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Has the EMU Reduced Wage Growth and Unemployment? Testing a Model of Trade Union Behaviour

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Abstract

By using a model of trade union behaviour Grüner (2010) argues that the introduction of the European Monetary Union (EMU) led to lower wage growth and lower unemployment in participating countries. Following Grüner's model, monetary centralization lets the central bank react less flexibly to national business cycle movements. This increases the amplitude of national business cycles which, in turn, leads to higher unemployment risk. In order to counter-balance this effect, trade unions lower their claims for wage mark-ups resulting in lower wage growth and lower unemployment. This paper uses macroeconomic data on OECD countries and a difference-in-differences approach to empirically test the implications of this model. Although we come up with some weak evidence for increased business cycle amplitudes within the EMU, we neither find a significant general effect of the EMU on wage growth nor on unemployment.

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1. Introduction

Although in existence for more than a decade, it is still not clear what the macroeconomic consequences are of the European Monetary Union (EMU). Grüner (2010) has recently presented a theoretical model in which he argues that the introduction of a monetary union leads to structurally lower unemployment, wage growth and inflation rates. In a nutshell, by introducing a monetary union, monetary policy will be less equipped to deal with country-specific business cycle movements and hence will react less to those. This increases the risk of (risk-averse) trade union members to become unemployed in case of excessive wage demand. Hence, because country-specific business cycle volatility will increase, trade unions will restrain their wage demand which ultimately leads to a lower level of both inflation and unemployment in the participating countries.[1]

This paper puts the empirical implications of this model to the test. We use a difference-in-differences approach, i.e., we examine the change in different volatility measures, wage growth and unemployment for EMU member countries after the introduction of the euro, using several other industrialised countries as control group. According to the literature, difference-in-differences is an effective way to trace the economic consequences of "natural experiments", like in our case the introduction of EMU (see for instance Imbens and Wooldridge, 2009). To the best of our knowledge, it has not been used to study the macroeconomic effects of the EMU so far. In particular, the approach allows us to control for permanent differences between EMU and non-EMU members as well as economic trends over time which are unrelated to the introduction of the euro. By this we can also prevent problems of endogeneity, for instance the possibility that only countries with relatively low unemployment rates adopted the euro. Although we come up with some weak evidence for increased business cycle volatility within the EMU, we neither find any significant effect of the EMU on wage growth nor on unemployment as suggested by Grüner (2010).

There exists a large body of research dealing with the economic effects of the EMU. Mongelli and Vega (2006) provide a general overview including literature on the effects of the EMU on trade, business cycle synchronization, risk sharing, specialization, financial

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[1] In fact, the introduction of a monetary union acts very similar to increasing the degree of central bank conservatism: both lead to less accommodative monetary policy, at least at the national level.

markets, product and labour market reforms, and inflation. Baldwin (2006) surveys the literature on the impact of the EMU on international trade. Beetsma and Giuliodori (2009) provide an overview of the literature on macroeconomic consequences of the EMU with a focus on institutional and politico-economic aspects.

Quite a number of papers focus on the labour market effects of the EMU. On the theoretical side, Grüner and Hefeker (1999) and Cukierman and Lippi (2001) argue that EMU might lead to higher nominal wages, unemployment and inflation in EMU member countries. The intuitive reason in both papers is that a centralization of monetary policy increases the number of trade unions vis-à-vis the central bank. Consequently, the central bank reacts less to national or sector-specific wage increases which induces trade unions to act more aggressively.[2] Following Jensen (1993) monetary policy cooperation may increase nominal wages, inflation and decrease employment when the national economies are subject to symmetric shocks. The reason is that inflation becomes more uncertain in a cooperative setting as compared to a non-cooperative setting. This induces trade unions to claim higher wages.

Posen and Popov Gould (2006) investigate the impact of EMU on wages empirically and find that the EMU has not led to more aggressive wage setting. Rather, EMU has strengthened wage restraint. However, there set-up does not allow them to conclude to what extent the observed behaviour of wages was peculiar to member states of the euro area or rather a manifestation of a more general trend common to all industrial countries.

Several papers deal with the impact of the EMU on labour market reforms. For instance, according to Sibert and Sutherland (2000) monetary centralization increases the incentive to make labour markets more flexible and to reform factors which affect the inflation bias if macroeconomic shocks are uncorrelated across countries or the number of member countries in the monetary union is large because in this case the central bank is less able to stabilize shocks. In contrast, if the opposite holds true then a decentralized monetary policy may produce more reform since countries aim at protecting themselves from others' beggar-thy-neighbour policies. Consequently, a common monetary policy may produce more inflation

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[2] For further work on these and other aspects of (de)centralization of wage setting see Calmfors and Driffill (1988), Danthine and Hunt (1994), and Iverson and Soskice (2000).

than a decentralized setting.[3] On the empirical side, Duval and Elmeskov (2006) investigate whether the introduction of the EMU fosters or hinders product and labour market reform and observe a slowdown in EMU member countries' reform intensity after the introduction of the EMU.

The remainder of the paper is structured as follows. Section 2 summarizes the theoretical argument made by Grüner (2010) in more detail and formulates the hypotheses which we can test. Section 3 describes our data set and discusses the methodology used. Section 4 presents our empirical results, while Section 5 presents a number of robustness checks. The final section offers concluding comments.

