Universität St.Gallen

Wage divergence, business cycle co-movement and the currency union effect

Martin Gächter, Alexander Gruber, Aleksandra Riedl

March 2016 Discussion Paper no. 2016-05

School of Economics and Political Science,
Department of Economics

University of St. Gallen

Editor: Martina Flockerzi
University of St.Gallen
School of Economics and Political Science
Department of Economics
Bodanstrasse 8
CH-9000 St. Gallen
Phone +41 71 224 23 25
Fax +41 71 224 31 35
Email seps@unisg.ch

Publisher: School of Economics and Political Science
Department of Economics
University of St.Gallen
Bodanstrasse 8
CH-9000 St. Gallen
Phone +41 71 224 23 25

Electronic Publication: Fax +41 71 224 31 35
http://www.seps.unisg.ch

Wage divergence, business cylce co-movement and the currency union effect[1]

Martin Gächter, Alexander Gruber, Aleksandra Riedl

Author's address:

Alexander Gruber, Ph.D. HSG
Institute of Economics (FGN-HSG)
University of St. Gallen
Varnbüelstrasse 19
CH-9000 St. Gallen
Phone +41 78 854 32 42
Email alexander.gruber@unisg.ch
Website www.alexander-gruber.ch

Dr. Martin Gächter
Foreign Research Division
Oesterreichische Nationalbank
Otto-Wagner-Platz 3
AT-1090 Vienna
Phone +43 1 40420 5249
Email martin.gaechter@oenb.at
Website www.oenb.at

Dr. Aleksandra Riedl
Foreign Research Division
Oesterreichische Nationalbank
Otto-Wagner-Platz 3
AT-1090 Vienna
Phone +43 1 40420 5246
Email aleksandra.riedl@oenb.at
Website www.oenb.at

[1] We are grateful for very helpful comments by participants at the Meeting of the Royal Economic Society in Manchester (UK), the Conference of the Western Economic Association in Denver (USA), the Joint Accounting/Finance Seminar at Stanford Graduate School of Business (USA), the Austrian Central Bank (AUT), and the Economics Seminar at the University of Innsbruck (AUT). Alexander would like to thank the Swiss National Science Foundation (P1SGP1_148943) for supporting the work on this paper with the generous scholarship for his research year at the Stanford Graduate School of Business. Great and helpful comments have further been provided by Christian Keuschnigg, Hélène Rey, Paul Pfleiderer, Anat Admati, Guido Imbens, Jesus Crespo-Cuaresma, Reto Föllmi and Marco Giacoletti.

Abstract

The European debt crisis reminded us that some member countries of Economic and Monetary Union (EMU) experienced unsustainable pre-crisis booms accompanied by an increase in wages far beyond what would have been justified by long-lasting trends in labor productivity. Within a currency union, such diverging trends in wages and competitiveness cannot be mitigated by simply adjusting nominal exchange rates. Against this background, it is astonishing that the impact of labor cost dynamics on business cycle co-movement – the most widely used meta-criterion for an optimum currency area – has not been analyzed so far. In our empirical analysis, we reveal a highly significant and policy-relevant finding: While wage developments do not affect business cycle convergence outside a currency union, wage growth differentials across countries significantly reduce business cycle co-movement within a common currency area. The economic significance of the effect is surprisingly large and even exceeds the impact of bilateral trade relations.

Keywords

Business Cycle Synchronization, Unit Labor Costs, Competitiveness, Currency Union, Optimum Currency Area.

JEL Classification

E31, E32, F44.

1 Introduction

The European debt crisis and the associated threat of a possible break-up of the euro area have put the topic of optimum currency areas and their preconditions back to the very center of the political and economic discourse. In response to the crisis, European policy makers recognized that the economic coordination process among members of Economic and Monetary Union (EMU) would have to be strengthened in order to avoid future tensions on debt markets, to forestall internal imbalances and to assure the proper functioning of the common currency area in general. Indeed, several steps in this direction have already been undertaken. The introduction of the European Semester to coordinate economic policies and national budget plans, the installation of a European Systemic Risk Board to ensure a healthy financial sector and the initiation of the Banking Union exemplify the trend towards intensified economic coordination.[6] These measures are essentially based on the ideas of the optimum currency area (OCA) literature, which has been proclaimed almost half a century ago. The first contributions in this field of research were mainly theoretical studies, which proposed a broad set of prerequisites for a successful integration of member states such as (i) price and wage flexibility (Friedman, 1953), (ii) mobility of factors of production including labor (Mundell, 1961), (iii) financial market integration (Ingram, 1962), (iv) similarities of inflation rates (Fleming, 1971), (v) fiscal integration (Kenen, 1969) and (vi) a high degree of economic openness (McKinnon, 1963).[7] All these criteria were intended towards harmonizing economic developments among member states and thereby lowering the costs associated with relinquishing the potential compensation mechanisms of sovereign monetary policies.

While the empirical literature has devoted increased attention towards these factors in recent years, a consensus on their relative importance for the proper functioning of EMU is yet to be reached. The most widely used criterion to assess their relevance and to judge whether economies are suited to form a currency union is the degree of synchronization among their business cycles (BC).[8] The underlying argument is simple: If business cycles in countries within a monetary union diverge, a common monetary policy will not be optimal for all countries concerned (Bayoumi and Eichengreen, 1997; Masson and Taylor, 1993). Recent events and the introduction of EMU thus spurred renewed interest in the topic and – based on the aforementioned BC synchronization concept – several factors have been suggested to determine cyclical co-movement. While the positive effect of bilateral trade relations on business cycle synchronization is now firmly established in the literature (Artis and Okubo, 2011; Inklaar et al., 2008; Baxter and Kouparitsas, 2005; Frankel and Rose, 1998; Gächter and Riedl, 2014), the jury is still out on other determinants. Darvas et al. (2005), for instance, highlight the importance of fiscal variables such as budget deficits

[6] For an overview on all new measures taken by the EU and its member states see: `http://ec.europa.eu/economy_finance/economic_governance/index_en.htm`.

[7] See Mongelli (2002) and Mongelli (2008) for a detailed review of OCA theory and evidence.

[8] See de Haan et al. (2008) for a broad literature survey on empirical papers exploring determinants of business cycle synchronization and its development over time in the European context.

and public debt while Imbs (2004) stresses the relevance of financial integration. Gächter and Riedl (2014) show that EMU membership *per se* has increased BC synchronization across member countries. Yet, one factor that has been prominently discussed both in the theoretical literature and in policy circles has been disregarded in empirical studies so far: the impact of labor market developments such as unit labor costs.

At first glance, the impact of wage growth differentials on business cycle co-movement is theoretically ambiguous. On the one hand, wage flexibility is considered one of the most important prerequisites for countries to join a currency union, in order to be able to adjust to both internal and external imbalances. In the case of an asymmetric exogenous demand shock, wage dispersion is necessary to move back to equilibrium, and would therefore increase business cycle co-movement. On the other hand, however, wage dispersion (and corresponding inflation differentials) can also be the cause of demand shocks in individual countries, thereby acting as a disequilibrating mechanism leading to lower business cycle co-movement. While previous literature disagrees on whether higher wage growth in the periphery was caused by institutional differences in wage bargaining or rather by strong capital inflows, both strands of the literature highlight the crucial role of wage developments in fueling domestic demand booms in the euro area's periphery, while core countries exhibited significantly lower GDP growth rates due to substantial wage restraint. In this respect, the real interest rate channel additionally reinforced this effect in a vicious circle, and thus further contributed to business cycle divergence. While Fleming (1971) has already stated that *'the principal danger ... in participating in a fixed exchange rate area arises from the certainty, in the absence of perfect competition in product and factor markets, that developments would occur from time to time that pushed the relative cost levels of the participating countries out of line'*, the considerable differences in inflation rates in early years of EMU were not regarded as a major problem and were commonly interpreted as a natural catching-up process resulting from the widely known Balassa-Samuelson effect. The European debt crisis, however, eventually illustrated that this view had been far too optimistic. In fact, recent policy work on possible reforms of the EMU governance framework has highlighted wage developments as one key factor for a proper functioning of EMU (see, for instance, Sapir and Wolff, 2015). Surprisingly, however, this factor has been neglected so far in the empirical literature on optimum currency areas.

Against this background, the present paper aims at exploring whether diverse unit labor cost developments indeed exerted a negative impact on the co-movement of European business cycles. To the best of our knowledge, no other study has tackled this venture so far. While cyclical synchronization has been widely regarded as the 'meta' criterion for OCAs for long, diverging unit labor cost developments have not been suggested as a major determinant in the literature yet. The missing empirical evidence, however, may well have been a consequence of a lack of adequate econometric tools. By using novel synchronization measures as recently proposed by Cerqueira and Martins (2009) and Cerqueira (2013) as well as a dynamic panel estimator, we are able to exploit the time variability in our data sample and to handle the issue of endogeneity in an appropriate manner. Based on data

for 27 European Union countries in the period 1993 to 2011, we show that differences in growth rates of NULC have been one of the most important determinants of business cycle synchronization among the group of euro countries. In contrast, the impact of labor cost developments among non-EMU members is not statistically significant, most likely due to the possibility of nominal exchange rate adjustments. Hence, the present paper constitutes an important contribution to the current policy debate in Europe on how to reform monitoring mechanisms to move EMU closer to an OCA. The empirical insight that the divergence of national unit labor costs leads to less synchronized business cycles and thus to an increase of the costs of a common currency calls for a much stronger institutional framework at the European level.

2 Theoretical background

2.1 Wage dispersion, external imbalances and the OCA theory

This section outlines the relationship between diverging wage developments and business cycle synchronization within a currency union. From a theoretical perspective, the impact of wage growth dispersion on business cycle synchronization is ambiguous. On the one hand, wage flexibility is considered one of the most important prerequisites for countries in a currency union (see, for instance, De Grauwe (2009)). By irrevocably fixing their exchange rates and adopting a common currency, members lose their control over monetary policy and the exchange rate as main adjustment instrument to internal (inflation) and external (current account and trade balances) imbalances. Thus, if one country experiences an exogenous (negative) demand shock and moves into recession, relative wage and price adjustments are the only possibility to move back to equilibrium. In the case of exogenous demand shocks, higher wage dispersion – acting as an equilibrating mechanism – might therefore increase business cycle co-movement. On the other hand, however, wage dispersion can also be the cause of demand shocks in individual countries, as relatively pronounced wage increases are likely to induce domestic demand booms. In this case, higher wage dispersion acts as a disequilibrating mechanism, leading to lower business cycle co-movement.[9]

For the case of EMU countries, however, we subsequently argue that the latter effect outweighs the former for several reasons. Previous literature has suggested various causes for the occurrence of persistent external imbalances in the euro area. These theories can be summarized in two different views, which are not mutually exclusive, but are rather likely to reinforce each other (Johnston and Regan, 2014).

