Business Cycle Synchronization in the Euro Area and the Impact of the Financial Crisis

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The extent of synchronization of national business cycles is a widespread indicator for gauging whether individual countries are indeed ready to adopt a common currency. The occurrence of asymmetric shocks and their consequences in Economic and Monetary Union (EMU) may hamper implementation of monetary policy, as such shocks may significantly raise the cost of the single monetary policy for individual countries. This study analyzes whether the synchronization pattern of business cycles in the euro area has systematically changed since the outbreak of the global financial crisis in 2008. Country-specific differences in the terms of trade and fiscal imbalances may have caused the global shock to affect euro area countries asymmetrically. Conversely, the business cycles of individual countries may have become more closely synchronized, as all countries slipped into recession at the same time. For the purpose of this study we use empirical data to establish which of the two effects dominates. The results of the analysis show a pronounced desynchronization of business cycles during the crisis period, both with respect to dispersion and to the correlation of business cycles. Moreover, interesting differences and parallels may be observed between the developments since the beginning of the most recent financial crisis and an earlier period, around 2004, when the output gap in the euro area was negative as well.

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In the empirical literature, the synchronization of business cycles between individual countries has become established as a key criterion of whether these countries are ready to form a monetary union (see section 1 for a literature review). The argumentation is as follows: If the potential members of a monetary union are subject to symmetric economic shocks, the benefits of a common currency exceed the cost of relinquishing a national autonomous monetary policy (among others, Bayoumi and Eichengreen, 1997; Masson and Taylor, 1993; Alesina et al., 2002). Although the criterion of synchronized business cycles is controversial,[2] it would appear expedient to analyze the synchronization of business cycles in the euro area after the introduction of the euro, as the identification of divergent tendencies is an important prerequisite for economic policymakers to take appropriate corrective action.

Since the outbreak of the global financial crisis, the heterogeneity of the euro area has again moved to the forefront of economic policy discussions. Country-specific differences in the terms of trade and fiscal imbalances prior to the outbreak of the crisis may have led to asymmetrical effects of the global shock on the euro area on the one hand; on the other hand, the global financial crisis may have caused European business cycles to become more strongly synchronized, given the weak international environment. Ultimately, with the onset of the crisis, all industrial countries slipped into recession

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[2] *The argument of the endogeneity of optimum currency areas (OCAs) was first pointed out by Frankel and Rose (1998). It states that individual countries are more likely to meet some OCA criteria (in particular symmetrical business cycles) after establishment of a monetary union than ex ante. They argue that the establishment of a monetary union strengthens trade ties between member countries and, as a consequence, may lead to more closely synchronized business cycles.*

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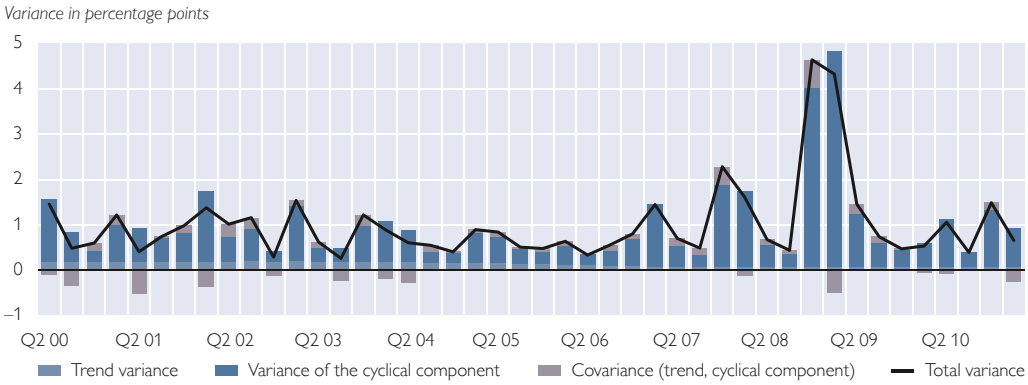
more or less at the same time. The current consolidation course may, in theory, work both ways: On the one hand, fiscal policy itself can trigger asymmetric shocks, e.g. because of nonuniform national fiscal measures; on the other hand, it can also be used as an instrument to smooth asymmetric shocks. Therefore, the theoretical effect of divergent budget deficits such as those observable during the crisis is ambiguous. Crespo Cuaresma and Fernández-Amador (2010) and Crespo Cuaresma et al. (2011) show that fiscal deficits may be a major source of idiosyncratic macroeconomic volatility, especially in the euro area. Therefore, this study uses empirical data to provide clearer insights into whether the crisis has caused business cycles to become more synchronized or more desynchronized. Although the impact of the financial crisis on the synchronization of business cycles is highly topical, the academic literature has not treated this issue so far, among other things due to the short time series since 2008.

What is the best method for measuring the symmetry of shocks or the synchronization of business cycles between the member countries of a monetary union? A common method used in the relevant literature is to filter country-specific GDP time series to isolate the cyclical from the trend component. The difference between the GDP time series and the long-term trend is equivalent to the cyclical component, also frequently referred to as the output gap, i.e. the divergence of current output from potential output. It is an important indicator for determining the optimality of a monetary union from the monetary policy perspective: If the output gap is negative, unemployment threatens, whereas a positive output gap increases inflationary pressure. Therefore, it becomes very hard to conduct a monetary policy that fits all countries' needs if cyclical components differ greatly among individual countries.

A simple look at the GDP growth rates in individual euro area countries signals possible divergent trends during the crisis. Chart 1 shows the total variance of the quarterly real GDP growth rates in the 17 euro area countries in the respective quarters from 2000 to early 2011. The double rise in the variance of growth rates at the end of 2007 and again at the end of 2008 is clearly

Chart 1

Contributions to the Total Variance of Real GDP Growth Rates (Quarter on Quarter) in Euro Area Countries



Source: Eurostat, authors' calculations.

visible. Moreover, the variance contributions[3] show that in particular the cyclical component contributed strongly to the heterogeneity of growth rates. As growth rates capture only the change on the previous period and thus make no statement about the output gap level (in particular about whether the output gap is positive or negative), the level of the output gap is analyzed below. Two indicators are used to measure synchronization, namely bilateral correlation coefficients and the standard deviation of the cyclical component. Next, the extent to which particular countries drive the development of these indicators is discussed. This allows for those countries to be filtered which contributed most to the desynchronization of business cycles. To assess the robustness of these results, the analysis is also applied to the monthly industrial output data. Although these variables represent only a relatively small share of GDP (around 20%), these industrial output data have the advantage of being available more often – monthly – as well as of exhibiting a high correlation with GDP.

Section 1 discusses the relevant academic literature on European business cycles to provide an overview of historical developments also prior to the establishment of EMU. Section 2 describes the data set and the methods used to produce the empirical estimates presented in section 3. The results are discussed in section 4, where possible conclusions from the analysis are drawn.

1 Synchronization of European Business Cycles – A Literature Survey

The economic analysis of the suitability of a region of sovereign states for monetary union originates with the theory of optimum currency areas, or OCA theory. Nearly half a century has passed since publication of the first academic contribution to OCA theory (among others, Mundell, 1961; McKinnon, 1963; Kenen, 1969). During this period, several criteria were suggested in the literature that a region should meet before establishing an OCA.[4] These include (1) price and wage flexibility (Friedman, 1953), (2) high factor mobility, in particular for the labor market (Mundell, 1961), (3) a high degree of financial integration (Mundell, 1973), among other things to create a "private" insurance system for asymmetric shocks,[5] (4) a high degree of openness of the economy (McKinnon, 1963), (5) a high diversification of production and consumption (Kenen, 1969), (6) similar inflation rates and stable terms of trade (Fleming, 1971), (7) a high degree of fiscal integration, preferably with supranational fiscal transfers (Kenen, 1969) or a coordinated economic policy, and (8) political integration or the political will to found such a currency area (Mintz, 1970; Haberler, 1970). OCA theory has often been criticized, however, as the different criteria could not be integrated within a uniform framework. Moreover, some of the listed criteria are difficult to measure (Robson, 1987) or to compare (e.g. Tavlas, 1994).

[3] *GDP was split into a trend component and a cyclical component (see also section 2) by applying a Hodrick-Prescott filter (Hodrick and Prescott, 1997) to the log of the GDP time series. Consequently, the contributions to total variance may be easily calculated using the following equation:*
$Var(dY) = Var(dT) + Var(dC) + 2 * Cov(dT, dC)$, *with dY representing GDP growth, dC the growth of the cyclical component and dT trend growth.*

[4] *See e.g. Mongelli (2008) for a comprehensive literature survey.*

[5] *This study defines "asymmetric shock" as an unexpected supply-side or demand-side shock or financial impulse that has different effects on output and employment in the affected countries.*

In the end, the discussion led to the development of a few "metacriteria" that implicitly subsume some of the individual conditions. In particular, the synchronization of business cycles has become established as a key OCA metacriterion.

The academic literature features a number of studies that treat the synchronization of business cycles in the EU or in the euro area and that contain observations of developments over time. However, only few robust patterns can be derived from these studies,[6] as the contributions differ in the following ways: (1) the samples include different countries; (2) the periods covered in the analysis differ; (3) the methods to determine the cyclical component (i.e. the chosen filter) differ; and (4) the methods for measuring the synchronization of the business cycles differ.[7] One question has been debated particularly broadly in the literature, namely whether the introduction of the single currency would contribute to the synchronization of business cycles, or whether it would instead reinforce the divergence of business cycles. On purely theoretical grounds, the answer is not clear-cut. On the one hand, intensified trade relations may have led to a more symmetrical transmission of arising shocks to individual member countries, so that the OCA criteria may be easier to fulfill ex post than ex ante (e.g. Frankel and Rose, 1998). On the other hand, as Krugman (1991) argues, economies of scale and scope in a monetary union may also induce individual regions to concentrate more on particular industries, which could reinforce asymmetrical shocks. Other authors cover the question of whether the business cycles in European countries have both a global and a European component, allowing a separate European business cycle to be discerned.

