DNB Working Paper
No. 644 / July 2019

Medium-term Asymmetric Fluctuations and EMU as an Optimum Currency Area

Jeroen Hessel

DeNederlandscheBank
EUROSYSTEEM

Medium-term Asymmetric Fluctuations and EMU as an Optimum Currency Area

Jeroen Hessel*

* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

Working Paper No. 644

De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

July 2019

Medium-term Asymmetric Fluctuations and EMU as an Optimum Currency Area

Jeroen Hessel*
De Nederlandsche Bank

July 2019

Abstract

Recent studies find that *short-term* fluctuations in EMU have been symmetric. This finding leads to benign views on the functioning of EMU as an optimum currency area (OCA), that are difficult to reconcile with the sovereign debt crisis. We try to solve this puzzle by looking at *medium-term* fluctuations instead, and reach five conclusions. First, medium-term fluctuations in EMU are much larger and less symmetric than short-term fluctuations. Second, medium-term fluctuations have become larger and less symmetric over time, while short-term fluctuations have become smaller and more symmetric. Third, medium-term fluctuations in EMU are less symmetric than in the US, while short-term fluctuations are more symmetric. Fourth, medium-term fluctuations in the euro area have become more strongly correlated with financial variables like credit and house prices, and less strongly correlated with real variables like productivity. Finally, medium-term fluctuations are more closely related to imbalances in price competitiveness, current accounts and budget deficits than short-term fluctuations. We conclude that our medium-term perspective has become relevant in the monetary union, due to the increasing importance of financial factors. It leads to less benign views on the functioning of EMU and on the endogenous OCA hypothesis.

Keywords: EMU, optimum currency areas, economic fluctuations, financial cycle
JEL classifications: E44, E58, F36, G15, G21

---

*Senior Economist at the Economics and Research Division of De Nederlandsche Bank, P.O. box 98, 1000AB Amsterdam. E-mail: j.p.c.hessel@dnb.nl. We would like to thank Steven Brakman, Jakob de Haan, Gabriele Galati, Niels Gilbert, Mark Mink, Christiaan Pattipeilohy, Jasper de Winter, seminar participants at DNB and participants in the CEUS workshop on European Economics in Vallendar/Koblenz on May 17-18 2018 for valuable comments and suggestions. All remaining errors are my own. The views expressed in this paper are those of the author and do not necessarily represent the views of De Nederlandsche Bank.

1 Introduction

A central part of the theory of optimum currency areas (OCAs) is the occurence of asymmetric shocks or fluctuations in a monetary union. While the original OCA-theory did not specify the nature of these fluctuations, the application of this theory to the Economic and Monetary Union (EMU) often focused on *short-term* fluctuations, especially business cycle fluctuations with a frequency of up to 8 years.[1] A key question was how the symmetry of short-term fluctuations would evolve once EMU was established. An optimistic view was that the single currency would increase trade integration and thereby endogenously increase the symmetry of cycles (Frankel and Rose, 1998). De Haan et al. (2008) provide an overview of the empirical literature.

In the almost 20 years since the start of EMU, short-term fluctuations have been surprisingly symmetric, even during the sovereign debt crisis (figure 1). This is confirmed in several recent studies, and has led to benign views on the functioning of EMU as an optimum currency area. Van Beers et al. (2014) conclude that: *"co-movement of real GDP per capita among EMU countries [...] is on average slightly stronger than that among US states"*. Gächter and Riedl (2014) conclude that: *"the adoption of the euro has significantly increased the correlation of member countries' business cycles [...]. Thus, [...] a country is more likely to satisfy the criteria for entry into a currency union ex post rather than ex ante"*. Campos and Macchiarelli (2016) state that their analysis: *"provides renewed support for the endogenous OCA hypothesis. Moreover, [...] there might be less wrong with the euro than commonly thought"*.

[FIGURE 1 AROUND HERE]

It remains an important puzzle, however, how these benign views can be reconciled with the sovereign debt crisis, that hit the euro area severely and is sometimes seen as *"the mother of all asymmetric shocks"* (Krugman, 2012). The euro crisis was related to the buildup and correction of several large and long-lasting divergences: in the growth of credit and house prices, in price competitiveness, in current account balances and in budget deficits (De Haan et al., 2015). It seems unrealistic that these divergences have left no mark on economic fluctuations. Moreover, it is well established that some EMU countries have experienced much deeper and longer recessions after the crisis than others. For example, cumulative growth between 2009 and 2013 was 3.4% in Germany but -7.8% in Italy, -8.0% in Portugal and -9.2% in Spain.

In this paper, we explore a possible solution to this puzzle. Our idea is that the sovereign debt crisis and its divergences *did* lead to asymmetric fluctuations, but that they were *longer lasting* than normal business cycles. These longer fluctuations cannot be captured with common methods to calculate business cycles, which are often directed at short-term frequencies. In these common methods, the longer-term fluctuations therefore do not end up in the fluctuations, but in the underlying trends. Two indications support this hypothesis. First, the recent literature confirms

[1] Or as an alternative, short-term underlying shocks from VAR-analyses (Bayoumi and Eichengreen, 1993).

that crises and macroeconomic imbalances affect trend growth. Potential GDP has declined in many countries after the financial crisis, for instance due to deleveraging and hysteresis (European Commission, 2014; Ball, 2014; IMF, 2015; Bayoumi and Eichengreen, 2017). Fluctuations in trend growth are linked directly to the build-up and unwinding of macro-financial imbalances, like credit and house price bubbles (Borio et al., 2013; Berger et al., 2015) or growing current account deficits and losses in price competitiveness (Alberola et al., 2013; Ollivaud and Turner, 2014). Second, trend growth rates in the euro area indeed display surprisingly large and persistent asymmetric fluctuations (figure 2). While trend growth was stable in countries like Germany and Austria, it fluctuated strongly in countries like Ireland, Spain and Greece.

[FIGURE 2 AROUND HERE]

Our idea is therefore that around the crisis, EMU member states may have experieced asymmetric *medium-term* fluctuations, rather than short-term fluctuations. We build on the literature on medium-term fluctuations, including Blanchard (1997), Caballero and Hammour (1998), Solow (2000), Comin and Gertler (2006), Drehmann et al. (2012) and De Winter et al. (2017). The attention for medium-term cycles is growing, due to the so-called *financial cycle*, a medium-term fluctuation driven by credit and house prices (Drehmann et al., 2010; Borio, 2012). However, medium term fluctuations can also be driven by real factors like productivity (Blanchard, 1997; Comin and Gertler, 2006). We compute measures of medium-term fluctuations using statistical filters with lower frequencies derived from this literature.

Our central hypothesis is that looking at medium-term fluctuations instead of short-term fluctuations leads to a less benign view on the functioning of EMU as an optimum currency area, that is more in line with the experience of the debt crisis. To confirm this hypothesis, we first need to establish that medium-term fluctuations in the euro area are less symmetric than short-term fluctuations. In addition, we also need to establish that these asymmetric medium-term fluctuations are relevant for the functioning of EMU as an optimal currency area, and do not reflect divergences in the "genuine" growth potential of member states that may be relatively harmless.

Our analysis has three parts. In the first part, we compare the symmetry of medium-term fluctuations in the euro area to that of short-term fluctuations. Part of this has also been done by De Grauwe and Yi (2016) and Alcidi (2017), but we use longer time-series since 1970. In addition, we are to our knowledge the first to make a comparison with medium-term fluctuations in US states and regions. Furthermore, we follow Mink et al. (2012) by using separate measures for symmetry in the *phase* of fluctuations and symmetry in the *amplitude* of fluctuations. Differences in the amplitude of fluctuations are also relevant in a monetary union, for instance because the single monetary policy cannot take them into account (Mink et al., 2012; Belke et al., 2016).

The second part tries to relate medium-term fluctuations to their potential drivers. We look at the relative role of *real* drivers, in particular productivity, and *financial* drivers, in particular credit and house prices. The literature suggests that especially medium-term fluctuations driven by financial factors cause macroeconomic imbalances and crises (Drehmann et al., 2012; Borio, 2012). The relative importance of financial drivers should therefore give an indication on the harmfulness of medium-term fluctuations and on their relevance for the functioning of EMU.

Third, we investigate if the buildup and correction of imbalances in price competitiveness, current accounts and budget deficits in EMU can be related to medium-term rather than short-term fluctuations. According to the literature, these imbalances are at least partly related to medium-term oriented financial cycles (De Haan et al., 2015). We estimate panel regressions for these imbalances that include measures of the cycle, and compare the (partial) explanatory power of medium-term and short-term fluctuations. A higher explanatory power of medium-term fluctuations would be a further indication on their relevance for the functioning of EMU.

We present five key findings. First, medium-term fluctuations are much larger and less symmetric than short-term fluctuations. Second, medium-term fluctuations became larger and less symmetric over time, while short-term fluctuations became smaller and more symmetric. Third, medium-term fluctuations in EMU are less symmetric.than in the US, while short-term fluctuations are more symmetric. Second, we find that medium-term fluctuations in the euro area have become more strongly correlated with financial variables like credit and house prices, and less strongly correlated with real variables like productivity. Finally, imbalances in competitiveness, current accounts and budget deficits in the euro area are more closely related to medium-term fluctuations than to short-term fluctuations.

We conclude that the medium-term has become a relevant dimension for the functioning of EMU as an optimum currency area. This is due to the increasing role of financial factors and financial cycles, that has increased the asymmetry of medium-term term fluctuations, mainly due to larger differences in the amplitude of fluctuations. Financial factors have also made medium-term fluctuations more harmful, increasing the risk of macro-financial imbalances and crises. Overall, the focus on medium-term fluctuations therefore leads to less benign views on the functioning of EMU, that are more in line with the sovereign debt crisis. It also casts doubt on the idea that EMU has endogenously become closer to an optimum currency area.

The paper is structured as follows. Section 2 reviews the literature on medium-term fluctuations and their potential evolution in a monetary union. Section 3 describes the methodology. Section 4 describes the data, while section 5 presents the results. Section 6 concludes.

2 Literature

2.1 Medium-term fluctuations

It is common to see cycles as relatively short-term fluctuations around a stable trend (figure 3, left panel). These fluctuations result from shocks and their propagation, which are often assumed to peter out in a number of years. Growth then returns to its long-run trend, which may vary due to changes in demographics or technical progress, but which is essentially stable. Yet the possibility of medium-term fluctuations is not new. It dates back to Kuznets (1930) and has been the subject of a small number of papers like Blanchard (1997), Caballero and Hammour (1998), Solow (2000), Comin and Gertler (2006) and Drehman et al. (2012). The idea has gained considerable traction after the financial crisis. It is assumed that in addition to the short-term fluctuations and the long-term trend, countries may also experience longer lasting fluctuations (figure 3, right panel). In the literature, these medium-term fluctuations result from propagation mechanisms that start later, move more slowly and are more persistent. They are usually related to the (endogenous) buildup and correction of certain imbalances. Medium-term fluctuations may lead to longer periods of strong and robust growth (like the 1960s and 1990s), followed by longer periods of low and vulnerable growth (like the late 1970s and early 1980s).

[FIGURE 3 AROUND HERE]

There is no consensus on the underlying causes of medium-term fluctuations. Blanchard (1997), Caballero and Hammond (1998) and Comin and Gertler (2006) emphasize the role of *real* economic factors. They point at wage-markup shocks, like the gradual increase in labour income shares in the 1970s (Blanchard, 1997; Caballero and Hammour, 1998). This development triggers no adjustment in the short term, when capital is "fixed", but eventually lead to medium-term adjustment in the form of substitution from labour to capital (Blanchard, 1997) or innovation and endogenous technological progress (Comin and Gertler, 2006). The implication is that medium-term fluctuations in GDP are correlated with fluctuations in labour and total factor productivity.

By contrast, Drehman et al. (2012) emphasize the role of *financial* factors. Their idea is that the financial accelerator amplifies and prolongs economic fluctuations via movements in asset prices, credit and private debt. Borio (2012) for instance shows that financial deregulation may lead to a credit-and house price boom that eventually self-corrects and triggers a longer period of declining house prices and deleveraging. This is closely related to the so-called financial cycle, which is thought to have a higher amplitude and longer duration than normal business cyles, and which has become more important due to financial liberalization (Borio, 2012). So far, financial cycles have mainly been derived from financial variables only (Galati et al., 2016). Several papers find some relation with fluctuations in GDP (Drehman et al., 2012), while a few studies find more systematic relationships.[2] Medium-term GDP fluctuations are correlated with fluctuations in credit and house prices (Borio, 2012).

There is no consensus either on the frequency of medium-term fluctuations. Comin and Gertler (2006) look at fluctuations of up to 50 years in their empirical analysis, while Drehman et al. (2012) look at fluctuations of up to 30 years. Borio (2012) claims that the financial cycle would have a duration of 16-20 years. The lack of consensus is understandable. In practice, the distinction between short-term fluctuations, medium-term fluctuations and trends is uncertain, also because these variables are unobservable. It may be hard to separate short- and medium-term fluctuations, that are often driven by the same shocks (Comin and Gertler, 2006). Likewise, genuine increases in trend growth, due to for instance convergence or higher labour force participation, may be hard to distinguish from unsustainable credit booms. Statistical filters cannot provide full clarity either, as they often require assumptions on the frequency of fluctuations. Through the lens of a short-term statistical filter, medium-term fluctuations result in relatively small and stable cycles accompanied by large fluctuations in trend growth (figure 4, left panel). Applying a statistical filter with a medium-term frequency, leads to a more stable trend and to much larger and longer lasting fluctuations (figure 4, right panel). Therefore, choices will to some extent remain subject to debate, as there is no absolute certainty. However, De Winter et al. (2017) have tried to identify the frequency medium-term fluctuations without making prior assumptions using spectral density analysis. They conclude for G7 countries and the Netherlands that their frequency approximately lies between 25 and 30 years.

[FIGURE 4 AROUND HERE]

2.2 The monetary union perspective

Relatively little is known yet about how medium-term fluctuations behave in a monetary union. Only a few papers have so far applied ideas that resemble medium-term fluctuations to EMU. De Grauwe and Yi (2016) and Alcidi (2017) calculate longer-lasting fluctuations for euro area countries in the EMU period, an conclude that they differ in amplitude. Models by Cuerpo et al. (2013), In ‘t Veld et al. (2014) and Martin and Philippon (2017) show that the interaction between financial factors and adjustment channels in EMU induced large and long-lasting asymmetric fluctuations. Yet the broader literature on the euro crisis indirectly allows three conclusions regarding possible medium-term fluctuations in EMU.

First, any potential medium-term fluctuations in EMU are more likely to be related to financial factors than to real factors (Lane, 2013; Obstfeld, 2013). The start of EMU coincided with a period

[2] See primarily Borio et al. (2013; 2014) and Berger et al. (2015). However, these papers are not necessarily directed at medium-term frequencies.

of strong financial development and integration worldwide, stimulated even further by the single currency (Forbes, 2012). Yet there was a strong asymmetry in this development, as credit and house price growth has been stronger in the periphery than in the core of the euro area (Samarina et al., 2015). This is partly because these countries were expected to have upward convergence potential (Giavazzi and Spaventa, 2010) and partly because they benefited from a strong decrease in (real) long-term interest rates in the run-up to EMU-membership. There is less evidence that the medium-term fluctuations in the euro area are related to productivity. On the contrary, the strong increase in credit in in Southern European contries has spurred growth of non-tradable sectors with lower productivity (Gilbert and Pool, 2016), and helped to uphold low-productive companies that would otherwise have gone bankrupt (Reis, 2013). The benign financial conditions also induced a postponement of structural reforms (Fernandez-Villaverde et al., 2013) and an increase in structural differences between member states (Buti and Turrini, 2015).

