireland (IE) and Spain (SP). In this group only Luxembourg started above the average while the other countries started below the average level of output per capita before the start of the Euro.

Note that in comparing levels of economic activity one should be aware of measurement issues. In particular, if lack of precision in the calculation of purchasing power parities is taken into account, a

series. This implies a lack of homogeneity over time, but has the advantage of using a price structure that is constantly updated and of protecting against the variance from one year to another of PPP calculations which is quite large (see Lequiller and Blades, 2006).

Table 1: Real GDP per-head. Percentage difference with respect to the euro area

| | 1970 | 1980 | 1990 | 1999 | 2006 | 1970-1998 | 1999-2006 | Weights |
|---|---|---|---|---|---|---|---|---|
| Germany | 5.9816 | 4.6662 | 5.2049 | 5.0789 | 2.7851 | 5.1641 | 2.8321 | 27.1819 |
| France | 6.2354 | 7.3947 | 4.5943 | 1.4335 | 0.7428 | 5.5033 | 1.1018 | 19.551 |
| Italy | 0.1412 | 3.6302 | 5.7794 | 3.2955 | -2.0718 | 3.1775 | 0.8867 | 19.2345 |
| Spain | -22.1873 | -25.8476 | -21.5717 | -17.8209 | -11.494 | -21.7787 | -13.2354 | 13.124 |
| Netherlands | 21.3416 | 13.73 | 10.1749 | 15.4823 | 16.2235 | 13.9666 | 15.6633 | 5.0325 |
| Greece | -16.6007 | -9.9608 | -29.4855 | -31.271 | -13.6088 | -19.972 | -21.3453 | 3.459 |
| Belgium | 10.7573 | 12.4221 | 10.0924 | 9.4879 | 11.207 | 10.9122 | 10.2991 | 3.404 |
| Portugal | -60.8551 | -54.9653 | -45.4417 | -38.4188 | -42.5336 | -50.7258 | -39.7879 | 3.3559 |
| Austria | 8.4662 | 13.6951 | 13.2693 | 15.5907 | 16.1375 | 13.3786 | 15.283 | 2.6414 |
| Finland | -2.3158 | 1.3018 | 5.7416 | 0.7445 | 11.9744 | 0.14 | 6.7632 | 1.6837 |
| Ireland | -41.8626 | -38.9094 | -27.5039 | 3.3636 | 28.1836 | -30.655 | 22.0886 | 1.1994 |
| Luxembourg | 47.5378 | 36.8334 | 59.3318 | 68.7465 | 86.1238 | 51.2636 | 80.3809 | 0.1328 |

The table reports the percentage difference between the euro area and each country in specific periods and on average before and after the inception of the euro. The countries are ordered accordingly to the average population share over the entire period, as reported in the last column

difference in levels of less than 5% between the GDP per head of two different countries should not be considered really significant (Lequiller and Blades, 2006). For example, for Greece, recent changes in the construction of the official statistics have produced a series which does not seem to be reliable[3]

The differences between GDP per capita of countries of the core and periphery, however, is economically significant since it exceeds 10%.

It is interesting to note that the countries in the core group have remained homogeneous throughout the sample while countries with heterogeneous starting conditions have no general tendency to become closer to the euro area. Differences in levels of economic activity are persistent. Some countries seem to converge, like Spain, others do not seem to catch up, like Greece. Ireland, on the other hand, caught up and over overshot. Overall, by superficial inspections of these numbers, nothing much seems to have changed since the nineties. The same findings are in Giannone and Reichlin (2006).

# 5 Business cycles

Rather than filter data, we consider annual growth rate. This is partly because business cycle facts are not robust to different de-trending techniques (see, for example, Canova (1998)) and annual growth rates are easily interpretable, partly because considering any smoother component of growth rates implies

[3]Greek national accounts were revised in September 2006 to take into account underground activity, raising the level of output by about 26% (see Fund, 2007).

extracting a moving average with the consequence of losing points at the end of the sample, which, for the EMU regime, is already quite short.

Since each country's growth depends on both euro area developments and its idiosyncratic dynamics it is useful to consider the following decomposition:

$$\Delta y_{i,t} = \Delta y_{ea,t} + (\Delta y_{i,t} - \Delta y_{ea,t})$$

where $\Delta$ is the difference operator.

The variations in the gap $(\Delta y_{i,t} - \Delta y_{ea,t})$, which is the growth differential with respect to the euro area, represent country specific business cycle developments which may originate either in idiosyncratic shocks or in heterogenous reactions to euro area shocks. This is a rough measure of business cycle heterogeneity.

Table (2) reports estimates for average growth and its variance. Estimates are computed for different sub-samples.

Results are also reported for a test on whether the numbers are significantly different across periods. The test is constructed by comparing the measure computed using the observed post-EMU data and the distribution of the measures we obtained by using block bootstrap over the pre-emu period. Stars indicate that there have been significant changes in our measures after the EMU.[4]

For most countries, the average rate of growth was lower during the EMU period. However, the difference is not significant, except for Austria and Italy. The same is true for the variance which has decreased everywhere, but significantly only for Greece (it should be recalled that numbers for Greece are not very reliable).

Let us now analyze the pattern of heterogeneity. To this end we consider the quadratic mean of growth differentials and look at its cross-sectional and time series pattern.

The choice of this statistic is motivated by the fact that it has a simple economic interpretation.

Following Kalemli-Ozcan, Sorensen, and Yosha (2001), we assume log utility and define utility in autarky as $U^A$ and utility in a full risk sharing equilibrium as $U^S$. Under normality and the assumption that

[4]Statistical significance have been assessed by using block bootstrap, with block of length two year.

