The Wage-Price Setting Behavior: Comparing The Evidence from EU28 and EMU

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The consensus of empirical evidence on the wage and price relationship reveals that causal relationships are difficult to identify. Moreover, elements other than wages, prices and productivity have significant impact in determining the wage-price setting equilibrium. Application of VECM analysis in the wage-price relationship for EU28 and EMU over the period 2000:Q1–2014:Q4 implies that there is statistically robust evidence of long-run cointegration relationship between wages and prices. Additionally, the estimated values of cointegration coefficients provide strong evidence in favor of hypothesis that assumption of near-rational behavior in the wage-price relationship is valid in case of EU28, whereas that of rational expectations is valid in case of EMU. Specifically, the evidence suggests that wage setters have under-adjusted for inflation as probably in their view the costs of such behavior were low. This can serve as an argument that wage and price setters have unconditionally accepted the strict rigor of monetary policy authorities. Such behavior can also be attributed to labor market flexibility which is a central element in determining the overall economic performance. In principle, wage moderations induced by a flexible labor market should improve and/or restore the international competitiveness and result in more output and employment in EU28 and EMU.

Keywords: Inflation, Rational Expectation, Causality, Co-integration

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1. Introduction

In general, one has to agree with the argument of Knotek and Zaman (2014) that connection between wages, prices and economic activity is more akin to a tangled web than a straight line. Specifically, in the United States (US), they have found that wages and prices have tended to move together, even though the causal relationships are difficult to identify. Regardless, of this argument as well as of many caveats faced in empirical work this paper will attempt to examine the wage-price relationship in the European Union (EU or EU28) and European Monetary Union (EMU) and try to untangle the issue by employing Vector Error Correction Model (VECM). Additionally, it will evaluate whether labor market characteristics play any significant role in the adjustment dynamics of the wage-price relationship. The specific dilemma examined in this paper is why following the events of global recession in the year 2008, the wage setters in EU and EMU have responded with wage moderation and not with demands for higher wages so as to restore their real wages. Moreover, it will also investigate whether there has been an equal or differential wage moderation in EU and EMU.

Certainly, the answers to these questions are complex too and therefore the investigation should be carried out by taking comprehensively into account multiple aspects of the wage-price setting dynamics. In the first place, different sample lengths, number of explanatory variables, measures of time series data, different models etc. will produce different inferences on the respective issue, (Hess and Schweitzer, 2000). Moreover, the adjustment process may also depend on the reaction of monetary policy authorities and their willingness to accommodate certain expansionary fiscal policies, (Mehra, 2000). Additionally, one may also list other relevant dimensions to the complex nature of the wage-price setting process such as market competition, export shares, collective wage agreements, employment protection legislation as well as the reaction of temporary unemployment, (Bertola, Dabusinskas, Hoeberichts, Izquierdo, Kwapil, Montornès and Radowski, 2010). Indeed, it is a well known fact in the literature that the levels of nominal and real rigidities are not universal across the countries, (HM Treasury Report, 2003; OECD, 2004).

In particular, over time the economy is subjected to structural changes (Marcellino and Mizon, 2000), however the failure to take into account those changes (i.e. structural changes or regime shifts), which are often observed in the economic and financial time series data, has led many authors to view it as the main cause of forecast failures, (Pesaran, Pettenuzzo and Timmermann, 2004). Furthermore, in a study of a large set of macroeconomic time series, Stock and Watson (1996) have reported that majority of the series displayed evidence of instability. In their view, such structural breaks pose a formidable challenge to economic forecasting and have led many authors to view it as the main source of forecast failure. In particular, even though modeling and forecasting of wages, prices and unemployment with Vector Autoregressive (VAR) models performs well in some cases, it is evident that Vector Error Correction Model (VECM) provides a better description of the data within sample and moreover the equilibrium terms are significant at conventional significance levels, (Clements and Hendry, 1996). Considering that structural changes are pervasive in economic time series relationships it can be quite perilous to ignore them. Certainly, under those circumstances, inferences about economic relationships can go astray, forecasts can be inaccurate, and policy recommendations can be misleading or worse, (Hansen, 2001).