Second, medium-term fluctuations could be related to the buildup and correction of macroeconomic imbalances in EMU. Imbalances in price competitiveness, current accounts and budget deficits seem partly driven by asymmetric financial cycles (De Haan et al., 2015). Vice versa, especially the correction of these imbalances has had a longer-lasting effect on GDP. Several channels may amplify the interaction between medium-term fluctuations and imbalances:

Relative prices. In a monetary union, fluctuations could be amplified and prolonged via the interaction with relative prices. The effects depends on the relative strength of the competitiveness channel and the real interest rate channel (European Commission, 2008). A positive asymmetric fluctuation increases relative prices vis-á-vis other EMU member states, and this has two opposing effects. First, the resulting loss of competitiveness slows growth and dampens the fluctuation. Second, higher inflation decreases real interest rates and amplifies the fluctuation: the so-called Walters' effect (Wyplosz and Mongelli, 2008). In the euro area, the competitiveness channel is weak due to wage and price rigidities (Biroli et al., 2010). As a result, asymmetric fluctuations caused longer-lasting differences in real interest rates that amplify the fluctuation: a *super Walters' Effect* (Buti and Turrini, 2015; Bonam and Goy, 2017). During the downturn, both channels work in the opposite direction and amplify the slowdown. The need to restore competitiveness reduces inflation and increases real interest rates, which were already higher due to the increase in risk premia after the crisis.

Current accounts and capital flows. The interaction with current accounts and capital flows may also amplify fluctuations. Credit driven domestic demand booms are an important cause of current account deficits in southern Europe, while the need to correct these deficits after the crisis has contributed to the downturn in these countries (Gaulier and Vicard, 2012; Wyplosz, 2013; Comunale and Hessel, 2014; Gilbert and Pool, 2016). This channel is amplified further by capital flows. Benign financial conditions before the crisis enabled peripheral countries to finance current account deficits that would have been unsustainable in more normal circumstances. Moreover, capital inflows helped to amplify the credit boom (Samarina and Bezemer, 2016). During the downturn, capital outflows may have amplified the adjustment in current accounts and deepened the downturn (Martin and Philippon, 2017), although the public sector financial aid that became available via the ESM and the ECB softened part of the adjustment (Gross and Alcidi, 2013).

Fiscal policy. The interaction with fiscal policy could amplify fluctuations as well. Medium term financial cycles can have large effects op public finances (Bénétrix and Lane, 2015). Financial booms increase government revenue. Rising asset prices increase revenue from capital gains and transaction taxes, while wealth effects drive up the share of domestic demand and thereby revenue from indirect taxes (Eschenbach and Schuknecht, 2004; Dobrescu and Salman, 2011; Lendvai et al., 2011). In practice, the temporary revenues are often mistaken for structural improvements, and therefore lead to procyclical government spending, that amplifies the boom. This reverses when the downturn of the financial cycle causes an unusually strong decline in public revenue and a much larger budgetary deterioration than normal (Gilbert and Hessel, 2014; Bénétrix and Lane, 2015). It forces countries into budgetary consolidation that amplifies the downturn.

Third and finally, EMU could be more prone to asymmetric medium-term fluctuations than the US. Adjustment mechanisms work better in the US, due to higher labour mobility (Beyer and Smets, 2014), the presence of a federal budget (Sala-i-Martin and Sachs, 1992) and better private risk-sharing due to more advanced financial integration (Asdrubali et al, 1996). In addition, the channels described above may be stronger and more asymmetric in the euro area. Financial developments could be more asymmetric due to decreasing long-term interest rates in some countries at the start of EMU and due to differences in financial systems between member states. The interaction with relative prices could also be stronger in EMU, because higher inflation persistence strengthens and prolongs real interest rates differentials (European Commission, 2015). Moreover, EMU is more bank-based and banks are more attached to their domestic market, which could amplify downturns if non-performing loans reduce local banks' lending capacity (Hoffmann and Sorensen, 2015). Finally, EMU countries seem more vulnerable to capital flight than US states, because government debt is issued at the decentralized level, the sovereign-bank nexus is relatively strong and a lender of last resort for sovereigns is lacking (De Haan et al., 2015).

3 Methodology

As mentioned, our central hypothesis is that looking at medium-term fluctuations rather than short-term fluctuations leads to a less benign view on the functioning of EMU as an optimum currency area, that is more in line with the experience of the debt crisis. To confirm this hypothesis, we need to establish that medium-term fluctuations in the euro area are less symmetric than short-term fluctuations. In addition, we need to establish that these asymmetric medium-term fluctuations are relevant for the functioning of EMU as an optimal currency area, and do not reflect divergences in the "genuine" growth potential of member states that may be relatively harmless. Our analysis therefore consists of three main parts.

3.1 Symmetry of medium term fluctuations

3.1.1 Calculation of fluctuations

In the first part, we compare the symmetry of medium-term fluctuations to that of short-term fluctuations. We also compare the fluctuations in the euro area with fluctuations in US states and regions. We calculate short-term and medium-term fluctuations for euro area countries with the bandpass or Christiano-Fitzgerald filter. For short-term fluctuations, we use the standard bandpass filter for fluctuations between 2 and 32 quarters (8 years). The frequency used to culculate medium-term fluctuations varies somewhat in the literature. Comin and Gertler (2006) use frequencies between 2 and 200 quarters (50 years), while Drehmann et al. (2012) use frequencies between 2 and 120 quarters (30 years). We follow Comin and Gertler (2006), but it should be noted that the results are not very sensitive to this choice.[3] The filter takes up all fluctuations with a frequency *up to* 50 years, and it turns out that most of the medium-term fluctuations in GDP have a lower frequency than that.[4]

We apply these bandpass filters to GDP, but also to domestic demand. This comes from Dobrescu and Salman (2011), Lendvai et al. (2011), Comunale and Hessel (2014) and Bénétrix and Lane (2015). Domestic demand should provide a better measure of domestic absorption that is driven by financial factors, such as credit and house prices than GDP. In addition to these central measures, we use a number of other methods in order to check the robustness of our results.[5] For short-term fluctuations we also use the output gap calculated by the European Commission. This measure is based on a production function method, and is widely used in policy discussions.

[3] Importantly, the aim of our paper is to shift the perspective on the frequency of fluctuations from the short-term to the medium-term, and not necessarily to find the most reliable or accurated estimates of financial cycles, medium-term output gaps or "genuine" potential GDP. From our broader perspective, the exact choice of medium-term frequency is less important.

[4] Moving from 30 years to 50 years does not make much difference. We have re-estimated part of our analysis with fluctuations calculated with a bandbass filter over 30 years, and the differences turned out to be small. In addition, results with a HP-filter with a frequency between 16 and 20 years are also very comparable.

[5] We also apply the Hodrick-Prescott filter to GDP and domestic demand. We calculate short-term fluctuations with the traditional value for the smoothing parameter lambda of 1,600. For the medium-term fluctuations, we use a values of lambda of 100,000, that should filter out fluctuations with a mean duration of 16-20 years (Alessi and Detken, 2009; Drehmann et al., 2010). In addition, in the spirit of Borio et al. (2013; 2014) we obtain medium-term fluctuations by estimating the principle component of: i) the output gap calculated with an HP-filter with lambda 1,600, ii) the growth in real house prices and iii) the growth in real credit to the private sector. While Borio et al. (2013; 2014) use a Kalman-filter, our measure only captures co-movement and does not impose a frequency.

3.1.2 Symmetry measures

We compare medium-term fluctuations with short-term fluctuations via a number of measures. The *size* of fluctuations is approximated by the standard deviation over certain periods. For the *symmetry* of fluctuations, we do not use ordinary correlation coefficients, as they are an imperfect measure (Mink et al., 2012). Correlations do not properly take into account whether or not fluctuations have the same sign, and also do not take into account differences in the amplitude of fluctuations (figure 5).

[FIGURE 5 AROUND HERE]

As an alternative, we first use the *synchronicity* of fluctuations (Mink et al., 2012). It measures the extent to which the cycle of a certain country has the same sign (i.e. positive or negative) as the cycle of a reference country - in this case the euro area (figure 5, left panel).[6] The synchronicity index varies between a maximum of 1 (when all gaps have the same sign as the reference country) and a minimum -1+2/n, wich equals -1 for large n (when all gaps have the opposite sign). The index is calculated as:

$$synchronicity = \frac{1}{n}\sum_{i=1}^{n}\frac{g_{i,t}g_{ref,t}}{|g_{i,t}g_{ref,t}|}$$

The second measure is the *similarity* index (Mink et al., 2012), which roughly measures the extent to which fluctuations in different countries are similiar in amplitude (figure 5, right panel). As mentioned before, in a monetary union differences in the amplitude of fluctuations may matter just as much as differences in the phase of fluctuations. The measure relates the (absolute) size of differences between the fluctuations of a certain country and the euro area reference cycle to the (absolute) size of the fluctuations in the country itself. The similarity index varies between a maximum of 1 (when all fluctuations are exactly similar) and a minimum of 2-n. It is calculated as:

$$similarity = 1 - \frac{\sum_{i=1}^{n}|g_{i,t} - g_{ref,t}|}{\sum_{i=1}^{n}|g_{i,t}|}$$

The third measure we use is another proxy for the similarity of fluctuations. We use the R-squared, which we determine here as the fraction of the variation in fluctuations in the sample

[6] Mink et al.(2012) argue that the cross-section *median* of the output gaps in the sample should be used as the reference cycle. However, calculations in our sample show that this median fluctuation is very close to the fluctuation of the euro area as a whole. We therefore use the euro area fluctuation as the reference cycle, as it is more easy to interpret.

that can be explained by the variation in the fluctuation of the reference country.[7] This R-squared is comparable to to the similarity index, but is closer to more widely-used concepts. It naturally varies between 0 and 1. Because the R-squared uses squared deviations, rather than average absolute deviations, it is more sensitive to large deviations than the similarity index, and may therefore be more volatile. The R-squared is calculated as:

$$R^2 = \frac{n\sum\limits_{t=1}(g_{ref,t} - \overline{g})^2}{\sum\limits_{i,t=1}^{n}(g_{i,t} - \overline{g})^2}$$

3.2 Drivers of medium-term fluctuations

In second part, we try to relate medium-term fluctuations to their potential drivers from the literature. We look at the relative role of *real* drivers, in particular productivity, and *financial* drivers, in particular credit and house prices. The literature suggests that especially medium-term fluctuations driven by financial factors cause macroeconomic imbalances and crises. Therefore the relative importance of financial drivers should give an indication on the potential harmfulness of medium-term fluctuations and their relevance for the functioning of EMU.

We relate the medium-term fluctuations in GDP (and domestic demand) to medium-term fluctuations in potential real and financial drivers. We focus on the deviations from the EMU-aggregate.[8] We estimate the following equation for our panel of EMU-countries:

$$relative\_output\_gap_{i,t} = c + c_i + relative\_driver\_gap_{i,t} + \varepsilon_{i,t}$$

Here $relative\_output\_gap_{i,t}$ is the relative medium term fluctuation in GDP (or domestic demand) of country i vis-á-vis the EMU-aggregate, c is a constant and c_i are country-specific fixed effects. The variable $relative\_driver\_gap_{i,t}$ captures the medium-term fluctuations in the potential underlying drivers in country i vis-á-vis the EMU-aggregate. We investigate the role of two real drivers, labour productivity and total factor productivity (Blanchard, 1997; Comin and Gertler, 2006), and two financial drivers, real credit and real house prices (Drehmann et al., 2012).

We estimate our model using weighted least squares (GLS) to account for possible cross-country heteroskedasticity. As endogeneity of some of the explanatory variables may be an issue, we also use GMM (Arellano-Bond estimator), using first-differenced data for the instrument weighting

[7] The R-squared calculated in this way is similar to the R-squared of a panel-regression of country-specific output gaps on the aggregate output gap, where we impose that the coefficient of the aggregate output gap equals 1.

[8] We have also performed all analyses for the levels of medium-term fluctuations. The results are qualitatively mostly similar, but somewhat less pronounced.

matrix.[9] We use as internal instruments the lagged values of the respective underlying drivers. We add these potential underlying drivers one by one, to prevent multicollinearity due to correlation between the explanatory variables.[10] We then calculate how much of the variation in medium-term fluctuations can be explained by the respective potential drivers with the *partial* R^2. The partial R^2 is calculated by taking the variation from the explanatory variable multiplied by its coefficient in the regression, and dividing this by the variation in the dependent variable.

3.3 Connection with euro area imbalances

Third, we investigate if the buildup and correction of imbalances in price competitiveness, current accounts and budget deficits in EMU can be related to medium-term rather than short-term fluctuations. According to the literature, these imbalances are at least partly related to medium-term oriented financial cycles (De Haan et al., 2015). A clear link between medium-term fluctuations and these imbalances would therefore be a further indication on their relevance for the functioning of EMU as an optimum currency area.

We estimate three separate panel models, where the relevant imbalance is related to a number of explanatory variables that include (relative) output gaps. We estimate these models with short-term and with medium-term output gaps, and then see whether the medium-term fluctuations explain more of the variation than short-term fluctuations. We do this again by calculating the partial R^2.We primarily focus on the period since the start of EMU, 1995-1999 to 2016. We again estimate our model using weighted least squares (GLS) and GMM (Arellano-Bond first differenced specification).[11]

The first model for **relative prices** is derived from Biroli et al. (2010) and European Commission (2015). We estimate the following equation:

$$\Delta reer_{i,t} = c + c_i + \Delta reer_{i,t-1,...,i,t-4} + reer_{i,t-1} + relative\_gap_{i,t-1} + \varepsilon_{i,t}$$

Here $\Delta reer_{i,t}$ is the change in relative prices, measured by the real effective exchange rate against other euro area countries.[12] As explanatory variables, c is a constant and c_i are country fixed effects. We incorporate four lags to capture the persistence of relative price changes. We also incorporate $reer_{i,t-1}$,the lagged level of the real effective exchange rate, which captures mean

[9] We have also estimated the model with OLS. Results are comparable but less pronounced.

[10] We also ran multivariate regressions where we included both financial and real variables as drivers, which confirm the overall conclusions of the univariate regressions. Simple tests show that the risk of multicollinearity between real and financial variables is not high for the full sample, but could be an issue in subperiods.

[11] We have also estimated the model with OLS. Results are comparable but less pronounced.

[12] We therefore focus on internal price adjustment and exclude exchange rate effects. We check the senstivity of the results to moving to broader measures of the real effective exchange rate, compared to a larger group of trade partners, also outside the euro area. In addition, we also estimated the model for real effective exchange rates based on the consumer price index and the GDP-deflator. Both changes do not affect the outcomes much.

reversion due to the competitiveness channel (see literature section). Finally, we incorporate the (lagged) relative output gap ($relative\_gap_{i,t-1}$), that should capture how relative prices respond to asymmetric fluctuations.

The second model for **current account balances** is derived from Guillemette and Turner (2013), Comunale and Hessel (2014) and Lane and Milesi-Ferretti (2015). We regress current account balances on a number of fundamental and cyclical factors. We estimate the equation:

$$ca_{i,t} = c + c_i + gdp/capita_{i,t} + \Delta pop_{i,t} + dep_{i,t} + bb_{i,t} + fd_{i,t} + reer_{i,t} + gap_{i,t} + \varepsilon_{i,t}$$

Here $ca_{i,t}$ is the current account balance as a percentage of GDP. As fundamental factors we incorporate GDP per capita ($gdp/capita_{i,t}$) to capture convergence effects, population growth ($\Delta pop_{i,t}$) because societies with young children tend to save less, and the old-age-depency ratio ($dep_{i,t}$) as countries with more aged populations also tend to save less. As cyclical factors, we use the budget balance ($bb_{i,t}$), and as country specific foreign demand ($fd_{i,t}$) to capture differences in export destination (Chen et al., 2012). We also incorporate price competitiveness, this time the real effective exchange rate ($reer_{i,t}$) against a broader group of 37 countries. Finally, we include various short and medium-term output gaps ($gap_{i,t}$).