Table 2: Annual growth rates of real GDP per-head

| Countries | Average Growth Rate | | Variance Growth Rate | |
|---|---|---|---|---|
| | Pre EMU | EMU | Pre EMU | EMU |
| Euro Area | 2.24 | 1.59 | 2.30 | 1.27 |
| Germany | 2.21 | 1.30 | 2.64 | 1.58 |
| France | 2.07 | 1.50 | 2.70 | 1.05 |
| Italy | 2.35 | 0.92** | 3.96 | 2.13 |
| Spain | 2.40 | 2.38 | 4.62 | 1.30 |
| Netherlands | 2.03 | 1.68 | 2.36 | 2.47 |
| Greece | 1.71 | 3.80 | 12.29 | 0.28*** |
| Belgium | 2.20 | 1.80 | 3.29 | 1.37 |
| Portugal | 3.04 | 1.07 | 14.03 | 2.68 |
| Austria | 2.50 | 1.66* | 3.01 | 1.30 |
| Finland | 2.35 | 2.99 | 9.57 | 1.56 |
| Ireland | 3.85 | 4.69 | 7.90 | 5.39 |
| Luxembourg | 3.00 | 3.76 | 11.48 | 4.42 |

The table reports (i) the average real GDP per capita growth rate, (ii) the variance of the growth rate of the euro area and the twelve countries we study. One (two, three) star(s) indicates that the EMU values are significantly different from those in the Pre Emu period at 10 (5, 1)% confidence level.

output is a random walk, we have:

$$U^A[Y_{i,0}(1+G_i)] = U^S[Y_{i,0}]$$

where

$$G_i = \frac{1}{2\delta}\mathrm{E}(\Delta y_{,ti} - \Delta y_{ea,t})^2$$

is the permanent increase in output needed to compensate an average consumer in an autarkic country for not being in a full risk sharing equilibrium and $\delta$ is the inter-temporal discount rate.

As noted by Kalemli-Ozcan, Sorensen, and Yosha (2001), under these simplifying assumptions, $G_i$ can be used as a measure of the gains from risk sharing. This is explained as follows. In the extreme case in which the countries that are members of the monetary union are able to fully share risk, only area wide fluctuations matter and asymmetries are painless. At the other extreme, if countries are autarkic, they are forced to consume at each point in time what they produce and asymmetries are painful. How economically important asymmetries are depends on how close we are to autarky[5].

[5]Of course a measure of the costs of business cycle asymmetries should be based on data on consumption as well as output. Giannone and Reichlin (2006), for example, use output and consumption data and apply the method proposed by Sorensen and Yosha (1998) to assess the changes in the degree of risk sharing within the euro area over time. They find that risk sharing has increased in the last decade.

Notice that, the quadratic mean of the growth differential of country $i$ with respect to the euro area, apart from a scaling coefficient, is an estimate of $G_i$ .

We first ask whether our measure of asymmetry is related to the initial (nineteen seventies) level of the gaps.

In Figure (2) we plot the quadratic mean of the growth differential for each member country against the differentials in starting conditions, measured by the gap in GDP per capita in 1970.

INSERT FIGURE 2 OVER HERE

Heterogeneity is smaller for those countries that were closer to each other in the seventies in terms of levels of GDP (the exception is Finland, which experienced an idiosyncratic period of volatility in the early nineties related to the banking crisis). For those countries the average quadratic growth differential is also small with respect to the variance of GDP growth (see Table 2).

Since the ratio between the mean of the quadratic gap and the the variance of GDP growth is equal to the variance explained by the euro area under the assumption of extreme symmetry (i.e. assuming that the expected growth of each country GDP, given the euro area GDP is equal to the euro area GDP growth itself), our results suggest that most of the business cycle fluctuations in countries with similar starting conditions are driven by euro area wide shocks which propagate in an homogeneous way.

Let us now look at heterogeneity over time. Has it changed since the seventies?

To this end we compute the statistics:

$$\frac{1}{2H+1}\sum_{h=-H}^{H}\left[\sum_{i=1}^{12}\omega_{i,t}(\Delta y_{i,t+h}-y_{ea,t+h})^2\right]$$

where $\omega_{i,t}$ is the share of population in country $i$ relative to the euro area during the year $t$: at any point in time this is a measure of cross-sectional dispersion of growth rates across member countries. Countries are weighted according to their size. The measure is temporally smoothed by taking a centered moving average.

Since population weights are quite constant over time, the measure can be interpreted as the weighted cross-sectional average of the quadratic mean of the gap of the dispersion of GDP growth between

member countries and the area average, the economic meaning of which we discussed above:

$$\sum_{i=1}^{12} \overline{\omega}_i \left[ \frac{1}{2H+1} \sum_{h=-H}^{H} (\Delta y_{i,t+h} - y_{ea,t+h})^2 \right]$$

where $\overline{\omega}_i$ is the average population weight of the member country $i$.

Results are illustrated in Figure 3 below.

INSERT FIGURE 3 OVER HERE

Cross-sectional dispersion today is less than half of what is was at the beginning of the sample. Dispersion clearly declined in the early eighties, reflecting the worldwide decline of business cycle volatility (for an exhaustive documentation of decline in world-wide volatility, see Stock and Watson (2005)). No significant variation of dispersion is associated to the EMU.

To sum up, asymmetries are very small for countries with similar level of development and larger for countries with low GDP per capita relative to the euro area. Asymmetries have declined over time as an effect of decline output volatility in the early eighties ("Great Moderation"). Since asymmetries have changed very little as a consequence of the EMU, the costs of business cycle heterogeneity associated with it have been small.

# 6 A model of dynamic interactions among member countries

To go beyond descriptive statistics, we must build a model to study cross-country dynamic interaction in economic activity.

We have chosen to base our analysis on output data only. This is obviously a narrow approach, but it is justified on two grounds.

First, as it is well documented, nominal variables have been converging since the early nineties to reach similar levels at the end of the decade. This allows the design of a control experiment where real activity in a period of nominal heterogeneity can be compared with real activity with nominal homogeneity and it is an alternative way to estimate a model for the whole period, including also nominal variables.

Therefore it makes sense to study the dynamic relation amongst real variables only, provided that we try to understand the changes induced by the EMU.