The first strand of literature argues that structural imbalances between export-led (core) countries and domestic demand-led (periphery) countries resulted in divergent wages,

[9] The arguments resemble the controversial debate on the impact of fiscal policy differentials on business cycle co-movement, which is also theoretically ambiguous (see, for instance, Darvas et al., 2005; Gächter and Riedl, 2014).

inflation rates and eventually competitiveness (see, for instance, Hall, 2012; Shambaugh, 2012; Johnston et al., 2014), as the nominal exchange rate is no longer available as an equilibrating mechanism in a common currency area. Thus, according to this institutional view, export-led core countries which typically exhibit corporatist wage-bargaining institutions produced significant wage moderation relative to their southern peripheral counterparts where such coordinated wage bargaining systems are non-existent. This led to low inflation and increasing current account surpluses in the core and a corresponding loss of competitiveness in the periphery. In this first view, trade and financial imbalances were therefore caused by a loss in competitiveness in peripheral countries (i.e. via the current account); financial flows from the EMU's core to the periphery followed as a consequence via the financial account.[10]

The second view, on the contrary, argues that imbalances started in the financial account, and that the loss of competitiveness was merely a consequence rather than the cause of financial imbalances (Johnston and Regan, 2014): With the convergence in nominal exchange rates and interest rates in EMU, peripheral countries experienced significant reductions in borrowing costs (Hellwig, 2011; Lane, 2012, 2013). This access to cheap credit fueled consumption and real-estate booms in the periphery, and thereby increased both wages and inflation. The appreciation of real exchange rates, which can therefore be seen as a consequence of financial inflows rather than their cause, eventually led to the observed imbalances across euro area countries.

While the two different perspectives basically constitute a chicken-and-egg problem, it seems likely that both lines of arguments have played a significant role in the euro area. More importantly, however, wage developments play a crucial role in reinforcing external imbalances in both theories, irrespective of whether wage increases were mainly due to institutional factors (i.e. differences in wage bargaining institutions) or strong capital inflows. Pronounced wage growth has fueled domestic demand booms in peripheral countries mainly via two self-amplifying transmission channels. First, higher wages increased domestic demand directly by increasing households' disposable income. Second, the increase of the inflation rate due to excessive wage growth reduced domestic real interest rates which in turn stimulated investment and domestic demand in an indirect way and further amplified the original inflation differentials. While this real interest rate channel has hardly been considered in previous literature on the OCA theory, it acted as a self-reinforcing vicious circle which triggered further business cycle divergence.

Although the divergence in real exchange rates should theoretically cause a loss of competitiveness and weaker export performance of peripheral EMU countries which would have an equilibrating effect, empirical data suggest that the 'internal' effect (i.e. domestic demand boom) came into play instantaneously, while the 'external effect' (i.e. lower net

[10] External financing mainly stemmed from core countries due to a significant home bias in European investment (Gros, 2012). Thus, it is not surprising that current account deficits in the periphery were virtually mirrored by current account surpluses in the core, while the euro area as a whole exhibited a more or less balanced current account to the rest of the world prior to the crisis.

exports) needed a considerable time span to become relevant (i.e. the widely known "J-curve" effect). The systemic circulation, which fueled domestic demand booms and external deficits, just came to a halt when the euro area was hit by the global financial crisis and the subsequent debt crisis. External financing dried up (similar to a "sudden stop" scenario) and wages started to decrease. Once again, the 'external' effect of lower wages should theoretically lead to a recovery in corresponding countries due to a real depreciation and increasing net exports. In fact, the opposite happened, because domestic demand collapsed immediately when wages decreased thereby starting a vicious circle in another direction. Following this line of reasoning, we expect a negative link between wage dispersion and business cycle co-movement because domestic demand effects are stronger and take full effect faster than external demand effects.

We furthermore argue that this self-reinforcing vicious circle could only have been interrupted by coordinating wages across EMU countries. The latter is the only policy tool with some room of manoeuvre in an environment of capital mobility and free trade within the euro area. Thus, while wage flexibility is still needed to cope with exogenous demand shocks, it must be assured that wage dispersion does not act as an endogenous demand shock, which causes asymmetric cyclical movements within a currency area. The fact that wage setting mechanisms and institutions are still under national responsibility in the EMU governance framework increases the probability of such wage-induced cost-push shocks, which tend to be further amplified by generous wage settlements in non-export oriented goods and labor market segments that are still fragmented.

2.2 The role of wage dispersion in EMU

A first look at the data as illustrated in figure 1 shows that peripheral EMU countries featured significantly higher economic growth rates than their peers in the core during the first years of the euro. These different growth paths were facilitated by domestic demand booms in the periphery (Greece, Ireland, Italy, Portugal, Spain), which were fuelled by labor compensation increases far above what would have been justified by productivity improvements alone (see figures 2 (a) to (c)). Such generous wage settlements were possible due to the aforementioned difference in wage bargaining mechanisms and considerable capital inflows, which generated additional economic leeway. In fact, compensation versus productivity growth developments in peripheral EMU countries is very similar to that of non EMU countries, which underwent a comparable post-millennial catching-up process.

The heterogeneous dynamics of NULC – defined as labor compensation over productivity – between 2000 and 2011 are documented for selected countries in figure 2 (d). Nominal unit labor costs rose most strongly in non-EMU countries such as Romania, Latvia, and Slovakia. But the EA periphery also experienced substantial upward movements while wage restraint in core countries of EMU such as Austria and Germany kept them relatively low (figure 2 (e)).

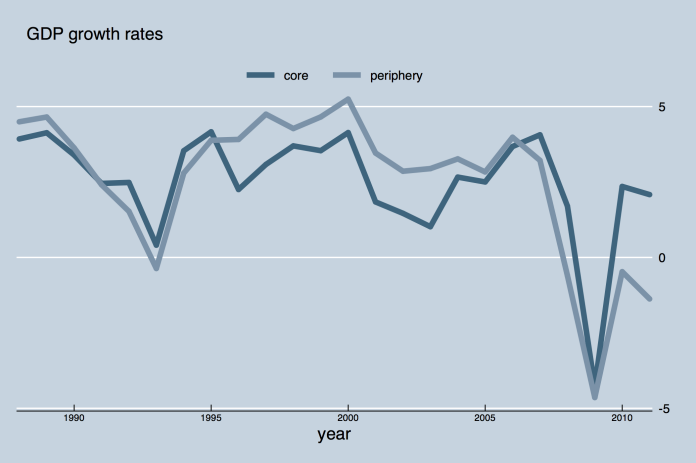
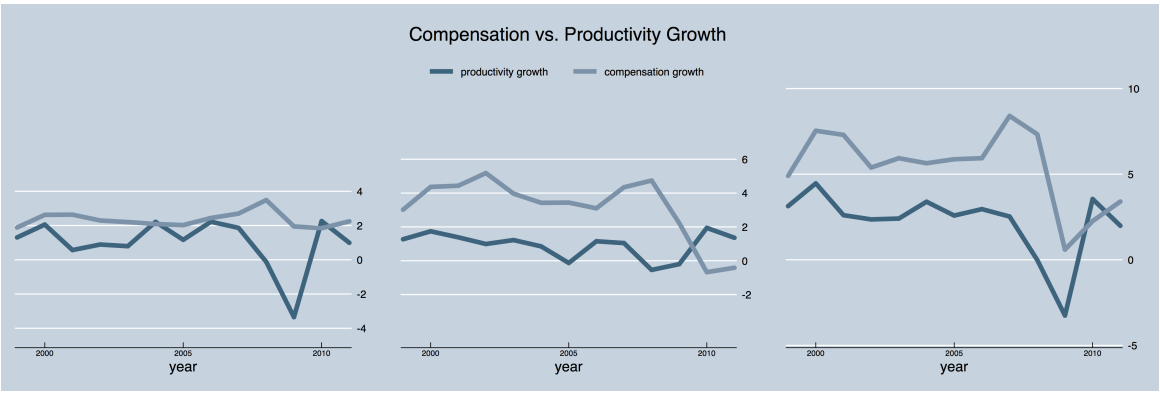


FIGURE 1: Average growth rates in core and peripheral EMU countries over time

(A) core (B) periphery (C) non EMU



(D) (E)

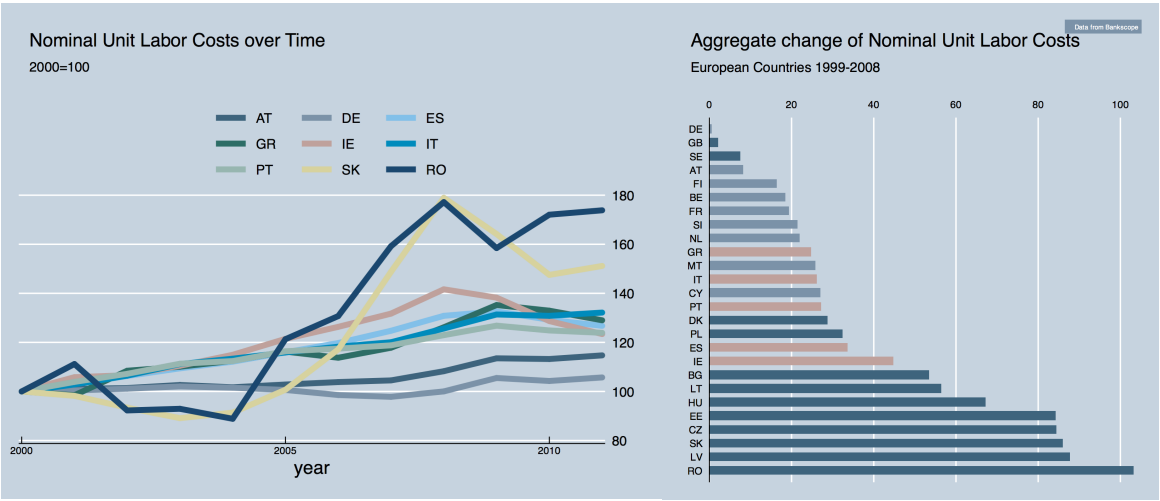


FIGURE 2: Nominal unit labor costs in Europe (2000=100)

These persistent differences eventually translated into diverging levels of inflation and real interest rates, a mechanism which has also been stressed by Lane (2006) and Hellwig (2011) and which emerges naturally within a monetary union, where there is only one

common nominal interest rate set by the ECB. The relatively low real interest rates in the periphery right up to the onset of the crisis are illustrated in figure 3 (a). Following the formal logic of the arguments discussed, this stimulated demand (as well as credit growth and housing markets) in high inflation countries. This euphoria in turn induced periphery countries to raise wages faster than productivity dynamics would have justified. These generous wage settlements provoked wage-driven inflation and lowered real interest rates even further. A vicious circle of further divergence emerged. Keuschnigg (2012) and Hellwig (2011) argue that these effects were furthermore accentuated by an important capital market failure, which essentially made nominal interest rate differentials in the euro area disappear. This observation is indeed evident from figure 3 (b). Hence, public debtors