Finally, the third model for **budget balances** is loosely based on Benetrix and Lane (2015) and Berti et al. (2016). We estimate the following equation:

$$bb_{i,t} = c + c_i + bb_{i,t-4} + d_{i,t-4} + i_{i,t} + fri_{i,t} + gap_{i,t} + \varepsilon_{i,t}$$

Our dependent variable is the budget balance ($bb_{i,t}$). The first explanatory variable is the lagged budget balance that should capture fiscal policy inertia. We also incorporate the public debt ratio ($d_{i,t-4}$). Higher debt may worsen the budget balance via higher interest payments, or it may improve the budget balance as countries take measures to restore fiscal sustainability. We also include the long-term (nominal) interest rate ($i_{i,t}$) that may have an upward effect on the budget balance, and the fiscal rules index ($fri_{i,t}$) as proxy for the quality of fiscal frameworks. Finally, we again include the various measures of short-term and medium term output gaps ($gap_{i,t}$).

4 Data

Our sample contains the member states that joined EMU from the beginning or shortly thereafter (Greece), with the exception of Luxemburg, for which not all relevant data were available. For some parts of the analysis, we compare the euro area with US states and regions.[13] We use quarterly data from 1970 to 2016, or sometimes for shorter subperiods.

For the first part of the analysis (symmetry of fluctuations) we used a number of data sources. The data on GDP and domestic demand for EMU countries are quarterly data from the OECD database. We also use the European Commission's output gaps from the AMECO database, and intrapolate these data to obtain quarterly data. For US states and regions, the US Bureau of Economic Analysis (BEA) only has data for GDP, not for domestic demand. These data go back to 1978 and are part quarterly and part annual data that are intrapolated.

For the second part of the analysis (potential drivers of medium-term fluctuations) we used the following additional data. Data on labour productivity are quarterly data from the OECD. For some countries these are complemented with annual data that are intrapolated. The data on total factor productivity are annual data from the AMECO database, and are also intrapolated. The quarterly data on nominal house prices are taken from the OECD, while quarterly data on credit to the non-financial domestic sector are taken from the BIS. Nominal data are made real on the basis of the GDP-deflator from the OECD.

For the third part of the analyses (connection with euro area imbalances), we focus on the period 1995 to 2016. This is partly due to data availability, and partly because this captures the EMU-period and the runup towards it. We use the following additional data. For the model on relative prices, we use quarterly data on the real effective exchange rate come from the European Commission. We take.real effective exchange rates measured in unit labour costs for the whole economy compared to other euro euro area countries. For the model on current accounts, quarterly data on current account balances come from the IMF International Financial Statistics (IFS) database. GDP per capita comes from the IMF WEO database, while data on population growth and the old-age-dependency ratio come from Eurostat, and data on the budget balance come from the AMECO database. These series are annual and hence intrapolated. Country-specific foreign demand is calculated by weighing GDP-growth of countries and regions by their export weights from the IMF Direction Of Trade Statistics (DOTS) (Comunale and Hessel, 2014). In this model we also incorporate the real effective exchange rate (from the European Commission), but this

[13] The 8 U.S. regions are New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountains and Far West. We use both states and regions because it is not entirely clear which are most comparable to EMU member states. US states are on average about 2.7 times smaller than EMU member states in terms of GDP, so US states may be more specialised and therefore more prone to asymmetric fluctuations than EMU member states. By contrast, US regions are on average about 2.4 times larger than EMU member states, so that some of the asymmetric fluctuations may average out.

time measured in unit labour cost against a broader group of 37 countries. For the model on budget balances, quarterly data on long-term interest rates come from OECD. Data on budget balances and government debt come from the AMECO database, complemented by data from Mauro et al. (2015), while the data on the fiscal rules index come from the European Commission. Annual data are again intrapolated.[14]

5 Results

5.1 Symmetry of medium-term fluctuations

We want to know whether looking at medium-term fluctuations instead of short-term fluctuations leads to a less benign view on the functioning of EMU as an optimum currency area. We therefore first investigate whether medium-term fluctuations in the euro area are less symmetric than short-term fluctuations. We present measures on the *size* and the *symmetry* of both types of fluctuations over 10-year rolling windows since 1970 (figures 6 and 8) and for the EMU-period 1999-2016 (table 1 and figure 7). We also compare short-term and medium-term fluctuations in the euro area to those in US states and regions (table 2 and figure 9). Three conclusions emerge.

First, medium-term fluctuations in the euro area are much larger than short-term fluctuations. This confirms the findings of Comin and Gertler (2006) and Drehman et al. (2012). The standard deviation of medium-term fluctuations is around 2 to 3 times larger than the standard deviation of short-term fluctuations (table 1). Moreover, the difference has increased over time (figure 6). Short-term fluctuations have gradually become smaller since the 1970s, in line with the *great moderation* (figure 6, upper and lower left panels).[15] By contrast, medium-term fluctuations have not become smaller, and recently even increased to their highest level since the 1970s (figure 6 upper and lower right panels). A qualification is that this result does not hold for all member states in the EMU period (figure 7). In countries like Belgium, France and Germany, medium-term fluctuations are about as large as short-term fluctuations. Medium-term fluctuations are larger than short-term fluctuations in countries like Spain, Portugal, Ireland and Greece - exactly the countries with the largest macroeconomic imbalances before the crisis (see section 5.3 below).

[TABLE 1 AROUND HERE] [FIGURES 6 AND 7 AROUND HERE]

Second, medium-term fluctuations in the euro area are less symmetric than short-term fluctuations (table 1 and figure 8). This is not so much related to the phase of fluctuations: the

[14] This is somewhat unusual for fiscal data, but it fits better to our measures of fluctuations and also allows us to maintain the same quarterly frequency for all analyses in the paper.

[15] While the crisis has increased their volatily, it remains below the peaks in the 1970s.

synchronicity of medium-term fluctuations is comparable to the synchronicity of short-term fluctuations (figure 8, upper two panels).[16] The main reason why medium-term fluctuations are less symmetric is that differences in amplitudes are: medium-term fluctuations are substantially less similar than short-term fluctuations (see also De Grauwe and Yi, 2016). Both the similarity index and the R-squared are clearly lower for medium-term fluctuations (table 1). In addition, medium-term fluctuations have become less symmetric over time, while short-term fluctuations have become more symmetric. The similarity of short-term fluctuations has increased (figure 8, middle and bottom left panels), which confirms the benign findings of Gächter and Riedl (2014) and Campos and Macchiarelli (2016). But by contrast, medium-term fluctuations have become less similar since the 1970s (figure 8, middle and bottom right panels).

[FIGURE 8 AROUND HERE]

Third, medium-term fluctuations in EMU are less symmetric than in the US, while short-term fluctuations are more symmetric. Short term fluctuations in the euro area have about the same size as in US states an regions (table 2). More importantly, short-term fluctuations are more symmetric in the euro area, which confirms the findings of Van Beers et al. (2014). Short-term fluctuations in the euro area are more synchronized than in US states and regions (figure 9, upper left panel), while their similarity is comparable (similarity index) or higher (R^2) than in the US (middle and lower left panels). By contrast, mudium-term fluctuations in the euro area are less symmetric than in the US: both the sychronicity and the similarity of medium-term fluctuations is substantially lower (figure 9, right panels).[17]

[TABLE 2 AROUND HERE] [FIGURE 9 AROUND HERE]

All in all, our focus on medium-term instead of short-term fluctuations clearly changes the picture. Our analysis of short-term fluctuations largely confirms the benign findings in the rest of the literature: these fluctuations have become smaller and more symmetric, and are more symmetric than in the US. However, our analysis of medium-term fluctuations leads to substantially less benign findings: these have become larger and less symmetric, and are less symmetric than in the US.

5.2 Drivers of medium-term fluctuations

We then try to relate medium-term fluctuations to their potential real and financial drivers. The importance of financial drivers should give an indication on the potential harmfulness of medium-

[16] Although for short-term fluctuations, the synchronicity of domestic demand fluctuations in clearly lower than for GDP fluctuations.

[17] An interesting addition is that the size of nedium-term fluctuations is surprisingly similar in the euro area and the US (table 2). This is in line with Philippon and Martin (2015), who show that the fluctuations in employment are very similar in Arizona and Ireland, as well as in Florida and Spain.

term fluctuations and their relevance for the functioning of EMU. As a first step, we plot bivariate correlation coefficients over a 10 year rolling window (figure 10). The correlation of medium-term fluctuations with financial drivers has clearly increased since the 1970s, both for credit (figure 10, lower left panel) and house prices (lower right panel). By contrast, the correlation of medium-term fluctuations with real drivers has gradually decreased since the 1970s. The decrease is most pronounced for fluctuations in labour productivity (figure 10, upper left panel), while the correlation with total factor productivity has remained higher, especially for GDP (upper right panel).

[FIGURE 10 AROUND HERE]

These results are confirmed by panel regressions performed over three time periods of comparable length: 1970-1985, 1986-1998 and 1999-2016. We show for every potential driver and subperiod the estimated coefficient of the panel regression, as well as the partial R^2 (tables 3 and 4 for GLS and GMM estimations). We find a consistent increase in the explanatory power of both financial variables, house prices and credit. We also find a consistent decrease in the explanatory power of labour productivity, but not of total factor productivity.

[TABLES 3 AND 4 AROUND HERE]

To see what this means in practice, we show how well the real and financial drivers explain differences in medium-term fluctuations in EMU at the last peak (second half of 2007) and trough (first half of 2013) of the cycle (figure 11). We calculate the contributions of the drivers by multipliying their value by the coefficient in the regression. The results show that real drivers explain part of the differences in medium-term fluctuations, but that the role of financial factors is also very important. At the peak of the cycle, differences in productivity cannot explain why the output gap is so far below the EMU-aggregate in Germany, and so far above it in Ireland and Spain (figure 10, upper left panel). These differences are mainly due to financial factors: credit and house price developments have been subdued in Germany and buoyant in Spain and Ireland (figure 11, upper right panel). A similar picture emerges at the trough of the cyle. Differences in productivity cannot explain why medium-term output gaps are far below average in Spain, Ireland and Finland, and above-average in Germany and France (figure 11, lower left panel). These differences are again related to financial factors: house prices did not decrease much in Germany and France, while they decreased sharply in Spain, Ireland and Finland (figure 11, lower right panel).[18]

[FIGURE 11 AROUND HERE]

All in all, we show that medium-term fluctuations have become more strongly connected to financial factors like credit and house prices, while real factors like productivity have become less

[18] House prices perform better than credit. This may be because it is difficult to reduce outstanding credit (a stock variable) quickly during a bust phase. That would require very rapid deleveraging and/or widespread defaults.

important. This confirms the findings of Drehmann et al. (2012) that financial cycles has become more pronounced due to financial deregulation and integration. It also confirms the results of Jordá et al. (2016) that the strong increase in financial development has influenced the characteristics of fluctuations. Financial factors seem to explain an important part of the recent asymmetries in medium-term fluctuations in the euro area. The increased connection with financial factors has made medium-term fluctuations more relevant for the functioning of EMU as an optimum currency area. This type of fluctuations tends to be more harmful and tends to increase the risk of imbalances and crises.

5.3 Connection with euro area imbalances

5.3.1 Relative prices

We then investigate if the buildup and correction of imbalances in price competitiveness, current accounts and budget deficits in EMU can be related to medium-term rather than short-term fluctuations. A clear link with medium-term fluctuations would be a further indication on the relevance of these fluctuations for the functioning of EMU as an optimum currency area.

We first present our results for relative prices. We estimate our panel equation for the EMU period only (1999-2016), because the loss of exchange rates has fundamentally changed the working of relative prices (Biroli et al., 2010).[19] The results with GLS (table 5) and GMM (table 6) are relatively comparable and in line with expectations.[20] First, we find a relatively strong persistence of changes in relative prices in all specifications. We also find a significant negative coefficient for the (lagged) level or the real effective exchange rate. This suggests that relative prices show mean reversion and that deviations in competitiveness are corrected, albeit relatively slowly. Finally, the coefficients for the various relative output gaps are positive and in most cases significant. Hence, as expected positive asymmetric fluctuations trigger an increase in relative prices.

The results show that medium-term fluctuations explain much more of the changes in relative prices in the euro area than short-term fluctuations.[21] In the GLS estimations, short-term fluctuations explain only a very small fraction of the relative price changes, although the output gap of the European Commission does slightly better than the other two (table 5). The explanatory power of medium-term fluctuations is clearly higher, at 8% for medium-term fluctuations in GDP and almost 9% for medium-term fluctuations in domestic demand. The results with GMM show

[19] A quick comparison of estimations for the EMU-period and for the period before suggests that EMU has lead to i) a strong increase in the persistence of price changes, ii) a decline in the speed of mean-reversion, iii) a lower response to differences in output gaps and iv) a strong increase in the R-squared of the regression, due to the absence of exogenous exchange rate disturbances. These results are available upon request.

[20] Compared to the GLS estimations, the persistence seems to be slightly lower in the GMM estimations, while the estimated mean reversion is a bit stronger. We also find slightly higher coefficients for the relative output gap.

[21] As mentioned, we have calculated the explanatory power of each of the fluctuations with the partial R^2. In the calculation, we have incorporated one year of extra feedback via the persistence in relative price changes.

an even more pronounced difference (table 6). Again the explanatory power of the short-term fluctuations is very low, while the Commission gap does better. But also here the explanatory power of medium-term flucutations is siginficantly higher: 31% for medium-term GDP-fluctuation and 37% for the medium-term domestic demand fluctuations.

[TABLES 5 AND 6 AROUND HERE]

To see what this means in practice, we relate the estimated effects of the short-term and medium-term GDP fluctuations to the actual changes in relative prices. We calculate the effects of the output gaps by multiplying the relative gaps with their coefficient (taken from the GMM estimation), and including four quarters of feedback via the persistence of relative prices. We cumulate the relative changes over two longer periods: the period in the runup to the crisis (1999-2007) and the period afterwards (2008-2016). Our calculations clearly confirm that medium-term fluctuations explain a much larger share of the cumulative changes in relative prices (figure 12). The contribution of short-term fluctuations is almost negligible: the orange bars are barely visible for most countries. Medium-term fluctuations explain a much larger part of the changes, especially before the crisis. In 1999-2007, medium-term fluctuations explain the large divergence in relative prices between on the one hand Germany and on the other hand Greece, Spain and Ireland. After the crisis (2008-2016), medium-term fluctuations also explain a larger part of the price changes than short-term fluctuations, although the overall pattern is somewhat less clear.[22]

[FIGURE 12 AROUND HERE]

5.3.2 Current accounts and capital flows

We now present estimates for current account balances for the period 1995-2016. In the GLS estimation, all coefficients are significant, while most of the coefficients have the expected sign (table 7).[23] Importantly, price competitiveness has the expected negative coefficient: an increase in relative prices tends to lower the current account balance. All output gaps also have the expected negative coefficient, suggesting that an increase in the output gap worsens the current account balance. The regressions using GMM show very similar results, although the significance of individual coefficients tends to be lower (table 8).

Again, the results show that medium-term fluctuations explain a much larger share of the evolution of current account balances in the euro area than short-term fluctuations. In the GLS-

[22] The estimated effect of the medium-term fluctuations is relatively small in several countries. This may be because it may take a while before the large positive output gaps in Southern Europe turn negative, and because even then it may take time before relative prices are affected because of the persistence of relative price changes.

[23] There are two exceptions. First, the coefficient for the old-age-dependency ratio is positive, which suggest that in contrast with expectations, countries with a more aged population tend to save more, not less. Second, the coefficient for country-specific external demand is negative, which suggest that countries with the highest external demand growth have lower current account balances.

estimations, short-term fluctuations explain only a small fraction of the variation in current account balances, varying from less than 1% for the bandpass-filtered gaps to around 6% for the Commission gap. The explanatory power of medium-term fluctuations is much higher, at almost 17% for the medium-term GDP gap and even 40% for the medium-term domestic demand gap. The results for the GMM estimations are comparable, although the overal explanatory power is slightly lower: medium-term GDP-fluctuations explain around 11% of current account balances, and meditum-term domestic demand fluctuations around 30%.