Second, although, in principle, other real information like consumption and external accounts is informative on the effect of the EMU (see Blanchard, 2006; Boivin, Giannoni, and Mojon, 2008; Lane, 2006, among others), heterogeneity in these variables should be reflected in output dynamics, unless they were leading indicators of output. There is no clear evidence, however, that consumption and current account have predictive power for GDP.

Our controlled experiment consists of computing the expected path of a member country, conditioning on the pre-EMU correlation structure and on the entire path of the euro area, and then asks whether intra euro area relations have changed since the EMU.

The model is a VAR on output per capita of twelve countries of the euro area. A VAR is a very general dynamic model suitable for describing dynamic correlations. Moreover, a VAR can be estimated with level variables allowing common trends to be taken into account .

We collect all the time series in a vector $Y_t = (y_{1,t}, ..., y_{12,t})'$. We consider the model

$$Y_t = c + A_1 Y_{t-1} + ... + A_p Y_{t-p} + e_t$$

where $e_t \sim \mathrm{WN}(0, \Sigma)$.

Since, with twelve variables and twenty nine years of data, there are too many parameters to estimate, we use Bayesian shrinkage and set the shrinkage parameter as in Banbura and Reichlin (2008)[6]

Let us denote the vector of the estimated parameters for the pre-EMU years as $\theta_{\mathrm{pre-emu}}$.

The expectation of GDP per capita for each member country on the basis of pre-EMU data, conditional on the aggregate outcome, that is the entire (pre and post EMU) path of area-wide aggregate GDP, is:

$$\Delta\hat{y}_{i,t|ea} = \mathrm{E}_{\theta_{\mathrm{pre-emu}}}\left[y_{i,t}|y_{ea,70}, y_{ea,71}, ..., y_{ea,05}, y_{ea,06}\right]$$

for t=70,...,06[7] where $y_{ea,t}$ denotes the euro area average output per capita[8].

[6]We set the tightness parameter such that the in-sample fit for the euro area growth is the same found with a bivariate VAR with euro area and US GDP.

[7]The conditional mean is computed using the Kalman filter and the confidence bands are computed using the Carter and Kohn algorithm. For details see Giannone and Lenza (2008).

[8]The algorithm used to compute the conditional expectation is the same as in Giannone and Lenza (2008).

Notice that $y_{ea,t}$ is approximately equal to $\omega_{1,t}y_{1,t} + ... + \omega_{12,t}y_{12,t}$ where $\omega_{i,t}$ is the share of population in country $i$ relative to the euro area during the year $t$.

Figure 4 reports results for core countries. Figure 5 provides results for the other group, but also includes Finland. The charts report 68% and 95% confidence intervals around the conditional forecast and realized GDP growth in country $i$'s and in the euro area.

Let us first analyze the pre-EMU years, on the basis of which we have estimated the parameters.

What emerges from the Figures is that, for the countries of the core, uncertainty around the country's forecasts, conditional on observed area-wide developments, is rather limited. Moreover, for each country, realized GDP growth is within the confidence bands around the conditional forecasts. These two facts indicate that country specific fluctuations are rather limited and that the linkages among those countries and the aggregate are strong.

In addition, for each country, GDP growth is very close to the growth rate of the euro area.

Finally, the individual country's GDP growth forecasts, conditional on the euro area, are not significantly different from the euro area GDP growth itself. This is not only a further indication that asymmetric, idiosyncratic shocks are small, but also implies that asymmetries of the propagation of shocks are limited.

Let us now look at the conditional forecast for the EMU period, derived under the pre-EMU structure.

In general, the realized values are not significantly different from what we would have expected on the basis of euro area wide developments and the pre-EMU distribution. This suggests that there is no evidence in the breakdown in the inter-relationship amongst euro area member countries, although Austria, Italy and the Netherlands's growth is at the edge of the 68% confidence bands in the most recent period.

INSERT FIGURE 4 OVER HERE

INSERT FIGURE 5 OVER HERE

For the so-called periphery, the picture is more complex. For countries of this group, GDP growth dynamics is less similar to that of the euro area. However, uncertainty around the conditional forecast

is large, indicating that the linkages between each of these countries and the rest of the euro area have been rather weak. As a consequence of such uncertainty, realized GDP is, in general, not statistically different from the forecast conditional on the average. This is the case not only in the pre-EMU period, but also during the EMU years.

Spain and Portugal are interesting cases because uncertainty is more in line with that of the core group. However, while in Spain there is a high degree of similarity with euro area aggregate dynamics and realized GDP growth in the EMU period is exactly in line with the conditional expectation (in the center of the confidence bands), in Portugal, the forecast conditional on the euro area is more volatile than that of the euro area. Moreover, in Portugal, in the EMU period the realized GDP growth has been systematically in the lower part of the distribution of the forecast conditional on area wide developments.

Overall, these results tell us that some idiosyncracies are definitely present and, in general, they have not decreased over time, but they remain confined to the experience of small countries, both before and after the introduction of the common currency. Given the uncertainty, any statement on the real effect of the EMU in these countries is likely to be ill founded.

# 7 The area wide business cycle

In Table 2 we have seen that, during the EMU years, all countries of the euro area experienced a relatively low GDP growth. The average growth from 1971 to 1998 was approximately 2.2% while, from 1999 to 2006 it was approximately 1.6%.

Seven years of data is very little to perform historical comparisons since the average length of a business cycle is between six and nine years. However, we can perform a conditional exercise similar to the one proposed in the previous Section. While in that exercise we forecast each country GDP per capita conditional on the per-EMU structure and the observed path of euro area wide growth, here we forecast euro area growth, conditionally on the pre EMU structure and on the observed path of US GDP growth. The choice of the US as a conditioning variable, however, must be justified. To this end, we must show that the relationship between US and euro area GDP growth is tight and stable.

