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Chapter Author: Domenico Giannone, Michele Lenza, Lucrezia Reichlin

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Business Cycles in the Euro Area

Domenico Giannone, Michele Lenza,
and Lucrezia Reichlin

4.1 Introduction

When asked for his opinion in the 1960s on what 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 effects of the European Monetary Union (EMU) on euro area business cycles in 250 years. Indeed, some of these effects may take a long time to manifest themselves, as they result from changes in trade and specialization patterns across the euro area (see, for example, Krugman [1993] and Frankel and Rose [1998]).

However, other effects, such as the loss of flexibility in macroeconomic policies, emphasized, for example, by Feldstein (1998), have more immediate consequences on business cycles, and it should already be possible to identify them at the occasion of the tenth anniversary of the union.

A lot has been written on business-cycle synchronization within the euro area, and a few papers are trying to address how it has been affected by the EMU. The literature, however, is far from being consensual. (In the next section, we review the findings.) Moreover, very little is known about the

Domenico Giannone is professor of economics at the Université Libre de Bruxelles. Michele Lenza is an economist at the European Central Bank. Lucrezia Reichlin is professor of economics at the London Business School.

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Please address any comments to Domenico Giannone (dgiannon@ulb.ac.be), Michele Lenza (michele.lenza@ecb.europa.eu), or Lucrezia Reichlin (lreichlin@london.edu).

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. Because we are looking for robust results on a topic for which 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, because the well-documented changes in nominal variables and the convergence of inflation and interest rates that have taken place since the early 1990s, 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 gross domestic product (GDP) per capita only, disregarding other real indicators, such as labor market or consumption data. This choice is partly motivated by the 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 activity, and then we 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 that characterizes the joint output dynamics of the euro area countries and one that studies the euro area aggregate cycle in relation to that of the United States, 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, based on the economic structure prevailing before 1999 and conditioning on the observed path of euro area growth before and after 1999, we ask whether 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 U.S. GDP growth. The choice of U.S. output as a conditioning variable is motivated by the findings in Giannone and Reichlin (2005, 2006) and by some additional results reported here, which show that the dynamic correlation between U.S. and euro area growth is robust and has been stable over time.

Overall, the results of the chapter should reassure the early critics of the EMU. The level of heterogeneity that we have observed over the last ten years is 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 United States. However, the causes of slow growth do not appear to be related to the asymmetric adjustment to shocks emphasized in the discussion that took place ten years ago.

4.2 What Do We Know about the Euro Area Business Cycles?

There is a large empirical literature that describes the characteristics of business cycles and their evolution in Organization for Economic Cooperation and Development (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 noneuro area nations), the Group of 7 (G7), or a larger number of OECD economies. What we have learned about the euro area business cycles comes from this literature. Next, 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 the synchronization of recessions or use growth rates and filtered data to identify the cross-country pattern of comovements 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 exchange rate mechanism (ERM), the Maastricht treaty, and the EMU. Some studies have looked backward and have estimated the degree of heterogeneity of the response to common euro area, European, or world shocks before the inception of the EMU in order to infer on that basis what would have happened as a consequence of the single currency and to 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.

Because 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. Following is a review of the findings.

4.2.1 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 to date the turning points of its classical cycle has been pursued by the Center for Economic Policy Research (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 U.S. recessions as classified by the National Bureau of Economic Research (NBER; www.nber.org), although euro area turning points lag U.S. 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 been identified so far.

Turning points have also been established on the basis of a cyclical component extracted from many economic activity indicators. This component, the coincident indicator of the euro area business cycle (EuroCOIN), corresponds to a growth-cycle concept and is regularly updated by the CEPR (see www.CEPR.org and Altissimo et al. 2001).

4.2.2 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 that includes 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 et al. 2004). Others have emphasized the strong link between the U.S. and the euro area business cycle (Agresti and Mojon 2001; Canova, Ciccarelli, and Ortega 2005; Del 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. While some studies identify the emergence of a European cycle in the 1990s, some date it back to the 1970s, and others don't find it at all (see the following review).

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), on the basis of data including only a couple of years of the EMU sample, have shown that a regional component—orthogonal to the national one—explains a large component of national European cycles (around 30 percent).

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

4.2.3 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 1990s 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 that on a sample of twenty-three countries, 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 thirteen 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 slowdown 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 on seven euro area and three European noneuro area countries, Canova, Ciccarelli, and Ortega (2008) find that an 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-1980s. Del Negro and Otrok (2008), with data from 1970 to 2005, find no change in average cross-country correlations of euro area business cycles or for the larger set of European countries, while they do detect a decline in G7 average correlations.

4.2.4 Shocks and Propagations

Few studies have tried to assess the propagation of U.S., German, or world shocks across countries on the basis of semistructural or structural models.