Another interesting result is that the inclusion of medium-term instead of short-term output gaps tends to lower the coefficients and the explanatory power of relative price competitiveness. In the GLS-regressions with short-term fluctuations, relative prices explain between 4 and 8% of the variation in current account balances, which underlines the importance of competitiveness within the euro area. However, in the regression with medium-term fluctuations, the explanatory power of price competitiveness is much lower and even almost disappears. This underlines results by Gaulier and Vicard (2012) and Comunale and Hessel (2014), that suggest that the current account deficits in EMU are not only driven by losses in price competitiveness, but also due to medium-term fluctuations in GDP and domestic demand related to the financial cycle.[24]

[TABLES 7 AND 8 AROUND HERE]

We again try to see what this means in reality. We plot the actual current account balances against the contributions of short and medium-term fluctuations in GDP to these imbalances (figure 12). The contributions are calculated with the coefficients of the GLS estimation. Short-term fluctuations are a poor explanation for the evolution of current accounts (the orange lines in figure 13). They consistently predict changes in current accounts that are small and short-lived. The medium-term fluctuations do a much better job (the grey lines in figure 13). They predict differences in current account balances that are much larger and much more persistent that short-term fluctuations. Moreover, they do a really good job in explaining the direction of changes in the current account. The model with medium-term fluctuations provides the best fit for Greece, Spain and Ireland, where the financial boom and bust was accompanied by a worsening and subsequent improvement in current accounts. The same holds for Portugal and Italy, where the model predicts a more or less stable current account deficit before the crisis, and an improvement subsequently. And while the model cannot fully explain the level of the current account surplus for the Netherlands, it does seem to explain its changes over time surprisingly well.[25]

[24] However, it is difficult to draw too strong conclusions from our results in terms of causality, because there seems to be a strong medium-term co-movement in gdp-gaps, relative prices and current account balances.

[25] Interestingly, the model does not fit developments in Germany and Finland well. In Germany, the model predicts a worsening of the current account after the crisis, but in reality the surplus even improved further, possibly due to strong demand for German products in other parts of the world. The model predicts an increase in the Finnish current account after the crisis, but in reality the current account worsened considerably. This suggest that Finland was hit by a negative competitiveness shock, which may be related to the demise of Nokia.

[FIGURE 13 AROUND HERE]

5.3.3 Fiscal policy

Finally, we present the estimations for budget balances for the period 1995-2016. A priori, we expect it to be more difficult to obtain clear result for the effects of medium-term fluctuations on budget balances, for two reasons. First, it is well established that budget balances are closely linked to short-term fluctuations. Second, even if medium-term fluctuations have an influence on fiscal outcomes, this may not necessarily translate into consistent effects on the budget balance over the whole sample. For example, medium-term fluctuations may lead to higher temporary revenues that are spent and hence do not improve the budget balance. The effects of the medium-term cycle may therefore only show up during certain periods, such as an unusually strong decline in budget balances during downturns (Gilbert and Hessel, 2014).

These difficulties are visible in the results for the GLS estimation (table 9). As expected, we find a strong persistence of the budget balance, as well as an upward effect of the debt ratio (as more debt increases interest payments). The effect of the interest rate is not statistically significant, while the coefficient of the fiscal rules index varies in sign. The various output gaps have the expected positive sign, but the coefficients for medium-term fluctuations are small and not always significant. The GMM-estimation provides better results, with more variables significant and generally higher coefficients for the output gap variables (table 10).[26]

The results reveal that medium-term fluctuations do have some value added compared to short-term fluctuations, but that results are mixed. In the GLS-estimations, short-term fluctuations have a reasonable explanatory power, varying from 1-2% for the bandpass-filtered gaps to 11% for the European Commission's output gap. However, in this specification the explanatory power of medium-term fluctuations is lower than of short-term fluctuations. The results for the GMM-estimation reveal that medium-term fluctuations do have some value added compared to short-term fluctuations (table 10). The partial R^2 for the short-term fluctuations ranges from 2-4% for the bandpass to 26% for the Commission output gap. While no medium-term fluctuation performs better than the Commission gap, they do consistenly outperform the bandpass-filtered short-term fluctuations. Both medium-term gaps explain around 10% of the variation in budget balances.

[TABLES 9 AND 10 AROUND HERE]

To see what this means in practice, we compare which fluctuations better explain the budgetary deterioration after the financial crisis. We focus on the change in the budget balance between the second half of 2007 (just before the crisis) and the second half of 2011 (figure 14). As Gilbert and Hessel (2014) point out, the deterioration in public finances differs considerably from country to

[26] In line with Bénetrix and Lane (2015) we also ran regressions for public revenue and public expenditure separately (both expressed as growth rates and as a percentage of GDP). The effects of the medium-term fluctuations were not clearly visible in these regressions either.

country (figure 14). Short-term fluctuations cannot explain these differences, as the short-term output gaps are relatively similar (the orange bars in figure 14). Medium-term fluctuations do a better job. The medium-term GDP gap explains why budgetary deteriorations are larger and more persistent in Spain, Finland, Ireleland Portugal and the Netherlands. Even though budget deficits are to an important extent driven by short-term fluctuations, only the medium-term fluctuations are able to explain why the deterioration of budget deficits after the crisis was so much larger and so much more persistent in some countries than in others. This confirms the results of Eschenbach and Schuknecht (2004) and Bénétrix and Lane (2015). That said, additional research seems necessary on how and when medium-term fluctuations exactly affect public finances.

[FIGURE 14 AROUND HERE]

5.3.4 Summary

We conclude this section by summarizing the previously presented explanatory power of medium- and short-term fluctuations for all three imbalances (table 11). It clearly emerges that the evolution of imbalances in the euro area is more closely connected to medium-term fluctuations than to short-term fluctuations. This finding holds most firmly for the developments in relative prices and in current account balances, but to a lesser extent also applies to the evolution of budget balances. Our findings suggest that the buildup and correction of imbalances in the period surrounding the sovereign debt crisis has been a medium-term phenomenon, and that medium-term fluctuations are relevant for the functioning of EMU as an optimum currency area.

[TABLE 11 AROUND HERE]

6 Conclusions and policy implications

We have looked at medium-term fluctuations in EMU and reach five conclusions. First, we find that medium-term fluctuations in the euro area are much larger and much less symmetric than short-term fluctuations. Second, short-term fluctuations became smaller and more symmetric, but medium-term fluctuations became larger and less symmetric. Third, while short-term fluctuations in EMU are more symmetric than in the US, medium-term fluctuations are less symmetric. Fourth, differences in medium-term fluctuations in the euro area have become more strongly correlated with financial variables like credit and house prices, and less strongly correlated with real variables like productivity. Finally, medium-term fluctuations are more closely related to imbalances in price competitiveness, current accounts and budget deficits than short-term fluctuations.

We draw several policy implications. First, *medium-term* fluctuations add a relevant dimension for the functioning of EMU as an optimum currency area. This dimension has become more important due to the increasing role of financial factors and financial cyles, which heightenes the risk that medium-term fluctuations go together with macro-financial imbalances and crises. We also find that not only differences in the *phase* of medium-term fluctuations matter, but also differences in the *amplitude* of these fluctuations - which can be both substantial and persistent. While medium-term fluctuations were relatively synchronized in the EMU-period, their amplitude varied widely, possibly because member states reacted very differently to the loose financial conditions before the crisis. Our medium-term perspective therefore leads to less benign view on the functioning of EMU as an optimum currency area, that seems more in line with the sovereign debt crisis. Our perspective also casts doubt on the idea that EMU has endogenously become closer to an optimal currency area. Since the start of the euro, medium-term fluctuations have been larger and less symmetric than before.

Second, our results suggest that the asymmetric medium-term fluctuations in EMU result from the complex interaction of several factors. These include a period of rapid rapid financial integration that had asymmetric effects due to differences in economic and in financial development and financial systems between member states. These effect have been amplified because several member states had economic structures that were not able to cope with financial divergences, due to structural rigidities, insufficient adjustment mechanisms and in some cases lack of policy discipline. Deficiencies in the institutional setup of the monetary union have added to the problem, for instance via the lack of instruments to contain crises and capital flight. The interaction of these real, financial and institutional channels has led to medium-term fluctuations and the related buildup and correction of macro-economic imbalances in the euro area. However, more research seems necessary to determine the relative importance of these factors.

Third, our results underline that financial factors deserve sufficient attention in the debates on EMU. Financial factors had been largely missing from macroeconomic paradigms before the financial crisis, and also hardly featured in the debates on EMU. The Maastricht Treaty was directed at *nominal* factors with the aim to contain inflation, while the theory of optimum currency areas focused on *real* factors like wage flexibility and labour mobility. Neither of these approaches had anticipated (fully) how financial factors could lead to medium-term fluctuations, macroeconomic imbalances and crises, and hence also affected the real side of the economies in the monetary union. Attempts to further improve the functioning of EMU should therefore not only focus on real measures, like structural reforms, but also on financial measures, like macroprudential policy, the banking union and other aspects of financial regulation. A question for further research is how these financial factors should be incorporated more systematically into the theory of optimum currency areas. For example, it could be argued that the degree and the nature of financial integration in a monetary union should be criteria in the OCA theory.

A final implication is that the medium-term dimension should be strengthened in the setup of the monetary union. So far, both the theory of optimum currency areas and existing mechanisms to deal with asymmetric fluctuations (the Stability and Growth Pact) focus on the short-term. Since the financial crisis, the medium-term dimension has been strengthened with the Macroeconomic Imbalances Procedure (MIP) and macroprudential policy frameworks. However, more can be done. In monetary policy, longer horizons would allow central banks to implement leaning against the wind policies during booms, and pay (more) attention to negative side effects of long periods of loose monetary policy during downturns. Fiscal policy should more explicitly take into account the budgetary consequences of financial cycles, both during the boom and busts. This calls for larger buffers during booms, and for more robust indicators like (long-term) expenditure growth instead of cyclically adjusted budget balances. At the same time, the presence of medium-term fluctuations may make some measures to strenghten EMU more controversial. In these circumstances, further increases in public risk sharing, such as a budgetary stabilisation fund, are more likely to lead to politically sensitive permanent redistribution between member states.

References

Alberola, E., A. Estrada and D. Santabárbara (2013). Growth beyond imbalances. Sustainable growth rates and output gap reassessment. Banco d'España working paper 1313.

Alcidi, C. (2017). Fiscal Policy Stabilisation and the Financial Cycle in the Euro Area. European Economy discussion paper 052.

Alessi L. and C. Detken (2009). Real Time early warning indicators for costly asset price boom/bust cycles - a role for global liquidity. ECB working paper 1039.

Asdrubali, P., B. Sorensen and O. Yosha (1996). Channels of interstate risk sharing: United States 1963-1990. Quarterly Journal of Economics, 111, 1081-1110.

Baldwin, R. and F. Giavazzi (2015). The Eurozone Crisis: A Consensus View of the Causes and a Few Possible Solutions. VoxEU e-book, www.voxeu.org.

Ball, L. (2014). Long-Term Damage from the Great Recession in OECD Countries. NBER working paper 20185.

Bayoumi, T. and B. Eichengreen (1993). Shocking aspects of European Monetary Unification. In: Torres, F. and F. Giavazzi (eds). Adjustment and Growth in the European Monetary Union. Cambridge University Press.

Bayoumi, T. and B. Eichengreen (2017). Aftershocks of Monetary Unification. Hysteresis with a financial twist. NBER working paper 23205.

Bénétrix, A and P. Lane (2015). Financial cycles and fiscal cycles. Trinity Economic working paper 0815.

Belke, A., C. Domnick and D. Gros (2016). Business Cycle Synchronization in the EMU: Core vs. Periphery. CEPS working document 427.

Berger, H., T. Dowling, S. Lanau, W. Lian, M. Mrkaic, P. Rabanal and M. Taheri Sanjani (2015). Steady as She Goes— Estimating Potential Output During Financial "Booms and Busts". IMF working paper 15/233.

Beyer, R. and F. Smets (2015). Labour market adjustments in Europe and the US: How different? ECB working paper 1767.

Biroli, P., G. Mourre and A. Turrini (2010). Adjustment in the euro area and regulation of product and labour markets: an empirical assessment. CEPR discussion paper 8010.

Blanchard, O. (1997). The Medium-Run. Brookings Papers on Economic Activity, 89-158.

Bonam, D. and G. Goy (2017). Home-biased expectations and macroeconomic imbalances in a monetary union. DNB working paper 556.

Borio, C. (2012). The Financial Cycle and Macroeconomics. What Have We Learnt? BIS working paper 395.

Borio, C., Disyatat, P. and M. Juselius (2013). Rethinking Potential Output. Embedding information about the financial cycle. BIS working paper 404.

Borio, C., Disyatat, P. and M. Juselius (2014). A parsimonious approach to incorporating economic information in measures of potential output. BIS working paper 442.

Buti, M. and A. Turrini (2015). Three waves of convergence. Can Eurozone countries start growing together again? 17 April 2015, www.voxeu.org.

Caballero, R. and M. Hammour (1998). Jobless growth: appropriability, factor substitution, and unemployment. Carnegie-Rochester Conference Series on Public Policy, 5-94.

Campos, N. and C. Macchiarelli (2016). Core and Periphery in the European Monetary Union: Bayoumi and Eichengreen 25 Years Later. Economics Letters, 147, 127-30.

Chen, R., G. Milesi-Ferretti and T. Tressel (2012). External Imbalances in the Euro Area. IMF working paper 12/236.

Comin, D. and M. Gertler (2006). Medium-term business cycles. American Economic Review, 96, 523-551.

Comunale, M. and J. Hessel (2014). Current account imbalances in the euro area: competitiveness or financial cycle? DNB working paper 443.

Cuerpo, C., I. Drumond, J. Lendvai, P. Pontuch and R. Raciborski (2013). Indebtedness, Deleveraging Dynamics and Macroeconomic Adjustment. European Economy economic papers 477.

De Haan, J., R. Inklaar and R. Jong-a-Pin (2008). Will Business Cycles in the Euro Area Converge? A Critical Survey of Empirical Research. Journal of Economic Surveys, 22, 234-73.

De Haan, J., J. Hessel and N. Gilbert (2015). Reforming the Architecture of EMU: Ensuring Stability in Europe. In: Badinger, H. and V. Nitsch (eds.), Handbook of the Economics of European Integration, Routledge.

De Grauwe, P. and Y. Ji (2016). Flexibility versus stability. A difficult trade-off in the Eurozone. CEPR discussion paper 11372.

De Winter, J., S. Koopman, I. Hindrayanto and A. Chouhan (2017). Modeling the business and financial cycle in a multivariate structural time series model. DNB working paper 573.

Dobrescu, G., and F. Salman (2011). Fiscal Policy During Absorption Cycles. IMF working paper 11/41.

Drehmann, M., C. Borio and K. Tsatsaronis (2012). Characterising the Financial Cycle: Don't Lose Sight of the Medium Term! BIS working paper 380.

Drehmann, M., C. Borio, L. Gambacorta, G. Jiménez and C. Trucharte (2010). Countercyclical capital buffers: exploring options. BIS working paper 317.

Eschenbach, F. and L. Schuknecht (2004). Budgetary risks from real estate and stock markets. Economic Policy, 19, 313-346.

European Commission (2008). EMU@10. Successes and challenges after ten years of Economic and Monetary Union. European Economy 2/2008.

European Commission (2014). Growth differences between EA Member States since the crisis. Quarterly report of the euro area, 13(2), 7-20.

European Commission (2015). An overview of market-based adjustment in the euro area in the light of the crisis. Quarterly report of the euro area, 14(4), 5-58.

Fernandez-Villaverde, J., L. Garicano and T. Santos (2013). Political Credit Cycles: The Case of the Eurozone. Journal of Economic Perspectives, 27, 145-66.

Forbes, C. (2012). The big "C": Identifying and Mitigating Contagion. NBER working paper 18465.