This is a controversial fact. For example, Alesina and Giavazzi (2006) studying the relation between

GDP per capita in the US and in the largest euro area countries since 1945, have claimed that, after a period of catch-up, the gap stabilized since the seventies, but widened again in the last decade. On the other hand, Giannone and Reichlin (2005) and Giannone and Reichlin (2006) show that since the 70s the euro area business cycle has experienced a stable relation with the cycle of the US.

Let us report some descriptive statistics on the US and euro area business cycle drawn from Giannone and Reichlin (2005) and Giannone and Reichlin (2006).

In the Figures below we show the level of GDP per head in the two areas of the world and the gap between the levels.

INSERT FIGURE 6 OVER HERE.

INSERT FIGURE 7 OVER HERE.

Clearly, the US and the euro area GDP per capita have moved along the same trend since 1970 with a gap that is stationary around a constant. GDP per capita has been on average 30% lower than in the US with no sign of catching up. Fluctuations in the gap reflect different duration and amplitude of the two cycles (see Giannone and Reichlin, 2005, for details).

Another key characteristic, illustrated in Figure 8 and Figure 9, is that the euro area growth lags the US. Figure 8 plots growth rates of GDP per-capita and Figure 9 its corresponding 5-years centered average where the leading-lagging relation emerges very clearly.

INSERT FIGURE 8 OVER HERE

INSERT FIGURE 9 OVER HERE

To show that the US leading relation with respect to the euro area is robust, we must also show that US GDP growth is a good predictor of euro area growth. The appendix shows this point by reporting both Granger causality tests (in-sample predictability) and out-of-sample results. Results in the appendix also show that the forecasting performances have not deteriorated with the EMU. This gives further

support to the hypothesis that the introduction of the euro has not significantly changed the historical transatlantic linkages. In spite of the relevant changes in the macroeconomic environment (the Great Moderation, German reunification, the euro area inception) the relationship between the US and euro area real economic activity highlighted in Giannone and Reichlin (2005) and Giannone and Reichlin (2006) has remained stable.

These results suggest that the euro area - US dynamics can be characterized as the euro area rate of growth adjusting itself to the US growth while the US not responding to shocks specific to the euro area[9].

All these results, and in particular the robustness of the out-of-sample forecast, indicate that US GDP is a good candidate as a control variable for the counterfactual exercise on the euro area.

As we did for the countries of the euro area, here we characterize the joint dynamics of the US and the euro area aggregate by mean of a VAR estimated until 1998. With the counterfactual we would then ask if the latter has changed. Precisely, we ask whether, conditionally on the US cycle and the structure of the euro area economy before the start of the EMU, we would have expected the growth rate observed between 1999 and 2006.

The VAR is now bivariate with $Y_t = (y_{US,t} \;\; y_{EA,t})$:

This exercise is complementary to the one performed in the previous sub-section. There we kept average euro area as given and explored changes in heterogeneity. Here we explore changes in the average growth. We ask whether the low growth of the euro area after 1998 should have been expected on the basis of the pre-1999 economic structure in the area and conditional on the present, past and future realization of the US growth.

Using the same notation as in previous section, we compute the conditional expectation:

$$\Delta\hat{y}_{i,t|ea} = \mathrm{E}_{\theta_{\mathrm{pre-emu}}}\left[y_{ea,t}|y_{us,70}, y_{US,71}, ..., y_{US,05}, y_{US,06}\right]$$

for t=70,...,06.

If observed euro area growth is in the bands of the conditional density, we should conclude that the

[9]Giannone and Reichlin (2005) use the restriction implied by the Granger causality tests to simulate levels of output and verify whether it is possible to reproduce the properties of the dating of business cycle identified from the data. They find that the model reproduces them with a large degree of accuracy.

slowdown would have been observed independently of the introduction of the euro. This is because, in that case, euro area growth is insignificantly different from what was expected on the basis of pre-EMU area parameters, conditional on external exogenous events.

INSERT FIGURE 10 OVER HERE

This exercise illustrates that we would have observed a large part of the slowdown, but not all. In particular, from 2001 till 2005 growth in Europe has been within the confidence bands of its conditional expectation given the US developments, but always on the lower side.

# 8 Conclusions

Contrary to the conjecture of the pessimists and to that of the optimists, the feature of euro area business cycles have hardly changed since the beginning of the EMU.

All evidence presented so far tells us the same story: in those countries of the EMU which started from similar initial conditions in terms of real activity in the seventies, business cycles are very similar and no significant change can be detected since 1999. For the other countries, there is a lot of uncertainty and not much can be said. No clear change since the EMU can be identified.

This is a simple story, but it has a a remarkable implication. Countries which have been hit by large asymmetric shocks in the form of large changes in real interest rates and real exchange rates since 1999, like Italy and Spain, have not shown output growth rates significantly different from countries which have faced smaller idiosyncratic shocks, like, for example, Germany or Belgium. Moreover, although the costs of the elimination of exchange rate adjustments and of independent monetary policy are likely to have been different across countries, this element of the EMU has not magnified asymmetries.

It remains to be explained why aggregate growth has been lower than expected.

# References


Agresti, A. M., and B. Mojon (2001): "Some stylised facts on the Euro area business cycle," Working Paper Series 095, European Central Bank.

Alesina, A., and F. Giavazzi (2006): *The Future of Europe: Reform or Decline*. The MIT Press.

Altissimo, F., A. Bassanetti, R. Cristadoro, M. Forni, M. Hallin, M. Lippi, and L. Reichlin (2001): "EuroCOIN: A Real Time Coincident Indicator of the Euro Area Business Cycle," CEPR Discussion Papers 3108.

Artis, M. (2003): "Is there a European Business Cycle?," Discussion paper.

Artis, M. J., M. Marcellino, and T. Proietti (2005): "Dating the Euro Area Business Cycle," in *Euro Area Business Cycle: Stylized Facts and Measurement Issues*, ed. by L. Reichlin, pp. 83–93. CEPR.