1.1 Synchronization of Business Cycles in the Euro Area

Whereas even before the introduction of the euro a broad set of literature analyzed the synchronization of business cycles in the euro area and thus the suitability of countries for forming a currency union, more recent studies cover the difference in the symmetry of shocks before and after the introduction of the euro. In their paper, Massmann and Mitchell (2004) provide a historical overview in which they examine over 40 years' worth of monthly industrial production data using eight different variables. They identify both periods of divergence as well as convergence; in the 1990s, however, they observe a clear trend increase in the synchronization of business cycles. Other studies (e.g. Altavilla, 2004; Darvas and Szapáry, 2004) confirm this development, which might partly be driven by the introduction of the convergence criteria stipulated in the Maastricht Treaty. Camacho et al. (2006) find a relatively high degree of synchronization between euro area countries, but their results do not show a significant increase in synchronization since the adoption of the euro. By contrast, Böwer and Guillemineau (2006) analyze the determinants of the synchronization of business cycles and identify an increase in the synchronization of business cycles since the euro introduction, mainly on account of the rise in intra-industrial trade within

[6] *For a comprehensive literature survey on this issue, see De Haan et al. (2008).*

[7] *Section 2 treats the different filtering techniques with which to decompose the time series and derive the cyclical component of GDP and possible measures of synchronization (such as bilateral correlation coefficients, etc.) in more detail.*

EMU. Gayer (2007), in turn, sees a general decline in the dispersion of output gaps in EMU member states, which he attributes to a general narrowing of the amplitude of the cyclical component, whereas synchronization (measured in terms of bilateral correlation coefficients) is relatively high but has not augmented further since the 1990s. Giannone et al. (2009) also point out that EMU has changed neither the historical characteristics of national business cycles nor the bilateral correlation coefficients of these cycles. Furceri and Karras (2008) compare the five-year period preceding the introduction of the euro and the five years after introduction using a fixed five-year window for each country and establish a markedly higher correlation of national business cycles. They ascribe this effect above all to trade-related influences and stepped-up fiscal coordination of EMU member countries. Weyerstraß et al. (2011) cannot confirm these effects after performing a more comprehensive analysis with dynamic correlations; they do not find that the euro area business cycles have become more synchronized after 1999. Although the results depend on the respective sample, the method and the measure of synchronization, as mentioned above, this literature does allow some facts to be concluded. Most of the studies concur in identifying convergence in euro area business cycles in the 1990s in the run-up to EMU, and in determining stabilization at a relatively high degree of symmetry thereafter. Moreover, most studies reject a further convergence of the business cycles since the foundation of EMU.

1.2 Is there a European Business Cycle?

In addition to the strand of literature that examines the synchronization of business cycles, there is a strand that treats the decomposition of the fluctuations in the different regions, industries or countries.[8] Artis (2003) comes to the conclusion that a particular European business cycle is very difficult to identify. The findings of a lack of a coherent, exclusively European business cycle confirm the results of Massmann and Mitchell (2004). In the same vein, Kose et al. (2003) do not find a specifically European business cycle, as only a small part of euro area GDP can be attributed to a common European factor. Mansour (2003) splits the variance of growth into global, European and country-specific factors. Whereas the European component does not play an insignificant role, the influence of this European business cycle varies strongly among countries. In contrast, other authors, such as Lumsdaine and Prasad (2003) or Canova et al. (2005), emphasize the existence of a global business cycle. Camacho et al. (2006) develop indicators of the distance between national business cycles. While they reject the existence of a European business cycle, they find that the bilateral distances in the euro area are relatively small and hence that these economies are more synchronized among each other than with countries that are not EMU members. To conclude, the evidence from the literature available is very heterogeneous on the issue of the existence of a European business cycle.

[8] *For an overview of the key methods in this field of research, see Clark and Shin (2000).*

1.3 Have the Patterns Changed since the Onset of the Financial Crisis?

By contrast to the abundant literature on the impact of the single monetary policy on the synchronization of business cycles, the academic literature has not yet examined the effects of the current financial crisis since 2008. The main reason is likely to be that only a fairly short time series on the crisis is available at the end of the sample, which makes it hard to draw meaningful conclusions. Gayer (2007) establishes that the correlation of euro area countries' business cycles declines quite sharply around 2003 but begins to strengthen again in the course of 2004. From earlier periods of economic weakness, the author concludes that a decline in the synchronization of business cycles often occurs in the early recovery phase after a recession (e.g. the beginning upturn after dot-com bubble burst in 2003). Therefore, it would be particularly interesting to clarify whether this pattern is repeated or even reinforced in the far stronger recession or crisis from 2008.

2 Methodological Framework

2.1 Data

To measure the synchronization of business cycles, this study avails itself of the two most important variables that are also most frequently used in the literature, GDP and industrial production (De Haan et al., 2008). Whereas GDP is the most comprehensive output variable,[9] industrial production is also frequently used, because it correlates strongly with GDP and because data are collected monthly. As long time series of quarterly GDP data are often not available, the use of data with a higher frequency is an advantage in terms of the robustness of the results. Therefore, the data used in this study are (1) quarterly real GDP data (seasonally adjusted, at 2005 prices) for the quarters Q1 95 to Q3 11, and (2) the index of industrial production (excluding construction) (2005 = 100) from January 2000 to January 2012 (also seasonally adjusted). The countries covered are the 17 EMU member states and EMU aggregate (EA-17).[10] To ensure comparability of the synchronization variables over time, the countries that joined EMU after 2000 – Estonia (2011), Slovakia (2009), Malta (2008), Cyprus (2008), Slovenia (2007) and Greece (2001) – are taken into account for the entire observation period. All data used are taken from Eurostat's online database[11] and are thus comparable across the cross-section of countries and over time.

2.2 Measurement of Business Cycles

The output gap is a fundamental determinant of central banks' key interest rate policy, as it indicates inflationary pressure in an economy. Therefore, the synchronization of the output gaps of individual countries is chosen as a measure of the optimality of a monetary union. The concept that the literature employs to measure the output gap is a purely statistical decomposition

[9] *Some studies examine GDP as well as GDP subcomponents, such as consumption, investment and exports (e.g. Sopraseuth, 2003).*

[10] *Data are available only from Q1 97 for Ireland and Slovakia and from Q1 00 for Greece and Malta. Moreover, the time series for Greece already ends in Q1 11. Therefore, the synchronization measures are calculated only from Q1 00 to Q1 11 (except in chart 8). However, all available data are used to estimate the business cycles, meaning that the time series for most countries begin in Q1 95. With the exception of Malta (from January 2005), industrial production data are available for all countries from January 2000.*

[11] *http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/ (as retrieved on March 5, 2012).*

process in which a trend is extracted from the time series (in this case of GDP and industrial production data) that can be interpreted as potential output. The cyclical component is obtained by subtracting potential output from the original variable and is thus an estimate of the output gap.

Several filter methods are available to estimate the cyclical component of a time series. A handful of business cycle extraction methods are used in the literature, mainly the Hodrick-Prescott filter (HP filter; Hodrick and Prescott, 1997), the Baxter-King band-pass filter (Baxter and King, 1999), the Christiano-Fitzgerald band-pass filter (Christiano and Fitzgerald, 2003), and finally the phase-average trend (PAT; Boschan and Ebanks, 1978). As the choice of the filter method only insignificantly influences the result (Massmann and Mitchell, 2004), i.e. the degree of synchronization of euro area business cycles, we use the HP filter to decompose the relevant time series. This filter is used most often in the literature, thus increasing the comparability of results with those of other studies. What is more, use of the HP filter dispenses with the need to generate additional series values at the beginning and at the end of the time series (backcasts and forecasts), unlike with the use of the Baxter-King filter, where such values are needed to estimate a cyclical component at the endpoints of the time series. This is a particularly relevant argument for a study such as this one focusing on the analysis of the end period.

A multitude of standard textbooks on time series econometrics provide a formal description of HP filter estimation (e.g. Enders, 1995, p. 210). The underlying idea is to estimate a trend component so that the deviations of the individual observations from a trend are minimized. The degree of trend smoothing is determined ex ante. Smoothing is carried out according to the methods commonly recommended in the literature.[12] The estimated output gaps of the euro area countries are shown in chart 9 in section 3.3, where they are also compared and discussed. The growth of the estimated potential output is shown in the descriptive table in the annex (table 1). A comparison of the development over time indicated that potential growth is below the long-term average of the period from Q1 01 to Q3 11 in all countries except Malta after the beginning of the global recession (the "Great Recession") in 2008. The estimation of potential output used here may differ from other estimations, as other authors have used other calculation methods. The concept we used is a purely statistical decomposition process, whereas the estimates of the European Commission, for example, are based on the production function approach, which takes into account important economic variables of countries, such as capital stock and the unemployment rates.

Caveats in Measuring Business Cycles

As some studies have shown (e.g. Orphanides and Norden, 2002), the estimation of the output gap (and hence potential output) at the end of the sample and based on real-time data is subject to great uncertainty. This is traceable mainly to three factors: First, the latest GDP data are subject to revisions, which may lead to substantial changes in the output gap ex post. Second, the results calculated with the

[12] *We calculated the estimation with the respective application provided in EViews 7.0.0.1 and chose 1,600 as the smoothing parameter for the quarterly data and 14,400 as the smoothing parameter for the monthly data.*

estimation methods available – this includes the HP filter method – differ if additional data become available after the relevant quarter (end-of-sample problem). Third, the future GDP development may go hand in hand with a structural change in the economy, so that revisions may change potential output as well as the output gap.