Frankel, J. and A. Rose (1998). The Endogeneity of the Optimum Currency Area Criteria. Economic Journal, 108, 1009-25.

Gächter, M. and A. Riedl (2014). One Money, One Cycle? The EMU Experience. Journal of Macroeconomics, 42, 141-55.

Galati, G., I. Hindrayanto, S. Koopman and M. Vlekke (2016). Measuring financial cycles with a model-based filter: Empirical evidence for the United States and the euro area. DNB working paper 495.

Gaulier, G. and V. Vicard (2012). Current account imbalances in the euro area: competitiveness or demand shock? Banque de France Qquarterly selection of articles, 27, 5-26.

Giavazzi, F. and L. Spaventa (2010). Why the current account may matter in a monetary union: Lessons from the financial crisis in the Euro area. CEPR Discussion Papers 8008.

Gilbert, N. and J. Hessel (2014). The financial cycle and the European budgetary reversal during the crisis: consequences for surveillance. In: Fiscal Policy and Macroeconomic Imbalances. Proceedings of the 15th Banca d'Italia public finance workshop, 3-4 April 2013, Perugia.

Gilbert, N. and S. Pool (2016). Sectoral allocation and macroeconomic imbalances in EMU. DNB working paper 536.

Gros, D. and C. Alcidi (2015). Country adjustment to a 'sudden stop': Does the euro make a difference? International Economics and Economic Policy, 12, 5-20.

Guillemette, Y. and D. Turner (2013). Policy Options to Durably Resolve Euro Area Imbalances. OECD economics department working paper 1035.

Hofmann, M. and B. Sørensen (2015). Small Firms and Domestic Bank Dependence in Europe's Great Recession. European Economy discussion papers 12.

In 't Veld, J., R. Kollmann, B. Pataracchia, M. Ratto and W. Roeger (2014). International Capital Flows and the Boom-Bust Cycle in Spain. European Economy economic papers 519.

IMF (2015). Where are we headed? Perspectives on Potential Output. Chapter 3 of the Spring 2015 World Economic Outlook, www.imf.org.

Jordà, O., M. Schularick and A. Taylor (2016). Macrofinancial History and the New Business Cycle Facts. NBER working paper 22743.

Krugman, P. (2012). Revenge of the Optimum Currency Area. In: Acemoglu, D., J. Parker and M. Woodford (eds), NBER Macroeconomics Annual 2012, 439-448.

Kuznets S. (1930). Secular Movements in Production and Prices. Their Nature and their Bearing upon Cyclical Fluctuations. Boston: Houghton Mifflin.

Lane, P. (2013). Capital Flows in the Euro Area. European Economy economic paper 497.

Lane, P. and G. Milesi-Ferretti (2015). Global Imbalances and External Adjustment After the Crisis. In: Raddatz, C., D. Saravia and J. Ventura (eds.). Global Liquidity, Spillovers to Emerging Markets and Policy Responses. Central Banking, Analysis, and Economic Policies Book Series Central Bank of Chile, 20, 105-142.

Lendvai, J., L. Moulin and A. Turrini (2011). From CAB to CAAB: correcting indicators of structural fiscal positions for current account imbalances. European Economy economic paper 442.

Martin, P. and T. Philippon (2017). Inspecting the mechanism. Leverage and the great recession in the Eurozone. American Economic Review, 107, 1904-1937.

Mauro, P., R. Romeu, A. Binder, A. Zaman (2015). A modern history of fiscal prudence and profligacy. Journal of Monetary Economics, 76, 55-70.

Mink, M., J. Jacobs and J. de Haan (2012). Measuring coherence of output gaps with an application to the euro area. Oxford Economic Papers, 64, 217-36.

Mongelli, P. and C. Wyplosz (2008). The euro at ten – unfulfilled threats and unexpected challenges. In: Mackowiak, B., P. Mongelli, G. Noblet and F. Smets (eds). The euro at ten – unfulfilled threats and unexpected challenges. Fifth ECB Central Banking Conference, 13-14 november 2008.

Obstfeld, M. (2013). Finance at Center Stage: Some Lessons of the Euro Crisis. European Economy economic paper 493.

Ollivaud, P. and D. Turner (2014). The Effect of the Global Financial Crisis on OECD Potential Output. OECD economics department working paper 1166.

Reis, R. (2013). The Portuguese slump and crash and the euro crisis. Brookings Papers on Economic Activity, 143–210.

Sala-i-Martin, X. and J. Sachs (1992). Fiscal federalism and optimum currency areas: evidence for Europe from the United States. In: Canzoneri, M., V. Grilli and P. Masson (eds). Establishing a Central Bank. Issues in Europe and Lessons from the US. Cambridge University Press, 195-219.

Samarina, A. and D. Bezemer (2016). Do capital flows change domestic credit allocation? Journal of International Money and Finance, 62, 98-121.

Samarina, A., L. Zhang and D. Bezemer (2015). Mortgages and Credit Cycle Divergence in Eurozone Economies, SOM Research Reports 15021.

Solow, R. (2000). Toward a macroeconomics of the medium run. Journal of Economic Perspectives, 14, 151-158.

Van Beers, N., M. Bijlsma and G. Zwart (2014). Cross-country insurance mechanisms in currency unions: an empirical assessment. Bruegel working paper 2014/04.

Wyplosz, C. (2013). Europe's Quest for Fiscal Discipline. European Economy economic paper 498.

TABLE 1: PROPERTIES SHORT AND MEDIUM-TERM CYCLES IN EMU

		volatility		symmetry		
		gap	diff_{EMU}	synchronicity	similarity	R^2
short-term	GDP_{BP}	1.36	0.84	0.78	0.25	0.80
	GDP_{EC}	2.51	1.53	0.69	0.33	0.43
	DD_{BP}	1.52	1.15	0.39	0.14	0.40
medium-term	GDP_{BP}	4.07	3.13	0.54	0.15	0.17
	DD_{BP}	5.17	4.28	0.48	0.13	0.15

Note: calculations with quarterly data for the period 1999-2016 and presented as unweighted averages for 11 EMU countries. Fluctuations are calculated for GDP and domestic demand separately. Volatility is calculated as the standard deviation, and is applied to country-specific fluctuations, as well as to the deviation of thes fluctuations from the EMU-aggregate. The three measures of symmetry (synchronicity, similarity and R2) are described in section 3.1.

TABLE 2: SHORT & MEDIUM-TERM CYCLES EMU AND US

		volatility		symmetry		
		gap	diff$_{EMU}$	synchronicity	similarity	R^2
short-term	EMU	1.36	0.84	0.78	0.25	0.80
	US regions	1.09	0.61	0.62	0.36	0.67
	US states	1.43	1.16	0.41	0.14	0.36
medium-term	EMU	4.07	3.13	0.54	0.15	0.17
	US regions	3.21	1.47	0.81	0.51	0.78
	US states	4.23	3.28	0.56	0.24	0.43

Note: calculations with quarterly data for the period 1999-2016 and presented as unweigthed averages for EMU countries, US states and US regions. Cycles are calculated on the basis of GDP (as domestic demand was not available for US states and regions). Volatility is calculated as the standard deviation, and is applied to country specific fluctuations, as well as to the deviation of these fluctuations from the aggreated fluctuation for EMU or the US as a whole. The three measures of symmetry are described in section 3.1.

TABLE 3: UNIVARIATE REGRESSIONS DRIVERS - GLS

			deviations EMU-aggregate			
			1970-1985	1986-1998	1999-2016	change
estimates for GDP gap						
real drivers	productivity	coefficient	0.42**	0.33**	0.43**	
		partial R^2	0.26	0.06	0.06	$\Downarrow$
	tfp	coefficient	0.58**	0.91**	0.96**	
		partial R^2	0.20	0.35	0.44	$\Uparrow$
financial drivers	credit	coefficient	-0.01**	0.05**	0.11**	
		partial R^2	0.00	0.04	0.09	$\Uparrow$
	house prices	coefficient	0.12**	0.13**	0.20**	
		partial R^2	0.32	0.19	0.35	$\Uparrow$
estimates for domestic demand gap						
	productivity	coefficient	0.50**	0.23**	0.03	
		partial R^2	0.17	0.01	0.00	$\Downarrow$
	tfp	coefficient	0.80**	0.97**	0.99**	
		part R^2	0.18	0.22	0.28	$\Uparrow$
financial	credit	coeff	-0.00*	0.07**	0.16**	
		part R^2	0.00	0.03	0.10	$\Uparrow$
	house prices	coeff	0.12**	0.24**	0.28**	
		part R^2	0.14	0.35	0.44	$\Uparrow$

Note: panel regressions on underlying drivers of medium term fluctuations for 11 EMU countries in 3 different time periods, using GLS with cross-section weights, country fixed effects and white robust standard errors. All medium-term fluctuations are expressed in deviation from the fluctuation for EMU as a whole. The tables contains the coefficients of the underlying drivers as well as their signficance (* is 95% significance, ** is 99% significance). The partial R2 is calculated as the share of the variation in medium term fluctuations explained by the respective underlying driver (see section 3.2).

TABLE 4: UNIVARIATE REGRESSIONS DRIVERS - GMM

			deviations EMU-aggregate			
			1970-1985	1986-1998	1999-2016	change
estimates for GDP gap						
real drivers	productivity	coefficient	0.61**	0.29*	0.81	
		partial R^2	0.55	0.05	0.23	$\Downarrow$
	tfp	coefficient	0.79**	0.95**	0.93**	
		partial R^2	0.38	0.38	0.41	$\Uparrow$
financial drivers	credit	coefficient	-0.02	0.14	0.36**	
		partial R^2	0.01	0.26	0.89	$\Uparrow$
	house prices	coefficient	0.04	0.25**	0.29**	
		partial R^2	0.04	0.72	0.76	$\Uparrow$
estimates for domestic demand gap						
real drivers	productivity	coefficient	0.69**	0.15	0.76	
		partial R^2	0.34	0.01	0.12	$\Downarrow$
	tfp	coefficient	0.87**	1.10**	1.02**	
		partial R^2	0.22	0.28	0.29	$\Uparrow$
financial drivers	credit	coefficient	-0.05	0.19	0.49**	
		partial R^2	0.02	0.26	0.99	$\Uparrow$
	house prices	coefficient	0.07	0.34**	0.39**	
		partial R^2	0.05	0.71	0.83	$\Uparrow$

Note: panel regressions on underlying drivers of medium term fluctuations for 11 EMU countries in 3 different time periods, using GMM with first-differences for the instrument weighting matrix (Arellano-Bond) and white standard errors. We use as internal instruments the lagged values of the respective underlying drivers. All medium-term fluctuations are expressed in deviation from the fluctuation for EMU as a whole. The tables contains the coefficients of the underlying drivers as well as their signficance (* is 95% significance, ** is 99% significance). The partial R2 is calculated as the share of the variation in medium term fluctuations explained by the respective underlying driver (see section 3.2).

TABLE 5: REGRESSIONS RELATIVE PRICES - GLS

		short-term			medium-term	
		(1)	(2)	(3)	(4)	(5)
c		0.12**	0.10**	0,13**	0.20**	0.26**
$\Delta reer_{t-1,\ldots,t-4}$		0.85**	0.78**	0.85**	0.78**	0.77**
$reer_{t-1}$		-0.027**	-0.021**	-0.027**	-0.043**	-0.056**
$gap_{i,t-1} - gap_{EMU,t-1}$	short-term GDP gap	0.09**				
	short-term EC gap		0.14**			
	short-term DD gap			0.02		
	medium-term GDP gap				0.08**	
	medium-term DD gap					0.07**
R^2		0.93	0.92	0.93	0.94	0.94
partial R^2 *gap*		0.005	0.042	0.001	0.076	0.087
#observations		748	748	748	748	748

Note: * is 95% significance, ** is 99% significance. Panel regressions with quarterly data for 11 EMU countries in the period 1999-2016, using weighted least squares (GLS) with country weights, country fixed effects and white robust standard errors. The partial R2 is calculated as the share of the variation in relative prices explained by the respective short-term and medium-term output gaps (see section 3.3).

TABLE 6: REGRESSIONS RELATIVE PRICES - GMM

		short-term			medium-term	
		(1)	(2)	(3)	(4)	(5)
c						
$\Delta reer_{t-1,\ldots,t-4}$		0.67**	0.64**	0.66***	0.63**	0.61**
$reer_{t-1}$		-0.078**	-0.066**	-0.078**	-0.13**	-0.16**
$gap_{i,t-1} - gap_{EMU,t-1}$	short-term GDP gap	0.11**				
	short-term EC gap		0.24**			
	short-term DD gap			0.07**		
	medium-term GDP gap				0.18**	
	medium-term DD gap					0.16**
R^2						
partial R^2 *gap*		0.006	0.112	0.004	0.308	0.370
#observations		748	748	748	748	748

Note: * is 95% significance, ** is 99% significance. Panel regressions with quarterly data for 11 EMU countries in the period 1999-2016, using GMM with first-differences for the instrument weighting matrix (Arellano-Bond) and white standard errors. We use as internal instruments the lagged values of the real effective exchange rate and the output gap. The partial R2 is calculated as the share of the variation in relative prices explained by the respective short-term and medium-term output gaps (see paragraph 6).

TABLE 7: REGRESSIONS CURRENT ACCOUNTS - GLS

			short-term			medium-term	
			(1)	(2)	(3)	(4)	(5)
cyclical	c		-35.6**	-67.2**	-35.8**	-159.0**	-207.3**
	fd_t		-0.11**	-0.14**	-0.11**	-0.20**	-0.22**
	b_t		0.07**	0.16**	0.08**	0.25**	0.29**
	$reer_t$		-0.13**	-0.18**	-0.13**	-0.08**	-0.03**
	gap_t	short-term GDP gap	-0.14*				
		short-term EC gap		-0.44**			
		short-term DD gap			-0.25**		
		medium-term GDP gap				-0.37**	
		medium-term DD gap					-0.45**
fundamental	$gdp/capita_t$			0.09**	0.04**	0.18**	0.23**
	Δpop_t			-1.81**	-2.84**	-2.06**	-0.88**
	$dep.ratio_t$			0.68**	0.73**	0.61**	0.41**
	R^2		0.77	0.80	0.77	0.81	0.83
	$part.R^2.gap$		0.001	0.059	0.007	0.168	0.401
	$part.R^2.reer$		0.044	0.083	0.043	0.017	0.003
	$\#observations$		903	903	903	903	903

Note: * is 95% significance, ** is 99% significance. Panel regressions with quarterly data for 11 EMU countries in the period 1995-2016, using weighted least squares (GLS) with country weights, country fixed effects and white robust standard errors. The partial R2 is calculated as the share of the variation in current account balances explained by the respective short-term and medium-term output gaps (see section 3.3).

TABLE 8: REGRESSIONS CURRENT ACCOUNTS - GMM

			short-term			medium-term	
			(1)	(2)	(3)	(4)	(5)
cyclical	c						
	fd_t		-0.05	-0.05	-0.01	-0.19*	-0.19*
	b_t		0.13	0.18*	0.11*	0.24*	0.22**
	$reer_t$		-0.03	-0.07	-0.03	-0.01	0.01
	gap_t	short-term GDP gap	-0.04				
		short-term EC gap		-0.24**			
		short-term DD gap			-0.19**		
		medium-term GDP gap				-0.29**	
		medium-term DD gap					-0.39**
fundamental	$gdp/capita_t$		-0.07	-0.06	-0.09	0.11	0.16**
	Δpop_t		-1.74*	-1.02	-1.30	-1.77	-0.01
	$dep.ratio_t$		1.39*	1.18*	1.20*	1.04*	0.60
	R^2						
	$part.R^2.gap$		0.000	0.017	0.004	0.105	0.303
	$part.R^2.reer$		0.001	0.011	0.002	0.00	0.00
	$\#observations$		892	892	892	892	892

Note: * is 95% significance, ** is 99% significance. Panel regressions with quarterly data for 11 EMU countries in the period 1995-2016, using GMM using GMM with first-differences for the instrument weighting matrix (Arellano-Bond) and white standard errors. We use as internal instruments the lagged values of the real effective exchange rate and the output gap. The partial R2 is calculated as the share of the variation in current account balances explained by the respective short-term and medium-term output gaps (see section 3.3).