In order to provide an effective answer to the puzzle of the wage-price setting dynamics in EU and EMU in the post-2008 period it is necessary to assess the validity of arguments supported by Akerlof, Perry and Dickens (2000), and of Kromphardt and Logeay (2007). Specifically, Akerlof *et al.* 2000 have argued that in setting wages and prices, the lay public does not use the same model of the economy as economists. Given the complexity of their decisions and, for the most part, their lack of training as economists, it would, indeed, be surprising if they did. It is thus highly unlikely that the welter of interdependent, intuitively based decisions of a real economy will produce a coefficient of inflationary expectations on wage and price inflation that is always exactly one. In fact they have offered a theory for such a departure as price and wage setters under-adjust for inflation when it is not very salient and when the cost of such behavior is low. Correspondingly, in their view, this theory factually yields a lowest sustainable rate of unemployment and an accompanying rate of inflation. In addition to this, one may also ponder the Kromphardt and Logeay (2007) argument that the wage and price setters have finally accepted the rigor of monetary policy authorities, meaning that they would neither try nor do they have the market power, due to ever increasing globalization and international competition, to pursue a policy which raises the inflation rate significantly above the target inflation rate of the Central Bank, or alternatively as Akerlof *et al*. 2000 have suggested, above the rate of inflation that minimizes the sustainable rate of unemployment.

The rest of the paper is organized as follows: section 2 presents a brief literature review on the determinants of wages, prices, productivity, and on the role of labor market institutions in determining the wage-price dynamics; section 3 describes the mathematical and econometric modeling issues; section 4 describes the variables and examines the stationary properties of data; section 5, provides the analysis of the rate of growth of wage, price and productivity series; section 6, presents results of VECM analysis and of relevant diagnostic tests; finally, section 7 concludes by summing up the main findings.

2. Literature review

Although there is an abundant stock of papers on the issue of wage, price and productivity relationship this section will only present a brief review of selected number of papers.

Determinants of wages - For instance, Rich and Rismiller (2001) have provided an empirical investigation into the determinants and stability of the aggregate wage inflation process in US over the period 1967-2000. By using compensation per hour as the measure of wages, they have specified a Phillips curve model that links wage growth to its past values as well as to the unemployment rate, price inflation, labor productivity growth and additional set of labor market variables. Their results do not reject the hypothesis that real wages and labor productivity move proportionally in the long-run. Moreover, endogenous structural break tests provide little evidence of model instability. Correspondingly, Blanchard and Katz (1999) have argued that wage setting depends on the behavior of unions, stringency of the hiring and firing regulations as well as the dynamics of productivity. In addition to this, they have found a much stronger positive effects of productivity, capital intensity, and profitability on establishment wage differentials, conditional on worker characteristics, in France than in the US.

Likewise, Claussen and Staher (2001) have investigated the role of productivity on wages. In their view, lower unit labor costs might stem from higher productivity (possibly because of new technology) but could also be the result of wage restraint unrelated to New Economy (NE) developments. Correspondingly, Chen and Chihying (2007) have developed a method to uncover the causal order in stationary multivariate time series with a vector autoregressive presentation. They have applied the time series causal model (TSCM) to a wage-price dynamic and have consequently obtained the result that price-inflation rate is one of the causes that drive wage-inflation rate while the wage-inflation rate has had only a very weak indirect influence on the price-inflation rate. In contrast, Goretti (2008) has analyzed the wage-price setting relations in the new EU member countries. The estimated results have indicated a strong and significant relationship between real wages and labor productivity, as well as evidence of wage pass-through to inflation. Country-specific wage developments, beyond differences in labor productivity growth, are mostly explained by real wage catch-up from different initial levels and different labor market conditions. Qualitative evidence also suggests that public sector wage demonstration effects and institutional factors may play a role in wage determination.