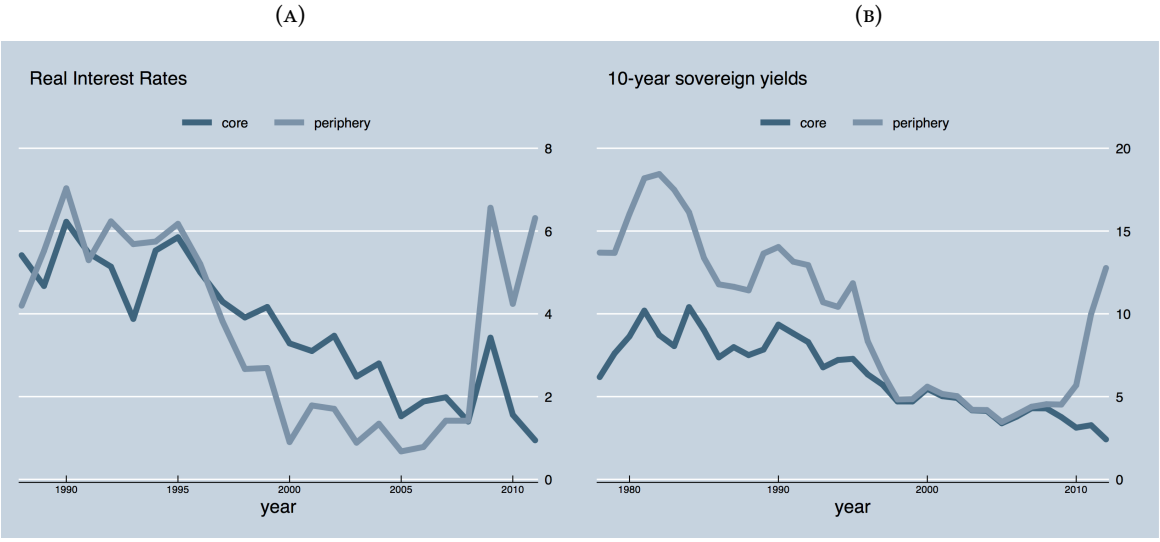


FIGURE 3: Average real interest rates and average sovereign yields on 10 year bonds over time

in Europe's periphery were tempted by excessively low levels of interest rates on public debt, borrowed well above what would have been justified by underlying real developments and boosted the economy with additional stimulus. Lane (2006) also highlights that the sizeable differences of average inflation rates over the first six years of EMU (1999–2004) were particularly distinct in the non-tradable services sector, which also supports the domestic boom narrative in the periphery.[11] Due to the country's subdued wage-setting, Germany experienced weak domestic demand, relatively low inflation rates and modest economic growth during the same period. The link between the increase in NULC and (cumulative) real GDP growth is shown in the left-hand chart of figure 4. The positive correlation between the two variables is clearly visible for the EA-12 sample, with Germany and Ireland at the extremes. This graphical evidence thus suggests that diverging wage developments triggered considerably less synchronized growth paths within EMU in this early period, i.e. generous wage settlements in the periphery may have facilitated local

[11] Inflation differentials as a result from catching-up developments (i.e. due to the Balassa-Samuelson effect) would emanate from the tradable (due to rapidly increasing productivity) to the non-tradable sector (which has less productivity gains). The empirical pattern in early years of EMU showed a reversed sequence, once again highlighting the domestic demand boom.

booms by stimulating domestic demand while the opposite holds true for core countries. Due to the Great Moderation, which guaranteed comparatively stable (global) external demand in the first years of EMU, however, cyclical co-movement remained relatively high initially.

Over time, though, wage-driven inflation continuously pushed-up the periphery's production costs. Real exchange rates therefore steadily appreciated. Portugal, Ireland, Italy, Greece and Spain alike suffered a considerable erosion of their price competitiveness as compared to core countries of the euro area thus building up substantial current account deficits. The latter point is plainly illustrated in the right-hand panel of figure 4, which again features Germany and Ireland on opposite ends of the distribution.

(A) (B)

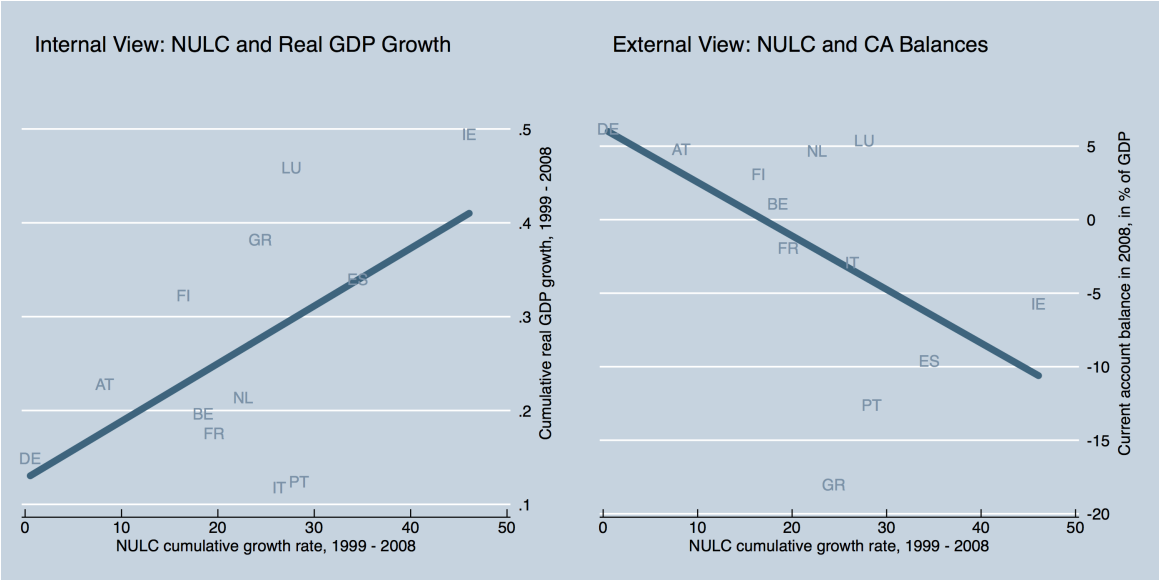


FIGURE 4: The internal and external view

While these decreasing export shares had been covered up by their domestic booms for long, the eruption of the crisis and the associated dry-up of external financing revealed the imbalances virtually overnight. In conjunction with the challenges in the banking sector and escalating levels of sovereign debt, these effects triggered doubts about the countries' economic viability as well as abrupt capital outflows, leading to a correction of NULC paths (see figure 2). The phenomenon was further accelerated by a sharp decline of global demand and the fact that national sovereigns could no longer provide the necessary public stimulus. Debt levels were already too high and new bond issues became excessively expensive for peripheral countries, when their risk premia suddenly shot up (figure 3). While these adverse dynamics may be mitigated by corresponding adjustments of the (nominal) exchange rate outside a common currency area, they may cause substantial tensions within a currency union. The same factors that had initially facilitated the booms now proved to cause recessionary (deflationary) effects, as the loss of competitiveness and the dry-up of external funding led to decreasing wages and thus

caused a collapse in domestic demand. It therefore seems obvious that diverging trends of unit labor costs eventually lead to asymmetric business cycles. For this reason, we suggest that NULC developments might be an important determinant of business cycle synchronization, particularly so in a common currency area like EMU.

3 Data and measurement issues

3.1 Business cycle synchronization

Following Gächter and Riedl (2014), the empirical analysis considers a slightly adapted version of the synchronization index proposed by Cerqueira and Martins (2009) and Cerqueira (2013) to measure the co-movement of two countries' time series $c_{j,t}$ and $c_{i,t}$, i.e.,

$$\text{Correl}_{ij,t} = \frac{1}{2}\log\left(\frac{1+\frac{\rho_{ij,t}}{2T-3}}{1-\rho_{ij,t}}\right) \tag{1}$$

where

$$\rho_{ij,t} = 1 - \frac{1}{2}\left(\frac{c_{j,t}-\overline{c}_j}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(c_{j,t}-\overline{c}_j)^2}} - \frac{c_{i,t}-\overline{c}_i}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(c_{i,t}-\overline{c}_i)^2}}\right)^2 \tag{2}$$

We deviate from the approach by Cerqueira and Martins (2009) in the sense that $c_{i(j),t}$ reflects the cyclical component of real GDP[12] rather than GDP growth rates. Hence, $\text{Correl}_{ij,t}$ measures the correlation of output gaps between country i and country j at each single point in time t.[13] This is an important distinction as our sample includes two very heterogeneous country groups, i.e. industrialized nations as well as former communist countries. Since these groups exhibit substantially different and changing trend growth rates the correlation between output gaps is also likely to differ from the correlation of GDP growth rates. Output gaps are also the relevant indicator from a monetary policy perspective. We therefore extract the cyclical component from GDP level data by applying the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997). This filtering technique is the most commonly used method, which makes our outcomes more comparable to other studies. As a standard procedure for yearly observations the trend smoothing parameter is set to 6.25 (see Ravn and Uhlig, 2002). For our robustness checks, however, we intend to test the sensitivity of our results with respect to another filtering technique. In particular,

[12] We use real GDP data (in euro) of 27 EU Member States (i.e. EU 28 excluding Croatia). As GDP data for some former communist countries are available only from 1993 onward, the subsequent estimations are restricted to the period 1993 to 2011. However, estimates for the output gap are based on the maximum available time span within the range 1988 to 2011. All data are extracted from Eurostat's online database and are therefore comparable across countries as well as over time. The number of observations for the synchronization measure amounts to 6669 ($\frac{N\times(N-1)}{2}$ country pairs, with $N = 27$ being the number of countries, which are observed for $T = 19$ years).

[13] Equation 1 shows the transformation of the correlation measure $\rho_{ij,t}$ proposed by Cerqueira (2013) to yield a symmetric range of the index (i.e. between $-\infty$ and $+\infty$) as the measure given in equation 2 is bounded between $3-2T$ and 1.

we also use the Baxter-King band-pass filter[14] as suggested by Baxter and King (1999), although results of others studies proved to be rather insensitive to the choice of filtering methods (see, for example, Gruber (2010)).

It is noteworthy that this index allows us to fully exploit the time variability of our data set, which is a major advantage compared to other econometric methods. It distinguishes between specific episodes of asynchronous behavior and periods of highly positive cyclical correlations, while its mean over time corresponds to the conventionally applied correlation coefficient, i.e., $\frac{1}{T}\sum_t \rho_{ij,t} = \rho_{ij}$ with $\rho_{ij} = \frac{Cov(d_i,d_j)}{\sigma(d_i)\sigma(d_j)}$. Employing this index sets us apart from earlier research and allows us to employ a dynamic panel approach to optimally capture the dynamic developments in Europe within the given time span. After all, countries joined EMU at different points in time, the financial crises hit countries to varying degrees, fiscal limits defined in the Maastricht Treaty were severely violated, and, most importantly, the degree of business cycle synchronization varied quite considerably over time. Given that the correlation measure is available on a yearly basis, there is also no need to choose arbitrary time spans as it is done in numerous other studies. This restriction often constrains empirical studies to pure cross-sectional estimates or forces them to sacrifice parts of the time dimension by computing correlation coefficients for non-overlapping windows such as Gruber (2010). Furthermore, the autocorrelation issues associated with the application of overlapping window spans and the loss of observations can be circumvented.[15]

Table 1 shows that average BC correlation has been generally higher among EMU countries than for EMU/non-EMU and non-EMU/non-EMU country pairs.[16] For both groups, the average pair-wise correlation index across country-pairs has increased until the recent crisis. After 2008, however, BCs became severely less synchronized as the turmoil exerted very heterogeneous impacts on different countries. Interestingly, this was especially true among EMU members, whose average bilateral correlation index fell below the non-EMU group for the first time in the period under review.[17] The corresponding numbers are shown in table 1 and figure 5, respectively.

Table 1: Average pair-wise correlation index

	1999-2002	2003-2007	2008-2011
EMU	0.844	0.893	0.609
non-EMU	0.652	0.773	0.646

[14] It admits periodic components between two and eight years, with lead-lag length of the filter being K=3. Thus, we lose three years at the beginning and the end of our sample. Due to the availability of real GDP data before this time period, however, this will impose no constraint at the beginning of our sample.

[15] For a more detailed discussion of the synch. index and its advantages see Gächter and Riedl (2014).

[16] EMU/non-EMU and non-EMU/non-EMU are subsumed into 'non-EMU' subsequently

[17] Business cycles of selected countries and their correlation measure with Germany – as measured by the bounded index (eq. 2) – are graphically illustrated in figures 8 (a) to (d). The variations over time and across country pairs are substantial.