TABLE 9: REGRESSIONS BUDGET DEFICITS - GLS

		short-term			medium-term	
		(1)	(2)	(3)	(4)	(5)
c		-2.73**	-4.86**	-2.72**	-3.37**	-2.96**
b_{t-4}		0.73**	0.59**	0.75**	0.72**	0.73**
d_{t-4}		0.03**	0.04**	0.03**	0.03**	0.03**
i_t		-0.05	0.08	-0.04	0.01	-0.00
fri_t		-0.30**	0.16*	-0.29**	-0.27**	-0.27**
gap_t	short-term GDP gap	0.38**				
	short-term EC gap		0.49**			
	short-term DD gap			0.29*		
	medium-term GDP gap				0.05*	
	medium-term DD gap					0.012
R^2		0.71	0.80	0.69	0.68	0.68
$part.R^2.gap$		0.017	0.113	0.014	0.005	0.000
$\#observations$		840	840	840	840	840

Note: * is 95% significance, ** is 99% significance. Panel regressions with quarterly data for 11 EMU countries in the period 1995-2016, using weighted least squares (GLS) with country weights, country fixed effects and white robust standard errors. The partial R2 is calculated as the share of the variation in budget balances explained by the respective short-term and medium-term output gaps (see section 3.3).

TABLE 10: REGRESSIONS BUDGET DEFICITS - GMM

		short-term			medium-term	
		(1)	(2)	(3)	(4)	(5)
c						
b_{t-4}		0.64**	0.53**	0.66**	0.72**	0.72**
d_{t-4}		0.05**	0.10**	0.06**	0.12**	0.12**
i_t		-0.18**	0.09**	-0.16**	-0.05**	-0.06**
fri_t		-0.71**	0.09	-0.76**	-1.29**	-1.24**
gap_t	short-term GDP gap	0.58**				
	short-term EC gap		0.73**			
	short-term DD gap			0.36**		
	medium-term GDP gap				0.24**	
	medium-term DD gap					0.18**
R^2						
$part.R^2.gap$		0.041	0.255	0.021	0.102	0.094
$\#observations$		840	840	840	840	840

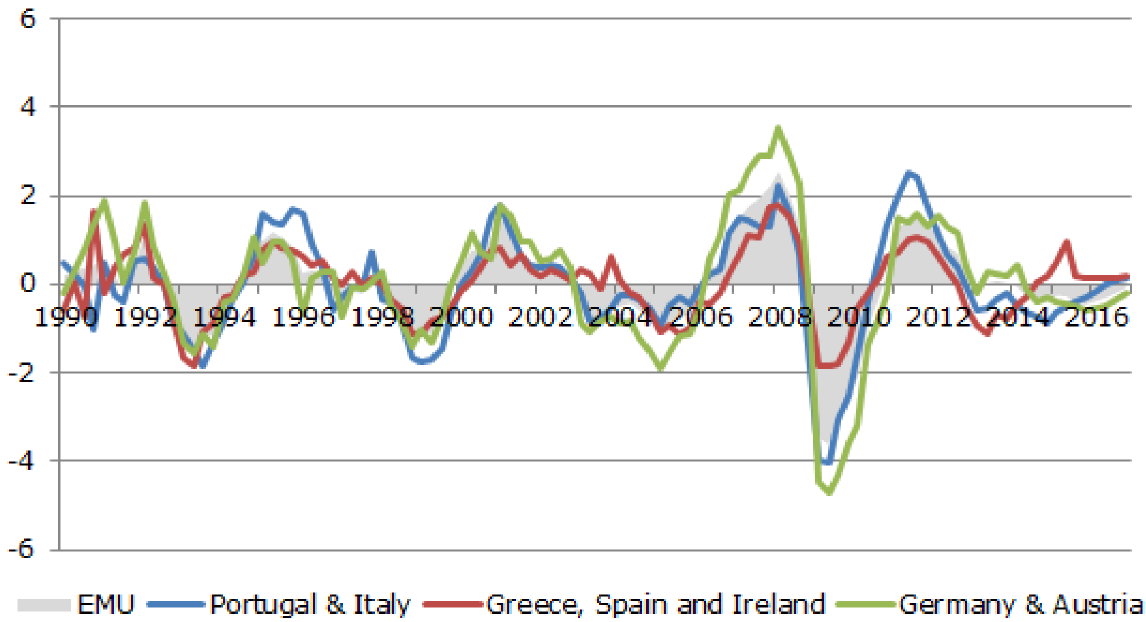
Note: * is 95% significance, ** is 99% significance. Panel regressions with quarterly data for 11 EMU countries in the period 1995-2016, using GMM with first-differences for the instrument weighting matrix (Arellano-Bond) and white standard errors. We use as internal instruments the lagged values of the output gap and the debt ratio. The partial R2 is calculated as the share of the variation in budget balances explained by the respective short-term and medium-term output gaps (see section 3.3).

TABLE 11: EXPLANATORY POWER SHORT AND MEDIUM-TERM FLUCTUATIONS

		short-term			medium-term	
	method	GDP	DD	EC	GDP	DD
Relative prices	GLS	0.005	0.001	0.042	0.076	0.087
	GMM	0.006	0.004	0.112	0.308	0.370
Current account balances	GLS	0.001	0.007	0.059	0.168	0.401
	GMM	0.000	0.004	0.017	0.105	0.303
Budget balances	GLS	0.017	0.014	0.113	0.005	0.000
	GMM	0.041	0.021	0.255	0.102	0.094

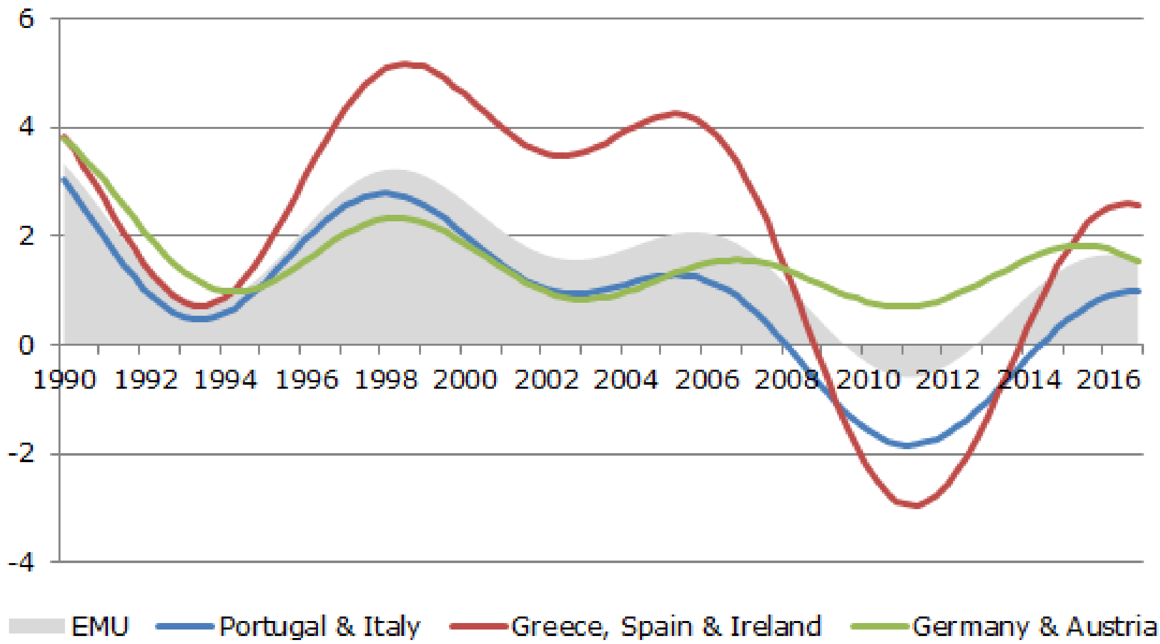
Note: summary table of the partial R2 for short-term and medium-term output gaps in regressions for euro area imbalances performend with GLS and GMM (internal instruments). The partial R2 is calculated as the share of the variation in budget balances explained by the respective output gaps (see paragraph 3). The partial R2 in this table are taken from tables 5-10 above.

Figure 1: Short-term output gaps EMU countries



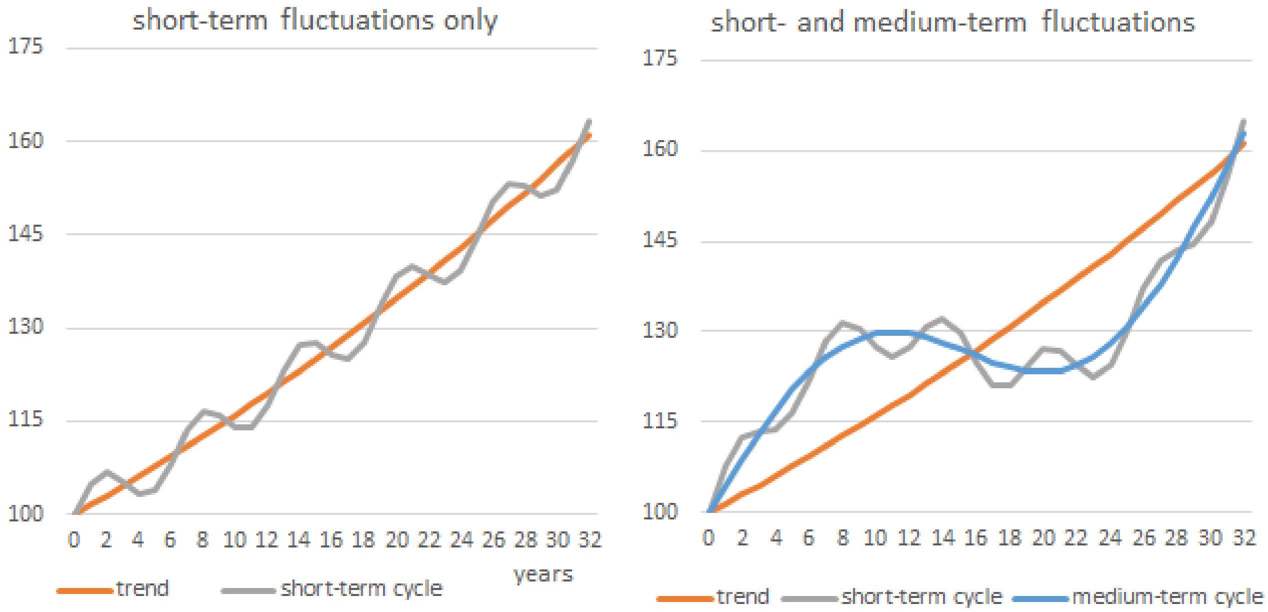
Note: short-term output gaps calculated with the bandpass (Christiano-Fitzgerald) filter for fluctuations between 2 and 32 quarters (8 years). Averages calculated with GDP weights.

Figure 2: Trend growth rates EMU countries



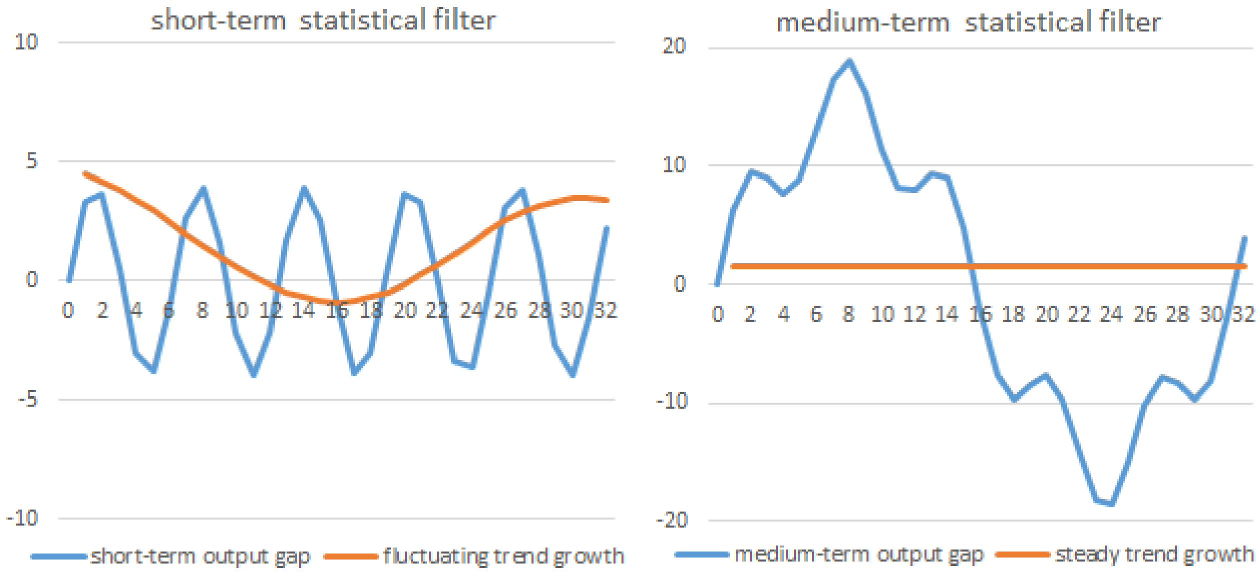
Note: growth rates of the underlying trend in GDP matching the short-term output gaps calculated with the bandpass (Christiano-Fitzgerald) filter for fluctuations between 2 and 32 quarters (8 years). Averages calculated with GDP weights.

Figure 3: Stylized representation of short-term and medium-term fluctuations in GDP



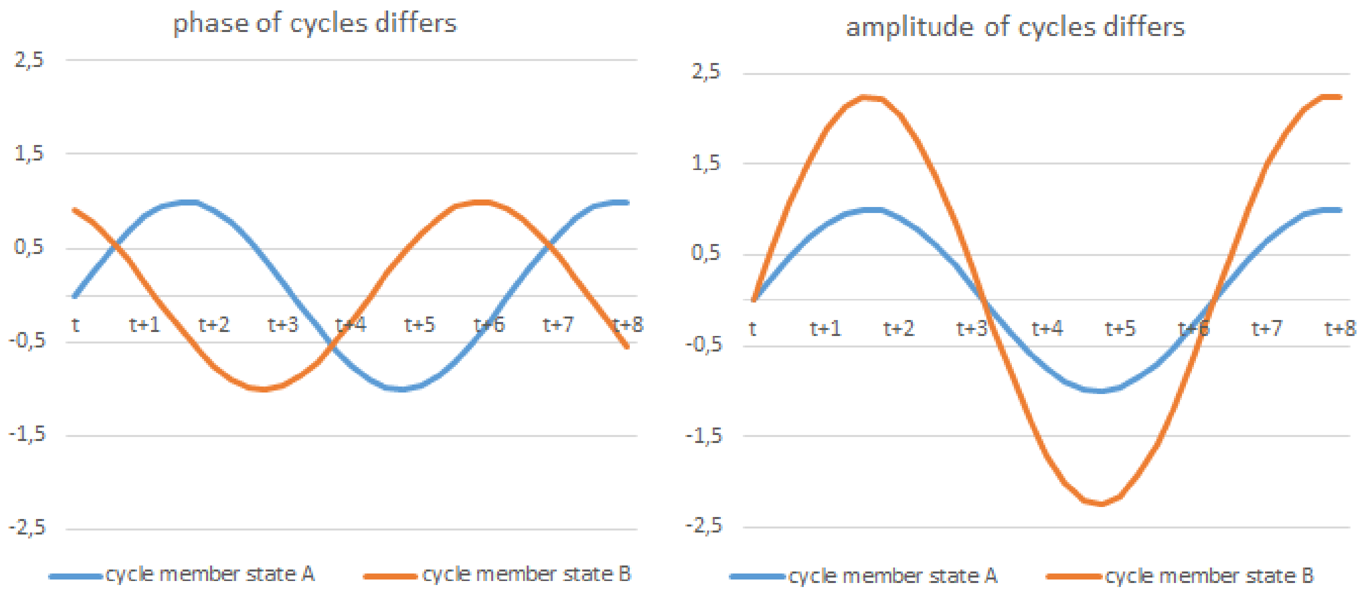
Note: stylized representation, does not necessarily reflect developments in particular EMU countries.