Determinants of prices - Similarly, the literature on the determinants of prices is rich. For example Gordon (1979) has argued that level of prices in the context of the price-wage spiral depends on excess labor demand, deviation of productivity from its trend value, changes in personal and social security tax rates, as well as the changes in unemployment. Specifically, Emery and Chang (1996) have found that inclusion of unit labor costs in forecasts of consumer price inflation provides no significant improvement in forecasting errors. Moreover, there is an argument suggesting that wage increases which cause higher prices, as described by the cost push view, depend on the reaction of monetary policy authorities, (Mehra, 2000). Furthermore, Bertola *et al.* 2010, in the context of the cost-push view, have argued that wage induced changes in prices depend on the level of market competition, export shares, collective wage agreements, employment protection legislation, and reaction of temporary unemployment. On the other hand, Nourzad (2010) has analyzed the effect of using different measures of wages and prices in predicting the causal relationship between wages and prices. Additionally, Knotek and Zaman (2014) have investigated the links between wages, prices and economic activity and their findings imply that causal relationships between wages and prices are difficult to identify and the ability of wages to help predict future inflation is limited.

Determinants of productivity - It is a well known fact from the Solow (1959) model that level of technology, capital and labor determine the level of output. Simultaneously, one may also add human capital and land as additional factors of production, which subsequently also have significant impact on productivity. Furthermore, there are a number of studies that have comprehensively examined productivity and its dynamics over time. For instance, Smolny (2000) has provided an empirical review on the sources of productivity growth by employing German sectoral data, with particular emphasis on allowing for inter-industry spillovers and scale economies at the aggregate level, as well as for scale economies associated with human capital at the sectoral level. Additionally, he has argued that business cycle affects observed productivity changes in the short-run and in the long run. In contrast, Stiroh (2001) has analyzed productivity growth by examining the key distinctions between the neoclassical and new growth theories. In his analysis of neoclassical view, the exogenous technical progress drives the long-run productivity growth as capital suffers from diminishing returns. In contrary, the new growth models yield long-run growth endogenously, either by avoiding diminishing returns to capital or by explaining technical progress internally. On the other side, Doraszelski and Jaumandreu (2013) have examined the relation between R&D and productivity, and their study provides account of endogenous productivity growth.

The role of labor market institutions on the wage-price relationship - There are many studies that have examined the relationship between wages and prices and the corresponding role of labor market institutions. Marcellino and Mizon (2000) have examined the relationship between wages, prices, productivity, inflation, and unemployment in Italy, Poland, and the UK (United Kingdom) between the 1960's and the early 1990's using a cointegrated vector autoregression subject to regime shifts, specifically the occurrence of structural changes in economy. They have argued that many economies in Europe have experienced significant changes in economic structure and economic policies. Some economies have undergone substantial liberalization of their labor, financial, and foreign exchange markets, an example being the UK. Other economies of Eastern and Central Europe, for example Poland, have moved from being centrally planned towards free market economies. On the other hand, the HM Treasury (2003) study has reported that a flexible and efficient labor market imply higher employment, thus a fairer, more competitive and more productive economy. It also implies an economy that is better able to adapt to the changing economic environment. Additionally, the study suggests that labor market flexibility is a central element in determining the overall performance of UK economy.

In contrast, Prasad (2004) has examined the relationship between labor market institutions and overall labor market performance, using micro data from the German Socio-Economic Panel to document that the wage structure in West Germany was remarkably stable over the period 1984–97. The results strongly suggest that stability of German wage structure is rather more attributable to the constraints imposed by institutional factors than to market forces. Furthermore, he has argued that although these "solidaristic" policies and the unbearable stability of the German wage structure may have served Germany well in previous decades, they have had a deleterious effect on labor market performance during 1984–97, a period during which the economy has been buffeted by a number of adverse shocks. Likewise, Bertola *et al.* 2010 have suggested that presence of collective wage agreements at industry or national level makes a price increase more likely. The data also seem to suggest that price increases are more likely in countries with more stringent employment protection legislation.