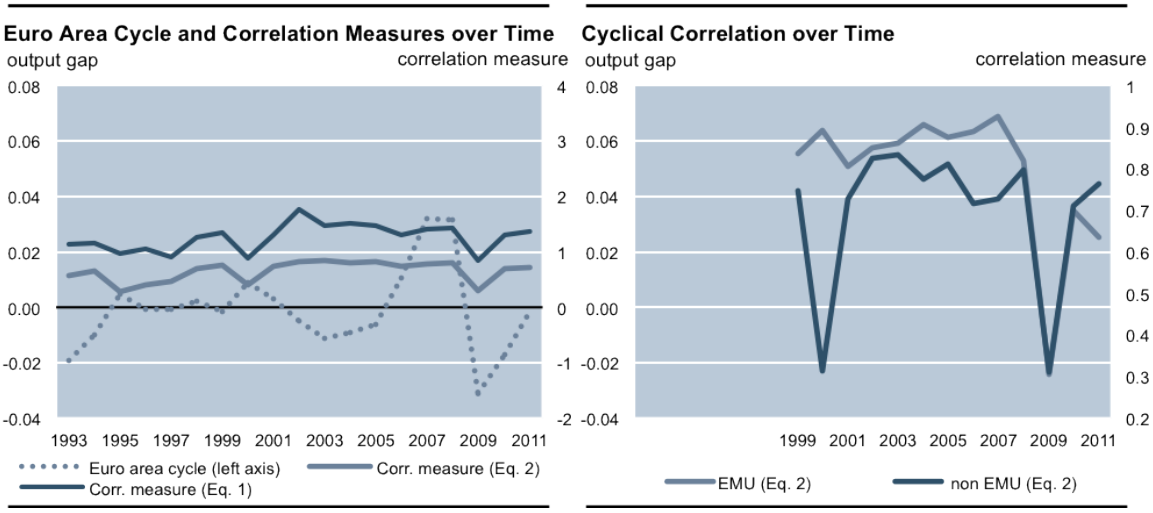


FIGURE 5: Euro area cycle and correlation measures over time

3.2 Labor cost variable

The labor cost dynamics described in section 2.2 and their impact on BC synchronization are the major focus of the empirical investigation. Unit labor costs are a measure of the average cost of labor per unit of output. More specifically, we use nominal unit labor costs (NULC) given that they adequately indicate inflationary pressures caused by rising wages (see e.g. Bellak et al., 2008). They are provided by the European Commission for almost all EU countries since 1993 and are calculated as the ratio of compensation per employee (in nominal terms, obtained from national accounts) to real GDP per person employed.[18] An alternative measure would be real unit labor costs, which are calculated as nominal compensation per employee over nominal GDP per person employed. It thus reflects the wage share in the value added of an economy, which, however, makes it more of a profitability measure, which is not directly relevant for our purpose. Since we are interested in the dynamics of labor cost developments between countries (i and j), we take the absolute difference of the growth rate of nominal unit labor costs for all country pairs over time, which we denote by Labor costs$_{ij,t}$, or in formal terms

$$\text{Labor costs}_{ij,t} = |\dot{nulc}_{i,t} - \dot{nulc}_{j,t}| \tag{3}$$

with $\dot{nulc}_{i(j),t} = \frac{nulc_{i(j),t} - nulc_{i(j),t-1}}{nulc_{i(j),t-1}} * 100$. It is noteworthy that developments in NULC across EU member countries are used by the European Commission as one of eleven competitiveness indicators[19] which are monitored on a regular basis in the context of the Macroeconomic Imbalances Procedure (MIP). Since the financial crises it has been recognized that sustained divergence of economic competitiveness creates enormous

[18] Source: Ameco database `http://ec.europa.eu/economy_finance/ameco`.

[19] A detailed list of the indicators is available at `http://ec.europa.eu/economy_finance/economic_governance/documents/alert_mechanism_report_2013_en.pdf`

imbalances and constitutes a considerable risk, especially within a currency union. Going forward, the Commission will thus identify member states for which certain developments are considered to warrant further in-depth analysis. The underlying mechanism in place is based on a scoreboard of indicators, amongst them the three-year change of nominal unit labor costs. The threshold above which this measure signals potential risks amounts to 9% for EMU members and 12% for non-members. Figure 6 illustrates that this monitoring mechanism would have been triggered on numerous occasions in the past for some peripheral countries.

FIGURE 6: Three-year NULC growth rates for selected countries

The absolute bilateral differences of NULC growth between EU country pairs, which we use for our estimates, are particularly interesting in the euro area context since our approach reflects differentials on an annual level and thus fully captures the divergence element of labor cost developments over time. Interestingly, the absolute annual bilateral differences are relatively high on average. In fact, the sample mean amounts to 7.7 percentage points as documented in table 2. The mean differences are considerably smaller among EMU countries as compared to countries outside EMU. This significant difference, however, is not surprising if one takes into consideration that former communist countries have experienced a remarkable catching-up process in the period under review, especially so in the mid 1990s. The full dynamics of the growth process of NULCs in levels and in absolute bilateral differentials – for peripheral as well as core countries – are highlighted in figures 7 (a) and (b), respectively. The spikes and dips towards the end of our sample indicate the sizeable and heterogeneous adjustments during the financial crisis.

In table 2 we also present the corresponding descriptive statistic for growth differences of absolute labor costs, measured as compensation per person employed (i.e., the nominator of NULC). This variable reflects labor cost differences when productivity is not accounted for. Unsurprisingly, growth differences in absolute labor costs are even more heterogeneous across different country groups. Although we consider unit labor costs to be the relevant measure for our purpose we will subsequently employ absolute labor costs as a robustness

TABLE 2: Labor cost variables

Variable	Full sample	Non-EMU	EMU
Labor costs$_{ij,t}$	7.70	8.84	2.13
Compensation per employee$_{ij,t}$	10.58	12.41	2.00
No. of observations	6,048	4,983	1,065

Differences in growth rates - sample averages for country pairs (in percentage points), 1993-2011.

(A) (B)

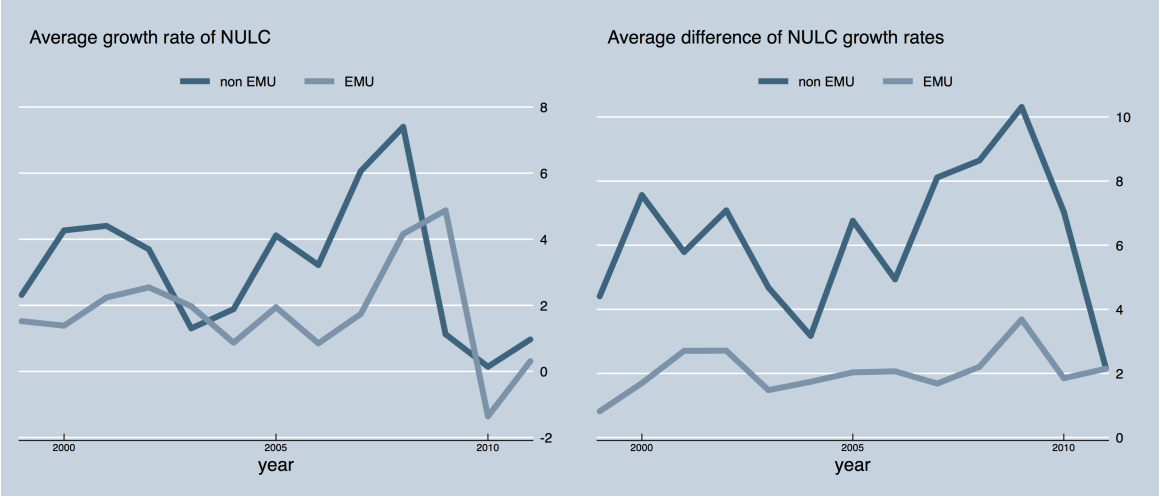


FIGURE 7: Average NULC growth and average absolute bilateral NULC differentials over time

check.

Finally, table 3 reports some first descriptive results for the relationship between labor cost dynamics and cyclical synchronization. Simple partial correlation coefficients for both labor market measures indeed suggest that diverging labor cost developments impacted negatively on countries' business cycle co-movement. Moreover, the impact seems to be significantly higher for countries that share the euro as reflected by the interaction term between EMU membership and labor costs. Whether this is a causal effect and whether the relationship still holds when other relevant variables are controlled for, will be comprehensively examined in section 5.

TABLE 3: Partial correlation coefficients for business cycle synchronization

	nominal unit labor costs	compensation per employee
Labor costs	-0.04***	-0.10***
Labor costs × EMU	-0.05***	-0.07***
EMU	0.09***	0.10***

3.3 Control variables

In order to show that labor cost divergences indeed exert an influence on business cycle co-movement we employ several control variables.[20] First, we control for bilateral trade in spirit of Frankel and Rose (1998) and Baxter and Kouparitsas (2005). Its effect is ambiguous in theory, as it may depend on whether trade integration is mainly based on intra-industry or rather on inter-industry trade (De Grauwe, 2009). In the empirical academic literature, however, the positive influence of this factor on BC convergence has been well established (Frankel and Rose, 1998). The bilateral trade measure is constructed as follows

$$\text{Bilateral trade}_{ij,t} = \frac{Exports_{ij,t} + Exports_{ji,t}}{GDP_{i,t} + GDP_{j,t}} \tag{4}$$

where $Exports_{ij,t}$ refers to all exported goods from country i to country j at time t. The bilateral and time-varying nature of this variable is ideal for our purposes. The determinant reflects the country-pair's trade interconnectedness relative to their GDP. To account for possible endogeneity issues bilateral trade will be instrumented accordingly.

Second, we include a measure reflecting the divergence in national fiscal policies. The variable has been frequently mentioned in the academic literature (Kenen, 1969; Annett, 2006; Lane, 2006; Gächter and Riedl, 2014). Once again, the impact of fiscal policy is ambiguous from a theoretical perspective. While fiscal interventions could possibly be used to counterbalance idiosyncratic economic shocks, proactive fiscal policies are a potential source of asymmetric shocks. Whereas the former would subsequently foster cyclical convergence, the latter may well have the opposite effect. Although ambiguous in theory, the Maastricht Treaty and the Stability and Growth Pact strongly emphasized the restrictions of national leeway with respect to fiscal policies. To properly reflect annual fiscal budget differentials across EU countries we use the measure already employed by Gächter and Riedl (2014) and Gruber (2010), i.e.,

$$\text{Fiscal policy}_{ij,t} = |fb^{ca}_{i,t} - fb^{ca}_{j,t}| \tag{5}$$

where $fb^{ca}_{i,t}$ and $fb^{ca}_{j,t}$ represent the cyclically adjusted fiscal balance (net lending/net borrowing in percent of GDP) of country i and j at time t, respectively.[21] So far, empirical papers have found that divergent fiscal policies are negatively related to business cycle co-movement (Darvas et al., 2005; Gruber, 2010; Gächter and Riedl, 2014).

Finally, we attempt to capture the effect of financial integration on BC synchronization. The variable might potentially play a role through two alternative channels. First, higher capital mobility is associated with faster cross-country spillovers and therefore might lead to a higher degree of cyclical correlation. On the other hand, more developed financial markets can provide a significant source of insurance against asymmetric shocks. Countries can

[20] Descriptive statistics for all variables are reported in table 6 in the appendix.

[21] Data were extracted from Eurostat for the years from 1990 and 2011 and complemented with data obtained from the Vienna Institute for International Economic Studies.

thus afford to specialize more strongly (see Kalemli-Ozcan et al., 2005), which in turn should have a negative impact on economic co-movement. Hence, the relationship is unclear in theory. To improve the comparability of our estimates we resort to an indicator developed by Lane and Milesi-Ferretti (2007), who have collected data of external assets and liabilities for individual countries over time. Based on these data, we construct a bilateral measure of financial integration, which is calculated as the sum of two countries' external (foreign) assets and liabilities as a share of the sum of their GDPs. More precisely, the measure is defined as

$$\text{Financial integration}_{ij,t} = \frac{A_{i,t} + L_{i,t} + A_{j,t} + L_{j,t}}{GDP_{i,t} + GDP_{j,t}} \tag{6}$$

where $A_{i,t}$ and $L_{i,t}$ represent a country i's total external assets and liabilities in year t. Assets and liabilities include portfolio equity, foreign direct investment, debt and financial derivatives.[22] A high value of this quantity-based measure indicates that both countries' financial markets are likely to be relatively integrated.