Based on data for the euro area, Marcellino and Musso (2010) showed that GDP time series revisions only contributed marginally to the uncertainty of estimations. Conversely, end-of-sample parameter instability of the estimation methods plays a significant role. To quantify how many of the observed quarters are subject to uncertainty at the end of the sample, a robustness analysis of the two main synchronization measures, dispersion and correlation (see section 2.3) is performed in section 3.1 to clarify the end-of-sample bias.

In a first step, several quarters at the end of the sample are left out when estimating the output gap. Next, the synchronization measures are calculated based on the new time series. A comparison with the original results indicates the number of quarters in which the synchronization measures deviated significantly at the end of the sample. Any evidence established about the synchronization of business cycles in the euro area will therefore be subject to a high degree of uncertainty in those end-of-sample quarters.

2.3 Choice of the Synchronization Measures

After determining the relevant variables as an OCA metacriterion, a suitable measure must be selected that provides information about the synchronization of this variable between countries. Several measures have been proposed in the relevant literature that are often referred to as synchronization measures, as among other things the temporal correlation of output gaps is important. The *correlation coefficient* is the most frequently used synchronization measure; it is also the one we use in this study. In addition, we analyze the *dispersion* of business cycles. To ascertain whether the pattern has changed since the onset of the most recent financial crisis, we compare the period up to the third quarter of 2008 with the subsequent period. As a cutoff date, we chose the insolvency of the U.S. investment bank Lehman Brothers on September 15, 2008. Other cutoff dates were also analyzed to verify the robustness of the results. The synchronization measures chosen are described in more detail below, and an explanation of why it is necessary to examine both measures to derive statements about the optimality of a single monetary policy is provided.

We use the standard deviation of the euro area countries' output gaps to measure the dispersion of the business cycles. Business cycle dispersion can be observed over time and thus provides insights into whether output gaps converge or diverge. The dispersion measure is an important bit of information, as countries whose output gap fluctuates sharply require larger interest rate steps than countries in which the size of the output gap fluctuates less. We use the weighted and unweighted standard deviation (STD) as a dispersion measure. Countries with a higher GDP are assigned a higher weight in weighted STD.[13] The last measure is used to reflect the fact that a weighted concept is at the heart of the euro area and that the ECB's monetary policy applies to

[13] *This study uses euro area GDP in 2005 for weighting.*

the entire euro area. After calculating the dispersion, we use the Carree and Klomp (1997)[14] test to establish whether the dispersion has changed significantly since the outbreak of the financial crisis. Finally, we use the cost-of-inclusion indicator proposed by Crespo Cuaresma and Fernández-Amador (2010) to measure the influence of participation in EMU by a particular country on the development of dispersion. This indicator demonstrates whether one country predominates the result in aggregate developments, i.e. how high the potential cost of that country's EMU inclusion (or entry) would be. The indicator of inclusion of country *j* in EMU consisting of country group *Ω* is calculated as follows:

$$coi_{t,j} \mid \Omega = \frac{\hat{S}_t \mid \Omega_{-j} - \hat{S}_t \mid \Omega}{\hat{S}_t \mid \Omega}$$

$\hat{S}_t \mid \Omega$ ($\hat{S}_t \mid \Omega_{-j}$) refers to the standard deviation of the cyclical components across all countries including (excluding) country *j*. The indicator thus shows the change in the dispersion rate (i.e., standard deviation) resulting from the inclusion of the respective country and is negative if the standard deviation of the country group increased because of the inclusion of country *j* (i.e. if the country contributes to the desynchronization of business cycles).

The disadvantage of using dispersion as a measure of synchronization is that business cycles with similar amplitudes may in fact be moving in opposite directions. This would make it harder to conduct a single monetary policy. As a rule, an expansionary monetary policy is called for to counteract a downswing, whereas monetary policy should react restrictively to an upswing. However, it must be noted that ECB's monetary policy is oriented primarily on a price stability goal. In this light, upturns and downturns are simply harbingers of a change in the inflation rate.

The correlation coefficient is suitable for identifying such developments, as it reveals the strength of the linear relationship between simultaneously measured values in two time series. As the correlation coefficient, in turn, has the shortcoming of not being able to indicate differences in the size of the amplitude, both measures are required to adequately assess the prerequisites for a single monetary policy.

To obtain a detailed impression of the temporal development of bilateral correlation coefficients, we calculate these coefficients for a moving two-year window, the mean values of which are displayed in a chart for ease of reading.[15] Additionally, we calculate the mean value of the bilateral correlation coefficients in both periods: the correlations between the business cycles of each country pair[16] are calculated individually and then averaged over one of the two periods. Both calculations take into account country weights, i.e. each bilateral coefficient is multiplied by a country pair-specific weight. This weight is measured on the basis of the GDP

[14] *The Carree and Klomp test statistic is calculated as follows:*
$T_{2,t,\tau} = (N-2.5) \log [1 + 0.25 (\hat{S}_t^2 - \hat{S}_{t+\tau}^2)^2 / (\hat{S}_t^2 \hat{S}_{t+\tau}^2 - \hat{S}_{t,t+\tau}^2)]$, *with* $\hat{S}_t^2$ *referring to the standard deviation of business cycles and* $\hat{S}_{t,t+\tau}^2$ *referring to the covariance of the business cycles at times t and t+τ. Under the null hypothesis that STD has not changed between times t and t+τ , the test statistic follows a* χ^2 *(1) distribution. For an application, see also Crespo Cuaresma and Fernández-Amador (2010).*

[15] *As the available time series is rather short (observations for all countries are available for the period from Q1 00 to Q3 11), the moving window is limited to two years, even though this period is too short to cover an entire business cycle. Nevertheless, the period appears meaningful for illustration purposes.*

[16] *The number of combinations is N(N–1)/2 = 136, with N = 17 representing the sample size.*

sum of both countries and the sum of all bilateral GDP totals (all from 2005). Above and beyond the comparison of mean values over various periods, we examine the connection between a specific country's business cycle and the euro area business cycle for all 17 euro area countries and again show the results in a chart to facilitate analysis. This combination is supposed to show whether a particular country's business cycle has developed significantly differently since the crisis than that of the euro area. To determine the statistical significance of the potential deviation, we test the difference between two independent coefficients for each country.[17]

Box 1

Measurement of the Synchronization of Business Cycles: An Overview

To determine the synchronization of business cycles between individual EMU countries, we apply an HP filter to the GDP and industrial production time series to separate the trend component from the cyclical component. Whereas the trend component may be interpreted as the level of potential output, the cyclical component is the output gap, i.e. the fluctuation around the long-term trend.

Business cycles are synchronous if the cyclical components of two countries move upward or downward at the same time, and/or if the output gaps have the same value at a given time. Conversely, asymmetrical shocks refer to situations in which output gaps do not have the same value and/or in which the business cycles diverge. Asymmetrical shocks can affect either a particular country (e.g. a natural catastrophe) or all countries, but to different degrees (e.g. an oil price shock). After establishing the cyclical components, we calculate different synchronization measures:

- ***Dispersion:*** *The dispersion of the output gap can be measured at any time using the standard deviation of the cyclical components. This synchronization measure makes it possible to assess whether the business cycles converge or diverge. However, the measure has one caveat that must be taken into account: Business cycles may be moving in opposite directions even if the size of the output gap is similar (and the dispersion consequently low).*
- ***Correlation:*** *The disadvantage cited above is taken into account in the second measure, the correlation coefficient. While the correlation coefficient measures the degree of linear connection between two simultaneous measures in two time series and thus measures the synchronization of business cycles, the absolute size of the output gap does not play a role, unlike in the case of the dispersion measure. Moreover, the correlation cannot be measured at any point in time, just for two time series (e.g. in moving time windows of two years' length). This synchronization measure is calculated either (1) from the average of the bilateral correlations of all country pairs, or (2) from the average of all correlation coefficients of the respective country and the euro area business cycle.*
- ***Cost of inclusion/Contribution of individual countries:*** *Finally, this indicator helps to assess the degree to which individual countries affect the results of the two measures. The term would appear to indicate that this variable is measured as a monetary variable; however, this is not the case: This indicator shows the percentage deviation of both synchronization measures if a country cycle is excluded from the sample. In the case of dispersion, the standard deviation falls if asynchronous countries are not taken into account in the analysis, whereas in the case of the correlation, the value will rise if these countries are excluded from the analysis. Those asynchronous countries (country pairs) that contributed most to the divergence of the business cycles can thus be identified.*

[17] *The test statistic z is calculated as follows:* $z = (Z_1 - Z_2) / \sigma_{Z_1 - Z_2}$, *with* $\sigma_{Z_1 - Z_2} = \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}$, $Z_{1,2}$ *referring to the Fisher-transformed correlation coefficients and* $n_{1,2}$ *representing the size of the respective sample. If the test measure is larger than* $|1.96|$ $(\alpha = 0.05)$, *the difference is significant (Leonhart, 2009).*

3 Empirical Findings

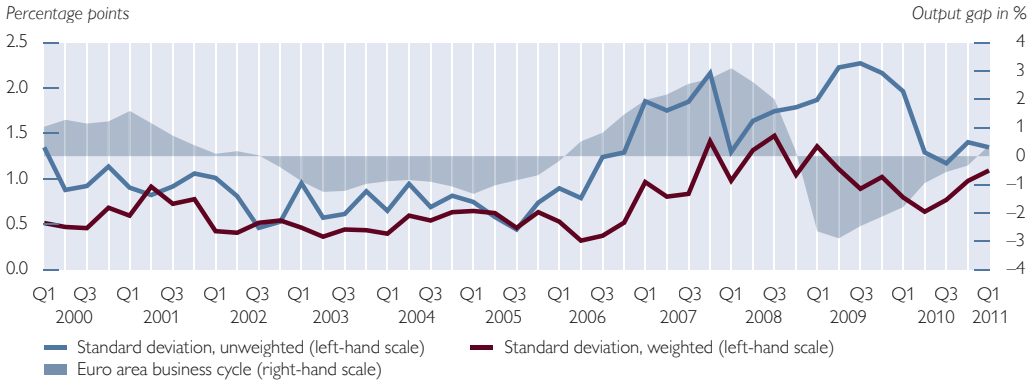
This section begins with a presentation of the results of the application of the methods described above to GDP data. After an overview describing the development of the synchronization measures in EMU since the adoption of the euro (section 3.1), the contribution of individual countries to synchronization is examined in section 3.2. In a next step, the degree of synchronization of the individual country business cycles with the aggregate EA-17 business cycle is analyzed. The different behavior of individual countries is highlighted before and after the outbreak of the financial crisis. To ensure that the results are robust, industrial output is also discussed in a brief digression (box 2).