2. Grüner's model of trade union behaviour

During the run up to the euro several papers were published dealing with its potential consequences. Amongst those, papers by Grüner and Hefeker (1999) and Cukierman and Lippi (2001) argued that the EMU would increase inflation and unemployment. In that line of work it was argued that introducing a monetary union would lead monetary policy to react less to country-specific business cycle and wage developments. By assuming that trade unions are not concerned with increased business cycle volatility, higher wage mark-ups would result. Consequently, the monetary union would face higher inflation and unemployment rates.

According to Grüner (2010, p. 1), the "EMU is by and large a success story and it performed much better than many economists predicted"; therefore Grüner challenges his own previous position by remodelling in particular trade union behaviour. Trade unions are dominated by risk-averse workers that not only care about their wages, but also about keeping their jobs. Higher business cycle volatility increases the risk of getting fired. To reduce this risk, trade unions restrain their wage demand and in this insider-outsider model thereby lower the natural rate of unemployment.

As any theory, also this model of trade union behaviour rests on several assumptions. For example, only due to at least some degree of risk aversion of trade union members, the increased employment volatility due to membership in a monetary union leads to subdued

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[3] See also Calmfors (2001) who analyzes several possible ways by which the EMU may affect the probability of labour market reform, wage flexibility and unemployment.

wage demand of the trade unions. In our view, the assumption that trade union members are on average risk averse appears reasonable.

The line of arguments also needs that negative macroeconomic shocks create unemployment risk. Indeed (and as we will show), there is an empirically robust negative relationship between basically any measure of economic activity and the unemployment rate. It appears more than reasonble that this implies that the subjective risk of trade union members to lose their jobs also increases in a downturn. Similarly, we follow mainstream economic theory and take the assumption that wage restraint will lower unemployment risk for granted.[4]

The assumed consequences of centralisation of monetary policy for national business cycle developments are crucial. It is required that economic conditions are not the same and national business cycles are not fully synchronised within the monetary union. Although it is difficult to assess to what extent this holds, it is safe to say that we do not live in a fully synchronised world. Furthermore, when moving away from nationally defined monetary policy towards monetary policy centralised at the level of the monetary union, countries become less flexible to react to nation-specific economic developments. Consequently, as compared to a situation without centralised monetary policy, this amplifies business cycles, i.e., increases the volatility in economic activity measures.[5] Within our difference-in-differences approach we will empirically test this hypothesis.[6]

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[4] To be more precise, for Grüner's argument to hold it is sufficient that members of trade unions *believe* wage restraint decreases unemployment risk.

[5] It is implicitly assumed that central banks are actually capable of influencing business cycles as intended. In fact, central bank policy might erroneously increase economic volatility instead of dampening it. Hence, it might be that by centralising monetary policy, i.e., tying the hands of central bankers, such errors are circumvented. We stick to the more traditional view of Grüner (2010), in the sense that monetary policy has in the recent decades been well capable of reducing business cycle volatility.

[6] Increased national cycles also imply that overall business cycle synchronisation is reduced in a monetary union. Hence, although favourable for the EMU in other dimensions, this model challenges the idea of the euro area being a self-fulfilling optimal currency area. Indeed, business cycles across the euro area do not appear to have become more synchronised over time. De Haan, Inklaar and Jong-A-Pin (2008) deliver a detailed survey of empirical research on business cycle synchronisation. See, e.g., Sturm and Wollmershäuser (2008) and EEAG (2007, 2009) for recent empirical analyses of the business cycle synchronisation in the EMU from a monetary policy perspective.

According to Grüner (2010), the above implies that trade unions claim lower wage mark-ups in a monetary union than under a national currency setting. Consequently, relative to non-members, wage growth is lower for EMU member countries.[7] This will be the next hypothesis we put to the test.

Finally, we will empirically investigate the consequences for unemployment. According to the model, reduced wage growth will lead to lower unemployment in member countries as compared to non-member countries.

3. The Data and empirical strategy

To test the hypotheses, we use macroeconomic data on up to 22 industrialised OECD countries.[8] All data collected stem from either the OECD Main Economic Indicators or the OECD Economic Outlook, are on a quarterly frequency and have been seasonally adjusted. We allow the data to go back to 1984 and end shortly before the outbreak of the world economic crisis, i.e., the second quarter of 2008. In this way, the sample on the one hand covers a set of relatively homogeneous countries during a relatively stable period and on the other hand leaves enough variation to produce meaningful results. Furthermore, it more or less equally divides up the sample into a group of EMU member and non-member countries and into an EMU and pre-EMU period.

The set of variables selected can be split into labour productivity, three economic activity variables and two price variables. The economic activity variables are GDP, industrial production and the standardised unemployment rate as published by the OECD.[9] The price

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[7] One might also argue that the increased risk of becoming unemployed results in trade unions allowing for more flexible wage settings, i.e., wages that react more flexibly to macroeconomic shocks. If that would be the case, wage volatility should increase after the introduction of the monetary union. See also Sibert and Sutherland (2000) and Calmfors (2001) on monetary policy centralization and labour market or wage flexibility.

[8] The following countries are included: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

[9] Unfortunately, the use of a fourth measure of economic activity, the output gap as taken from OECD (see Giorno et al. 1995) comes at the cost of a severe reduction in the number of countries in our sample. That is why we abstain from reporting regression results including this variable. This notwithstanding, our general results do not change when using the output gap as measure of economic activity.

variables are consumer price inflation (as measured by the percentage change in the harmonised consumer price index) and growth in the gross wage rate in the manufacturing sector.[10] Unfortunately, not all countries publish all variables and the starting date of publication varies substantially. As a consequence, the actual sample size varies across the regressions.