4 The econometric model

To properly assess the effect of diverging labor cost developments on the synchronization of business cycles we have to address two important issues. First, unit labor costs might react to the business cycle rather than *vice versa*. We will therefore apply GMM methods to control for potential endogeneity. Second, according to a test for autocorrelation the dependent variable is serially correlated. For this reason, we have to consider the first lag of the respective synchronization measure as an explanatory variable. The following dynamic panel data model is employed:

$$\begin{aligned} Correl_{ij,t} =& \alpha + \beta_1 Correl_{ij,t-1} + \beta_2 \text{Labor costs}_{ij,t} + \beta_3 EMU_{ij,t} \\ &+ \beta_4 (\text{Labor costs} \times EMU)_{ij,t} + \beta_5 Z_{ij,t} + \mu_{ij} + \lambda_t + \nu_{ij,t} \end{aligned} \tag{7}$$

where ij represents the country pair $ij = 1, ..., 351$ while t denotes the time periods $t = 1, ..., 19$. In order to test the hypothesis that different labor cost developments among country pairs cause business cycles to diverge particularly within a currency union, we include the interaction term $(Labor\ costs \times EMU)_{ij,t}$. The constitutive terms *Labor costs* and EMU capture the basic effects of the two variables. The latter takes on values of 1 if both countries i and j are members of EMU in year t and 0 otherwise. The coefficient estimate of the interaction term (β_4) is the key component of our analysis. It will reveal whether the impact of diverging labor cost developments on BC synchronization is significantly more pronounced for countries within EMU than for country pairs with different currencies. Based on our reasoning in previous sections of this paper, we would expect (β_4) to be negative while (β_2) should be insignificant given that countries outside the EMU can

[22] The database can be downloaded from `http://www.philiplane.org/EWN.html`.

mitigate changes of competitiveness by steering the value of their currency accordingly. Recent research from Gächter and Riedl (2014) shows that the adoption of the euro has increased the co-movement of business cycles across EMU members. We thus expect a positive coefficient estimate for this factor. The set of control variables is represented by matrix Z and consists of bilateral trade, financial integration and fiscal differentials. Finally, we include time-fixed effects (λ_t) as well as country-pair specifics (μ_{ij}).

The model in (7) is estimated by applying the feasible system GMM estimator introduced by Blundell and Bond (1998). This method adequately addresses the endogeneity issues of our data set as it not only uses lags in levels as instruments for the differenced variables as suggested by Arellano and Bond (1991) but also past differences as instruments for variables in levels. This is of particular importance for our study, as we apply time invariant measures such as the distance between country-pairs to instrument bilateral trade. Additionally, the application of the feasible GMM estimator also allows us to control for arbitrary patterns of heteroskedasticity. Although the method assumes that disturbances are not correlated across country pairs, which imposes a restriction on the error terms, this is reasonable given that time-dummies are included in all our regressions (Roodman, 2009).[23]

5 Results

5.1 Baseline estimations

The baseline results of the empirical investigation are presented in table 4. Column (1) includes our main variables of interest only, i.e. the labor cost indicator (differences in NULC growth), a dummy for EMU membership, and the interaction term between the two. Furthermore, we also add a lagged dependent variable given that the Arellano-Bond test confirms that the disturbances are autocorrelated of order one (but not of order two). All estimations in table 4 include country-pair specific and time-fixed effects, and the Hansen test of overidentifying restrictions indicates that the used set of instruments is valid across all specifications. Indeed, the results suggest that different growth rates of NULC per se do not have any significant effect on bilateral cyclical correlations. Interestingly, however, the negative coefficient of the interaction term of the two variables, $Labor\ costs \times EMU$ is highly statistically significant. Thus, while differences in NULC growth across countries seem to have no explanatory power for BC synchronization of countries outside a common currency

[23] For the concrete implementation of the estimator we use the stata command xtabond2 (option: two-step robust). Since the EMU dummy, bilateral trade, labor costs and the interaction term are assumed to be endogenous, we add them in the *gmmstyle* option. All other variables enter in the *ivstyle* option. Furthermore, we add external instruments for bilateral trade as additional exogenous variables. Concretely, we use three gravity variables commonly referred to in the literature: distances between two country pairs in logs, a common border dummy and a country's population size in logs. Due to the large number of instruments resulting from our chosen methodology and the associated specification choices, we restrict the number of instruments applied up to five time lags. This guarantees that the endogenous variables are not overfitted and that the Hansen test statistic is not weakened.

TABLE 4: Estimation results

	No controls	Baseline	Alternative wage measure 1	Alternative wage measure 2	BK-filter	Unfiltered GDP-growth	External instrument
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Labor costs	-0.002	-0.004	-0.002	-0.002	0.002	0.007	-0.003
	(-1.26)	(-1.22)	(-0.52)	(-0.78)	(0.47)	(1.64)	(-0.70)
EMU member	0.506***	0.300***	0.333***	0.378***	0.650***	0.303***	0.367***
	(7.02)	(3.53)	(3.65)	(4.57)	(6.04)	(3.22)	(3.97)
$Laborcosts \times EMU$	-0.136***	-0.110***	-0.087***	-0.145***	-0.208***	-0.143***	-0.134***
	(-5.03)	(-3.56)	(-2.86)	(-4.53)	(-5.99)	(-4.13)	(-4.13)
Bilateral trade		0.075***	0.074***	0.075***	0.057***	0.048***	0.080***
		(5.14)	(4.98)	(5.19)	(3.67)	(3.58)	(5.07)
Fiscal policy		-0.013**	-0.021***	-0.022***	0.008	-0.004	-0.015**
		(-2.28)	(-3.75)	(-3.80)	(1.06)	(-0.65)	(-2.45)
Financial integration		0.178***	0.051	0.146***	0.083*	0.105***	0.193***
		(4.45)	(1.27)	(3.52)	(1.83)	(2.66)	(4.60)
$Correl_{t-1}$	0.168***	0.068***	0.082***	0.065***	0.035*	0.152***	0.061***
	(4.96)	(4.31)	(4.79)	(4.12)	(1.89)	(5.08)	(3.81)
Obs	6247	5750	5021	5584	4655	5752	5349
Hansen	336.817	340.939	346.198	347.610	343.716	343.752	345.44
Hansen p	0.109	0.822	0.978	0.748	0.793	0.710	0.468
AR(1) p	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) p	0.990	0.194	0.116	0.285	0.867	0.088	0.106

Two-tailed significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T-statistics are reported in parenthesis. Out-of-sample instruments included: logdistance, logpopulation, common-border dummy. In-sample instruments: up to 5 lags. All estimations include country-specific and time-fixed effects as well as a lagged dependent variable given that the Arellano-Bond test confirms that the disturbances are autocorrelated of order one (but not of order two). Explanatory variables in column (8) are one-period lagged. Column (1) includes our main variables of interest only, i.e. the labor cost indicator (differences in NULC growth), a dummy for EMU membership, and the interaction term between the two. Column (2) adds three additional controls: bilateral trade, fiscal policy, and financial integration. Columns (3) and (4) use exchange rate adjusted ULCs from the OECD and absolute bilateral differences of labor compensation per employee, respectively. Column (5) reports results when a Baxter-King band-pass filter is employed instead of the Hodrick-Prescott technique used in all other specifications. Column (6) uses simple (unfiltered) GDP growth rates instead of cyclical components to calculate the correlation measure. Column (7) employs an additional instrument variable: an index that measures the type of coordination of wage setting on a scala from 1 (uncoordinated bargaining) to 5 (centralized bargaining by peak associates with or without government involvement).

area, this factor gains importance within such a union, where the common currency (i.e. the fixed nominal exchange rate) does not allow for any (short-term) adjustment of the real exchange rate. This first estimation thus supports our hypothesis that differences in wage developments lead to significantly less synchronized business cycles in a currency union. At the same time, the same channel does not seem to matter for countries outside the currency union, where differences in wage developments can be counter-balanced by movements of the (nominal) exchange rate. The regression also confirms the positive impact of EMU membership *per se* on cyclical synchronization, which has been suggested by Gächter and Riedl (2014).[24]

Column (2) adds three additional controls. The importance of bilateral trade for business cycle co-movements has been firmly established in the academic literature since the seminal contribution by Frankel and Rose (1998) and is also confirmed by our estimation. Hence, more intense bilateral trade relations between two countries lead to higher co-movement of their business cycles. The same holds true for financial integration. Differences in fiscal policy – defined as the absolute difference of (cyclically adjusted) budget balances in percentage points of GDP – on the other hand, significantly reduce the co-movement of business cycles. Thus, idiosyncratic (national) fiscal shocks exercise a stronger (negative) effect on cyclical synchronization than the potentially stabilizing (positive) effect of countercyclical fiscal policy which is in line with the results in Darvas et al. (2005), Gruber (2010), and Gächter and Riedl (2014). Importantly, however, the inclusion of these control variables does not interfere with the outcomes regarding our main hypothesis, i.e. the coefficients for *Labor costs* and *Labor costs* $\times$ *EMU*.[25] In fact, the strongly negative effect of diverging unit labor costs within the currency area prevails across all specifications.

Even more remarkable, however, is the economic significance of unit labor cost divergence for business cycle synchronization within a currency union. When the baseline regression in column (2) is repeated by calculating standardized coefficients, the interaction term between unit labor costs and the EMU dummy shows a slightly higher beta coefficient (-0.104) than the bilateral trade variable (0.100). Thus, when considering the standard deviations of the corresponding variables, the magnitude of the impact of differences in nominal unit labor costs is roughly equal to the impact of bilateral trade relations, which have been repeatedly highlighted as one of the most important determinants of business cycle synchronization. Thus, our results highlight the enormous importance of unit labor cost developments for business cycle convergence across countries within a currency union. On the contrary, while the coefficient for unit labor costs is generally negative, the effect is not statistically significant for countries outside EMU.

Regressions (3) and (4) subsequently use alternative measures for the *Labor costs* variable. Column (3), for instance, reports the results concerning the growth rate of exchange rate

[24] The authors conclude that this positive 'euro effect' is likely due to stronger spillovers across countries, increased labor mobility and the establishment of common risk sharing systems within EMU.

[25] Note, however, that the consideration of bilateral trade reduces the magnitude of the *EMU* coefficient, which is due to their considerable correlation.

adjusted ULCs, which are obtained from the OECD database.[26] The variable converts total labor costs to a USD basis and divides this number by a real output series, reported in USD as well.[27] Model (4) applies a further definition of the labor cost indicator and uses growth differences of labor compensation per employee, i.e. the numerator of the NULC indicator. This robustness test is of particular importance for this study. After all, it could be argued that the negative link between business cycle synchronization and NULC growth differences exists by definition given that NULCs are defined as the quotient of total labor costs and real output. Hence, when business cycles diverge, and real GDP growth rates drift apart, the corresponding NULC growth differential may rise mechanically. Although the system GMM estimator is theoretically able to cope with this form of endogeneity, it is nevertheless useful to show that our results are not driven by this technical feature of the NULC indicator. We find that the outcomes are indeed robust to this specification. Once again, these insights document that the divergence of labor costs does not affect cyclical synchronization outside EMU, but has a strong (negative) effect on BC co-movement within EMU. The coefficients of the remaining control variables are not affected by this adjustment. Model (5) subsequently employs a Baxter-King band-pass filter (Baxter and King, 1999) instead of the Hodrick-Prescott technique used in all other specifications (Hodrick and Prescott, 1997). Due to the technical properties of the former we lose three years at the end of our sample. The higher coefficient of the interaction term may be the consequence of this constraint and suggests that the role of unit labor costs may have been particularly pronounced prior to the crisis when they were not subject to sudden idiosyncratic political interventions and covenants attached to international rescue packages. Model (6) uses simple (unfiltered) GDP growth rates instead of the cyclical components to calculate the correlation measure. The dependent variable thus coincides with the one proposed by Cerqueira and Martins (2009). In both cases, the empirical results are qualitatively unaffected; the strong impact of wage growth differential on business cycle correlations is confirmed.