Before the establishment of the EMU, Bayoumi and Eichengreen (1992), with a sample of twelve members of the European Union from 1960 to 1988, identify demand and supply shocks on the basis of countries' vector autoregressions (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, as well as a periphery (the United Kingdom, 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 to 2005 sample. They find that a large part of countries' business cycles 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 years of the EMU.

This review shows that although there is a broad consensus on the 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 of 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 a lack of robustness with respect to data filtering and statistical methods.

The attempt of our chapter is to reevaluate some of the facts as we try to emphasize robustness. We aim to characterize the features of the euro area cycle for member countries and for the aggregate since 1970 and to compare these characteristics with those of the U.S. 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.

4.3 Data

Business-cycle analysis is typically performed with quarterly data. However, to avoid measurement issues, and because our aim is to cover all euro area countries for a period of time—including a few full business cycles—we have made the choice of using annual data. Although we may lose information on short-term dynamics, we consider annual data to be 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 United States, where quarterly data are of relatively good quality, quarterly GDP growth exhibits a peak at business-cycle frequencies and the bulk of the variance at low frequencies. It is interesting to look at Germany for comparison.

Figure 4.1 plots the spectral density for Germany and the U.S. quarterly GDP for the sample from 1970 to 1989.

Clearly, German and U.S. quarterly GDP show a very different frequency

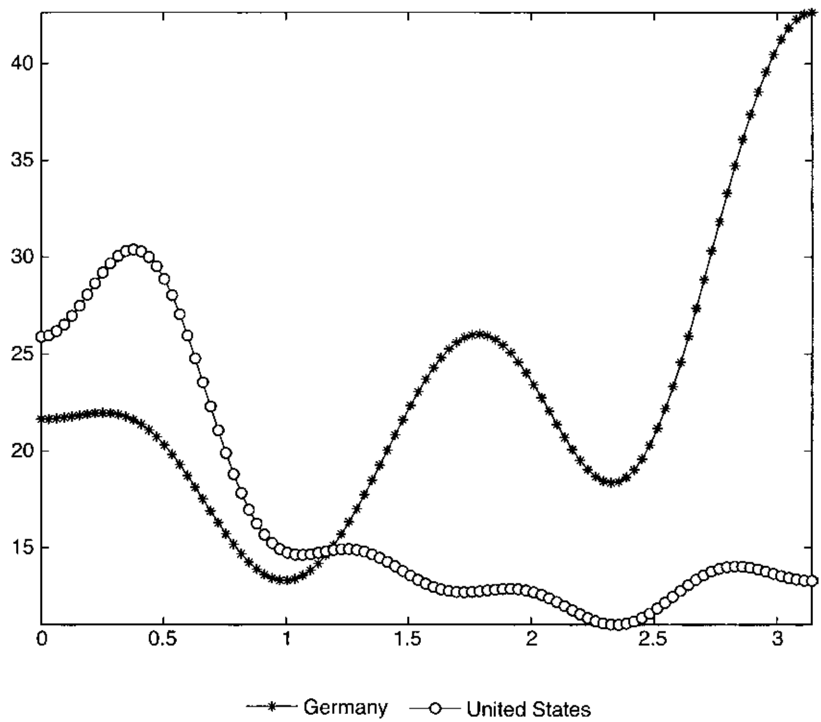

Fig. 4.1 Spectral densities: Germany and the United States, 1970 to 1989

Source: IMF International Statistics for GDP volume; 2000 = 100.

Note: The figure reports the spectral density of quarterly GDP growth in the United States and Germany in the 1970 to 1989 sample. The estimates are computed by using a Bartlett lag window of eight lags.

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 suggests that by using yearly data, the problem of measurement might be mitigated.

We consider real GDP per capita purchasing power parity (PPP) adjusted, because this facilitates international comparisons on the levels of economic activity. Data are PPP adjusted using 2000 weights. The sample is from 1970 to 2006.)[1]

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

4.4 Euro Area Economic Activity: 1970 to 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 1990s and the establishment of the euro in 1999.

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

Table 4.1 reports the percentage difference between the real GDP of each country and the euro area aggregate in different years and subperiods.

This corresponds to the last term of the expression:

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

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

The last column reports the population weights.

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

Looking at starting conditions in the 1970s, we can heuristically identify two groups of countries. The first is a core group with a 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). Second, 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.

1. The source is OECD, National Accounts. Data are constructed by using national series for GDP in volume at the prices of a common base year (2000) and then by 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 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 4.1 **Real GDP per head: Percentage difference with respect to the euro area**

	1970	1980	1990	1999	2006	1970 to 1998	1999 to 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
The 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

Note: 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 according to the average population share over the entire period, as reported in the last column.