3.1 Decline in the Synchronization of Business Cycles in the Euro Area

The empirical results are shown in charts 2 and 3. Chart 2 showcases the change in the dispersion of business cycles over time. Both the GDP-weighted and the unweighted standard deviation (STD) exhibit a conspicuous rise that did not begin with the onset of the recession in the euro area in Q3 08, but already in early 2007. From Q4 06 to Q4 07, unweighted STD nearly doubled, and the weighted STD in fact even tripled in the comparable period. Whereas the weighted STD fluctuates at a high level before diminishing again in 2009, the unweighted STD exhibits two distinct peaks that may be considered to be linked to the development of the euro area business cycle (shaded area). Both peaks – the first in Q4 07 and the second in Q3 09 – coincide almost perfectly with the peak and the trough of the euro area business cycle. The unweighted STD dropped sharply when the turning point in the business cycle was reached in Q4 08, the time at which most countries experienced a decline in GDP growth and dipped into recession. Then, the unweighted STD resumed its increase to reach a new peak during the trough of the euro area business cycle.[18] As the weighted STD is substantially lower than the

Chart 2

Dispersion in the Euro Area and the Euro Area Business Cycle

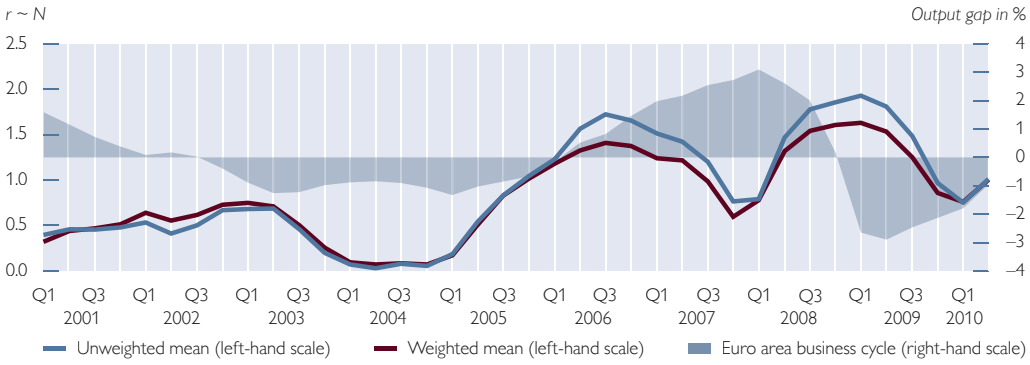


Source: Authors' calculations.

[18] *As the standard deviation can depend on the measuring unit, so that variables with large means have a greater variance, we performed a robustness analysis by calculating the variation coefficient (defined as the ratio of the standard deviation to the mean of the cyclical component in the respective period). The value 1 was added to the cyclical components first to prevent a division by zero. This relative dispersion measure shows the same deviation, which confirms the divergence trend.*

Chart 3

Bilateral Correlation Coefficients in the Euro Area and the Euro Area Business Cycle



Source: Authors' calculations.

unweighted STD, notably since 2007, the rise in the dispersion is largely driven by the smaller countries. Nevertheless, the rise in both aggregates is significant. If the values of the respective variables are compared at four-quarter intervals, the difference between the weighted and the unweighted STD is significantly different from zero at three comparison points (at least at a significance level of 10%).[19]

To ascertain whether the rises in dispersion are not just simply an increase in amplitude but also a decrease in the synchronization of business cycles, we calculated the mean of the bilateral correlation coefficient in a moving two-year window; the result is shown in chart 3.[20] The chart reveals that in the period since 2006, the mean values declined at two instances, with a low in Q4 07 and in Q1 10. These declines occurred nearly simultaneously with the rises in the dispersion of the business cycles. If, moreover, the unweighted mean of the bilateral correlations for the precrisis phase Q1 00 to Q3 08 and for the period after the crisis (Q4 08 to Q3 11) are calculated without a moving window, a distinct drop in the mean may also be observed (from 1.2 to 0.9). To sum it up, it may be asserted that the euro area business cycles have desynchronized since the most recent financial crisis, with this trend beginning already during the boom phase in 2007.

Robustness Analysis

In this section, we analyze how many of the last quarters are affected by the end-of-sample bias and which of the results presented here are thus subject to uncertainty. The synchronization measures presented up to now are based on an estimate of the output gap

[19] *In the case of the unweighted STD, the comparison periods are Q3 05 to Q3 06; Q1 06 to Q1 07; and Q2 06 to Q2 07; in the case of the weighted STD, the periods are Q2 06 to Q2 07; Q3 06 to Q3 07; and Q4 06 to Q4 07. The presented test results are supposed to show that the visually perceptible rises since 2005 are partly significant changes. The exact comparison periods are less relevant and were thus chosen arbitrarily. The detailed results of the test statistics are available from the authors on request.*

[20] *The correlation coefficients are transformed to a normal distribution to enable a comparison of the means. Therefore, the mean may exhibit values above 1. The Fisher transformation for correlation coefficient r is calculated as follows:* $Z = 0.5 * \ln\left(\frac{1+r}{1-r}\right)$ *(Leonhart, 2009).*

using GDP data up to Q3 11.[21] In the annex, charts 10 and 11 also show the dispersion of the business cycles if data only up to Q3 10 or Q3 09 are used to estimate the output gap. The dispersion using the unweighted STD is shown in chart 10 (annex); chart 11 (annex) shows the dispersion using the weighted STD. Both charts clearly indicate that uncertainty is especially prevalent in the last four quarters of the review period. Therefore, if the GDP data series had been available only until Q3 10, the rise in the unweighted STD at mid-2009 would have been underestimated; in the case of the weighted STD, it would have been overestimated.

By analogy, charts 12 and 13 (annex) depict the correlation coefficient. In the case of the correlation measure, the uncertainty is much smaller. In other words, the inclusion of future GDP data to calculate the output gap would have hardly any effect on the course of the bilateral correlation coefficient. End-of-sample parameter instability thus has an impact above all on dispersion, but not on the synchronicity of the countries. The analysis allows for the conclusion that the results presented in the study based on data up to mid-2010 will not lose their validity on publication of future GDP data, whereas the results for the dispersion from mid-2010 are affected by high uncertainty. Therefore, from this time onward the evidence on the synchronization of business cycles is also subject to a degree of uncertainty.

Box 2

A Comparison of Monthly Data: The Synchronization of Industrial Production

A comparison of the analysis performed in section 3.1 with the monthly industrial production (IP) data serves as a test of the robustness of the results attained thus far.

The left panel of the chart in this box shows the dispersion of the cyclical components of industrial production of all euro area countries (excluding Malta) in the period from January 2000 to January 2012. The right axis depicts the aggregate euro area (EA-17) industrial cycle. IP is subject to higher volatility than the dispersion of the GDP cycles (section 3.1), as the data are monthly. However, if changes in the dispersion are analyzed over time, a pattern similar to that of the GDP cycles may be discerned. First, the unweighted STD fluctuates around a mean of about 2.2 percentage points until mid-2008, only to rise to more than twice that level until the end of 2008. The unweighted STD peaks at 5.5 percentage points in April 2009. Compared to the value in July 2008, which at 2.1 percentage points corresponds roughly to the average of the entire preceding period, this represents a statistically significant rise. This rise, however, is limited to the end of the recession period from end-2008 to end-2009 and unlike the dispersion of GDP cycles does not already start in 2007. The weighted STD of the industrial cycles displays a similar pattern, coming to an average of roughly 1.4 percentage points until mid-2008 and peaking at 4.1 percentage points in April 2009. Both dispersion measures decline again from end-2009 and return to their previous path.