Our empirical testing strategy rests on difference-in-differences approaches. Since the seminal work by Ashenfelter (1978) and Ashenfelter and Card (1985), the use of difference-in-differences methods has become widespread in empirical economics (Imbens and Wooldridge 2009).[11] The basic principle of such approaches is to compare changes in a treatment group, EMU countries, to those in a control group, non-EMU countries, and therefore it appears particularly well suited to the problem at hand.[12]

In the empirical part we will use three closely related set-ups. The first one puts the simplest setting possible in which outcomes of the introduction of the euro are observed in one of two groups and in one of two time periods into a panel data framework. In the first period, which will be the average over the 1984-1998 period, no country is exposed to the euro. In the second period, i.e., in general 1999-2008, we observe the same countries again.[13] Those in the treatment group become EMU members in that period, whereas the others stay out and therefore represent the control group.

We use this set-up with using only two cross sections of information on the same set of countries in particular when analysing the consequences of the EMU on volatility. The treatment effect is now calculated as the average change in volatility over time in the control group subtracted from the volatility change in the treatment group. This double differencing

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[10] Some countries publish industrial production, unemployment rate and gross wage rate data on a monthly frequency. In those cases we take quarterly averages.

[11] See for example Meyer (1995), Angrist and Krueger (1999), Blundell and MaCurdy (1999), Angrist and Pischke (2009) and Imbens and Wooldridge (2009) for overviews and textbook discussions of difference-in-differences methods.

[12] In recent literature the issue of inference within such approaches is being discussed (see, e.g., Bertrand et al. 2004, Hansen 2007a, 2007b, and Donald and Lang 2007).

[13] Within our sample, only Greece enters the EMU at a different date, i.e., 2001. Hence, for Greece the sample split occurs at this date.

removes biases in second period comparisons between the treatment and control group that are the result of permanent differences between those groups, as well as biases resulting of time trends unrelated to the treatment (Imbens and Wooldridge 2009).

This treatment effect equals c in Equation (1) and can be directly estimated using OLS.

(1) $\Delta y_i = y_{i2} - y_{i1} = a + c \cdot G_i + u_i,$

where y_{it} is the variable of interest observed for countries $i=1,\ldots,I$ in periods $t=1,2$. G is a dummy variable which equals 1 if a country belongs to the treatment group, i.e., will become an EMU member, and u_i represents the usual residual which is assumed to be independent and identically distributed. One of the advantages of using a regression framework is that it allows us to include additional variables to control for differences across the treatment and control groups.

The second set-up stays within the two-period, two-group panel data framework but exploits the specific features of the panel data further by assuming unconfoundedness given lagged outcomes:

(2) $\Delta y_i = y_{i2} - y_{i1} = a + c \cdot G_i + d \cdot y_{i1} + v_i.$

As noted by, e.g., Imbens and Wooldridge (2009), this approach is quite different from the previous one as it uses different assumptions with respect to the residual term. On the one hand, Equation (2) allows a free coefficient on the lagged outcome, which makes it more flexible than Equation (1). On the other hand, however, it needs the assumption that y_{i1} is uncorrelated with the residual term. This makes it difficult to directly compare the two approaches.

The final set-up moves away from a two-period set-up and exploits the full information available in the time dimension of our data. As this is not feasible when using our volatility measures – which are by construction only available for two periods – this approach is used when exploring the effect of the EMU on wage and unemployment developments. The basic equation becomes:

(3) $\Delta y_{it} = a_i + b_t + c \cdot P_t \cdot G_i + d \cdot y_{i,t-1} + e_{it},$

where P_t is a dummy variable which equals 1 for the EMU period and 0 otherwise. The time subscript now runs from 1984 until 2008, i.e., $t = 1984q1,\ldots,2008q2$. The main advantage of this specification is that it allows us to include country-specific effects, a_i, to control for time-

invariant structural and institutional differences across countries.[14] Furthermore, and in line with the arguments of Grüner (2010), we remove the international business cycle by including period dummies, b_t.[15] Moreover, in all three approaches it is straightforward to include additional control variables. Standard economic theory suggests including the inflation rate and measures of economic activity to control for the business cycle. Finally, we cluster standard errors for each country separately across time periods in order to account for country-specific serial correlation. Hence, we assume that observations are independent across countries but not necessarily within countries. Admittedly, one may doubt whether cross-country independence is really in place in our sample. However, we stick to this assumption because it is in favour of Grüner's theory: the EMU introduces a common shock to EMU member countries; allowing for cross-section dependence would just drive the EMU group effect down.

Albeit being appropriate from an econometric point of view, the difference-in-differences set-ups in which additional controls are added in a somewhat ad hoc manner may not sufficiently reflect theories on the determinants of wage growth. For that reason, we also estimate a more theory-driven wage equation placed within difference-in-differences set-ups. In this we rely on Blanchard and Katz (1999). Based upon both efficiency wage theory and wage-bargaining models, they derive a wage Phillips-curve specification that is in line with empirically well-established relationships. Following Blanchard and Katz (1999, p.70) "[m]ost efficiency or bargaining models deliver a wage relation that can be represented (under some simplifying

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[14] Nickell (1981) has shown that the application of ordinary least squares to dynamic panel data models with fixed effects such as Equation (3) results in biased coefficient estimates, where the bias is of order $O(1/T)$. This is especially problematic for panel data settings with a high number of cross sectional units N and a limited number of time periods T. If, however, the number of time periods in the panel increases, the bias becomes less and less severe. With T = 98, as in our basic setting, the bias is small. We therefore refrain from approaches which aim at correcting for the Nickell bias, such as difference and system generalized method of moments estimators (see, for instance, Arellano and Bover, 1995, and Blundell and Bond, 1998).