Besides, Meager and Speckesser (2011) have investigated the issue of competitiveness and whether the improvements in the economic/employment situation in some EU member states can be enhanced through holding wages growth below productivity increases (or even reducing wages while productivity growth continues). They have found that such adjustments are taking place at least to some extent, particularly in economies which enjoy 'flexible' bargaining mechanisms (Ireland, Estonia, but also in the US, for example). In their view it is anticipated that wage moderation should improve/restore international competitiveness and result in more output and employment in these countries. However, it is also clear that the success of such a strategy crucially depends on the degree of international competition and the availability of substitutes in consumption, as well as the institutions of the labor market. Moreover, Bernal-Verdugo, Furceri, and Guillaume (2012) study employing a panel of 97 countries from 1985 to 2008 suggests that improvements in labor market flexibility have a statistically and significant negative impact on unemployment outcomes (over unemployment, youth unemployment and long-term unemployment). Among the different labor market flexibility indicators analyzed, they have found that hiring and firing regulations and hiring costs to have the strongest effect.

3. Methodology

The *mathematical relationship* of wages, prices and productivity can be expressed in various functional forms. *First*, wages can be expressed as function of prices and marginal productivity of labor,

$W = P \bullet MPL$ or $W = f(P, MPL)$ (3.1)

where, W - wages, P - prices, and MPL - productivity. *Second*, prices can be expressed as function of wages and productivity,

$P = W / MPL$ or $P = f(W, MPL)$ (3.2)

Third, real wages (wages/prices) can be expressed as function of productivity,

$W / P = MPL$ or $W / P = f(MPL)$ (3.3)

In addition to this, one may transform these equations using natural logarithms, thus obtaining the following forms: first, LNW = LNP + LNMPL, i.e. wage equation indicates that wages are positively related to prices as well as marginal productivity of labor; second, LNP = LNW – LNMPL, i.e. price equation indicates that prices are positively related to wages and negatively related to productivity; and third, LN(W/P) = LNMPL, i.e. real wages are positively related to productivity. Moreover, wages and prices will be treated as endogenous variables due to the fact that when they enter the model their values are determined from within the model or the system of equations, (see for example Emery and Chang, 1996; Hess and Schweitzer, 2000). Other variables may also be considered and included in the model. Nevertheless, increasing the number of variables and equations does not necessarily lead to a better model as by doing so it becomes harder to capture the dynamic and inter-temporal relations between relevant variables due to loss of power. In fact, in some forecast comparisons the univariate time series models were found to outperform large scale econometric models. Specifically, Lütkhepohl and Krätzig (2004) suggest that a possible reason for the failure of larger models is their insufficient representation of the dynamic interactions in a system of variables.

Applied econometric models – Initial analysis will begin with inspection of stationary properties of the time series data. After that the analysis will proceed with examination of the rate of growth of respective time series data in order to examine the dynamics of each series, as well to possibly derive some useful information on the pattern, dynamics and potential structural changes in the relationship. Finally, the analysis will conclude with VECM model as it certainly provides a more comprehensive framework for obtaining economically and statistically robust results. The respective model selection criteria for determining the number of lagged differences, as well the tests for the rank of cointegration will be carefully performed prior to estimating the VECM models. Additionally, section 6 will provide a detailed explanation of diagnostic tests which will facilitate in assessing the economical and statistical robustness of the VECM models. However, only the relevant results will be presented and discussed very concisely.

4. Data

The focus now shifts on explanation of data that will represent respective variables as well as to conduct the analysis of their stationary properties. Specifically, this study will use quarterly data covering period 2000:Q1-2014:Q4. First, wage variables WEU28 and WEMU represent labor cost index (LCI), i.e. nominal value, seasonally adjusted and adjusted data by working days for business economy. Second, price variables PEU28 and PEMU represent the Harmonized Index of Consumer Prices (HICP). Third, productivity variables QEU28 and QEMU represent the real labor productivity per person. The source of data for all three variables is EUROSTAT. Detailed description of all variables is provided in Table A4.1 in appendix. Accordingly, in Figure A4.1 in appendix the plots of log-levels and first difference of log-levels have been presented. The visual (informal) analysis of the plots of log-levels clearly indicate that time series data may not be stationary, i.e. series may be integrated of order 1 or I(1), and that deterministic trend may be present in the levels of respective data. In contrast, the first differences of logs clearly indicate stationarity, i.e. that time series data are integrated of order zero or I(0).