Artis, M. J., and W. Zhang (1997): "International Business Cycles and the ERM: Is There a European Business Cycle?," *International Journal of Finance & Economics*, 2(1), 1–16.

Banbura, Marta, D. G., and L. Reichlin (2008): "Large Bayesian VARs," Discussion Paper ??, ECB Working Paper Series.

Bank, E. C. (2007): "Output growth differentials in the euro area: sources and implications," *ECB Monthly Bullettin*, pp. 73–87.

Bayoumi, T., and B. Eichengreen (1992): "Shocking Aspects of European Monetary Unification," NBER Working Papers 3949, National Bureau of Economic Research, Inc.

Blanchard, O. (2006): "A Macroeconomic SUrvey of Europe," Discussion paper, mimeo.

Boivin, J., M. Giannoni, and B. Mojon (2008): "Macroeconomic Dynamics in the Euro Area," Discussion paper, mimeo.

Canova, F. (1998): "Detrending and business cycle facts," *Journal of Monetary Economics*, 41(3), 475–512.

Canova, F., M. Ciccarelli, and E. Ortega (2005): "Similarities and Convergence in G-7 Cycles," *Journal of Monetary Economics*, 54, 85–878.

——— (2008): "Did the Maastricht treaty or the ECB Creation Alter the European Business Cycle?," mimeo.

Croux, C., M. Forni, and L. Reichlin (2001): "A Measure Of Comovement For Economic Variables: Theory And Empirics," *The Review of Economics and Statistics*, 83(2), 232–241.

Fagan, G., J. Henry, and R. Mestre (2001): "An area-wide model (AWM) for the euro area," Working Paper Series 42, European Central Bank.

Forni, M., and L. Reichlin (2001): "Federal Policies and Local Economies: Europe and the US," *Journal of Financial Economics*, 45, 109–134.

Fund, I. M. (2007): *IMF country report No. 07/27*. IMF.

Giannone, D., and M. Lenza (2008): "Conditioanl forecasting with large Bayesian VARs," ECB Mimeo.

Giannone, D., and L. Reichlin (2005): "Euro Area and US Recessions, 1970-2003," in *Euro Area Business Cycle: Stylized Facts and Measurement Issues*, ed. by L. Reichlin, pp. 83–93. CEPR.

——— (2006): "Trends and cycles in the Euro Area: how much heterogeneity and should we worry about it?," Working Paper Series 595, European Central Bank.

Harding, D., and A. Pagan (2006): "Synchronization of cycles," *Journal of Econometrics*, 132(1), 59–79.

Helbling, T., and T. Bayoumi (2003): "Are they all in the same boat? The 2000-2001 growth slowdown and the G-7 business cycle linkages," Discussion paper.

Kalemli-Ozcan, S., B. E. Sorensen, and O. Yosha (2001): "Economic integration, industrial specialization, and the asymmetry of macroeconomic fluctuations," *Journal of International Economics*, 55(1), 107–137.

Kose, M. A., C. Otrok, and C. H. Whiteman (2003): "International Business Cycles: World, Region, and Country-Specific Factors," *American Economic Review*, 93(4), 1216–1239.

Lane, P. R. (2006): "The Real Effects of European Monetary Union," *Journal of Economic Perspectives*, 20(4), 47–66.

Lequiller, F., and D. Blades (2006): *Understanding National Accounts.* OECD, Paris.

Lumsdaine, R. L., and E. S. Prasad (2003): "Identifying the Common Component of International Economic Fluctuations: A New Approach," *Economic Journal*, 113(484), 101–127.

Monfort, A., J.-P. Renne, R. Rffer, and G. Vitale (2004): "Is Economic Activity in the G7 Synchronized? Common Shocks versus Spillover Effects," Discussion paper, EABCN/CEPRDiscussion Papers.

Negro, M. D., and C. Otrok (2008): "Dynamic factor models with time-varying parameters: measuring changes in international business cycles," Discussion paper.

Sorensen, B. E., and O. Yosha (1998): "International risk sharing and European monetary unification," *Journal of International Economics*, 45(2), 211–238.

Stock, J. H., and M. W. Watson (2005): "Understanding Changes in International Business Cycle Dynamics," *Journal of the European Economic Association*, 3(5), 969–1006.

**Appendix: predictive relation between the US and the Euro Area**

In this section, we evaluate the forecasting performance of the bivariate US - euro area VAR we used in Section 7.

Recall that the bivariate VAR was

$$Y_t = A(L)Y_{t-1} + Bu_t$$

with $Y_t = (y_{US,t} \;\; y_{EA,t})$ and $y_{US,t}$ and $y_{EA,t}$ indicating, respectively, the log-levels of the US and euro area per capita GDP.

The variable we target is the annualized h-period change of per capita GDP: $\frac{1}{h}(y_{i,t+h} - y_{i,t})$ where $i = EA, US$ and $h$ is the forecast horizon, which ranges from one to three years ahead. The full sample is 1970 - 2006 and we evaluate the forecasting performance of the model in the two samples 1980 - 2006 and 1999 - 2006.

The evaluation exercise is out-of-sample. For each period $t$ we estimate the bivariate VAR on the available information up to that period and iterate the VAR $h$ times forward to forecast US and euro area GDP $h$ periods ahead. We then update the database recursively until exhaustion of the sample. The VAR model is estimated with one lag, the same specification we used for the exercises in the main text.

We compare the performance of the bivariate VAR with a benchmark of non-forecastability, the random walk model, whose forecast at time $t$ for GDP growth per capita between time $t$ and $t+h$ is the estimated average GDP growth rate until time $t$.

We also report the outcomes of an AR(1) forecast for both US and euro area per capita GDP for the sake of assessing the contribution in terms of forecasting performance of the transatlantic linkages.

The table below can be split in two sections reporting the results for the evaluation samples 1980 - 2006 and 1999 - 2006. Results are cast in terms of the ratio of the Mean Squared Forecast error (MSFE) of the bivariate VAR and the AR(1) models with respect to the MSFE of the random walk model.