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 difference in levels of less than 5 percent 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 that does not seem to be reliable.[2]

The difference between GDP per capita of countries of the core and periphery, however, is economically significant, because it exceeds 10 percent.

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, such as Spain; others do not seem to catch up, such as Greece. Ireland, on the other hand, caught up and overshot. Overall, by superficial inspections of these numbers, nothing much seems to have changed since the 1990s. The same findings are in Giannone and Reichlin (2006).

4.5 Business Cycles

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

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

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

where Δ is the difference operator.

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

2. Greek national accounts were revised in September 2006 to take into account underground activity, raising the level of output by about 26 percent. (See International Monetary Fund [2007]).

Table 4.2 **Annual growth rates of real GDP per head**

	Average growth rate		Variance growth rate	
Countries	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
The 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

Note: The table reports (a) the average real GDP per capita growth rate and (b) the variance of the growth rate of the euro area and the twelve countries we study.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 4.2 reports estimates for average growth and its variance. Estimates are computed for different subsamples.

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. Asterisks indicate that there have been significant changes in our measures after the EMU.[3]

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

3. Statistical significance has been assessed by using block bootstrap, with blocks of two years in length.

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 output is a random walk, we have:

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

where $G_i = (1/2\delta)E(\Delta y_{i,t} - \Delta y_{\mathrm{ea},t})^2$ 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 δ is the intertemporal 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.[4]

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 (1970s) level of the gaps.

In figure 4.2, 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.

Heterogeneity is smaller for those countries that were closer to each other in the 1970s in terms of levels of GDP. (The exception is Finland, which experienced an idiosyncratic period of volatility in the early 1990s 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 4.2).

Because the ratio between the mean of the quadratic gap and 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 1970s?

4. 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.

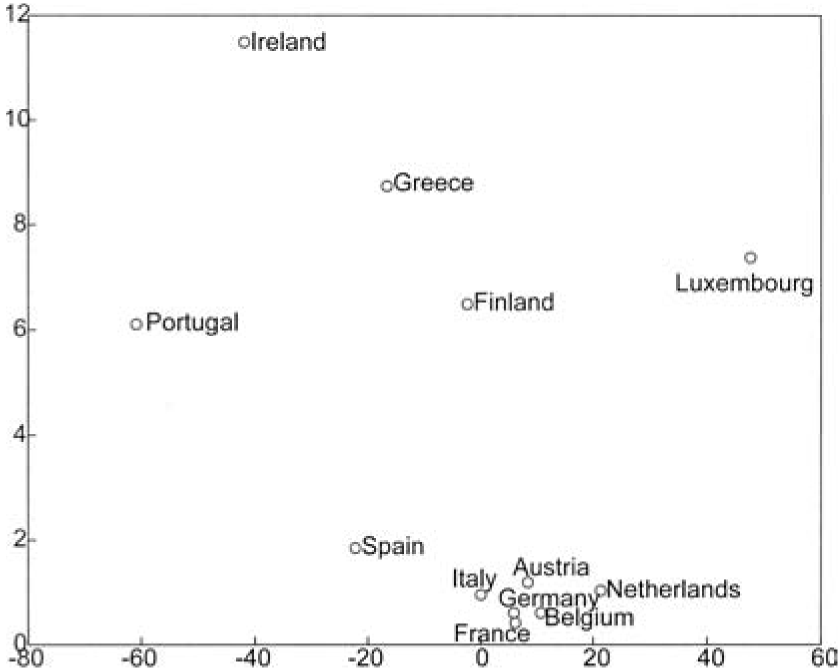

Fig. 4.2 Growth dispersion and starting conditions

Source: OECD, National Accounts.

Note: The figure plots the quadratic mean of the differential in GDP growth in twelve euro area countries (computed in the sample 1971 to 2006) against the gap in 1970 GDP per capita levels in each country with respect to the euro area aggregate.

To this end, we compute the statistics:

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

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.

Because 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 previously discussed:

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

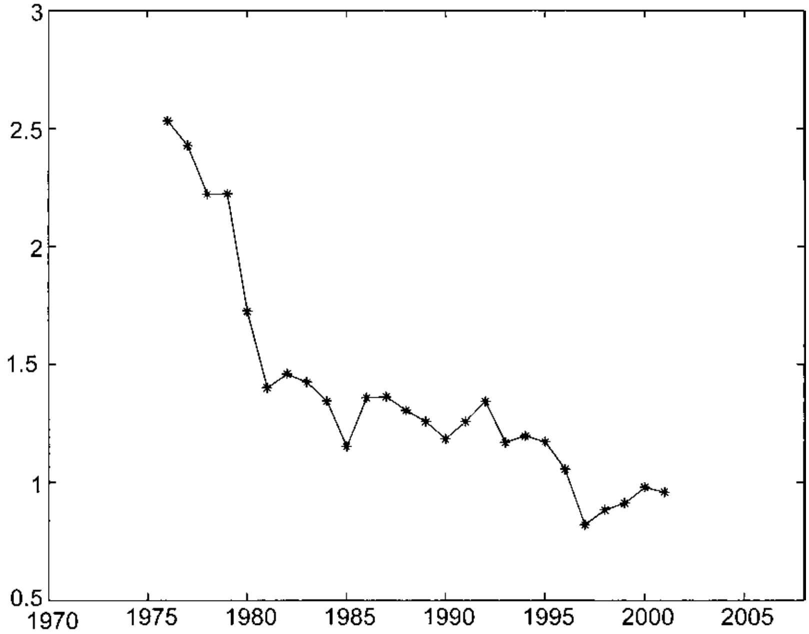

Fig. 4.3 Cross-country growth dispersion

Source: OECD, National Accounts.

Note: The figure reports $[1/(2H+1)]\sum_{h=-H}^{H}[\sum_{i=1}^{12}\omega_{i,t}(\Delta y_{i,t+h} - \Delta y_{\mathrm{ea},t+h})^2]$, a measure of cross-sectional dispersion of GDP growth rates across member countries of the euro area.

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

Results are illustrated in figure 4.3.

Cross-sectional dispersion today is less than half of what it was at the beginning of the sample. Dispersion clearly declined in the early 1980s—much earlier than the inception of the EMU, the fiscal and nominal convergence started with the Maastricht treaty, and the acceleration of financial and good market integration witnessed since the late 1980s.[5]

To sum up, asymmetries are very small for countries with a similar level of development and are 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 1980s (the Great Moderation). Because asymmetries have changed very little as a consequence of the EMU, the costs of business-cycle heterogeneity associated with it have been small.

5. The reduction in cross-country dispersion in business-cycle fluctuations coincides with a worldwide moderation of business-cycle fluctuations, which took place since the mid-1980s. For an exhaustive documentation of the decline in worldwide volatility, see Stock and Watson (2005).

4.6 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 1990s 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 such as consumption and external accounts is informative on the effect of the EMU (see Blanchard [2006]; Boivin, Giannoni, and Mojon [2008]; and 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 accounts 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 intraeuro 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 that is suitable for describing dynamic correlations. Moreover, a VAR can be estimated with level variables, which allows common trends to be taken into account.

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

$$Y_t = c + A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + e_t,$$

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

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

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

The expectation of GDP per capita for each member country on the basis

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 U.S. GDP.

of pre-EMU data, conditional on the aggregate outcome, that is the entire (pre- and post-EMU) path of area-wide aggregate GDP is:

$$\Delta\hat{y}_{i,t|\mathrm{ea}} = E_{\theta_{\mathrm{pre-emu}}}[y_{i,t}|y_{\mathrm{ea},70}, y_{\mathrm{ea},71}, \ldots, y_{\mathrm{ea},05}, y_{\mathrm{ea},06}] \text{ for } t = 70, \ldots, 06,$$

where $y_{\mathrm{ea},t}$ denotes the euro area average output per capita. We also compute uncertainty around the conditional expectations, which allows us to assess the statistical significance of the differences between observed euro area and country growth rates and the conditional expectations of the latter.[7]

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

Figure 4.4 reports results for core countries. Figure 4.5 provides results for the other group but also includes Finland. The charts report 68 percent and 95 percent confidence intervals around the conditional forecast and realized GDP growth in country i 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 it also implies that asymmetries in 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 interrelationship amongst euro area member countries, although the growth of Austria, Italy, and the Netherlands is at the edge of the 68 percent confidence bands in the most recent period.

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

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).