Besides, there are several formal unit root tests available such as Augmented Dickey-Fuller (ADF), Schmidt-Phillips, Phillips-Perron test for processes with level shift or Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests. However, this study will employ ADF and Schmidt-Phillips test procedures. Comprehensive theoretical account of all these tests is provided in Lütkepohl and Krätzig (2004), however for the purpose of maintaining space restrictions the results of tests will be presented in very concise way. In addition to this, a decision on the autoregressive (AR) order has to be made or, equivalently, on the number of lagged differences (LD) of respective series used in the relevant tests. This choice may rely on the model selection criteria (AIC – Akaike Information Criterion; FPE - Final Prediction Error; HQC – Hannan-Quinn Criterion; and SC – Schwarz Criterion), or a sequential testing procedure may be used to eliminate insignificant coefficients sequentially starting from some high-order model, (see also Lütkhepohl and Krätzig, 2006). The suggested numbers of LD have been estimated using both model selection criteria and sequential testing procedure.

Table 4.1

ADF test for EU28

Variable	*LD*	LW	LP	LQ	DLW	DLP	DLQ
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
μ_0	*1*	***-5.15	-2.29	-1.71	***-5.25	***-4.05	***-6.95
	0	***-3.54	-1.88	*-2.85	***-10.2	***-10.2	***-16.9
μ_0+s_i	*1*	***-5.02	-2.24	-1.79	***-5.09	**-3.40	***-5.50
	0	***-3.45	*-2.59	-1.52	***-9.92	***-4.76	***-5.77
$\mu_0+\mu_1$	*1*	-0.42	-0.61	*-3.15	***-7.91	***-4.43	***-6.94
	0	-1.32	-1.87	***-6.40	***-13.3	***-10.8	***-16.8
$\mu_0+\mu_1+s_i$	*1*	-0.36	-1.28	-2.43	***-7.69	**-3.74	***-5.66
	0	-1.26	0.04	-1.81	***-13.0	***-5.34	***-5.82

Note 1: Critical values for test with μ_0, and μ_0+s_i: *** - 1% = -3.43; ** - 5% = -2.86; * - 10% = -2.57; and for test with $\mu_0+\mu_1$ and $\mu_0+\mu_1+s_i$: *** - 1% = -3.96; ** - 5% = -3.41; * - 10% = -3.13.

Table 4.2

ADF test for EMU

Variable	*LD*	LW	LP	LQ	DLW	DLP	DLQ
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
μ_0	*1*	**-3.41	-1.96	-1.4	***-4.80	***-4.25	***-5.90
	0	**-3.12	-1.44	***-3.88	***-8.41	***-11.5	***-23.4
μ_0+s_i	*1*	**-3.31	-2.17	-1.46	***-4.62	**-3.18	***-4.73
	0	**-3.04	-1.89	-1.48	***-8.19	***-6.00	***-8.05
$\mu_0+\mu_1$	*1*	-0.48	-0.70	-2.69	***-6.00	***-4.53	***-5.86
	0	-1.17	-2.20	***-8.04	***-9.75	***-12.0	***-23.2
$\mu_0+\mu_1+s_i$	*1*	-0.41	-1.04	-2.42	***-5.79	**-3.45	***-4.73
	0	-1.11	-0.30	-2.62	***-9.51	***-6.50	***-7.99

Note 1: Critical values are the same as in Table 4.1.

The ADF test procedure has been performed for log-levels and first differences of log-levels using a) constant, (b) constant and seasonal dummies, c) constant and trend, 4) constant, trend and seasonal dummies. Respective tests have been presented in Table 4.1 for EU28 and Table 4.2 for EMU. Correspondingly, the Schmidt-Phillips test has been performed using the same number of LD as in the case of ADF test, and results have been presented in Table 4.3. In the same way as plots, the overall evidence derived from formal tests suggests that log-levels of all three time series data need to be differenced once in order to render them into stationary time series. Specifically, the test value of -2.29 for LPEU28 in column (4) of Table 4.1 indicates that H_0 that there is unit root in the series cannot be rejected at any reasonable level of significance (l.s.), whereas the test value of -4.80 for DLWEMU in column (6) of Table 4.2 indicates that H_0 can be rejected at 1 percent l.s. Remarkably, the H_0 can also be rejected at reasonable levels of significance for LWEU28 and LQEU28 when trend is not fitted in the testing procedures, though when trend variable is fitted one may not reject the H_0 in the respective levels of series. All other test results can be interpreted in similar way.