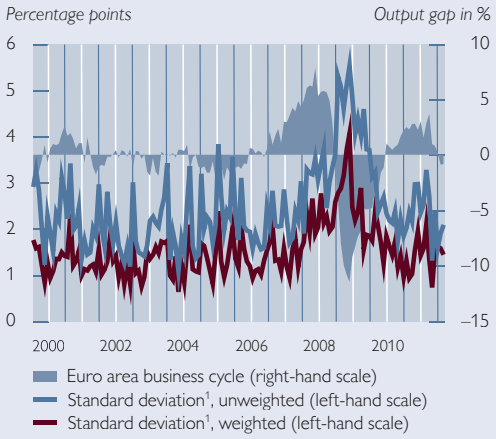
The right panel of the chart shows the weighted and unweighted means of the bilateral correlation coefficients (by analogy to chart 3 in section 3.1) of the industrial cycle in a moving two-year window that enables an estimate of the change in the synchronization of business cycles. A similar pattern emerges as that observed for the means of the GDP cycle correlation coefficients. The period characterized by a rise in dispersion (left panel) is also the period in which the mean correlation coefficients diminished (right panel). To conclude, both indicators

[21] *Data for Greece are available only until Q1 11; in other words, the dispersion in Q2 11 and Q3 11 excludes the Greek business cycle. However, this does not influence the ability to interpret the results, as the exclusion of Greece from the analysis merely has an insignificant impact on the course of the dispersion.*

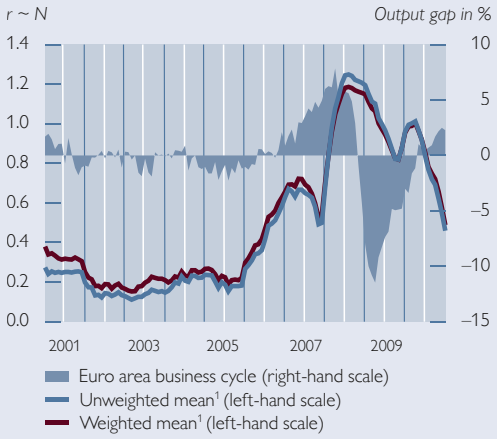
of the cyclical component of industrial production also indicate a reduction of the synchronization in the euro area, which, however, started only when the recession began at the end of 2008 and not, as is observable with the GDP cycles, in early 2007.

Industrial Production

Dispersion in the Euro Area and the Euro Area Business Cycle



Bilateral Correlation Coefficients in the Euro Area and the Euro Area Business Cycle (two-year window)

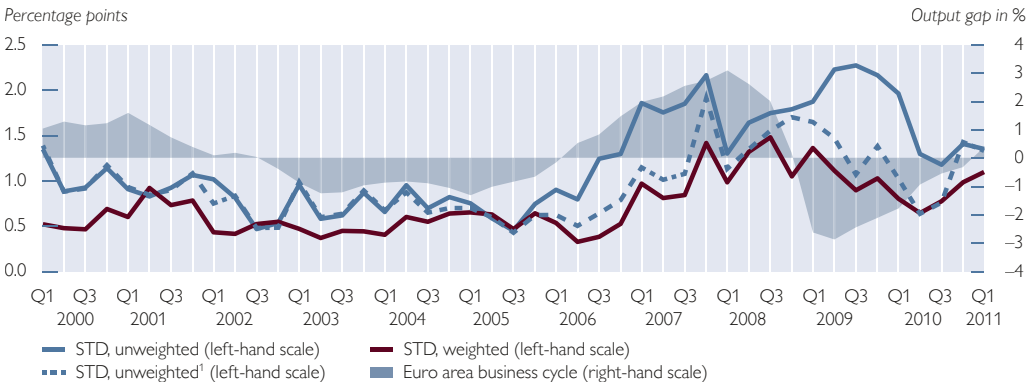


Source: Authors' calculations.

[1] Excluding Malta.

Chart 4

Dispersion in the Euro Area and the Euro Area Business Cycle



Source: Authors' calculations.

[1] Excluding Estonia.

3.2 Which Countries Contribute to the Synchronization of Business Cycles?

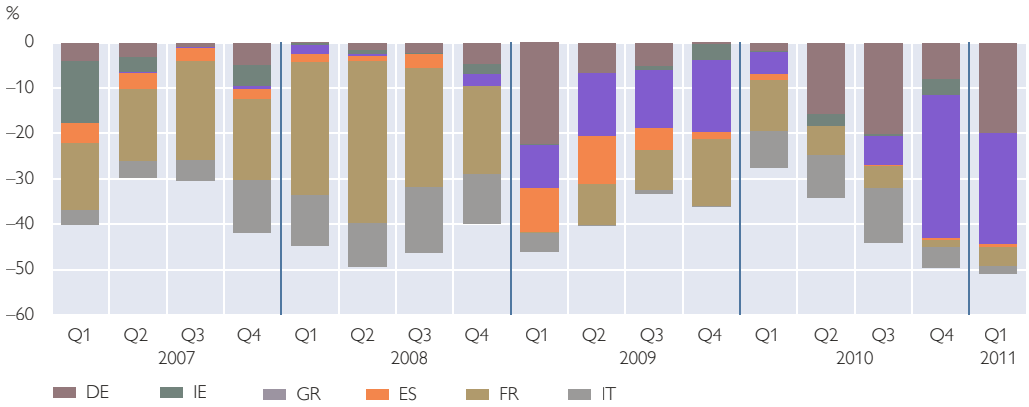
Section 3.1 showed that the synchronization of business cycles changed strongly during the crisis. The general rise in the standard deviation in the country cross-section was accompanied by a decline in the mean of the bilateral correlation coefficients. Moreover, it is clearly discernible that the unweighted standard deviation is perceptibly higher than the weighted one. This suggests that the swings were driven above all by the smaller euro area countries. Chart 4 shows the familiar weighted

and unweighted dispersion of euro area business cycles. As the standard deviation is sensitive to possible outliers, the unweighted dispersion result may be very strongly influenced by a small country. The dotted line represents the dispersion of business cycles without Estonia (EA-16). Obviously, the unweighted dispersion is very strongly driven by Estonia, as the business cycle of Estonia diverges decisively from the euro area business cycle. In this connection, however, it must be emphasized that Estonia was not yet an EMU member at the time. The development is similar in other countries: The brief rise in the fourth quarter of 2007 (chart 4), for instance, is attributable mainly to a contrary development in Slovakia,[22] also one of the countries that had joined the euro area shortly before.

This example shows that it is particularly important to identify the countries that contributed most to disper-

Chart 5

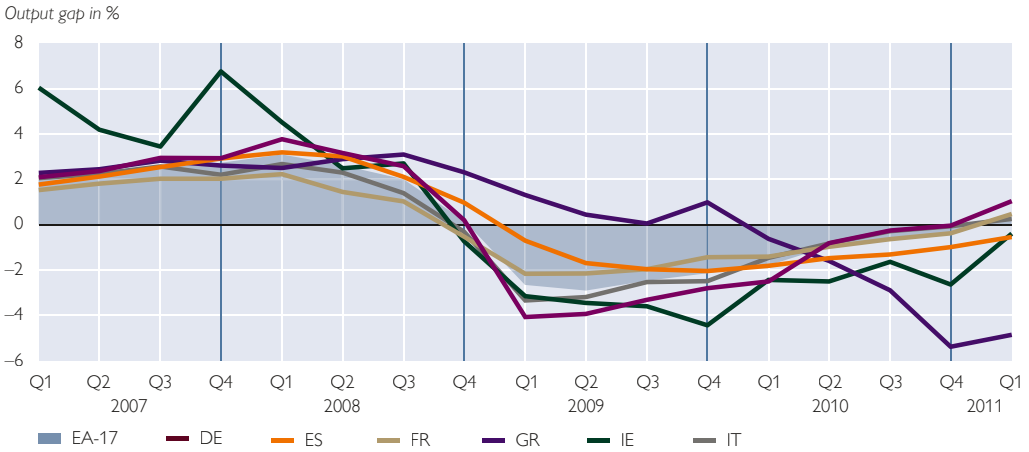
Change in the Weighted Standard Deviation Excluding Selected Countries



Source: Authors' calculations.

Chart 6

Business Cycles of Selected Countries



Source: Authors' calculations.

[22] *Section 3.3 describes the business cycles of the individual euro area countries.*

sion, or to asynchronous developments, in the euro area. Whereas both weighted and unweighted analysis provide interesting insights depending on the question posed, the analysis below primarily focuses on the country contributions to the weighted dispersion, as above all this aggregate is important in the overall European perspective.

Chart 5 shows the change in the dispersion measured in terms of the standard deviation of the cyclical component under the assumption that the respective country in the analysis is not an EMU member. The change in the dispersion may be interpreted as the cost of including the respective country in EMU (Crespo Cuaresma and Fernández-Amador, 2010). At this point, we would like to point out once again that this indicator is not measured as a monetary variable; instead, it simply shows the percentage deviation of dispersion on exclusion of a country cycle from the sample. The six countries with the highest weight in the inclusion cost indicator are described below.

In other words, these are the countries that have driven up weighted dispersion most since early 2007. The analysis reveals some very interesting patterns. Prior to the outbreak of the crisis (roughly up to the fourth quarter of 2008), it was mainly France which caused the STD to rise. Apart from the deviation from the weighted mean of the cycles (corresponds to the euro area cycle; chart 6), France's high share in euro area GDP (the second-highest share following Germany) plays a decisive role. During this period, Italy also contributed to the divergence of business cycles. As the Italian business cycle showed only a marginal deviation (chart 6), apparently the high weight of Italy (the third-largest euro area economy) was mainly responsible for its contribution. Although Ireland stands out most in terms of its cyclical component, this divergence had an impact only in the first quarter of 2007 because of Ireland's low GDP weight.