[15] Note that the country- and period-specific effects (a_i and b_t) make the inclusion of separate treatment and EMU-period dummies (G_i and P_t) superfluous. Only a dummy capturing the non-aligned entry of Greece into the EMU (in 2001) is needed. Although for the sake of brevity we have not included it in the equations in this section, the Greece-dummy is present in the regressions.

assumptions about functional form and the appropriate indicator of labour market tightness) as":

(4) $(w_t-p^e_t) = \mu \cdot r_t + (1-\mu) \cdot l_t + \beta \cdot u_t + \varepsilon_t,$

where w_t is the nominal wage rate, p^e_t is the expected price level, r_t is the reservation wage, l_t stands for labour productivity, u_t is the unemployment rate (all in logarithmic form) and ε_t is the usual error term. Furthermore, Blanchard and Katz argue that the reservation wage is likely to be determined by both productivity (l_t) and lagged real wages ($w_{t-1}-p_{t-1}$) and assume the following relationship (cf. ibid. p.70):

(5) $r_t = \alpha - \lambda \cdot (w_{t-1}-p_{t-1}) + (1-\lambda) \cdot l_t.$

Substituting Equation (5) into the wage Equation (4) and rearranging yields (cf. ibid. p.71):

(6) $(w_t-w_{t-1}) = \mu \cdot \alpha + (p^e_t-p_{t-1}) - (1-\mu\lambda) \cdot (w_{t-1}-p_{t-1}-l_{t-1}) + (1-\mu\lambda) \cdot (l_t-l_{t-1}) - \beta \cdot u_t + \varepsilon_t.$

The term $(w_{t-1,i}-p_{t-1,i}-l_{t-1,i})$ can be seen as an error correction term capturing the past strength of labour unions. If, for instance, real wages in the past have outpaced labour productivity, then this will dampen current wage developments. Equations along these lines have been estimated for various OECD countries by a number of researchers.[16]

To translate this equation into our difference-in-differences set-up, we follow two different strategies. In the first, we stick as closely as possible to the approach of Imbens and Wooldridge (2009). We fit the time-series setting of Blanchard and Katz into our panel set-up by adding a cross-section dimension to Equation (6). Then, we set the term $y_{i,t-1}$ in Equation (3) equal to lagged nominal wage growth, $(w_{i,t-1}-w_{i,t-2})$, and accordingly replace $y_{i,t-1}$ in Equation (3) by the right hand side of the one period lag of Equation (6). After rearranging, assuming rational expectations and relaxing some coefficient restrictions, we obtain:

(7) $\Delta(w_{it}-w_{i,t-1}) = a_i + b_t + c \cdot P_t \cdot G_i + d_1 \cdot (p_{i,t-1}-p_{i,t-2}) + d_2 \cdot (w_{i,t-2}-p_{i,t-2}-l_{i,t-2}) + d_3 \cdot (l_{i,t-1}-l_{i,t-2}) + d_4 \cdot u_{i,t-1} + f_{it}.$

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[16] See, for instance, OECD (1997).

The second strategy is to directly add our EMU dummy ($P_t \cdot G_i$) and country- (a_i) and year-fixed (b_t) effects to Equation (6). After rearranging and relaxing some constraints this results into:[17]

(8) $(w_t - w_{t-1}) = a_i + b_t + c \cdot P_t \cdot G_i + d_1 \cdot (p_{it} - p_{i,t-1}) + d_2 \cdot (w_{i,t-1} - p_{i,t-1} - l_{i,t-1}) + d_3 \cdot (l_{it} - l_{i,t-1}) + d_4 \cdot u_{i,t} + g_{it}.$

4. Empirical results

4.1 Did the EMU amplify business cycles?

Grüner (2010) argues that EMU leads to an increase in the amplitude of national business cycles or in the volatility of economic activity (see Section 2). We test this hypothesis by employing the first and second set-up of the previous section. Our volatility measures consist of standard deviations of GDP growth, growth in industrial production, and the unemployment rate in the pre- and post-EMU periods.

Table 1 displays the regressions results. Although the coefficient estimates on the EMU group dummy all have the predicted positive sign, most of them are not statistically significant. Concentrating on the first set-up, i.e., looking at the odd columns, reveals that volatility in any of our real activity measures has decreased across the two time periods: the estimated constants are all significantly negative. Those countries that introduced the euro have witnessed on average a smaller decrease in these volatility measures, albeit in none of the regressions this difference is statistically significant.

Turning to our second set-up, i.e., the even columns, does not fundamentally change the picture. For GDP growth and the unemployment rate, we observe mean reversion, i.e., those countries experiencing high (low) volatility in the earlier period see a reduction (increase) thereof in the second period. Volatility with respect to industrial production growth appears much more persistent. Again EMU countries underwent a higher level of volatility during the

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[17] Note that, when coefficient d in Equation (3) is negative (due to mean reversion, for instance), the coefficients of inflation, the error correction term, labour productivity growth and unemployment will switch signs when comparing Equations (7) and (8). For instance, whereas d_1 in Equation (7) equals $-d \cdot (1 - \mu\lambda)$, it equals $-(1 - \mu\lambda)$ in Equation (8).

second period. This time this effect is only statistically significant in case of the unemployment rate.[18,19]

Hence, overall we find some weak evidence in favour of Grüner's hypothesis: the EMU has led to a relative increase in business cycle volatility. As overall volatility has decreased, the EMU has acted against a general trend towards moderation of business cycles. This finding is supported by various robustness tests which we summarize in the appendix. Given the chosen set-ups and the consequently limited degrees of freedom, we certainly do not want to overemphasize these empirical results.[20]

4.2 Did the EMU decrease wage growth?

As discussed above, according to Grüner (2010) the introduction of the EMU has led to a decrease in nominal wage growth in member countries.[21] We test this proposition by first employing the same set-ups as before. However, to fully exploit the information contained in the time series dimension of the data, to correct for structural differences across countries and to capture the world business cycle, we will subsequently implement the third set-up as described by Equation (3) above. Furthermore, in order to control for price and economic activity effects, we include consumer price inflation as well as either the unemployment rate or industrial production growth in our regressions.[22] Moreover, we control for labour productivity growth.