Starting with the first section of the table which refers to the 1980 - 2006 evaluation sample, rows from one to three refer to the three forecast horizons of one to three years ahead. Columns two and three

refer to the euro area while columns four and five are the analogous for the US. Notably, column two (four) reports the ratio of the mean squared forecast error of the VAR relative to the random walk model for the euro area (US) while column three (five) reports the ratio of the autoregressive forecast relative to the random walk model. A number smaller than one in the ratios indicates that the VAR or the autoregressive models outperform the random walk.

The second section of the table is the analogous of the first for the evaluation sample 1999 - 2006 and does not need further explanation.

| **Evaluation period** | **1980 - 2006** | | | | **1999 - 2006** | | | |
|---|---|---|---|---|---|---|---|---|
| **Countries** | Euro Area | | US | | Euro Area | | US | |
| **Ratio** | VAR/RW | AR/RW | VAR/RW | AR/RW | VAR/RW | AR/RW | VAR/RW | AR/RW |
| **h=1** | 0.51 | 0.96 | 1.24 | 1.15 | 0.66 | 0.81 | 1.00 | 1.02 |
| **h=2** | 0.52 | 1.02 | 1.29 | 1.25 | 0.66 | 0.83 | 1.17 | 1.16 |
| **h=3** | 0.67 | 1.08 | 1.48 | 1.46 | 0.78 | 0.94 | 1.44 | 1.39 |

Focusing on the 1980 - 2006 sample, first, it can be seen that US GDP per capita helps to forecast GDP per capita in the euro area. The MSFE error of the VAR model, in fact, is about half of the MSFE of the random walk and the AR(1) model at the one and two years ahead horizon and about 70% three years ahead. The euro area GDP per capita does not help to forecast US GDP, instead.

Results are qualitatively confirmed in the euro area sample 1999 - 2006 showing that, in particular, the forecasting performance of the bivariate VAR is robust to the changes in the monetary policy regime that came with the inception of the euro area.