The pattern of the *inclusion cost indicator* appears to change noticeably once the recession takes hold at the end of 2008. Whereas France's indicator declines steadily, reflecting France's move toward the euro area average, above all Greece but also Germany display high inclusion costs. In other words, the inclusion of these countries' cycles result in a sharp rise in dispersion. At first glance, the patterns look similar (chart 5), but a closer look reveals nearly perfectly opposed patterns: While at the beginning of the crisis, Germany reacts more strongly than the other countries covered and has the largest negative output gap, the downturn starts much more slowly in Greece and does not produce a negative output gap until the beginning of 2010. An inverse pattern also characterizes both countries in the most recent quarters: Germany tended to recover faster than the euro area average and on account of its high weight posted a high inclusion cost indicator despite its fairly small dispersion. Whereas the inclusion cost indicator has high values in nearly all the large euro area countries,[23] the extraordinarily high value for Greece despite its very low weight[24] impressively signals the degree of financial distress that the debt crisis brought on for Greece. The recession takes a drastic course in Greece: From the outbreak of the crisis to end-2011, Greek

[23] *The countries with the highest weights in euro area GDP (2005) are Germany (27.3%), France (21.1%), Italy (17.6%) and Spain (11.2%).*

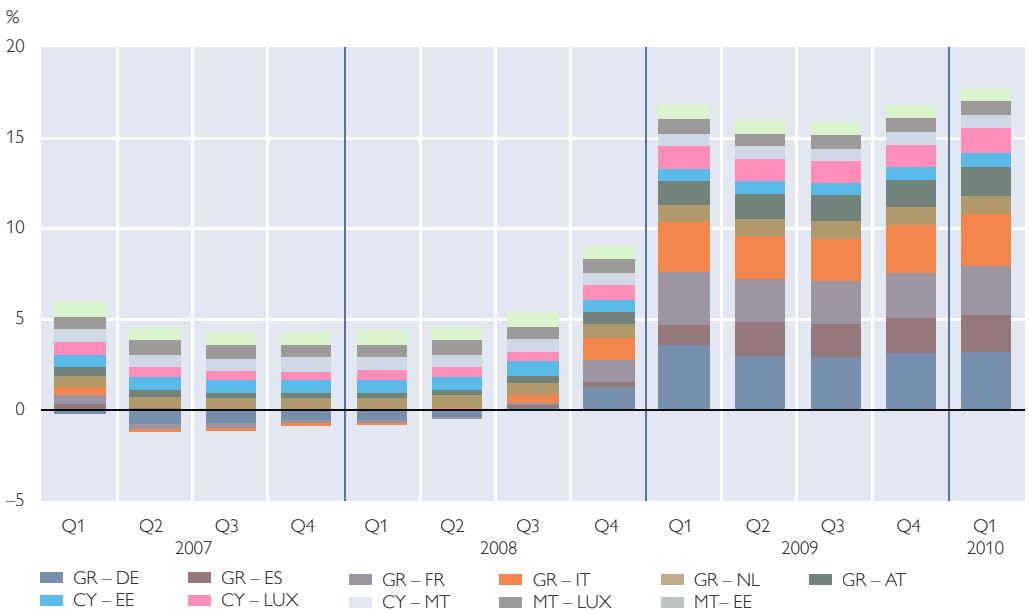
[24] *According to the 2005 GDP data, Greece only accounts for 2.4% of euro area GDP.*

GDP contracted by a total of some 11%, causing the business cycle to drift into negative territory. While the inclusion cost indicator for Greece still showed an upward deviation against the euro area for 2009, the opposite is the case after the third quarter of 2010. The differences between the dispersion measure (standard deviation) and the correlation of cycles are also readily identifiable in this example: In mid-2010, the Greek cycle was more or less equivalent to the European average (putting the Greek inclusion cost indicator at almost zero for the second quarter of 2010), only to develop in a completely opposite direction to the rest of Europe thereafter. Whereas euro area slowly recovered from the financial crisis, Greece felt the effects of the debt crisis all the more. This inverted tendency cannot be captured by the dispersion measure; it can only be shown using the correlation as a synchronization measure.

Therefore, like in the case of the dispersion measure, the change in the weighted mean of the correlations is analyzed, assuming that specific country pairs are excluded from the analysis. The results are summarized in chart 7. Like previous charts, chart 7 depicts selected countries, showing only the country pairs that had the greatest influence on the average weighted bilateral correlation factors in the euro area. Again, Greece dominates the picture: The bilateral correlations between Greece and Germany, France, Italy, Spain, Austria and the Netherlands would increase the (Fisher-transformed) correlation coefficients most if these country pairs were excluded from the analysis. This comes as no surprise: During the crisis, Greece's business cycle developed completely opposite to that in other countries. Together with the higher weights of the larger euro area countries, the development in Greece raises the average correlation

Chart 7

Change in the Weighted Mean of the Correlations Excluding Selected Country Pairs



Source: Authors' calculations.

coefficients most. By contrast, other country pairs deliver some surprising results: Although Estonia, Luxembourg, Malta and Cyprus range among the smallest economies in the euro area, their cyclical divergence has quite a strong impact in this analysis.

As the different weights in this analysis allow only limited conclusions about individual countries to be drawn, section 3.3 below examines the correlations of the individual countries with the euro area (EA-17) cycle. The correlations provide the basis for economic policy conclusions for the individual member countries. Whereas the literature mainly employed the OCA meta-criterion synchronization of business cycles to examine whether a hypothetical region was ready to join a currency area, the same line of argumentation may be applied to examine the euro area's fulfillment of this criterion ex post to determine deviations and take corrective economic policy action. Enforcing synchronization is basically what the new rules in the euro area apply by identifying macroeconomic imbalances between countries – e.g. divergent developments of unit labor costs, current account balances, inflation – and then suggesting adequate corrective measures in time.

3.3 Which Countries Follow the Euro Area Cycle?

Following the general overview of the synchronization of euro area business cycles using dispersion (standard deviation) and average bilateral correlation coefficients in section 3.1 and a first analysis revealing which countries contribute to convergence and which ones contribute to divergence of business cycles in section 3.2, an additional dimension to the discussion is added in section 3.3. The correlation of the country-specific cycle with the euro area aggregate (EA-17) cycle reveals which countries, being particularly hard hit by asymmetric shocks, found participation in EMU to be the greatest challenge.

Chart 8 presents the correlations of the respective countries' business cycle for the entire period (Q1 00 to Q3 11) and for the periods preceding the crisis (Q1 00 to Q3 08) and following the crisis (Q4 08 to Q3 11). The crisis is generally determined to have begun in Q4 08 in the literature. GDP data for Greece are available only until Q1 11, but the correlations for all other countries were calculated for the period up to Q3 11 to keep the post-crisis sample as large as possible. An eyeball inspection of the aggregated chart indicates that in most of the countries, the crisis had little impact on the symmetry of the shock; the correlations before and after the crisis are largely unchanged.[25] There are exceptions, though: The correlation coefficient falls markedly in some countries during the crisis, notably in Spain, in Cyprus and Greece (statistically significant at the 5% level), but also in Slovakia, Slovenia and Portugal (though not to a statistically significant degree). As expected, Greece posted the most pronounced decline in symmetry; the correlation coefficient slips well into negative territory during the crisis. The symmetry measure drops sharply also for Cyprus, whose

[25] *The post-crisis period is subdivided into a "Great Recession", whose onset was nearly simultaneous in all euro area countries, albeit at different strengths, and a subsequent recovery until at least mid-2011, which was quite heterogeneous in the individual member countries. The aggregation of these two periods to a single "post-crisis period" therefore conceals potential differences within the period, as the synchronization of cycles is particularly strong during the downturn but highly heterogeneous during the upswing. Because the time series is so short, it is difficult to quantify the structural break, but it should be taken into account in interpreting the results.*

Chart 8

Correlation of Country Cycles with the Euro Area Cycle

Source: Authors' calculations.

[1] *The correlation coefficients of the periods Q1 00 through Q3 08 and Q4 08 through Q3 11 differ significantly from one another (at the 5% level). Shorter period in GR: Q4 08 to Q1 11.*

economy is closely tied to that of Greece. The statistically significant rise for Germany, which, however, is barely discernible in the chart, shows how important a standardization of the correlation coefficients is for the statistical analysis.

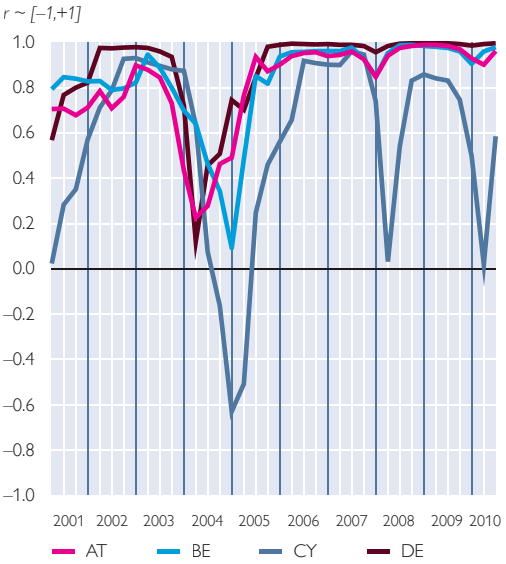
To better judge the developments over time, chart 9 presents the course of the correlations of country-specific cycles with the euro area cycle in rolling two-year windows (left panels). The respective cyclical component of the same countries (lines) and of the euro area (shaded area) are shown in the right panels. While fully describing all charts would exceed the limits of this study, some interesting details may be discussed representatively.