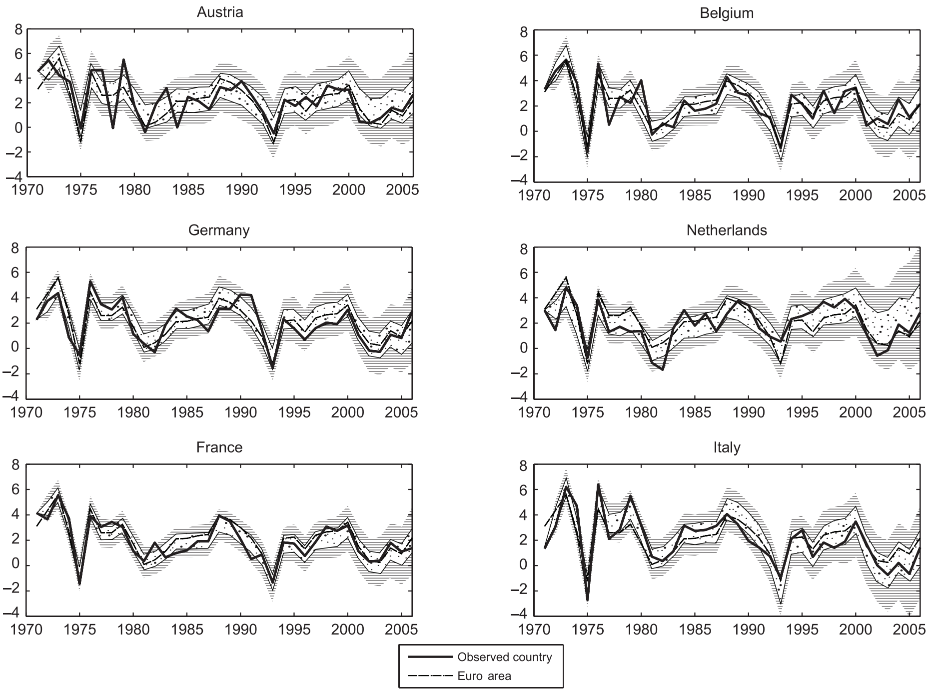

Fig. 4.4 Conditional expectations, given area-wide developments

Source: OECD, National Accounts.

Note: The figure reports GDP growth observed in each country and the euro area GDP growth. In addition, we report upper and lower bounds (black for the 68 percent and gray for the 95 percent confidence bands) 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 from 1970 to 1998.

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 generally 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, the realized GDP growth in the EMU period has been systematic in the lower part of the distribution of the forecast conditional on area-wide developments.

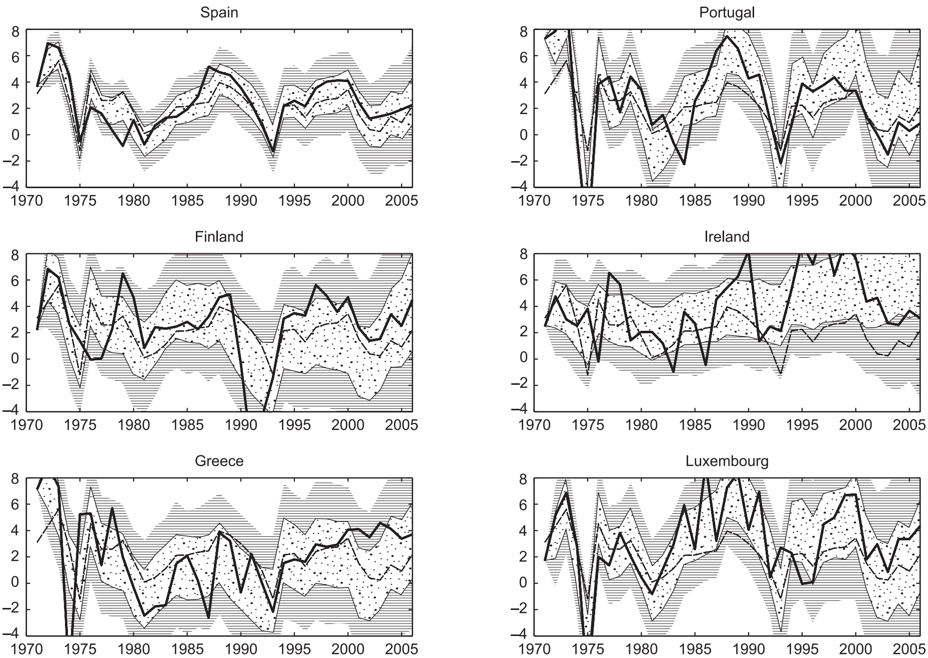

Fig. 4.5 Conditional expectations, given area-wide developments

Source: OECD, National Accounts.

Note: The figure reports GDP growth observed in each country and the euro area GDP growth. In addition, we report upper and lower bounds (black for the 68 percent and gray for the 95 percent confidence bands) 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 from 1970 to 1998.

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.

4.7 The Area-Wide Business Cycle

In table 4.2, 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 percent, while from 1999 to 2006, it was approximately 1.6 percent.

Seven years of data is very little to perform historical comparisons, as 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. In that exercise, we forecast each country GDP per capita conditional on the pre-EMU structure and the observed path of euro area-wide growth, while here, we forecast euro area growth, conditional on the pre-EMU structure and on the observed path of U.S. GDP growth. The choice of the United States as a conditioning variable, however, must be justified. To this end, we must show that the relationship between U.S. and euro area GDP growth is tight and stable.

This is a controversial fact. For example, Alesina and Giavazzi (2006) have studied the relation between GDP per capita in the United States and in the largest euro area countries since 1945 and have claimed that after a period of catch-up, the gap stabilized since the 1970s but widened again in the last decade. On the other hand, Giannone and Reichlin (2005, 2006) show that since the 1970s, the euro area business cycle has experienced a stable relation with the cycle of the United States.