Table 4.3

Schmidt-Phillips unit root test

Variable	EU28			EMU		
LD	*2*	*1*	*0*	*2*	*1*	*0*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
LW	-0.86	-0.82	-0.96	-1.27	-1.23	-1.28
LP	-2.49	-2.25	-2.49	-2.57	-2.28	-2.67
LQ	***-5.82	***-5.05	***-5.52	***-8.88	***-7.46	***-7.51
DLW	***-13.0	***-12.5	***-12.6	***-9.34	***-8.86	***-8.78
DLP	***-11.3	***-10.2	***-9.80	***-13.6	***-12.9	***-12.2
DLQ	***-15.4	***-15.0	***-14.0	***-24.2	***-25.4	***-23.2

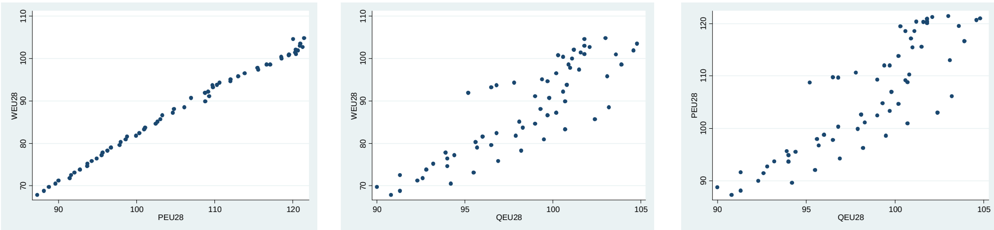
Note 1: Critical values: *** - 1% = -3.56; ** - 5% = -3.02; * - 10% = -2.75.

Similarly, the Schmidt-Phillips test indicates more or less the same results as the ADF tests. Specifically, the test value of -0.86 for LWEU28 in column (2) of Table 4.3 indicates that H_0 cannot be rejected at any reasonable l.s., whereas the test value of -13.02 for DLWEU28 in column (2) of Table 4.3 indicates that H_0 can be rejected at 1 percent l.s. In contrast to the ADF procedure though, on the basis of values of test statistics from Schmidt-Phillips procedure it can be argued that both log-level and first differences of log-levels of productivity series appear to be stationary, whereas now in variance with ADF test, irrespective of the number of lags used in the testing procedure, the levels of wage series are not stationary. For clarification, the Schmidt-Phillips test in contrast to ADF tests uses Z(tau) statistic, (see Lütkhepohl and Krätzig, 2004). In summary, based on overall results provided by the formal unit root tests, it can be clearly argued, that unlike log-levels, only the first differences of time series data are stationary beyond any reasonable doubt.