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[18] We further modified the set-up by including the country-specific means of the variables underlying the respective volatility measure over the pre-EMU period into the regressions. This did not change the results in any notable way (results are available upon request).

[19] In line with Grüner's argument all our volatility measures are real figures. In addition, we tested for the impact of EMU on the volatility of inflation but did not find any significant effect.

[20] Furthermore, one may argue that for Grüner's theory to hold, increased business cycle volatility is neither necessary nor sufficient. Instead, it is necessary that trade unions *believe* that EMU membership has increased the amplitude of national business cycles.

[21] According to Grüner (2010) it is foremost nominal wage growth which declines. Although in his line of arguing average inflation is lower in a monetary union, this is not sufficient to prevent real wage growth from falling as well.

[22] We concentrate on unemployment and industrial production growth, as these account for either the wage Phillips curve relationship or adjusts more quickly to economic shocks and focuses clearly on the manufacturing

The first four columns of Table 2 compare average annual nominal wage growth in the manufacturing sector across the two periods we consider, i.e. 1984 to 1998 versus 1999 until the second quarter of 2008.[23] Column (1) estimates Equation (1) and thereby summarizes the data: on average annual nominal wage growth decreased by 1.23 percent across these two periods. For EMU countries an additional average decrease of 0.04 percent is observed. However, this difference between EMU and non-EMU countries is statistically insignificant. The subsequent three columns add additional explanatory variables to this equation (and thereby alter the assumptions with respect to the residuals). There are clear signs of mean reversion. Those countries that experienced relatively high (low) wage growth during the first period see their wage growth decline (increase) after introduction of the euro. Furthermore, in column (4), lagged industrial production growth is a significant explanatory variable of changes in nominal wage growth in the manufacturing sector across countries. Although compared to column (1) this more elaborate model has a substantially better fit, our conclusion is not changed. There does not appear to be a significant difference between non-EMU and EMU countries with respect to nominal wage growth and in column (4) even the sign of the coefficient of interest is not in line with Grüner's hypothesis.

Columns (5) and (6) of Table 2 present the results when using our third set-up and hence move from a cross-country to a within panel regression. Despite the different angle and the higher degrees of freedom, the conclusions are not affected by this. Inflation and different measures of economic activity can explain a significant part of the within variation in the data. Higher inflation and/or economic activity results in stronger wage growth. However, labour productivity growth cannot significantly explain changes in wage growth. Also, the EMU dummy remains insignificant at conventional significance levels.

Column (7) of Table 2 implements the model in the spirit of Blanchard and Katz presented in Equation (7) of Section 3, while column (9) presents its version as outlined in Equation (8) of Section 3. In both regressions the coefficient of the EMU difference-in-differences dummy is clearly insignificant. Consumer price inflation remains significant at conventional levels. The fact that the consumer price coefficient is negative in column (7) whereas it is positive in

sector, respectively. We also used GDP growth as an alternative measure for economic activity. The results remain basically unchanged.

[23] The sample split differs for Greece as it only entered the EMU in 2001.

column (9) matches our expectation: in the presence of mean reversion (which is certainly the case in all our wage regressions), the inflation coefficient will switch signs when moving from Equation (7) to Equation (8).[24] Consequently, both columns indicate that higher inflation leads to higher nominal wage growth.

Labour productivity growth is insignificant in both column (7) and (9). Whereas the unemployment rate is also insignificant in column (7), it differs from zero at the 1 percent level and has the expected negative sign in column (9). Finally, the error correction term is negative and significant in column (7), but insignificant in column (9). When we substitute unemployment by alternative measures for economic activity – i.e. industrial production or GDP growth – the results remain basically unchanged (see column (8) and column (10) of Table 2 for industrial production growth).To sum up, our empirical analysis has not been able to find clear support for Grüner's hypothesis that wage growth has declined due to the EMU. As we show in the appendix, this finding is robust to a multiplicity of further tests.

4.3 Did the EMU decrease unemployment?

Following Grüner (2010), the introduction of EMU leads to a decrease in wage growth which subsequently leads to a reduction in unemployment (see Section 2). Hence, a further test of Grüner's theory will be to examine whether the introduction of the EMU has led to a decrease in unemployment in EMU member countries. Just as in the previous section, we include consumer price inflation, labour productivity and industrial production or GDP growth.