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

In figures 4.6 and 4.7, we show the level of GDP per head in the two areas of the world and the gap between the levels.

Clearly, the U.S. and the euro area GDP per capita have moved along the same trend since 1970, with a gap that is stationary around a constant. On average, GDP per capita has been 30 percent lower than in the United States, 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 figures 4.8 and 4.9, is that the

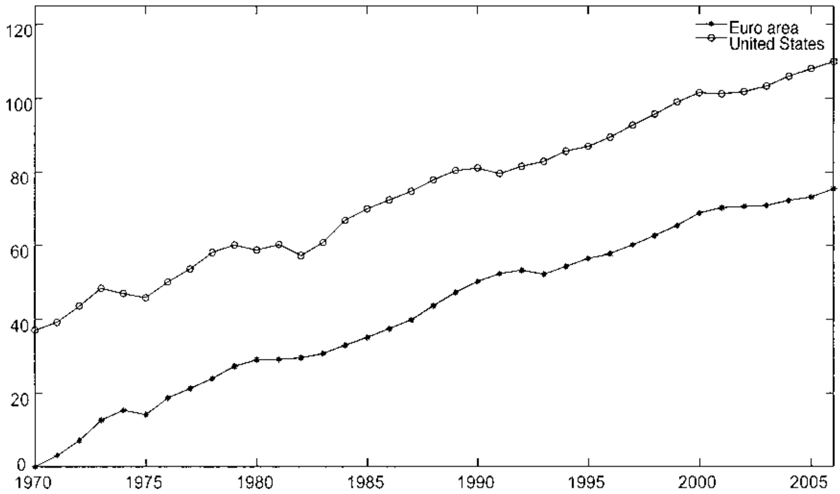

Fig. 4.6 The (log) level of GDP per head

Source: OECD, National Accounts.

Note: The figure reports the log-level of GDP per head in the United States and the euro area in the sample from 1970 to 2006.

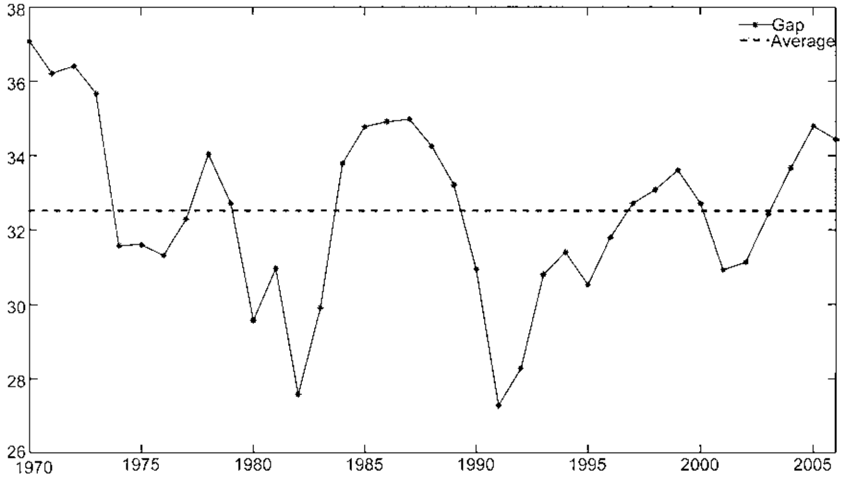

Fig. 4.7 The transatlantic gap

Source: OECD, National Accounts.

Note: The figure reports the difference between the log-levels of GDP per head in the United States and the euro area in the sample from 1970 to 2006.

euro area growth lags the United States. Figure 4.8 plots growth rates of GDP per capita, and figure 4.9 plots its corresponding five-years centered average, where the leading-lagging relation emerges very clearly.

To show that the U.S. leading relation with respect to the euro area is robust, we must also show that U.S. 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 U.S. and euro area real economic activity highlighted in Giannone and Reichlin (2005, 2006) has remained stable.

These results suggest that the euro area-U.S. dynamics can be characterized by the euro area rate of growth adjusting itself to the U.S. growth, with the United States not responding to shocks specific to the euro area.[8]

All these results, and particularly the robustness of the out-of-sample

8. Giannone and Reichlin (2005) use the restriction implied by the Granger causality tests to simulate levels of output and to 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.