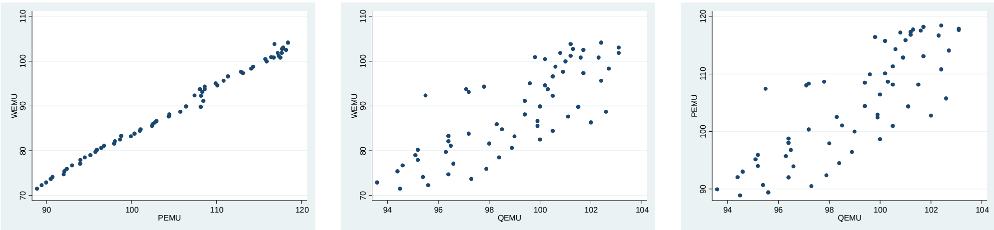
Figure 5.1

Cross-plots of time series data

a) WEU28 *vs.* PEU28 b) WEU28 *vs.* QEU28 c) PEU28 *vs.* QEU28



WEMU *vs.* PEMU WEMU *vs.* QEMU PEMU *vs.* QEMU



5. Analysis of the changes in the rate of growth of wages, prices and productivity

The Figure 5.1 shows the cross-plots of wages, prices and productivity series. The panel (a) indicates that wages and prices have a very strong positive relationship. Furthermore, on the basis of cross-plot evidence, there is a linear relationship between wages and productivity (panel b) as well as between prices and productivity (panel c). However, it appears that relationship is less stable and in addition to this there is greater variance in distribution for both EU and EMU data in post 2008 period. In fact, these changes have been possibly induced by the global economic recession that began in year 2008. Specifically, in statistical terms, the change can be explicitly explained by the fact that during 2000:Q1- 2008:Q4 period the quarterly rates of growth of wages, prices and productivity have been higher than the respective rates of growth of variables during 2009:Q1-2014:Q4 period. Additionally, on the basis of visual inspection of the data and plots it is possible to observe potential break-dates, respectively significant decreases in the level of productivity series QEU28 and QEMU in 2008:Q1 and 2009:Q1.

Figure 5.2

Quarterly rate of growth in percent – EU28 and EMU

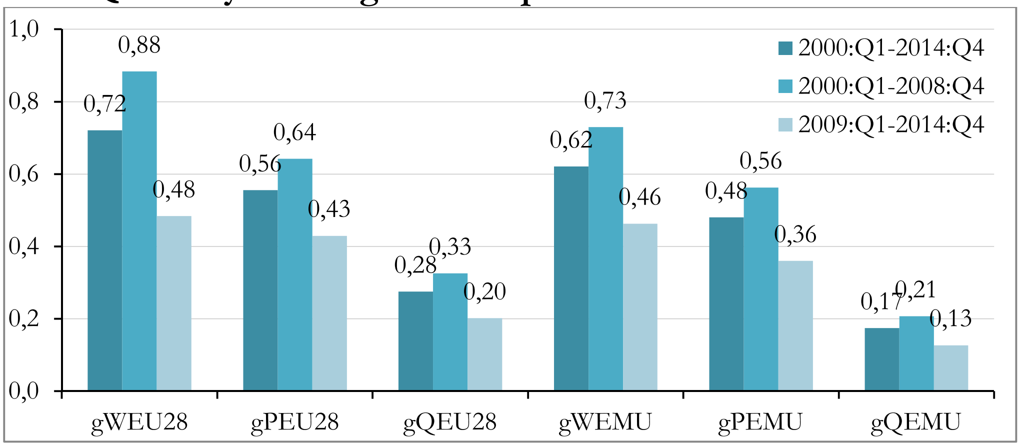
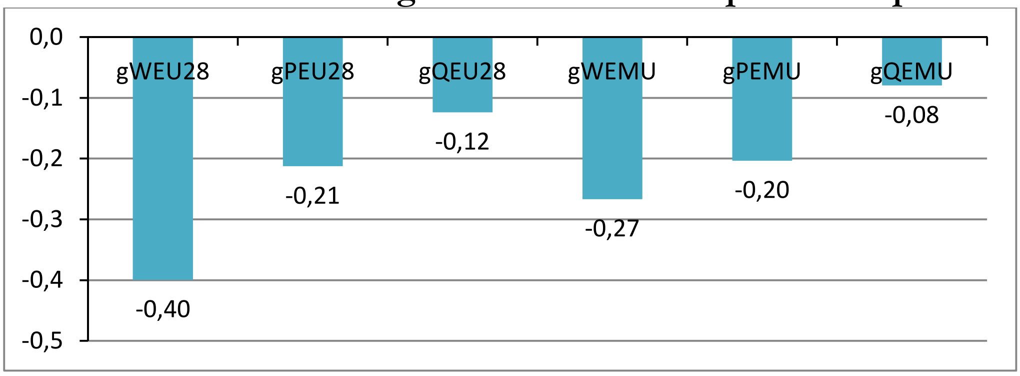