Figure 4: Two possible stylized ways to look at medium-term fluctuations



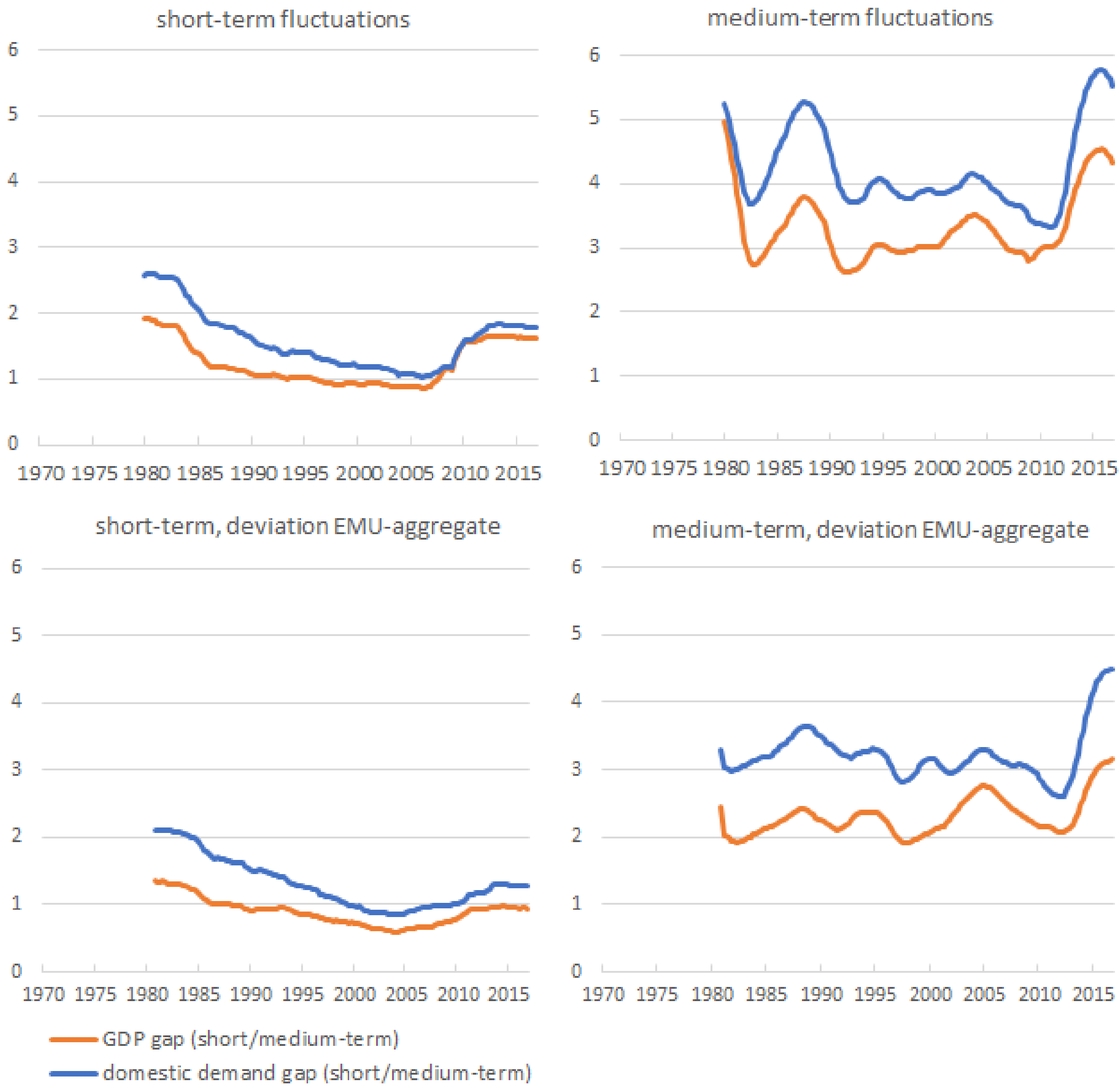
Note: stylized representation, does not necessarily reflect developments in particular EMU countries.

Figure 5: Difference in phase and amplitude of cycles



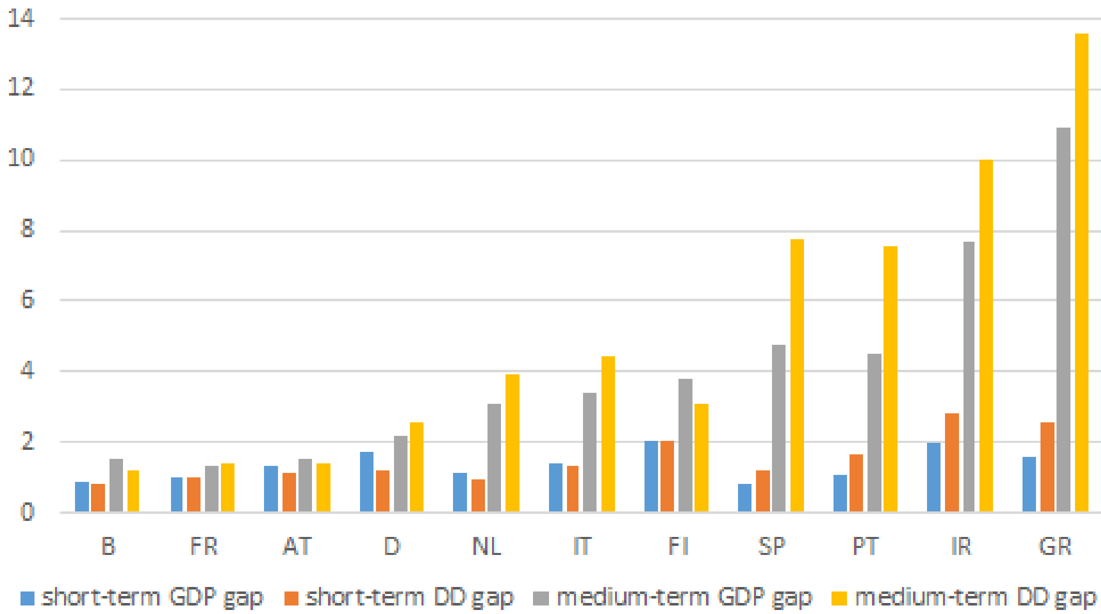
Note: stylized representation, does not necessarily reflect developments in particular EMU countries.

Figure 6: Volatility short-term and medium-term fluctuations



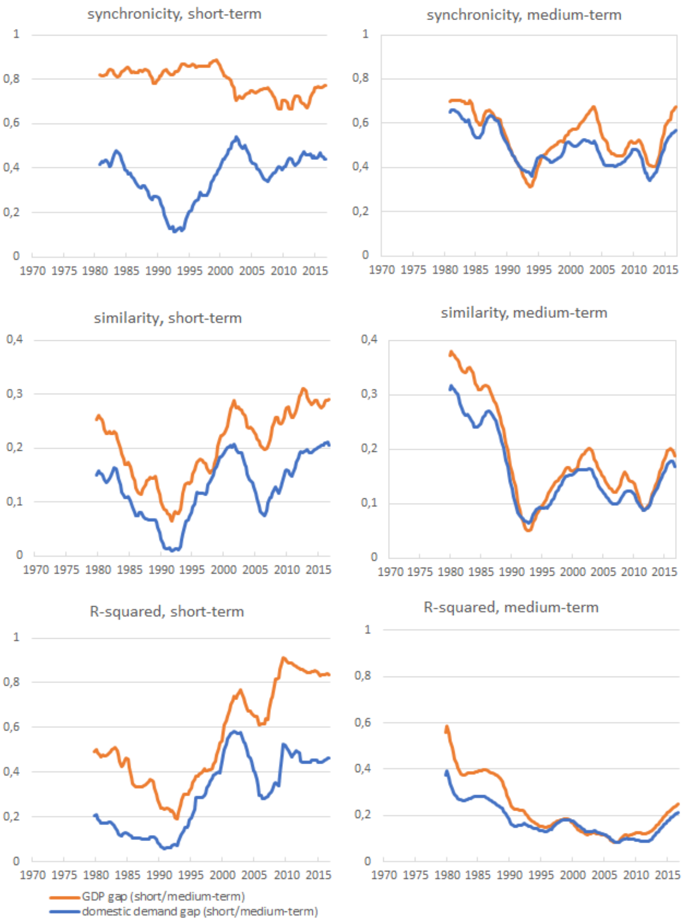
Note: volatility calculated as the standard deviation over a 10-year (40 quarter) rolling window for the period 1970-2016. The short-term gaps for GDP and domestic demand (DD) are calculated with a bandpass filter with a frequency up to 32 quarters. The medium-term gaps for GDP and domestic demand (DD) are calculated with a bandpass filter with a frequency up to 200 quarters.

Figure 7: Volatility individual EMU countries 1999-2016



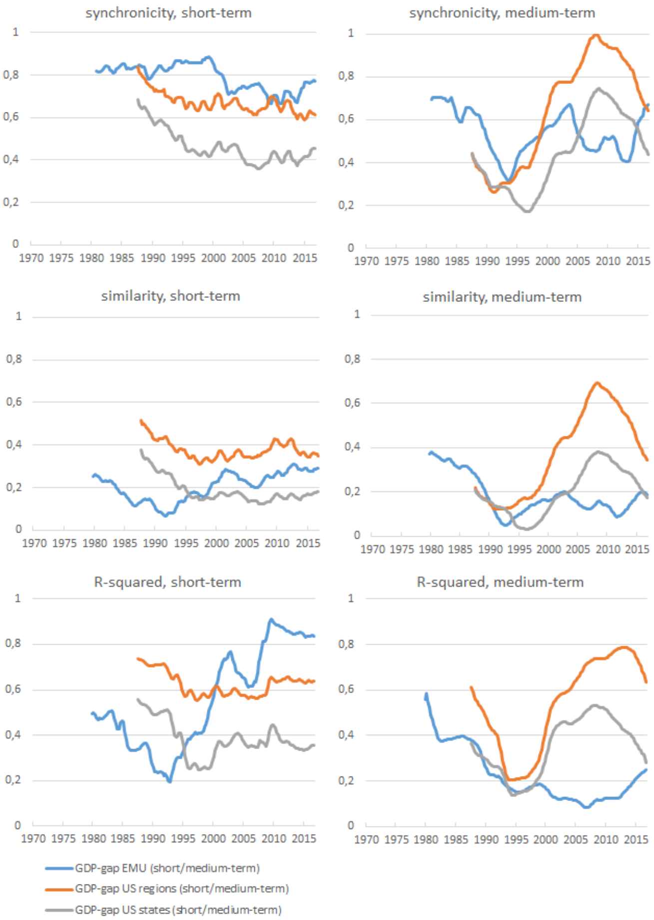
Note: volatility calculated as the standard deviation over the period 1999-2016. The short-term gaps for GDP and domestic demand (DD) are calculated with a bandpass filter with a frequency up to 32 quarters. The medium-term gaps for GDP and domestic demand (DD) are calculated with a bandpass filter with a frequency up to 200 quarters.

Figure 8: Symmetry of short-term and medium-term fluctuations EMU



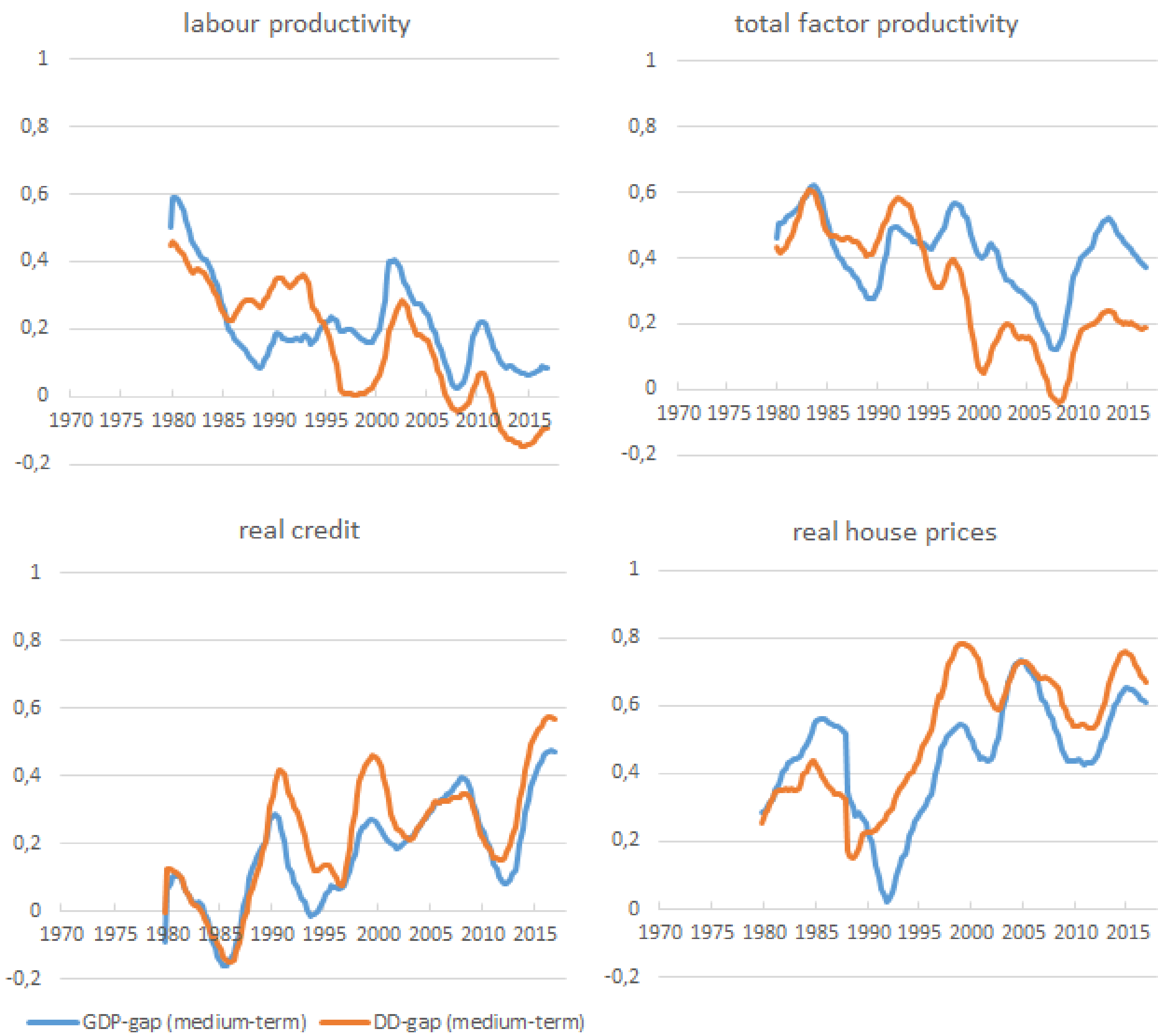
Note: synchronicity index, similarity index and R-squared calculated over a 10-year rolling window for the period 1970-2016 (see section 3.1).