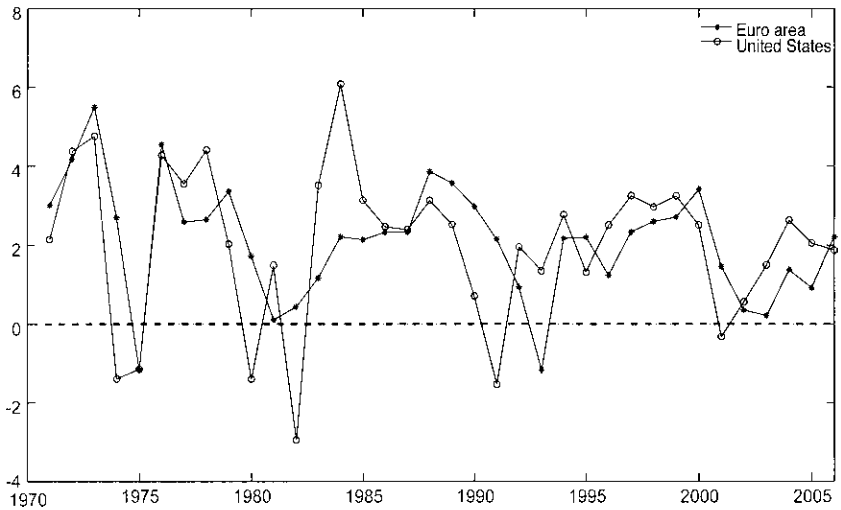

Fig. 4.8 GDP growth rates

Source: OECD, National Accounts.

Note: The figure reports the annual growth rates of GDP per head in the United States and the euro area in the sample from 1971 to 2006.

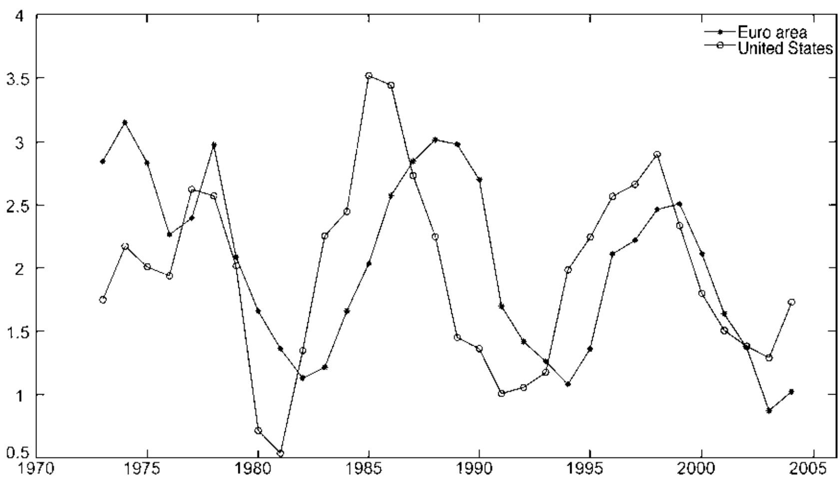

Fig. 4.9 GDP growth rates: five-years centered moving average

Source: OECD, National Accounts.

Note: The figure reports the five-years centered moving averages of annual growth rates of GDP per head in the United States and the euro area in the sample from 1973 to 2004.

forecast, indicate that U.S. 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 U.S. and the euro area aggregate by means of a VAR estimated until 1998. With the counterfactual, we would then ask if the latter has changed. Precisely, conditional on the U.S. cycle and the structure of the euro area economy before the start of the EMU, we ask whether we would have expected the growth rate observed between 1999 and 2006.

The VAR is now bivariate with $Y_t = (y_{\text{us},t}\, y_{\text{ea},t})$.

This exercise is complementary to the one performed in the previous subsection. 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 U.S. growth.

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

$$\Delta\hat{y}_{i,t|\text{ea}} = E_{\theta_{\text{pre-emu}}}[y_{\text{ea},t}|y_{\text{us},70}, y_{\text{us},71}, \ldots, y_{\text{us},05}, y_{\text{us},06}] \text{ for } t = 70, \ldots, 06.$$

Figure 4.10 illustrates that we would have observed a large part of the slowdown but not all of it. In fact, for each year since the inception of EMU, euro area growth is not significantly different from what is expected on the basis of pre-EMU economic structure and the U.S. business cycle. However, from 2001 to 2005, growth in the euro area is always on the lower side of the confidence bands.

4.8 Conclusions

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

We have identified two groups of countries. The first is composed of EMU members that had similar levels of GDP per capita at the beginning of our sample in the 1970s. These countries have also experienced similar business cycles throughout the sample period, and the establishment of the EMU has not changed this pattern. The second group is composed by member states with levels of economic activity that were more heterogeneous and that have historically been more volatile. For these countries, business cycles have been less correlated with the rest of the euro area throughout the period, and again, no change can be detected with the inception of the single currency.

This story has a remarkable implication. The loss of flexibility in exchange rate and monetary policy had almost no effect on output comovements across countries, even if, as it has been emphasized by many observers, EMU member states have differed from one another for what concerns degree of competitiveness, real interest rates, and other economic characteristics.