In accordance with the previous section, the first four columns of Table 3 compare the average annual unemployment rate in the second period to that of the first period. Column (1) implements the first set-up of Section 3. The constant lacks significance at conventional levels. Hence, on average there is no significant difference in unemployment across the two periods. Column (2) applies the second set-up of Section 2, and column (3) adds additional explanatory variables to this set-up. Just as for wage growth, there are clear signs of mean reversion. Those countries that experienced relatively high (low) unemployment rates during the first period see their unemployment rates decline (increase) after introducing the euro. Furthermore, whereas inflation does not significantly impact unemployment, labour productivity and industrial production growth do: the lower the former or the higher the latter

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[24] See footnote 17.

variable in the pre-EMU period, the stronger unemployment declines across the two periods. Importantly, none of the three regressions shows a significant *decrease* of unemployment related to the introduction of the EMU. As shown in column (4), replacing industrial production growth by GDP growth leaves the insignificance of the EMU difference-in-differences variable unchanged. This alternative measure, however, is insignificant by itself.

Columns (5) and (6) implement the third set-up of Section 3, i.e., the set-up that exploits the full information available in the time dimension of our data. Inflation turns out to be positive and significant at the 10 percent level in column (5) but insignificant in column (6). As one would expect from Okun's Law, industrial production growth and GDP growth are significantly negative, suggesting that the stronger economic performance the lower is unemployment. Albeit negative, the EMU difference-in-differences dummy variable is insignificant in both columns.

To conclude, as in the preceding section, we do not find support for Grüner's theory. This finding is confirmed by a multitude of robustness tests which we summarize in the appendix.

5. Concluding remarks

This paper has examined the effect of the introduction of the euro on a number of macroeconomic variables in the EMU countries using difference-in-differences approaches with several non-participating industrialised countries as control group. The three hypotheses tested stem from a recent model on trade union behaviour by Grüner (2010). According to that model the introduction of the EMU lets monetary policy react less flexibly to national business cycle movements. The latter increases the amplitude of national business cycles. In order to counterbalance the thereby increased unemployment risks, trade unions lower their claims for wage mark-ups resulting in lower wage growth and lower unemployment.

We apply several versions of the difference-in-differences approach using macroeconomic data on up to 22 OECD countries from the early 1980s onwards. Two set-ups summarize the data into two periods – a pre- and post EMU period. Although this reduces the degree of freedom substantially, it allows us to test for increased business cycle volatility induced by the EMU. In the third difference-in-differences set-up, we explore the within panel dimension of our dataset and use quarterly information. Moreover, we estimate a more theory-driven wage Phillips-curve specification following Blanchard and Katz (1999) which we integrate in two different ways into our difference-in-differences set-up.

Although we come up with some weak evidence for an increased business cycle amplitude within the EMU, we neither find any significant effect of the EMU on wage growth nor on unemployment as suggested by Grüner (2010). Robustness checks do not alter these conclusions.

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Appendix

We carried out a multitude of robustness checks for each of the three hypotheses derived from Grüner (2010) and tested in Section 4. This appendix summarizes these robustness tests.

As regards the hypothesis that the EMU has led to an increase in the amplitude of national business cycles or in the volatility of economic activity (see Section 4.1), we have implemented three robustness checks. First, we extended the sample to the latest available date, i.e. the last quarter of 2010 and thereby included the financial crisis period. Second, we re-ran our regressions excluding the run-up period to the EMU, i.e., 1992-1998 during which countries might have behaved differently to warrant entry to the EMU. Third, we excluded Denmark and Sweden from our sample and thereby from the control group; in these two countries referenda stopped entry into the EMU.

Given that we have three different robustness checks, three alternative measures of business cycle volatility (standard deviations of either GDP growth, industrial production growth, or the unemployment rate) and two alternative model set-ups (see set-up (1) and (2) in Section 3), we ran 18 robustness regressions in this case. In all except one of these regressions, the EMU difference-in-differences dummy is positive. However, in only 6 cases this relationship is statistically significant. Hence, these results are broadly consistent with our baseline results: there is some weak evidence in favour of Grüner's hypothesis that the EMU has led to a relative increase in business cycle volatility.

As regards the central hypothesis that the introduction of the EMU has led to a decrease in nominal wage growth we applied a multitude of robustness tests. First, we repeated our analyses using alternative samples:

a) A sample that allows the number of quarters to be equal before and after the introduction of the euro: 1989q3–2008q2;

b) A sample that starts as early as possible: 1970q1–2008q2;[25]

c) A sample that includes the financial crisis period: 1984q1–2010q3,

d) A sample excluding the run-up period to the EMU: 1984q1–1991q4, 1999q1–2008q2;

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[25] The downside of this sample is that it is highly unbalanced.

e) – g) Samples excluding Denmark or Sweden, or both: 1984q1–2008q2.

In this way, we ran a total of 35 cross-section wage regressions (7 different samples times 2 different difference-in-differences set-ups of which one is altered by employing 3 alternative proxies for economic performance as part of the additional control variables or no additional control variables at all). Moreover, we ran 63 panel wage regressions (7 different samples times 3 different empirical models[26] times 3 different proxies for economic performance). In none of the regressions the EMU difference-in-differences dummy variable showed up significant.

Second, in order to control for possible effects of adjustment and reform policies to meet the Euro convergence criteria, we included a second difference-in-differences set-up for the Maastricht-to-EMU period into our wage regressions. In none of our 9 regressions (3 different empirical models times 3 different proxies for economic performance), neither the Maastricht 1992 difference-in-differences dummy variable nor the EMU 1999 difference-in-differences dummy variable turned out to be significantly positive.

Third, we re-ran the panel set-up (3) presented in Section 3 with all control variables in first lags. In none of these regressions the EMU difference-in-differences dummy variable was significant.

Possibly, consumer price inflation, labour productivity and economic performance affect wage growth differently for non-EMU and EMU countries before and after introduction of the EMU. Hence, as a fourth robustness check we re-ran set-up (3) including interaction effects between the EMU group dummy and inflation, labour productivity or economic performance. In all cases, neither the EMU group dummy variable itself nor the interaction effects with inflation and economic performance showed up significant.