Figure 9: Comparison of symmetry of fluctuations in EMU and US



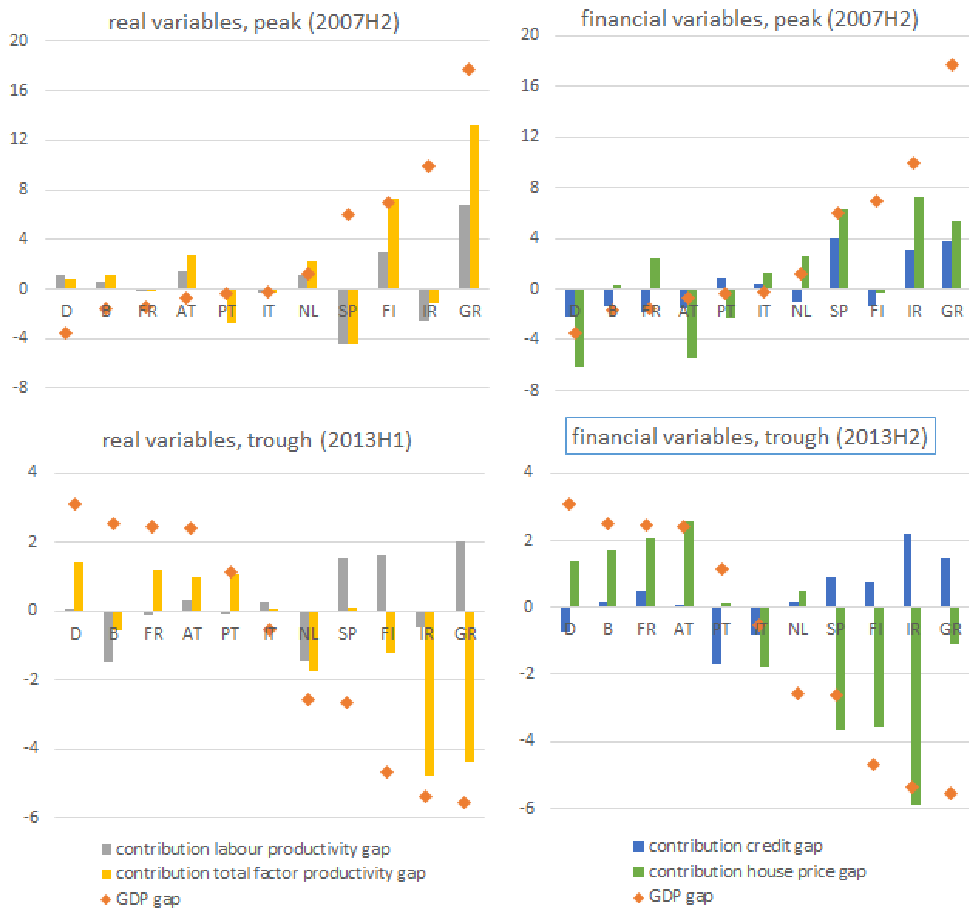
Note: synchronicity index, similarity index and R-squared calculated over a 10-year rolling window for the period 1970-2016 and 1978-2016 for US states and regions (see section 3.1).

Figure 10: Correlation medium-term fluctuations with potential real and financial drivers



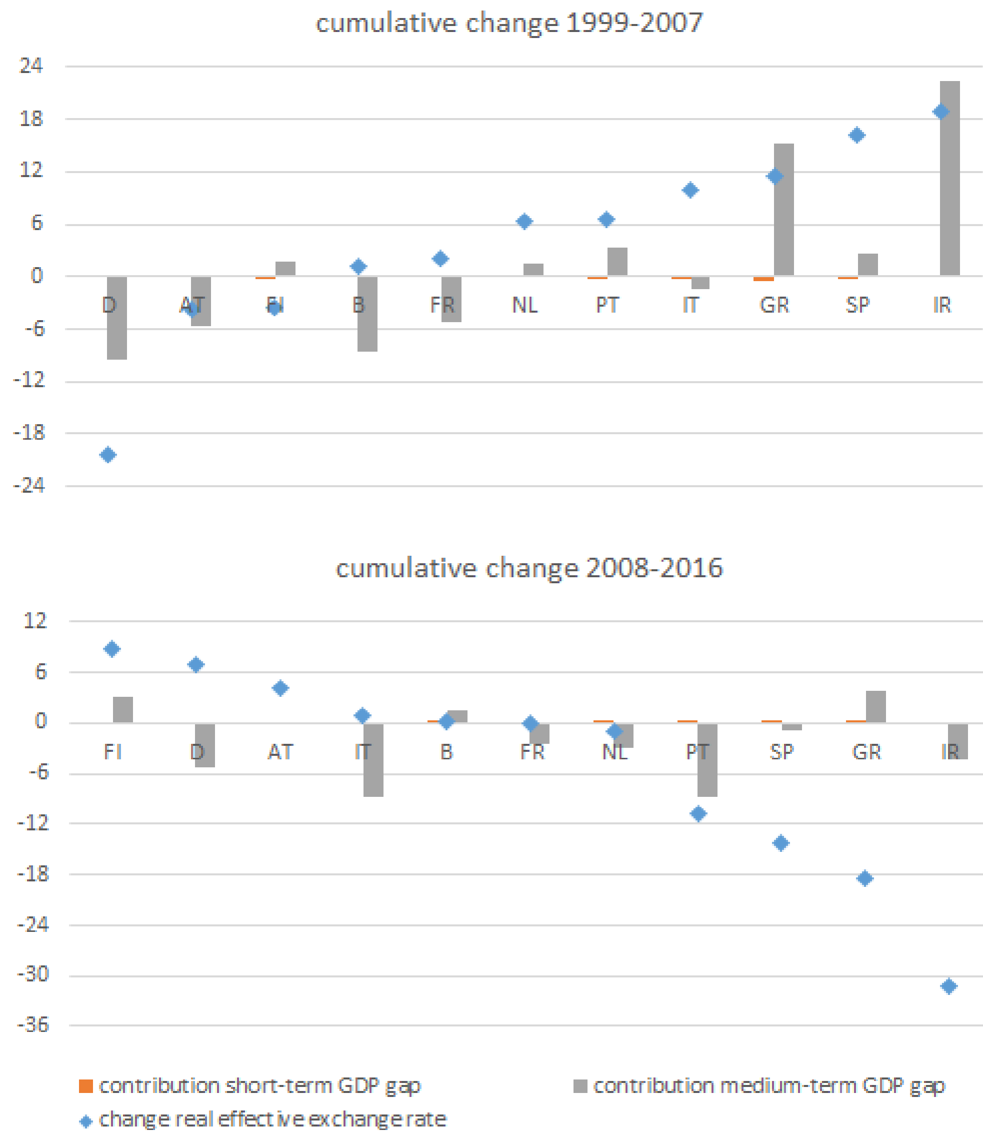
Note: correlations calculated over a 10-year rolling window for the period 1970-2016. The fluctuations are expressed in deviation from the EMU-aggregate. The two upper panels show that medium-term fluctuations in GDP and domestic demand have become less strongly correlated with medium-term fluctuations in labour and total factor productivity. The two lower panels show that medium-term fluctuations in GDP and domestic demand have become more strongly correlated with medium-term fluctuations in credit and house prices.

Figure 11: Contributions drivers to peak and trough medium-term fluctuations



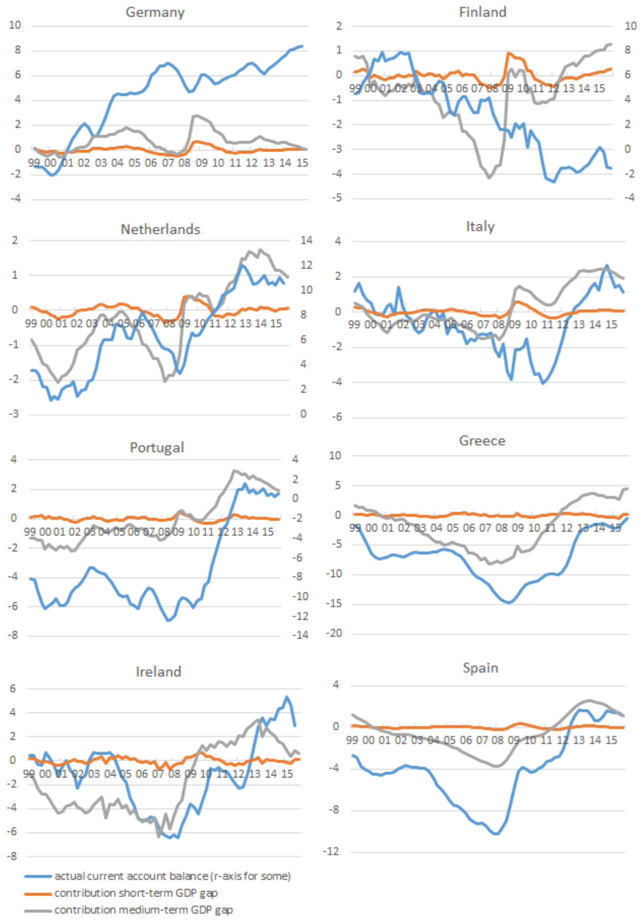
Note: the orange dots represent the actual medium-term output gaps in GDP relative to the EMU-aggregate at the peak (2007H2) and trough (2013H1) of the medium-term cycle. The bars represent the contributions of the respective medium-term gaps in the underlying drivers to these medium-term GDP-gaps. The contributions are calculated as the medium-term gap in the underlying driver (labour and total factor productivity, credit and house prices) multiplied by the relevant coefficient taken from the GLS estimation (table 3 above).

Figure 12: Contribution of short-term and medium-term fluctuations to changes in relative prices



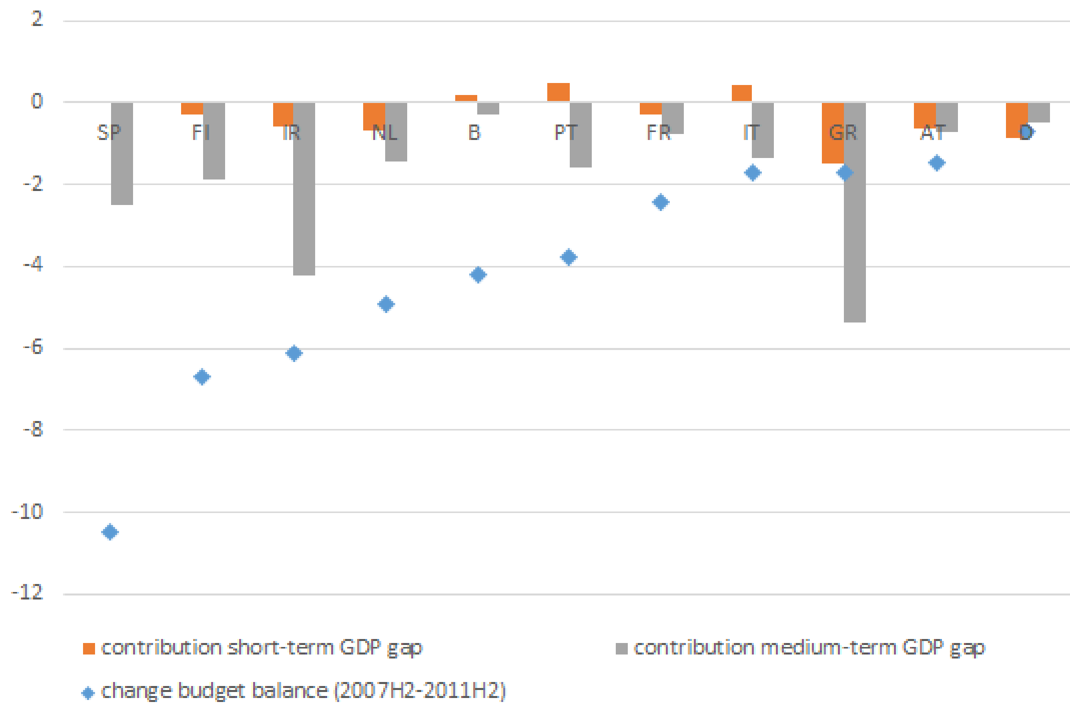
Note: the blue dots represent the actual cumulative change in relative prices over the relevant period. The bars represent the cumulated contributions of the respective short- and medium-term output gaps to this change in relative prices. These contributions are calculated as the output gap measure over the relevant period multiplied by their coefficient taken from the GMM estimation (table 6 above).

Figure 13: Contribution of economic fluctuations to evolution of current account balances



Note: the blue lines represent the actual current account balance as a percentage of GDP. The orange lines and grey lines represent the contributions of the short- and medium-term output gaps to the evolution of the current account balances. These contributions are calculated as the output gap measure multiplied by their coefficient taken from the GLS estimation (table 7 above).

Figure 14: Contribution short- and medium-term gap to change in budget balance



Note: the dots represent the actual change in the budget balance over the relevant period (in percentage points of GDP). The bars represent the contributions of the respective short- and medium-term output gaps to this change in the budget balance. This contribution is calculated as the output gap measure over the relevant period multiplied by their coefficient taken from the GMM estimation (table 10 above).

Previous DNB Working Papers in 2019

No. 622 **David-Jan Jansen,** Did Spillovers From Europe Indeed Contribute to the 2010 U.S. Flash Crash?
No. 623 **Wilko Bolt, Kostas Mavromatis and Sweder van Wijnbergen,** The Global Macroeconomics of a trade war: the EAGLE model on the US-China trade conflict
No. 624 **Ronald Heijmans and Chen Zhou,** Outlier detection in TARGET2 risk indicators
No. 625 **Robert Vermeulen, Edo Schets, Melanie Lohuis, Barbara Kölbl, David-Jan Jansen and Willem Heeringa,** The Heat is on: A framework measuring financial stress under disruptive energy transition scenarios
No. 626 **Anna Samarina and Anh D.M. Nguyen,** Does monetary policy affect income inequality in the euro area?
No. 627 **Stephanie Titzck and Jan Willem van den End,** The impact of size, composition and duration of the central bank balance sheet on inflation expectations and market prices
No. 628 **Andrea Colciago, Volker Lindenthal and Antonella Trigari,** Who Creates and Destroys Jobs over the Business Cycle?
No. 629 **Stan Olijslagers, Annelie Petersen, Nander de Vette and Sweder van Wijnbergen,** What option prices tell us about the ECB's unconventional monetary policies
No. 630 **Ilja Boelaars and Dirk Broeders,** Fair pensions
No. 631 **Joost Bats and Tom Hudepohl,** Impact of targeted credit easing by the ECB: bank-level evidence
No. 632 **Mehdi El Herradi and Aurélien Leroy,** Monetary policy and the top one percent: Evidence from a century of modern economic history
No. 633 **Arina Wischnewsky, David-Jan Jansen and Matthias Neuenkirch,** Financial Stability and the Fed: Evidence from Congressional Hearings
No. 634 **Bram Gootjes, Jakob de Haan and Richard Jong-A-Pin,** Do fiscal rules constrain political budget cycles?
No. 635 **Jasper de Jong and Emmanuel de Veirman,** Heterogeneity and Asymmetric Macroeconomic effects of changes in Loan-to-Value limits
No. 636 **Niels Gilbert,** Euro area sovereign risk spillovers before and after the ECB's OMT
No. 637 **Dorinth van Dijk,** Local Constant-Quality Housing Market Liquidity Indices
No. 638 **Francesco G. Caolia, Mauro Mastrogiacomo and Giacomo Pasini,** Being in Good Hands: Deposit Insurance and Peers Financial Sophistication
No. 639 **Maurice Bun and Jasper de Winter,** Measuring trends and persistence in capital and labor misallocation
No. 640 **Florian Heiss, Michael Hurd, Maarten van Rooij, Tobias Rossmann and Joachim Winter,** Dynamics and heterogeneity of subjective stock market expectations
No. 641 **Damiaan Chen and Sweder van Wijnbergen,** Redistributive Consequences of Abolishing Uniform Contribution Policies in Pension Funds
No. 642 **Richard Heuver and Ron Triepels,** Liquidity Stress Detection in the European Banking Sector
No. 643 **Dennis Vink, Mike Nawas and Vivian van Breemen**, Security design and credit rating risk in the CLO market

De Nederlandsche Bank N.V.
Postbus 98, 1000 AB Amsterdam
020 524 91 11
dnb.nl