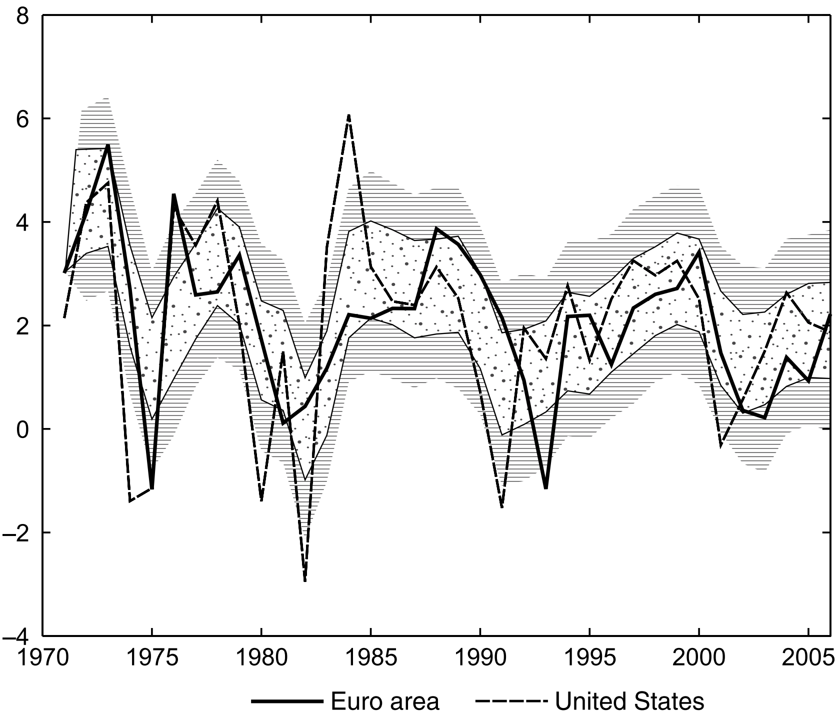

Fig. 4.10 Euro area GDP growth and its conditional expectations

Source: OECD, National Accounts.

Note: The figure reports GDP growth observed in the United States and the euro area. In addition, we report upper and lower bounds (black for the 68 percent and gray for the 95 percent confidence bands) for the GDP growth in the euro area, conditional to the observation of the U.S. GDP. The conditional distributions are computed using the parameters estimated using the sample from 1970 to 1998.

Finally, we have shown that part but not all of the relatively slow growth of the euro area in the first years of the millennium can be attributed to the lagged response to the U.S. cycle.

Appendix

Predictive Relation between the United States and the Euro Area

In this section, we evaluate the forecasting performance of the bivariate U.S.-euro area VAR we used in section 4.7.

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 the log levels of the U.S. and euro area per capita GDP, respectively.

The variable we target is the annualized h-period change of per capita GDP: $(1/h)(y_{i,t+h} - y_{i,t})$, where i = ea, us and h is the forecast horizon, which ranges from one to three years ahead. The full sample is from 1970 to 2006, and we evaluate the forecasting performance of the model in the two samples from 1980 to 2006 and from 1999 to 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 U.S. 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 nonforecastability, 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 U.S. and euro area per capita GDP for the sake of assessing the contribution in terms of forecasting performance of the transatlantic linkages.

Table 4A.1 can be split into two sections reporting the results for the evaluation samples from 1980 to 2006 and from 1999 to 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 to 2006 evaluation sample, rows from (1) to (3) refer to the three forecast horizons of one to three years ahead. Columns (2) and (3) refer to the euro area, while columns (4) and (5) are analogous for the United States. Notably, columns (2) and (4) report the ratio of the mean squared forecast error of the VAR relative to the random walk model for the euro area and United States, while columns (3) and (5) report the ratio of the autoregressive forecast relative to the random walk model. A number smaller than 1 in the ratios indicates that the VAR or the autoregressive models outperform the random walk.

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

When focusing on the 1980 to 2006 sample, it can first be seen that U.S. 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 one and two years ahead and is about 70 percent at three years ahead. However, the euro area GDP per capita does not help to forecast U.S. GDP.

Results are qualitatively confirmed in the euro area sample from 1999 to 2006 showing that in particular, the forecasting performance of the bivariate

Table 4A.1 **Evaluation period by region**

	1980 to 2006				1999 to 2006			
	Euro area		United States		Euro area		United States	
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

Note: VAR = vector autoregression; RW = random walk; AR = autoregression.

VAR is robust to the changes in the monetary policy regime that came with the inception of the euro area.

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Comment on this chapter, by Tommaso Monacelli, can be found on page 447.