A look exclusively at the left panels clearly shows that the decline, or low level, of the correlation coefficients around 2004, when the euro area's output gap was negative, spread to all countries,[26] admittedly with stronger declines in the correlation in some countries (e.g. Cyprus, Greece, Luxembourg, Malta and Slovakia) than in others (Austria, Belgium, Germany, Slovenia). Only Italy and the Netherlands registered barely any change during this period; the correlations with the euro area cycle remain comparatively high here. The decline in the correlations during the crisis, however, may be observed to be much more heterogeneous; it is driven by only a few countries. As in the mean bilateral correlations (section 3.1), two country groups predominate the decline in correlations with the euro area. The first of these declines is triggered by Cyprus and

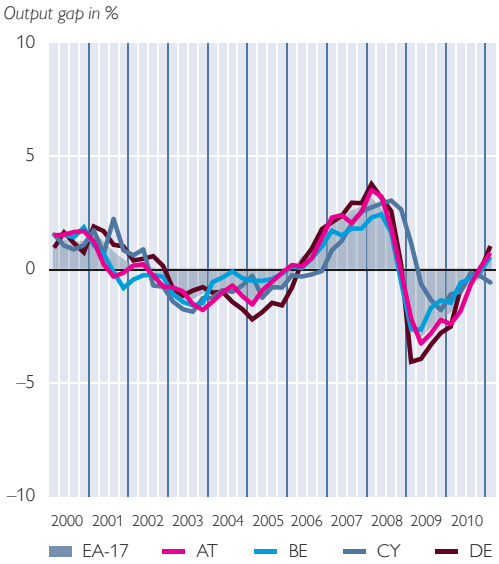
[26] *Not surprisingly, the mean bilateral correlation coefficients in section 3.1 show a similar picture, though the perspective of the analysis is a different one: Whereas section 3.1 focuses on the bilateral correlations of countries among one another, chart 9 presents the respective correlations with the euro area aggregate.*

Chart 9

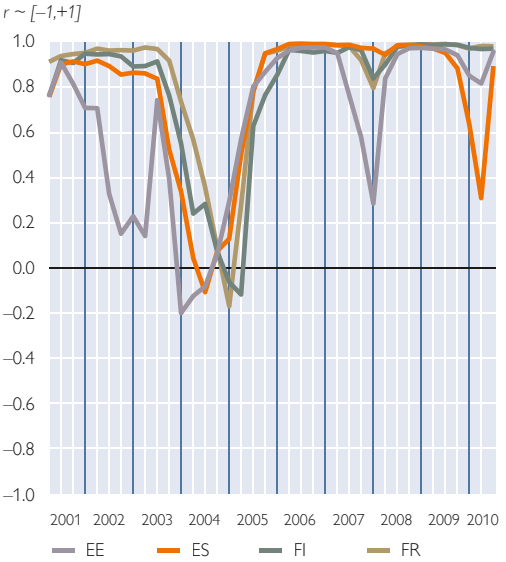
Correlations with the Euro Area Cycle (1)



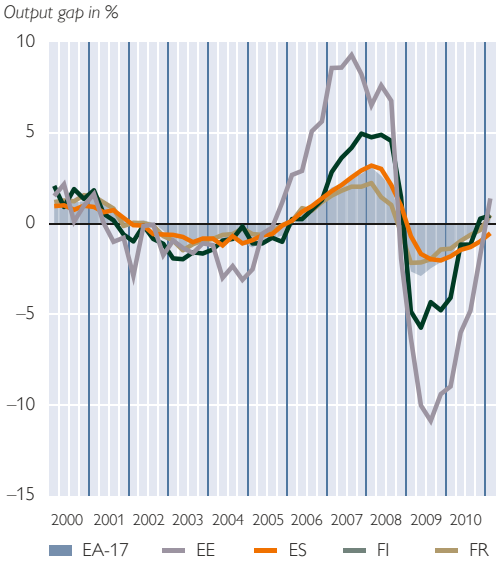
Selected Country Cycles and the Euro Area Cycle (1)



Correlations with the Euro Area Cycle (2)



Selected Country Cycles and the Euro Area Cycle (2)

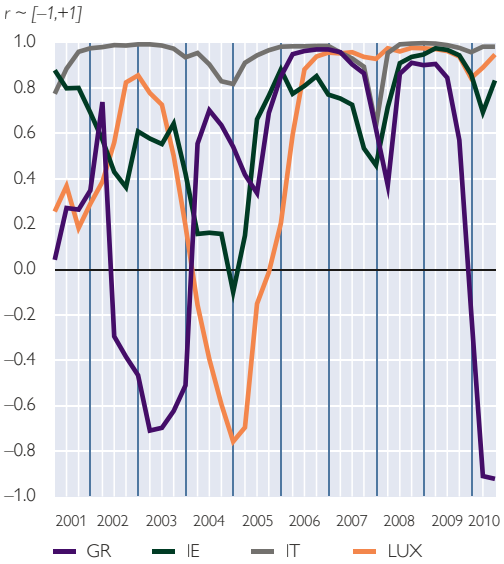


Slovakia, as well as Estonia, Greece, Ireland and Malta. The second reduction is characterized by a fall in the correlations to less than –0.9 in the case of Greece; this fall is further reinforced by Cyprus, Spain, Malta and Portugal.

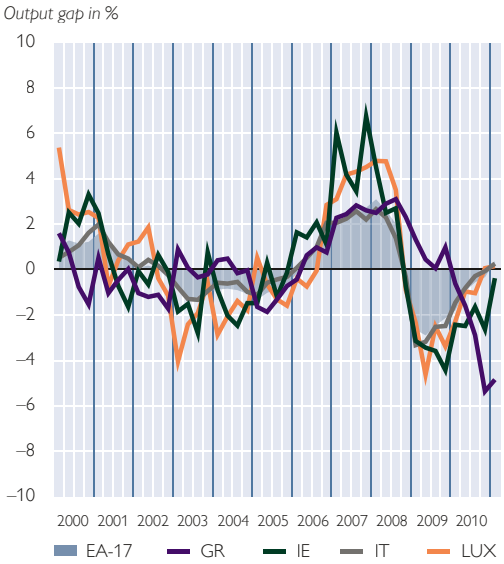
Interesting differences can also be seen among the countries that had already drawn on financial support to counteract the sovereign debt crisis, notably Greece, Ireland and Portugal. Whereas at the beginning of the crisis, the downturn was far less pronounced in Greece than in the euro area aggregate, Greece slipped inexorably into recession toward the end of the sample

Chart 9 – continued

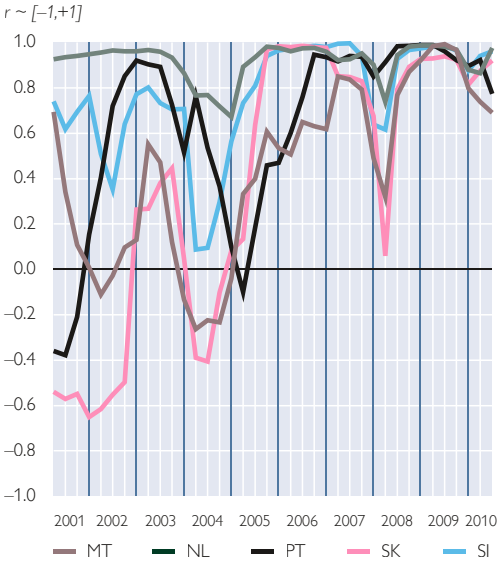
Correlations with the Euro Area Cycle (3)



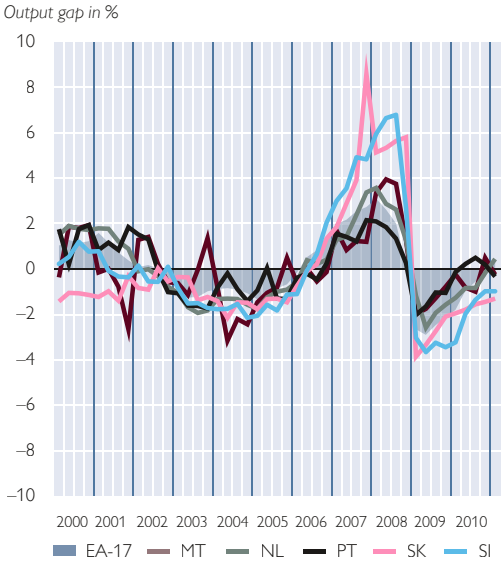
Selected Country Cycles and the Euro Area Cycle (3)



Correlations with the Euro Area Cycle (4)



Selected Country Cycles and the Euro Area Cycle (4)



Source: Authors' calculations.

and displayed the largest negative output gap. Ireland, too, remained below potential output. Nevertheless, unlike Greece, Ireland's synchronization with the euro area cycle hardly changed; at the end of the sample, its correlation coefficient remains very high at over 0.8; the value for Greece, by contrast, is –0.9. Toward the end of the sample, Portugal had nearly reached potential output, only to experience a decline in synchronization (to a correlation coefficient of about 0.7), which points to a weakening of economic activity.

Once again, the panels in chart 9 clearly show why the measure for the

synchronization of cycles (i.e. the correlation coefficient) and the dispersion measure (i.e. standard deviation) should complement one another. Whereas the decline in the correlation coefficients around 2004 is accompanied by fairly small deviations from the euro area cycle, the amplitude of the cycles during the most recent crisis are significantly higher; this, however, does not have a negative impact on all countries' correlation coefficients. For efficient monetary policymaking, it is not simply relevant whether the cycles tend to move in the same direction, but also how much they deviate from the respective other cycles.

The example which best illustrates this is the direct comparison between Estonia and Spain: While the swings of the Spanish cycle cover a smaller range (both during the boom and during the recession phase) than those of the euro area cycle, at the beginning of 2010, the correlation coefficients plummet nevertheless. The reason for this phenomenon is that the turnabout occurred later in Spain than in other countries, which in the end has a negative impact on the correlation coefficient.

While displaying a disproportionately large output gap (over 10% of potential output) at the outset, Estonia did not experience a strong impact on the correlation coefficient because the turnaround took place nearly at the same time as in all other countries. The sharp drop in the Greek correlation coefficient from 0.8 to around –0.9 is readily identifiable in the business cycle: Throughout most of the crisis period, the Greek economy reacted less strongly and posted a positive output gap for a long time. But the comparatively more powerful contraction of the Greek economy from early 2010 is obvious, as it occurred during a period in which the output gap slowly began to contract again in other euro area countries.