Model (7) eventually alters the baseline specification of model (2) by employing an additional instrumental variable to specifically take into account the potential endogeneity issue. As discussed, the causal direction is not entirely clear from an economic perspective. While differences in ULC growth are likely to lead to divergence in two countries' business cycles (see section 2), a reverse causal effect also seems possible. More precisely, business cycle divergences between two countries are likely to eventually lead to differences in wage growth (amplified by differing inflation rates), and thus, in ULC growth. While our dynamic panel method is theoretically able to consider this type of endogeneity by

[26] The exact definition can be found at `http://stats.oecd.org/mei/default.asp?lang=e&subject=19`. The OECD explicitly recommends this variable to compare ULC developments across countries in a common currency. While short-term movements can be very volatile as they are largely dependent on developments in the exchange rate, the time-fixed effects in our estimation are able to account for this effect. Thus, if the nominal exchange rate adjusted according to corresponding developments in NULC growth, this variable would not show any difference between the two countries, as the (real) exchange rate between the two countries remained constant.

[27] Note that the conversion uses the prevailing exchange rates in the OECD base year.

employing internal instruments (i.e. lags of the corresponding variables), we nevertheless employ a robustness check by adding an external instrument. For that purpose, we need an instrumental variable which is highly correlated to the differences in ULC growth, while it is not (directly) related to business cycle synchronization. Because national wage developments are not only determined by (national) business cycles, but also by national wage bargaining systems, we use a corresponding variable from the ICTWSS database to instrument ULC growth differentials.[28] The index variable *coord* measures the type of coordination of wage setting on a scala from 1 (uncoordinated bargaining) to 5 (centralized bargaining by peak associations with or without government involvement). There is a broad literature on the empirical fact that the level of wage restraint is considerably influenced by the level of centralization of the wage bargaining process (see, for instance, Aidt and Tzannatos, 2008). Furthermore, a simple panel estimation linking the difference in ULC growth to the difference in the index variable *coord* shows a positive link between the two variables which is highly significant. Thus, the *coord* seems to be an appropriate instrumental variable for our purposes. The empirical results are shown in model (7). Interestingly, while the results are qualitatively unaffected by this additional external instrument, the magnitude of the effect of differences in ULC growth on business cycle synchronization within a currency union even increases in this specification. Thus, we conclude that the causal direction indeed moves from wage growth differences to business cycle divergence rather than the other way round.

5.2 Further robustness checks

Table 5 presents further robustness tests. In a first step, column (1) excludes the financial crisis and restricts the sample to the years 1993 to 2007. While the results remain qualitatively unchanged, the larger coefficient on the interaction term confirms the findings of the Baxter-King specification from above. The negative effect of diverging ULC developments seems to have been more intense before the onset of the crisis. The specification in column (2) drops the years before the introduction of the euro. Since some country pairs exhibit extreme absolute NULC differences for certain years, the *Labor costs* variable is winsorized at the 95 percentile in regression (3). The estimation is thus more robust to outliers while – as opposed to trimming – the loss of data is limited to a minimum. A simple random effects panel model without the dynamic component (i.e. excluding the lagged dependent variable) is applied in model (4).[29] While this model is clearly inferior from a technical perspective as compared to its dynamic GMM counterpart, it constitutes a meaningful robustness check for our analysis. Even this simple static estimation confirms that diverging wage development within the EMU must not be disregarded by policymakers when discussing further measures to bring the euro area closer to an OCA. Specification (5)

[28] Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts in 34 countries between 1960 and 2012. For further information, see `http://www.uva-aias.net/208`.

[29] In order to (partly) account for endogeneity issues, all explanatory variables were used in their one-period lagged form. The estimation uses the Stata routine *xtivreg*. We instrument bilateral trade with the commonly applied gravity variables: distance (in logs), population, and common border.

TABLE 5: Robustness checks

	excluding crises	after 1999	winsorized	RE-model	EMU only
	(1)	(2)	(3)	(4)	(5)
Labor costs	-0.003	-0.003	-0.004	-0.004*	
	(-0.86)	(-0.79)	(-0.95)	(-1.74)	
EMU member	0.640***	0.298***	0.307***	0.212***	
	(6.61)	(3.56)	(3.48)	(3.36)	
$Laborcosts \times EMU$	-0.230***	-0.101***	-0.116***	-0.052***	-0.079***
	(-7.21)	(-3.34)	(-3.75)	(-2.63)	(-3.27)
Bilateral trade	0.058***	0.076***	0.074***	0.064***	0.167***
	(3.67)	(5.11)	(5.16)	(5.94)	(4.67)
Fiscal policy	-0.005	-0.015**	-0.013**	-0.042***	-0.021**
	(-0.67)	(-2.49)	(-2.27)	(-8.20)	(-2.40)
Financial integration	0.073*	0.099***	0.176***	0.056***	0.261***
	(1.83)	(2.66)	(4.33)	(2.66)	(3.55)
$Correl_{t-1}$	0.088***	0.065***	0.069***		0.056
	(5.27)	(3.96)	(4.46)		(1.55)
Obs	4348	4532	5750	5446	1064
Hansen	340.8136	344.5009	343.8256		126.31
Hansen p	0.4621	0.9596	0.7916		0.9560
AR(1) p	0.0000	0.0000	0.0000		0.000
AR(2) p	0.1082	0.1188	0.2144		0.221

Two-tailed significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T-statistics are reported in parenthesis. Out-of-sample instruments included: logdistance, logpopulation, common-border dummy. In-sample instruments: up to 5 lags. All estimations include country-specific and time-fixed effects as well as a lagged dependent variable given that the Arellano-Bond test confirms that the disturbances are autocorrelated of order one (but not of order two). Column (1) excludes the financial crisis and restricts the sample to the years 1993 to 2007. Column (2) drops the years before the introduction of the euro. Column (3) winsorizes the *Labor costs* variable at the 95 percentile. Column (4) estimates a simple random effects panel model without the dynamic component. Column (5) restricts the sample to EMU country-pairs only.

restricts the sample to EMU country-pairs only, which means that the sample starts only in 1999 or later for some pairs. Finally, in order to ensure that the results are not driven by a single country, we re-estimate the baseline model repeatedly and exclude one country at a time. Thus, 26 (out of 351) country pairs are consequently dropped from the sample in each regression. The outcomes reported in table 7 are unambiguous. The sign and the significance of our main variables remain unchanged across all specifications.

Overall, the results uniformly support our main hypothesis and are insensitive to a number of robustness checks and alternative estimation techniques. Diverging dynamics in NULC substantially reduce bilateral business cycle synchronization within EMU, while the impact is limited or even non-existent for countries outside the monetary union. Put differently, while EMU membership *per se* increases business cycle synchronization, the effect is counteracted by distortions on national labor markets. The empirical results therefore suggest that wage negotiations should be more closely coordinated across EMU member states and that nominal thresholds alone – as included in the MIP – may be insufficient.

6 Discussion and conclusion

The recent crisis has highlighted some crucial deficits of the euro area's political and institutional framework. National policy decisions and fiscal fragmentation partly stand in conflict with financial integration and the ECB's common interest rate policy. The latter is most efficient for a homogeneous group of countries. During the run-up of the crisis, however, excessively generous wage increases above productivity trends in Europe's periphery have triggered the build-up of substantial imbalances. This empirical study shows that distinct wage-setting behavior across EMU countries has significantly contributed to divergent business cycle co-movement since 1999. In fact, bilateral differences of nominal unit labor cost developments turn out to be among the most important determinants for cyclical synchronization within a currency union. Interestingly, NULC movements are irrelevant for the period before the introduction of the euro and for countries outside the euro area, where losses of competitiveness can be mitigated by a depreciation of the nominal exchange rate.

These novel findings fill an important gap in the literature, and thereby add a crucial building block to both the empirical OCA literature of the 1990s and 2000s and the original theories of the 1960s and 1970s. The insights are economically substantial and highly statistically significant. We also control for bilateral trade ties, financial integration, and national fiscal policies, which have been found to matter in numerous studies in the past, and confirm their relevancy. Our results draw on modern econometric techniques and withstand various robustness checks regarding time spans, business cycle measures and filtering methods. Furthermore, our study clarifies an important ambiguity of the theoretical literature, in which two contesting strands stress both the equilibrating and the dis-equilibrating role of heterogeneous wage developments on business cycle co-movement.

Given the intense debates on competitiveness within EMU and the considerable implications for the single monetary policy it is surprising that the role of nominal labor cost developments has not been investigated before in this context. The insights of this paper suggest that the original EMU treaties, which place particularly strong emphasize on fiscal variables, must be extended by a focus on national wage developments. While the newly created MIP in the framework of the Alert Mechanism Report (AMR) by the European Commission points in the right direction, our results imply that the focus on nominal thresholds alone is clearly insufficient. A reformed monitoring system should predominantly aim at avoiding disproportional relative wage adjustments across EMU countries. A lack of coordination, on the contrary, may facilitate the emergence of economic and financial imbalances, destabilize the euro area and increase the cost of the common currency.

References

Aidt, T. S. and Tzannatos, Z. (2008). Trade unions, collective bargaining and macroeconomic performance: a review. *Industrial Relations Journal*, 39(4):258–295.

Annett, A. (2006). Enforcement and the Stability and Growth Pact: How Fiscal Policy Did and Didn't Change under Europe's Fiscal Framework. *IMF Working Paper*, (06/116).

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equation. *The Review of Economic Studies*, 58(2):277–297.

Artis, M. and Okubo, T. (2011). Does international trade really lead to business cycle synchronisation? - A panel data approach. *The Manchester School*, 79(2):318–332.

Baxter, M. and King, R. G. (1999). Measuring business cycles: Approximate band-pass filters for economic time series. *The Review of Economics and Statistics*, 81(4):575–593.

Baxter, M. and Kouparitsas, M. A. (2005). Determinants of business cycle comovement: a robust analysis. *Journal of Monetary Economics*, 52(1):113–157.

Bayoumi, T. and Eichengreen, B. (1997). Ever Closer to Heavon? An Optimum-Currency-Area Index for European Countries. *European Economic Review*, 41:761–770.

Bellak, C., Leibrecht, M., and Riedl, A. (2008). Labour costs and FDI flows into Central and Eastern European Countries: A survey of the literature and empirical evidence. *Structural Change and Economic Dynamics*, 19(1):17–37.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1):115–143.

Cerqueira, P. (2013). A closer look at the world business cycle synchronization. *International Economics and Economic Policy*, 10(3):349–363.

Cerqueira, P. A. and Martins, R. (2009). Measuring the determinants of business cycle synchronization using a panel approach. *Economics Letters*, 102(2):106–108.