Fifth, we employed the panel set-up (3) where we interacted the EMU difference-in-differences dummy variable (and its individual components) with a dummy variable for large countries.[27] There is no evidence that EMU had a different impact on wage growth in large countries compared to small countries.

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[26] Equations (3), (7) and (8) of Section 3.

[27] As large countries we define Canada, France, Germany, Italy, Japan, Spain, the United Kingdom and the USA.

Sixth, we implemented panel set-up (3) where we excluded either all Southern EMU countries in our sample (Italy, Portugal, Spain) or all Northern EMU countries (Austria, Belgium, Finland, France, Germany, Ireland, Luxembourg, the Netherlands). The EMU difference-in-differences dummy variable is insignificant in the regressions excluding the Southern EMU countries and it is marginally significant and negative in the regressions excluding the Northern EMU countries. Grüner argues that his theory rather applies to the high-wage countries, and not as much to the "Southern Med" countries. Hence, these results rather contradict than support Grüner's theory.

Finally, we employed the difference-in-differences panel set-up (3) where only one EMU country is included at a time. In other words, the control group consists of all non-EMU countries as before, whereas the treatment group consists of only one country at a time. For Germany the EMU difference-in-differences dummy variable is clearly insignificant at conventional levels for all three alternative measure of economic performance. For Austria, it showed up significantly negative for two out of the three measures of economic performance. In contrast, for France, the EMU dummy variable turned out significantly positive at conventional levels for all alternative measures of economic performance. For Spain, the EMU dummy is significantly negative only in the unemployment regression, whereas it is significantly positive for Finland and Ireland in the industrial production regression and significantly positive for Luxemburg in the unemployment regression. For all other countries the EMU difference-in-differences dummy variable remains insignificant. To sum up, whereas for most cases we do not find any significant effect of EMU on wage growth, for some regressions we find a significantly negative effect and for some others we find a significantly positive effect. Hence, the robustness tests confirm our basic finding that it is not possible to in general establish a significantly negative effect of the EMU on wage growth as hypothesized by Grüner's model.

Regarding the hypothesis that the introduction of the euro leads to a reduction in unemployment in EMU member countries we also come up with a multitude of robustness tests analogous to our robustness tests for the wage growth hypothesis. First, we repeated what we did in Section 4.3 based on the seven alternative samples presented above. In none of 28 cross-section regressions the EMU difference-in-differences dummy variable is significantly negative. Only in 1 out of 14 panel regressions, the EMU difference-in-

differences dummy variable shows up significantly negative, whereas it is insignificant in all other regressions.[28]

Second, as for wage growth we included a second difference-in-differences set-up for the Maastricht-to-EMU period into our unemployment regressions. In neither of the two regressions (using our two different proxies for economic performance: industrial production and GDP growth), the EMU dummy turned out to be significant. In contrast, the Maastricht (1992) difference-in-differences dummy showed up significantly positive in the regression including industrial production growth. This result may be explained by increased reform efforts prior to EMU accession which resulted in higher unemployment. However, the Maastricht dummy is insignificant in the regressions including GDP growth.

Third, we re-ran the panel set-up (3) presented in Section 3 with all control variables in first lags. In none of the regressions the EMU difference-in-differences dummy variable is significant.

Fourth, we re-ran set-up (3) including interaction effects between the EMU difference-in-differences dummy and inflation, labour productivity or economic performance. Throughout all regressions neither the EMU dummy variable nor its interaction effects are significant at conventional levels.

Fifth, we employed the panel set-up (3) where we interacted the EMU difference-in-differences dummy variable (and its individual components) with a dummy variable for large countries. In the regression including industrial production growth the interaction effect between EMU and the large country dummy is negatively significant, whereas the EMU dummy itself is not significant at conventional levels. In the other regressions neither the EMU dummy nor its interaction effect is significant at conventional levels.

Sixth, we implemented panel set-up (3) where we excluded either all Southern EMU countries in our sample (Italy, Portugal, Spain) or all Northern EMU countries (Austria, Belgium, Finland, France, Germany, Ireland, Luxembourg, the Netherlands). The EMU difference-in-differences dummy variable is insignificant in the regressions excluding the Southern EMU countries. In contrast it is significantly negative at the 5 percent level in the

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[28] To be more specific, it is negatively significant in the regression including GDP growth based on the sample dating from the first quarter of 1984 to the third quarter of 2010.

GDP growth regression excluding the Northern EMU countries. As argued above these results rather contradict than support Grüner's theory.

Finally, we again employed the difference-in-differences panel set-up (3) where only one EMU country is included at a time. For Finland, France and Italy (Portugal), the EMU difference-in-differences dummy variable is now significantly negative at the 1 percent level (10 percent level) independent of the measure of economic performance. For Belgium (the Netherlands, Austria), it showed up significantly negative at the 1 percent level in the industrial production growth regression (GDP growth regression, GDP growth regression) only. In contrast for Ireland (Luxembourg), the EMU dummy is significantly positive at the 1 percent (10 percent) level in the industrial growth regression. In all other regression, the EMU difference-in-differences dummy variable is insignificant. To sum up, for some regressions we do not find any significant effect of EMU on unemployment, for some others we find a significantly negative effect and again for some others we find a significantly positive effect. Hence, the robustness tests confirm our basic finding that it is not possible to in general establish a significantly negative effect of the EMU on unemployment as hypothesized by Grüner's model.