4 Conclusions

This study examines the impact of the most recent financial and economic crisis on the synchronization of business cycles in the euro area. While an abundant literature analyzes the impact of the introduction of the euro on business cycle symmetry, the developments since the crisis have not yet been reviewed in detail. The results of the analysis show a pronounced desynchronization of business cycles during the crisis period, both with respect to dispersion and to the correlation of business cycles. Moreover, interesting differences and parallels may be observed between the developments since the beginning of the most recent financial crisis and an earlier period, around 2004, when the output gap in the euro area was negative as well.

The external shock that spread from the U.S.A. to the euro area when the financial crisis started to spread in 2008 appears to have impacted the real variables in the individual countries differently and thus to have led to a divergent development of the business cycles. The analysis of the dispersion measure shows, however, that the desynchronization already began in 2007 during the boom phase preceding the crisis rather than at the end of 2008 when the most recent recession emerged. It suggests itself that the size of the standard deviation of the cycles is influenced by the absolute size of the output gap. The output gap was just as large during the boom phase prior to the crisis as during the sharp recession, so that a maximum degree of dispersion was in fact identified for both periods. This pattern is also confirmed by an analysis of industrial

production data. Whereas the dispersion of industrial cycles also climbs strongly during the recession period, this was not the case during the preceding boom, as the cyclical peak was accompanied by a noticeably smaller absolute output gap than the cyclical trough in 2009.

Apart from the rise in dispersion, at the beginning of 2007 and 2009, the correlation coefficients of the GDP business cycles also diminished in the euro area. These declines occurred nearly simultaneously with the rises in dispersion. The same pattern may be observed for industrial production, where the decline in the correlation occurred hand in hand with a marked increase in dispersion.

The reduction of the correlations observed during the recession phase of 2009 was much smaller than during the 2004 period, when the output gap in the euro area was also negative. The reason was that in 2004, nearly all euro area countries experienced a decline in correlation measures; conversely, this was not the case during the recession phase of 2009. The renewed decline seems to have been triggered mainly by the countries hardest hit by the debt crisis, above all Greece. Because the absolute extent of the output gap was fairly small in the 2004 period, the decline in the correlation measures was not accompanied by a general rise in dispersion (i.e. the amplitude) of business cycles, unlike during the severe recession in 2009.

Subdividing the most recent crisis period into two stages – the "Great Recession" and the subsequent recovery (at least until mid-2011) reveals further country differences. Whereas most euro area countries were beset by the downturn at nearly the same time, the subsequent recovery started at different times in different countries, and was weaker in some, stronger in others. The following dichotomy may offer an explanation: While the triggering events were the same, individual countries started from disparate starting points and reacted with different policies. During the "Great Recession" – emanating from the U.S.A. – a loss of trust occurred in the banking system across the world and paralyzed capital markets all over, but during the temporary recovery which followed, the substantially different debt levels weighed on individual countries to different degrees: Countries with less debt were able to successfully wield an expansionary fiscal policy to effect a change in trend, whereas the more heavily indebted countries had considerably less room for maneuver, thus slipping ever deeper into the crisis. These countries were additionally handicapped by structural weaknesses such as tax evasion, low competitiveness and real estate bubbles, which slowed the recovery in these countries even more.

The differences ascertained for the periods before and after the collapse of Lehman Brothers contain important implications for the single monetary policy in the euro area. In the time immediately after 2004, during which correlation coefficients declined but dispersion reacted only insignificantly, the individual euro area countries, while not far away from reaching potential output, did not display synchronized cycles. Hence, countries that have already overcome their low would need to pursue a contractionary monetary policy; optimally, the other countries should retain an accommodative monetary policy.

During the "Great Recession" from 2008, the difficulties of a single monetary policy appear in an entirely different light: The correlation coefficients declined during the crisis, but then

persisted at a fairly high level even though dispersion increased markedly. While the countries more or less concur on the direction of interest rate policy, above all the size of the steps to be taken were a matter of discussion. The recent decline in the correlations toward the end of the first sample (Q1 11) implies a rekindling of the debate. Some countries – e.g. Germany – embarked on a recovery more quickly, but others took much longer to overcome the cyclical trough. Of course, given the parameter instability in estimating the cyclical component, there are limits to the robustness of statements about the synchronization of business cycles in the euro area at the end of the sample. As this study has been able to show, uncertainty about estimates of the output gaps from mid-2010 are high, so that the most recent developments cannot be analyzed with any certainty until the relevant GDP data have become available.

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Annex

Chart 10

Robustness Analysis: Euro Area Dispersion

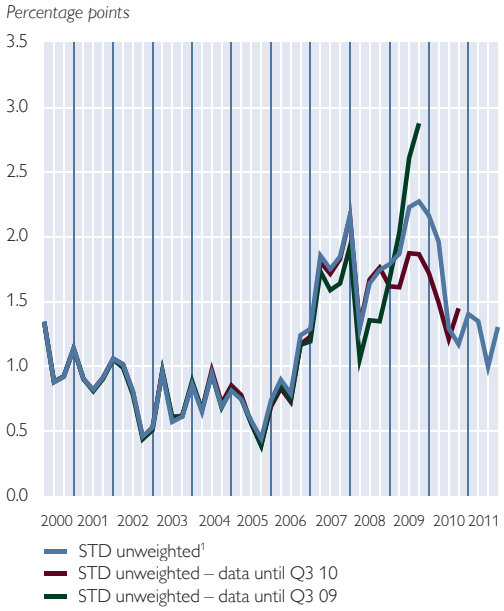


Chart 11

Robustness Analysis: Euro Area Dispersion

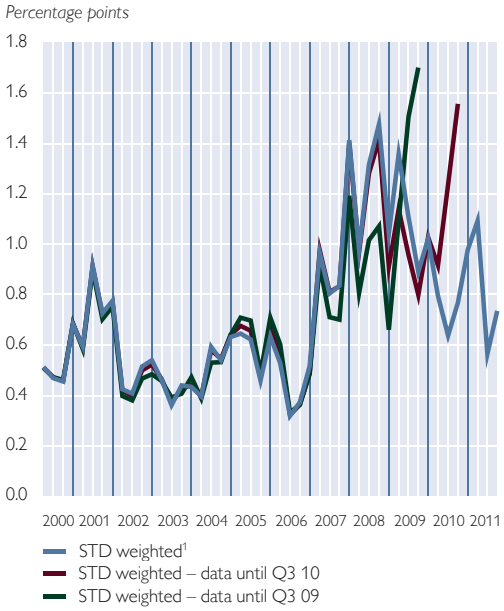


Chart 12

Robustness Analysis: Euro Area Bilateral Correlation Coefficients

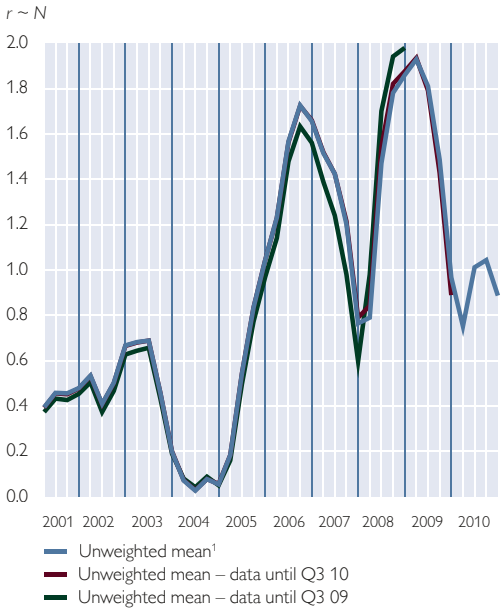
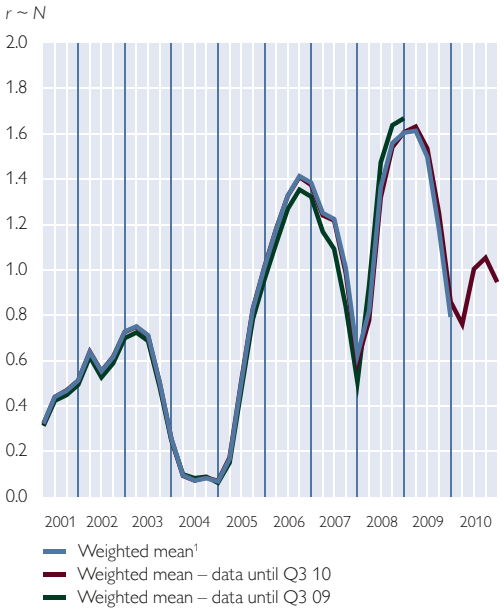


Chart 13

Robustness Analysis: Euro Area Bilateral Correlation Coefficients



Source: Authors' calculations.

[1] Q2 11 to Q3 11 excluding Greece.

Table 1

Average Growth of Potential Output

	Q1 01 to Q3 11	Q1 01 to Q3 08	Q4 08 to Q3 11
	Annual change in %		
Austria (AT)	1.8	2.0	1.0
Belgium (BE)	1.5	1.8	0.8
Cyprus (CY)	2.8	3.4	1.3
Germany (DE)	1.1	1.2	0.9
Estonia (EE)	3.7	5.7	–1.3
Spain (ES)	2.1	2.9	–0.1
Finland (FI)	2.0	2.7	0.3
France (FR)	1.3	1.6	0.3
Greece (GR)	2.5	3.5	–0.7
Ireland (IE)	2.5	4.0	–1.6
Italy (IT)	0.4	0.9	–0.8
Luxembourg (LU)	2.9	3.8	0.7
Malta (MT)	1.8	1.7	1.9
Netherlands (NL)	1.5	1.9	0.7
Portugal (PT)	0.7	1.0	–0.2
Slovakia (SK)	4.6	5.2	3.1
Slovenia (SI)	2.7	3.7	0.1

Source: Authors' calculations.