Darvas, Z., Rose, A. K., and Szapary, G. (2005). Fiscal divergence and business cycle synchronization: Irresponsibility is idiosyncratic. In *NBER International Seminar on Macroeconomics 2005*, NBER Chapters, pages 261–298. National Bureau of Economic Research, Inc.

De Grauwe, P. (2009). *Economics of a Monetary Union*. Oxford University Press.

de Haan, J., Inklaar, R., and Jong-A-Pin, R. (2008). Will business cycles in the euro area converge? a critical survey of empirical research. *Journal of Economic Surveys*, 22(2):234–273.

Fleming, J. M. (1971). On Exchange Rate Unification. *The Economic Journal*, 1:467–488.

Frankel, J. and Rose, A. (1998). The endogeneity of the optimum currency area criteria. *Economic Journal*, 108:1009–1025.

Friedman, M. (1953). *Essays in Positive Economics*. University of Chicago Press.

Gros, D. (2012). Macroeconomic Imbalances in the Euro Area: Symptom or cause of the crisis? CEPS Papers 6865, Centre for European Policy Studies.

Gruber, A. (2010). On the determinants of business cycle synchronization. Master thesis, University of Innsbruck.

Gächter, M. and Riedl, A. (2014). One Money, One Cycle? The EMU Experience. *Journal of Macroeconomics*, 42:141–155.

Hall, P. (2012). The Economics and Politics of the Euro Crisis. *German Politics*, 21(4):355–371.

Hellwig, M. (2011). *Quo vadis, Euroland? European Monetary Union Between Crisis and Reform*. FIC Press, Wharton Financial Institutions Center, Philadelphia.

Hodrick, R. J. and Prescott, E. C. (1997). Postwar U.S. business cycles: An emirical investigation. *Journal of Money, Credit and Banking*, 29(1):1–16.

Imbs, J. (2004). Trade, finance, specialization, and synchronization. *The Review of Economics and Statistics*, 86(3):723–734.

Ingram, J. C. (1962). *Regional Payments Mechanisms: The Case of Puerto Rico*. University of North Carolina Press.

Inklaar, R., Jong-A-Pin, R., and de Haan, J. (2008). Trade and business cycle synchronization in OECD countries – A re-examination. *European Economic Review*, 52(4):646–666.

Johnston, A., Hancké, B., and Pant, S. (2014). Comparative institutional advantage in the european sovereign debt crisis. *Comparative Political Studies*, 47(13):1771–1800.

Johnston, A. and Regan, A. (2014). European integration and the incompatibility of national varieties of capitalism. problems with institutional divergence in a monetary union. MPIfG Discussion Paper 14/15, Max Planck Institute for the Study of Societies.

Kalemli-Ozcan, S., Sorensen, B., and Yosha, O. (2005). Economic integration, industrial specialization and the asymmetry of macroeconomic fluctuations. *Journal of International Economics*, 55:107–137.

Kenen, P. (1969). *The optimum currency area: An eclectic view*. University of Chicago Press, Chicago.

Keuschnigg, C. (2012). Should Europe Become a Fiscal Union. *CESifo Forum*, 13(1):35–43.

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

Lane, P. R. (2012). The european sovereign debt crisis. *Journal of Economic Perspectives*, 26(3):49–68.

Lane, P. R. (2013). Capital Flows in the Euro Area. European Economy - Economic Papers 497, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Lane, P. R. and Milesi-Ferretti, G. M. (2007). The external wealth of nations mark ii: Revised and extended estimates of foreign assets and liabilities. *Journal of International Economics*, 73:pp. 223–250.

Masson, P. R. and Taylor, M. P. (1993). *Policy Issues in the Operation of Currency Unions*. Cambridge University Press.

McKinnon, R. I. (1963). Optimum Currency Areas. *The American Economic Review*, 53(4):717–725.

Mongelli, F. P. (2002). New Views on the Optimum Currency Area Theory: What is EMU Telling Us? *ECB Working Paper Series*.

Mongelli, F. P. (2008). European Economic and Monetary Integration, and the Optimum Currency Area Theory. *European Commission: European Economy. Economic Papers*.

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review*, 51(4):657–665.

NZZ (2014). Athen plant Sieben-Jahresanleihe und verzichtet auf neue Hilfskredite. `http://www.nzz.ch/finanzen/newsticker/athen-plant-sieben-jahresanleihe-und-verzichtet-auf-neue-hilfskredite-1.18385570`.

Obstfeld, M. (1997). Europe's gamble. *Brookings Papers on Economic Activity*, 28(2):241–317.

Ravn, M. O. and Uhlig, H. (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations. *The Review of Economics and Statistics*, 84(2):371–376.

Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal*, 9(1):86–136.

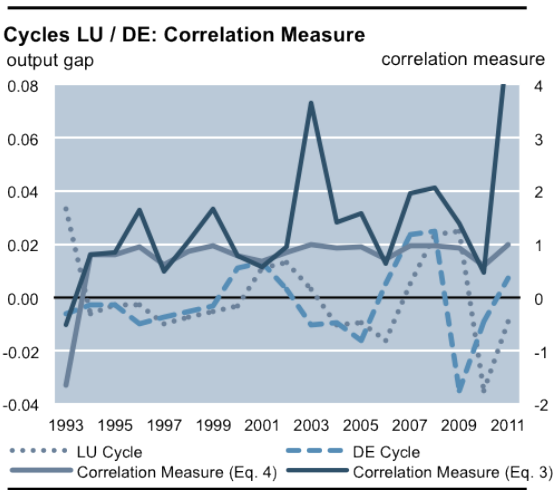
Sapir, A. and Wolff, G. B. (2015). Euro-area governance: what to reform and how to do it. Policy Briefs 870, Bruegel.

Shambaugh, J. C. (2012). The Euro's Three Crises. *Brookings Papers on Economic Activity*, 44(1 (Spring):157–231.

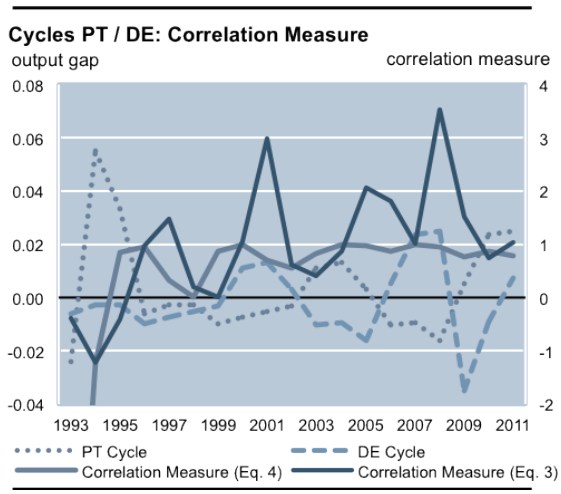
7 Appendix

7.1 Business cycles

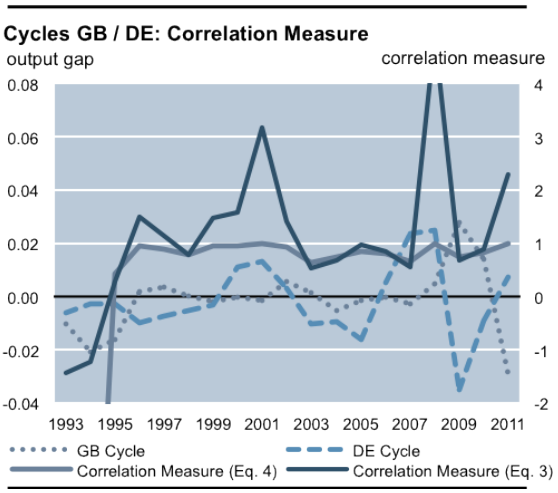
(A)



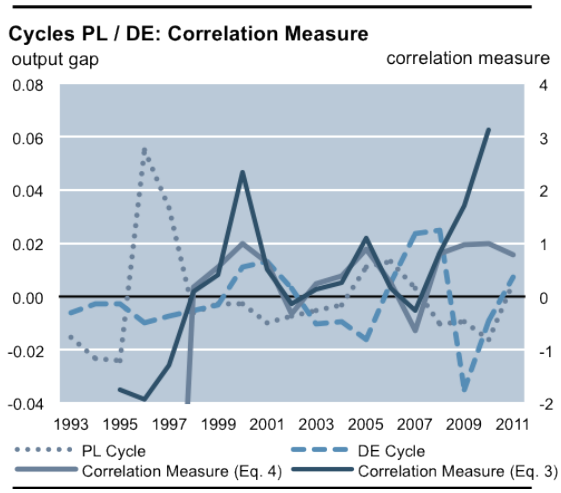
(B)



(C)



(D)



Avg. BC correlation with Germany (1994-2011, shaded cells indicate EMU membership in '11)

AT	BE	BG	CY	CZ	DK	EE	ES	FI	FR	GB	GR	HU
0.93	0.89	0.52	0.61	0.61	0.84	0.75	0.91	0.89	0.92	0.85	0.33	0.74
IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SL	SK
0.73	0.93	0.56	0.85	0.75	0.69	0.89	0.51	0.68	0.34	0.83	0.82	0.62

The panels show selected individual business cycles as well as pair-wise correlation measures as introduced in equations (1) and (2). Germany serves as the general reference point across all graphs and tables. Average correlation measures with Germany for the period between 1993 and 2011 – as measured by the bounded index (eq. 2) – are stated at the bottom. The latter has been highest with other core countries of the EMU such as Germany/Luxembourg (0.85) or Germany/Austria (0.93), while Germany's business cycle shows less co-movement with peripheral economies. Still, the average historical correlation coefficient for Germany/Portugal (0.68) and Germany/Ireland (0.73), for example, is far above those for EMU/non-EMU country pairs such as Germany/Poland (0.51) or Germany/Bulgaria (0.51). The EU pairs Germany/Great Britain (0.85) and Germany/Sweden (0.83) are notable but plausible exceptions. After all, these countries share strong international trade ties as well as similar economic levels of development.