Figure 1: Spectral densities: Germany and the US, 1970-1989

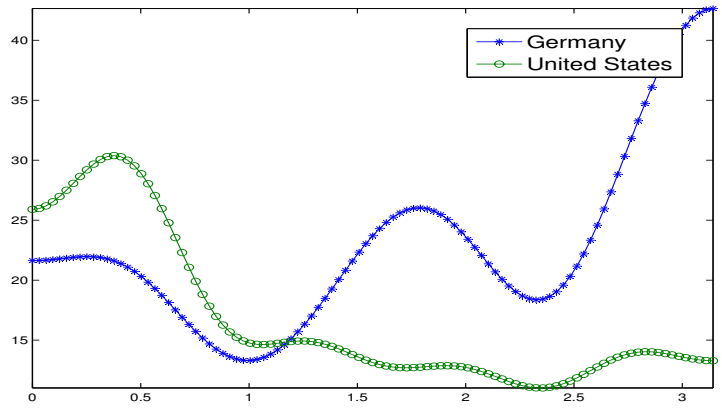



Figure 2: Growth dispersion and Starting Conditions

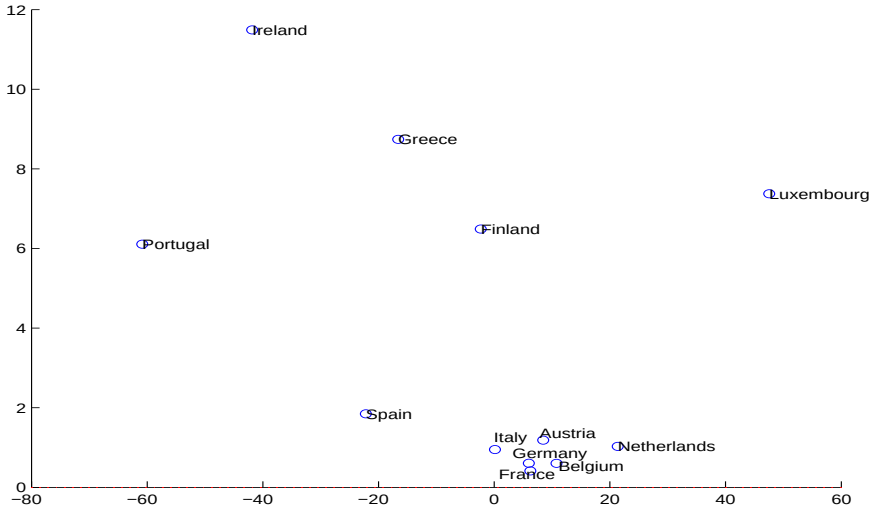


Figure 3: Cross-country growth dispersion

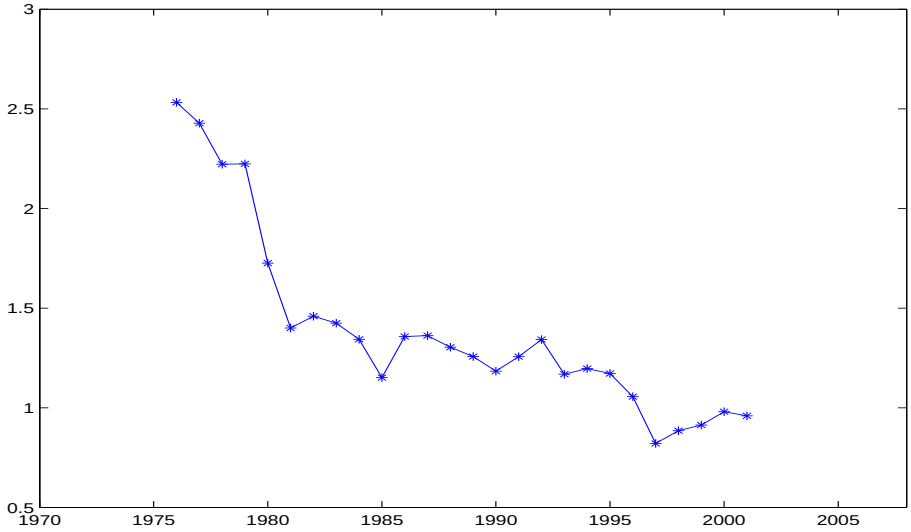
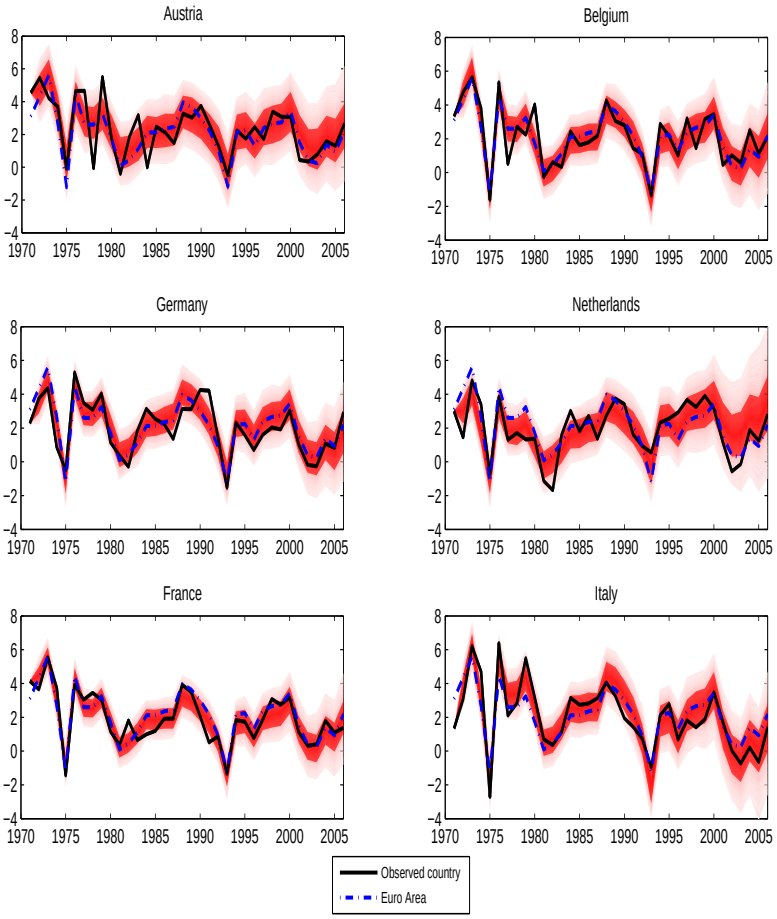
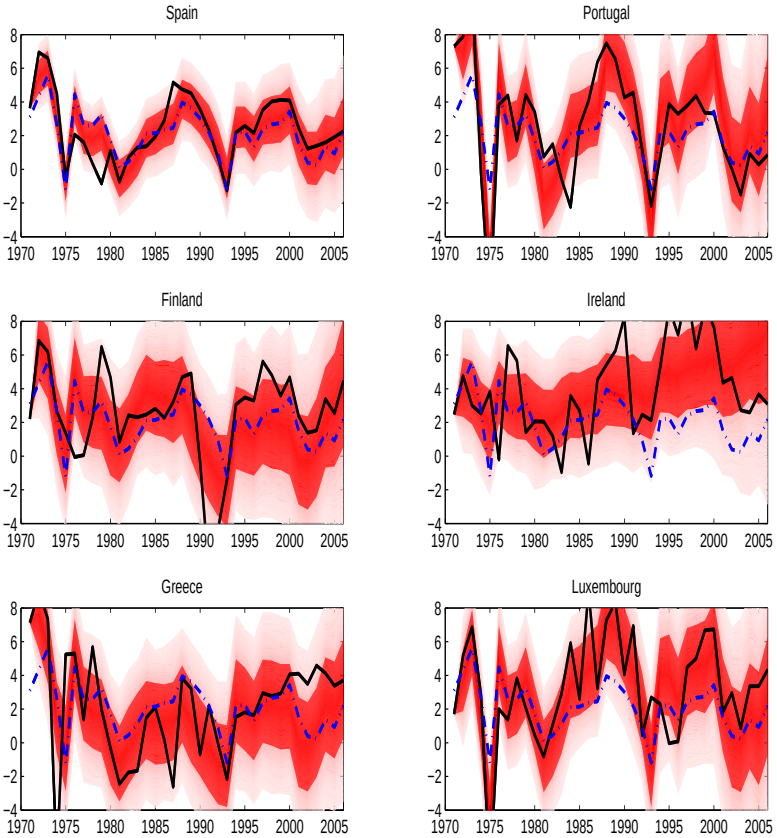


Figure 4: Conditional Expectations Given Area Wide Developments.




The figure reports GDP growth observed in each country and the Euro Area GDP growth. In addition we report upper and lower bounds for the GDP in each country conditional to the observation of the Euro Area GDP. The conditional expectations are computed using the parameters estimated using the sample 1970-1998

Figure 5: Conditional Expectations Given Area Wide Developments.