Tables

Table 1: Did the EMU amplify business cycles?

	ΔStd.(GDP growth)		ΔStd.(IP growth)		ΔStd.(Unempl.rate)	
	(1)	(2)	(3)	(4)	(5)	(6)
EMU group (G)	0.00462	0.00201	0.00282	0.00283	0.192	0.295**
	(1.340)	(1.183)	(0.663)	(0.648)	(0.415)	(2.142)
Lagged Std.		-0.847***		0.0121		-0.957***
		(-7.740)		(0.0586)		(-14.06)
Constant	-0.00756***	0.00978***	-0.00876**	-0.00926	-0.876**	0.640***
	(-3.103)	(3.863)	(-2.789)	(-1.017)	(-2.503)	(4.279)
No. Countries	20	20	22	22	21	21
of which EMU	10	10	12	12	12	12
R-squared	0.091	0.799	0.021	0.022	0.009	0.917

Notes: t-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 2: Did the EMU decrease wage growth?

	Δwage growth, 1984-98 vs. 1999-08†				Δwage growth, panel data				wage growth, panel data	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EMU (G or P·G)	-0.000432	-0.000795	-0.0000411	0.00312	-0.000675	-0.000968	0.000412	0.000295	-0.00340	-0.00310
	(-0.079)	(-0.20)	(-0.0074)	(0.74)	(-0.57)	(-0.83)	(0.52)	(0.35)	(-1.00)	(-0.98)
Lagged wage growth		-0.562***	-0.846***	-0.694***	-0.334***	-0.324***				
		(-4.01)	(-3.94)	(-4.16)	(-7.50)	(-7.44)				
Consumer price inflation#			0.285	0.277	0.113**	0.122**	-0.0397*	-0.0367**	0.363***	0.427***
			(1.12)	(1.31)	(2.30)	(2.40)	(-2.09)	(-2.42)	(3.50)	(4.23)
Labour productivity growth#			0.471	-0.399	-0.00318	-0.0385	0.0242	0.0243	-0.0195	-0.0680
			(1.07)	(-0.86)	(-0.13)	(-1.36)	(1.04)	(1.10)	(-0.35)	(-1.19)
Unemployment rate#			0.000914		-0.000478*		-0.0000714		-0.00168***	
			(1.25)		(-2.08)		(-0.39)		(-3.05)	
Industrial production growth#				0.367**		0.0284*		-0.00620		0.0211
				(2.79)		(1.88)		(-0.77)		(0.86)
Error correction term‡							-0.0263***	-0.0270***	-0.00519	0.00680
							(-3.07)	(-3.27)	(-0.25)	(0.32)
Constant	-0.0123***	0.0125*	0.000604	0.00503	0.0166***	0.0126**	0.00287	0.00900**	0.0555***	0.0348***
	(-3.10)	(1.83)	(0.058)	(0.57)	(3.30)	(2.83)	(0.52)	(2.85)	(6.22)	(4.54)
No. observations	19	19	19	19	1473	1481	1462	1470	1476	1484
No. countries	19	19	19	19	20	20	20	20	20	20
of which EMU	10	10	10	10	11	11	11	11	11	11
R-squared	0.0004	0.50	0.60	0.72	0.23	0.23	0.09	0.09	0.37	0.36

Notes: t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. In columns (5)-(10) a dummy variable to capture Greece during 1999-2000 is included (not shown). Columns (5)-(10) include country- and time-specific fixed effects (not shown) and the standard errors allow for observations to be correlated within countries. #Variables are lagged by one period in columns (1)-(4) and columns (7)-(8).‡The error correction term is lagged by two periods in columns (7)-(8) and by one period in columns (9)-(10). †The sample split differs for Greece as it only entered the EMU in 2001.

Table 3: Did the EMU decrease unemployment?

| | Δunemployment, 1984-98 vs. 1999-08[†] | | | | Δunemployment, panel data | |
	(1)	(2)	(3)	(4)	(5)	(6)
EMU (G or P ·G)	-0.342	1.046	0.676	0.808	-0.0336	-0.0566
	(-0.29)	(1.32)	(1.07)	(1.60)	(-0.50)	(-1.67)
Lagged unemployment		-0.644***	-0.546***	-0.492***	-0.0206***	-0.0416***
		(-5.36)	(-5.72)	(-5.65)	(-3.38)	(-6.70)
Consumer price inflation			3.236	-3.980	1.092*	0.678
			(0.20)	(-0.28)	(2.03)	(1.17)
Labour productivity growth			141.8*	132.2**	2.174**	7.684***
			(2.12)	(2.72)	(2.63)	(6.68)
Industrial production growth			-94.14***		-2.253***	
			(-3.85)		(-4.53)	
GDP growth				-44.53		-10.94***
				(-1.27)		(-8.73)
Constant	-1.407	2.854***	2.296*	0.981	-0.0244	0.565***
	(-1.58)	(2.93)	(1.80)	(0.63)	(-0.34)	(3.16)
No. observations	21	21	21	19	1602	1357
No. countries	21	21	21	19	21	19
of which EMU	12	12	12	10	12	10
R-squared	0.0045	0.62	0.81	0.79	0.33	0.52

Notes: t-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. In columns (5)-(6) a dummy variable to capture Greece during 1999-2000 is included (not shown). Columns (5)-(6) include country- and time-specific fixed effects (not shown) and the standard errors allow for observations to be correlated within countries. [#]Variables are lagged by one period in columns (1)-(4). [†]The sample split differs for Greece as it only entered the EMU in 2001.