FIGURE 8: Cycles and correlation measures

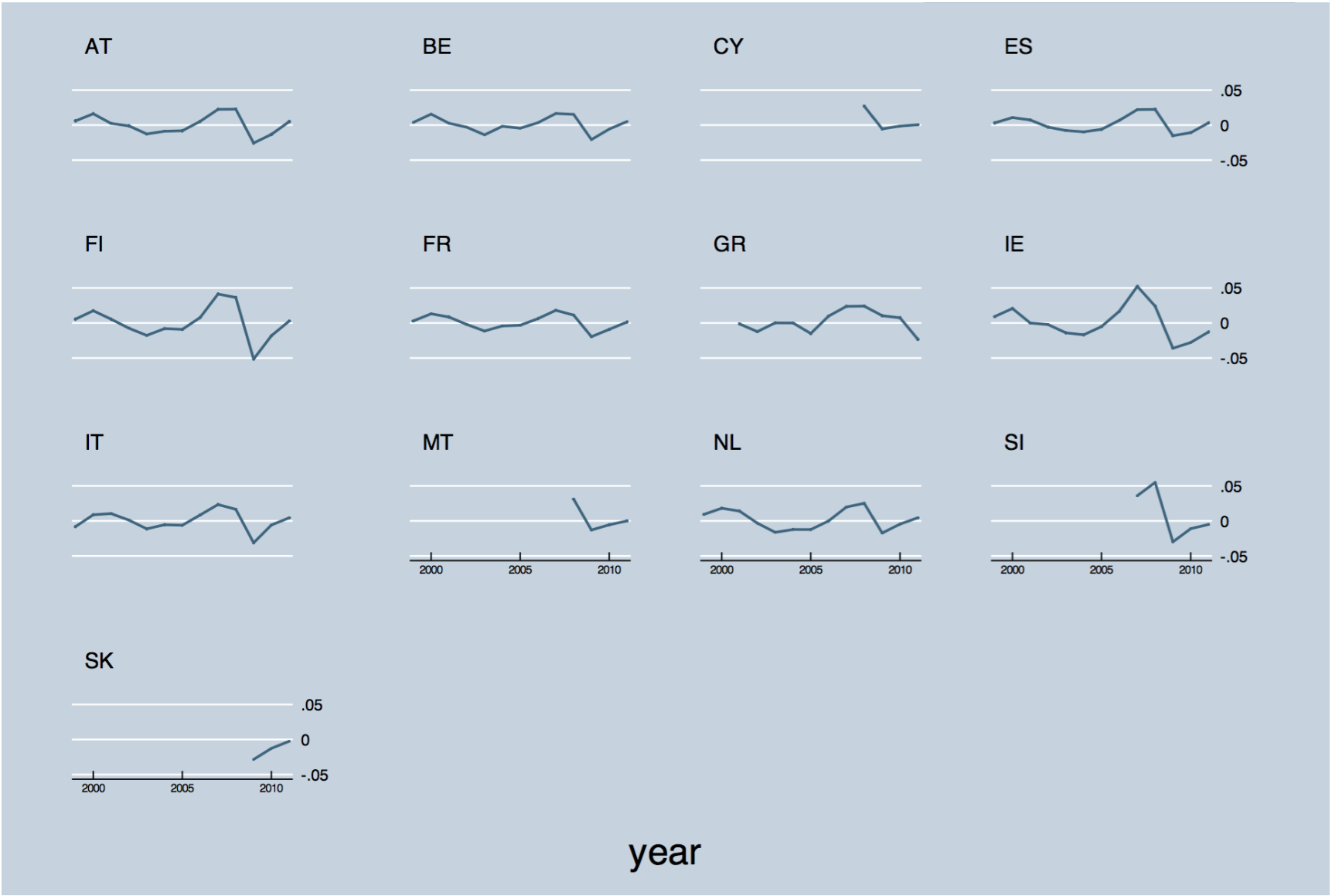


FIGURE 9: Business cycles of European countries over time

FIGURE 10: Business cycles of European countries over time cont'd

7.2 Descriptives

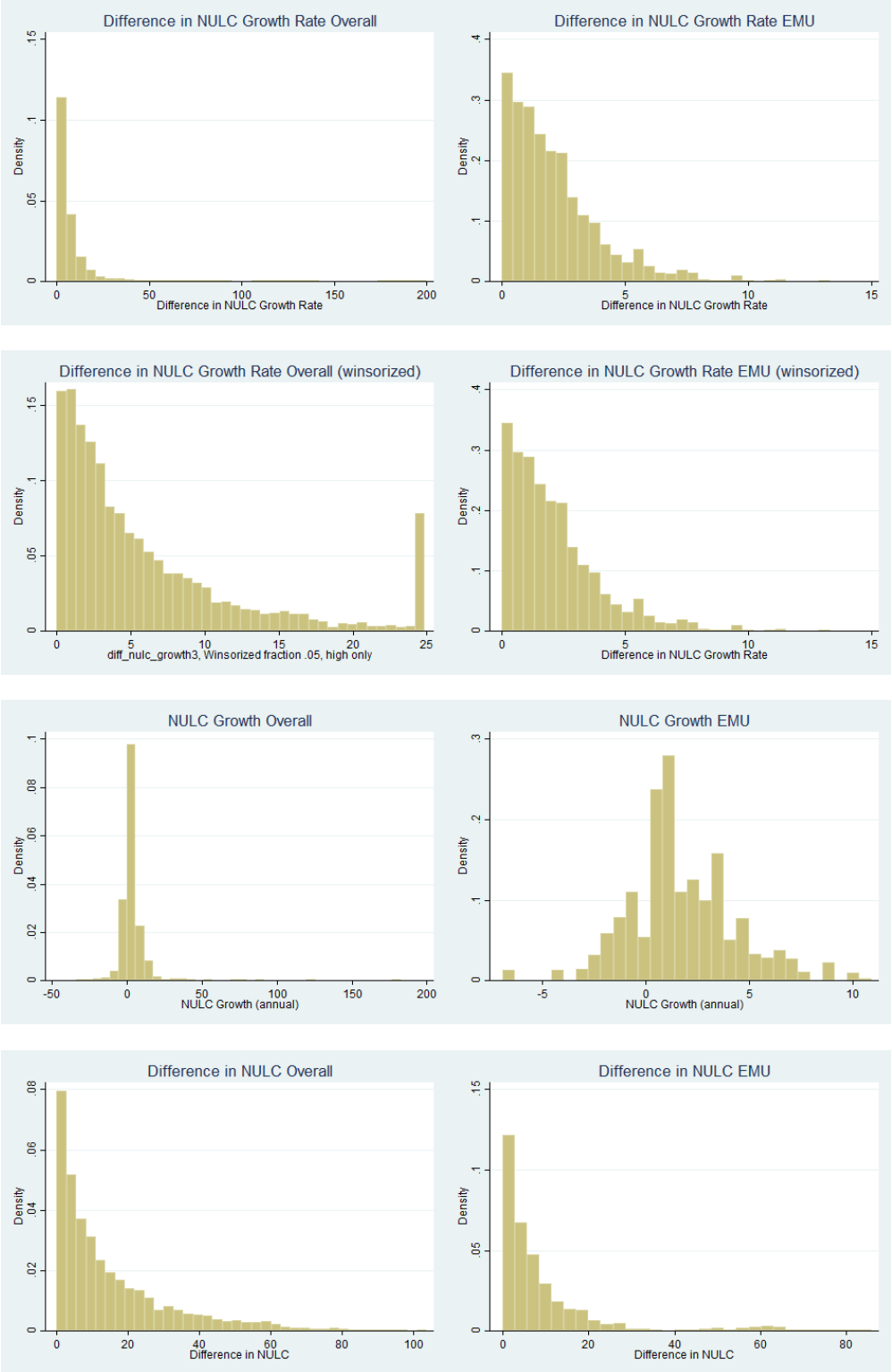


FIGURE 11: Histogram of nominal unit labor costs

TABLE 6: Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
NULC Growth*	overall	2.816	5.390	-23.067	15.090	N = 6367
	between		1.911	.577	6.597	n = 351
	within		5.046	-24.992	16.980	$\bar{T}$ = 18.140
NULC Growth Differential*	overall	6.186	6.482	.002	24.896	N = 6228
	between		3.111	.882	15.521	n = 351
	within		5.669	-8.916	28.225	$\bar{T}$ = 17.744
NULC Level Differential	overall	15.103	16.614	0	103.912	N = 6408
	between		8.669	1.121	37.329	n = 351
	within		14.182	-22.226	86.218	$\bar{T}$ = 18.256
Correl^{HP}	overall	1.260	1.146	-1.130	7.985	N = 6668
	between		0.335	0.344	2.338	n = 351
	within		1.097	-1.522	7.255	$\bar{T}$ = 18.997
Correl^{BK}	overall	1.292	1.168	-0.962	8.332	N = 5417
	between		0.340	0.475	2.442	n = 351
	within		1.118	-1.269	7.904	$\bar{T}$ = 15.433
Spread^{HP}	overall	1.541	1.745	0.000	14.867	N = 6669
	between		0.906	0.288	3.973	n = 351
	within		1.492	-2.351	14.672	T = 19
EMU	overall	0.160	0.366	0.000	1.000	N = 6669
	between		0.256	0.000	0.684	n = 351
	within		0.262	-0.525	1.107	T = 19
ERM	overall	0.322	0.467	0.000	1.000	N = 6669
	between		0.357	0.000	1.000	n = 351
	within		0.302	-0.468	1.006	T = 19
Bilateral Trade^{1,**}	overall	-6.562	1.657	-12.612	-2.199	N = 6350
	between		1.586	-10.120	-2.498	n = 351
	within		0.488	-10.247	-3.257	$\bar{T}$ = 18.091
Bilateral Trade^{2,***}	overall	-6.127	1.669	-12.698	-1.995	N = 6350
	between		1.628	-10.116	-2.707	n = 351
	within		0.414	-9.821	-2.977	$\bar{T}$ = 18.091
Fiscal Policy	overall	3.693	3.149	0.002	32.067	N = 6019
	between		1.577	1.043	9.459	n = 351
	within		2.723	-3.659	30.890	$\bar{T}$ = 17.148
EU	overall	0.560	0.496	0.000	1.000	N = 6669
	between		0.269	0.263	1.000	n = 351
	within		0.417	-0.335	1.296	T = 19
Financial Integration^{2}	overall	1.610	2.127	0.000	16.910	N = 4713
	between		1.113	0.101	4.426	n = 351
	within		1.810	-2.750	14.196	$\bar{T}$ = 13.427
Distance, in logs	overall	7.093	0.649	4.007	8.236	N = 6669
	between		0.650	4.007	8.236	n = 351
	within		0.000	7.093	7.093	T = 19
Common border	overall	0.194	0.503	0.000	2.000	N = 6669
	between		0.504	0.000	2.000	n = 351
	within		0.000	0.194	0.194	T = 19

* winsorized right-sided, 5 % of observations modified; ** measured in % of GDP, in logs; *** measured in % of total trade, in logs.

7.3 Robustness to country-exclusion

TABLE 7: Robustness to country-exclusion

Country	Labor costs	Labor costs×EMU	Country	Labor costs	Labor costs×EMU
Austria	-0.005	-0.106***	Ireland	-0.004	-0.128***
	(0.004)	(0.034)		(0.004)	(0.035)
Belgium	-0.007**	-0.101***	Italy	-0.005	-0.097***
	(0.004)	(0.033)		(0.004)	(0.034)
Bulgaria	-0.007*	-0.116***	Lithuania	-0.009**	-0.112***
	(0.004)	(0.031)		(0.004)	(0.031)
Cyprus	-0.005	-0.125***	Latvia	-0.009**	-0.110***
	(0.004)	(0.032)		(0.004)	(0.032)
Czech Rep.	-0.005	-0.108***	Luxembourg	-0.006	-0.108***
	(0.004)	(0.031)		(0.004)	(0.031)
Germany	-0.004	-0.084**	Malta	-0.006	-0.100***
	(0.004)	(0.034)		(0.004)	(0.033)
Denmark	-0.004	-0.111***	Netherlands	-0.004	-0.096***
	(0.004)	(0.033)		(0.004)	(0.032)
Estonia	-0.007*	-0.115***	Poland	-0.001	-0.112***
	(0.004)	(0.031)		(0.004)	(0.032)
Spain	-0.005	-0.117***	Portugal	-0.005	-0.123***
	(0.004)	(0.033)		(0.004)	(0.030)
Finland	-0.003	-0.097***	Romania	-0.004	-0.103***
	(0.004)	(0.033)		(0.005)	(0.032)
France	-0.004	-0.105***	Sweden	-0.004	-0.105***
	(0.004)	(0.035)		(0.004)	(0.031)
UK	-0.003	-0.105***	Slovakia	-0.005	-0.120***
	(0.004)	(0.032)		(0.004)	(0.031)
Greece	-0.005	-0.089**	Slovenia	-0.004	-0.122***
	(0.004)	(0.040)		(0.004)	(0.030)
Hungary	-0.002	-0.118***			
	(0.004)	(0.032)			

Two-tailed significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. T-statistics are reported in parenthesis. The regression is based on the baseline specification (column (2) of Table 4). The baseline model is re-estimated repeatedly excluding one country at a time; The two coefficients for 'Austria', for example, show the impact of labor cost developments on business cycle co-movement when Austrian data is excluded.