The figure reports GDP growth observed in each country and the Euro Area GDP growth. In addition we report upper and lower bounds for the GDP in each country conditional to the observation of the Euro Area GDP. The conditional distributions are computed using the parameters estimated using the sample 1970-1999

Figure 6: The (log) level of GDP per-head

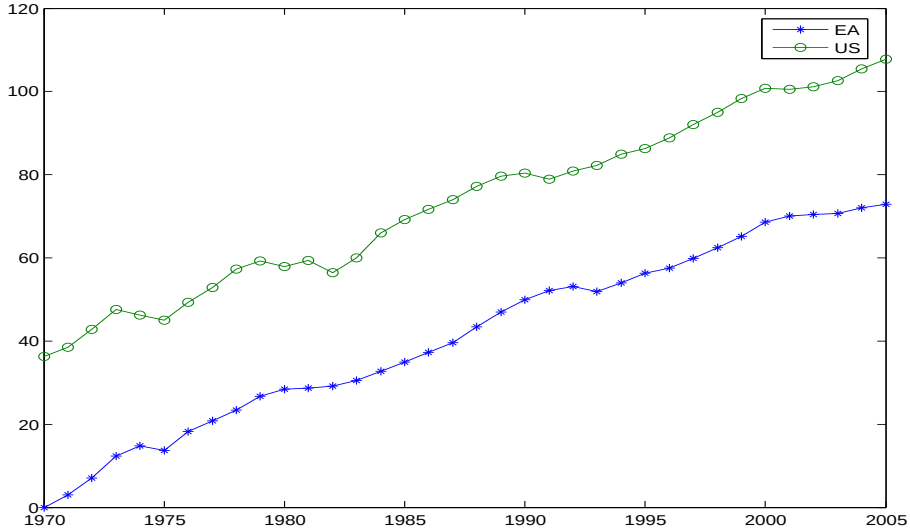



Figure 7: The transatlantic gap

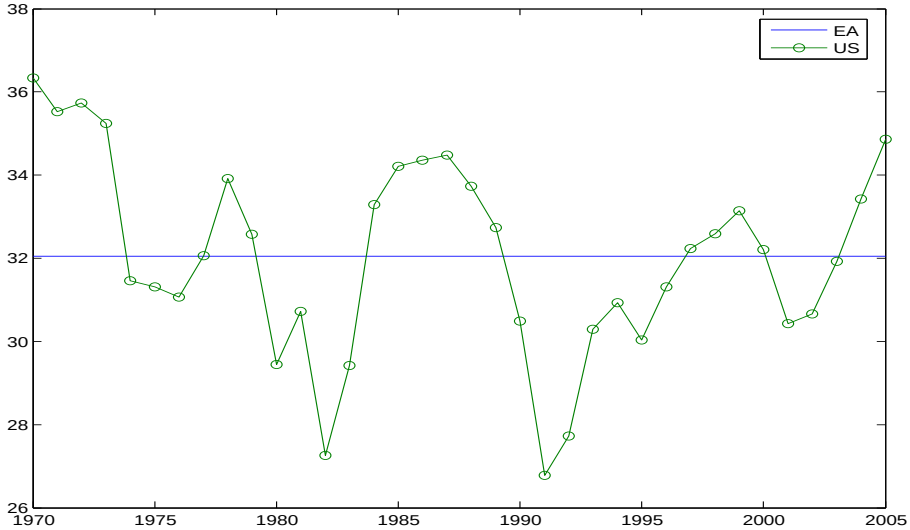


Figure 8: GDP growth rates

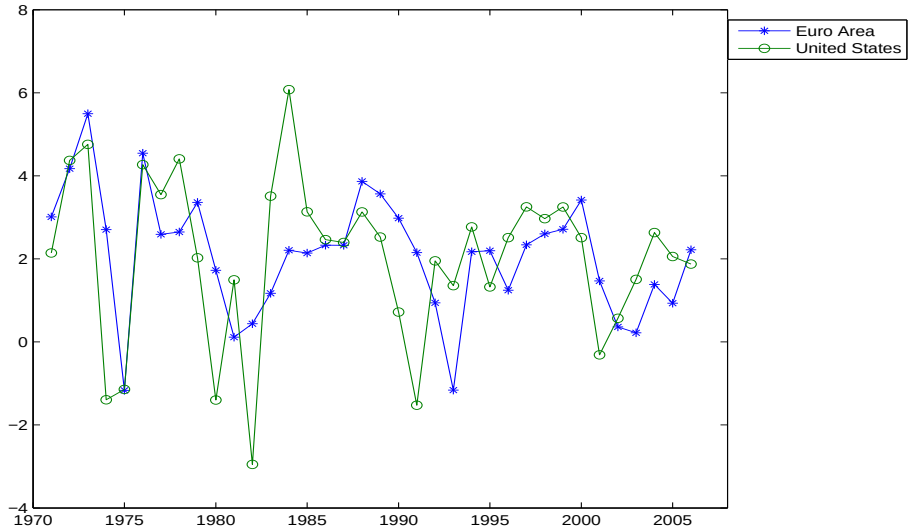



Figure 9: GDP growth rates: 5 years centered moving average

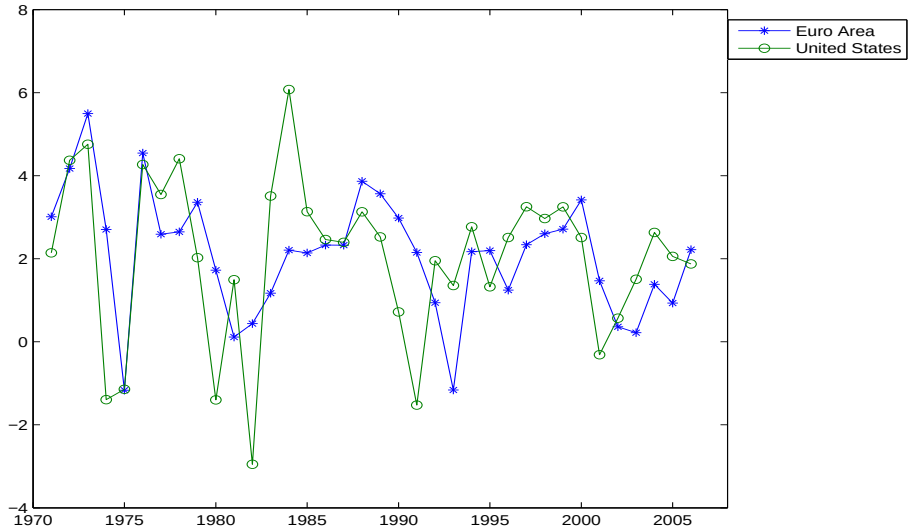


Figure 10: Euro Area GDP growth and its conditional expectations