Figure 5.3

Difference in the rate of growth between two periods in percent



Moreover the evidence presented in Figure 5.2 shows that there has been a significant degree of wage moderation in the post 2008 period, although this wage moderation has also been associated with a decrease in the rate of growth of prices and productivity. Specifically, the quarterly rate of growth of wages in EU28 has decreased from 0.88% to 0.48%, respectively from 0.73% to 0.46 in EMU. Likewise, the quarterly rate of growth of prices in EU28 has decreased from 0.64% to 0.43%, respectively from 0.56% to 0.36 in EMU. In the same way as wages and prices, the quarterly rate of growth of productivity in EU28 has decreased from 0.33% to 0.20%, respectively from 0.21% to 0.13 in EMU. Additionally, the Figure 5.3 indicates that the highest decrease has been in rate of growth of wages, by 0.40% in EU28 and by 0.27% in EMU. The respective decreases in the rates of growth of prices and productivity are 0.21% and 0.12% in EU28, correspondingly 0.20% and 0.08% in EMU. A possible cause for these changes may be the acceptance of 'flexible' bargaining mechanisms. In fact, as Meager and Speckesser (2011) have argued, it is expected that wage moderations should improve and/or restore the international competitiveness and result in more output and employment.

6.VECM Estimation

In principle, in case that two or more variables have a common stochastic trend, it may be possible that there are linear combinations of them that are I(0). If that is the case then variables are cointegrated. Although sometimes the VAR model may be suitable in accommodating variables with stochastic trends, it is not the most suitable type of model if interest centers on cointegration relations, because they do not appear explicitly in those models, (Lütkhepohl and Krätzig, 2004). For this reason, the VECM model is a more convenient setup for analyzing variables with common stochastic trend. Simultaneously, it may also be a more suitable model setup for analyzing the link between wages and prices in EU28 and EMU.

Determination of cointegration rank - rk (Π) – Prior to conducting any VECM regression analysis, one has to perform cointegration tests in order to determine the rank of cointegration. Complete results of cointegration tests have been presented in Table 6.1. Specifically, *Johansen Trace* and *Saikkonen and Lütkhepohl* tests have been carefully utilized in examining the cointegration properties of LWEU28 and LPEU28, respectively of LWEMU and LPEMU (see Lütkepohl and Krätzig, 2004). Tests have been performed using quarterly seasonal dummies as well. Furthermore, as suggested by information criteria, tests have been performed with eight and two LD for EU28, respectively two and one LD for EMU. Additionally, the case with a) intercept, b) intercept plus trend, and c) orthogonal trend (the trend that is confined to some individual variables but is absent from the cointegration relations) have been performed for both types of cointegration test. Comprehensive results of cointegration tests have been presented in Table 6.1. Next, due to space limitations, only a concise description of the tests will be provided. First of all, it is clearly visible in the case of Johansen test for LWEU28 and LPEU28 that choosing the number of eight LD, as suggested by AIC, is inadequate. Obviously, the evidence suggests that test results with two LD are more robust statistically. Specifically, when the Johansen Trace Test with two LD (as suggested by HQ and SC) is applied, the null hypothesis H_0 that rk (Π) = 0 is rejected in favor of alternative hypothesis H_1 that rk (Π) = 1, with relevant high values of LR statistics and low *p* values confirming this, (see column 3, 5 and 7). Likewise, the Johansen tests for LWEMU and LPEMU strongly indicate using rk (Π) = 1, with H_0 rejected in the case with intercept (column 3) and of orthogonal trend (column 7).

Table 6.1

Tests for the rank of cointegration

Test	LD	Intercept ($\mu_0 \neq 0$ $\mu_1 = 0$)		Intercept + trend ($\mu_0 \neq 0$ $\mu_1 \neq 0$)		Orthog. Trend
		rk(Π) = 0	rk(Π) = 1	rk(Π) = 0	rk(Π) = 1	rk(Π) = 0
(1)	(2)	(3)	(4)	(5)	(6)	(7)
a) EU28 Johansen	8	14.09 (0.29)	5.55 (0.24)	***31.90 (0.01)	5.44 (0.54)	9.67 (0.31)
	2	***56.29 (0.00)	4.40 (0.37)	**28.92 (0.02)	4.41 (0.69)	***25.77 (0.00)
a) EU28 S&L	8	8.13 (0.23)	0.22 (0.70)	11.88 (0.20)	0.86 (0.83)	7.47 (0.13)
	2	***16.19 (0.01)	0.20 (0.71)	*15.01 (0.07)	1.78 (0.59)	***14.94 (0.01)
b) EMU Johansen	2	***51.52 (0.00)	5.89 (0.21)	21.00 (0.18)	5.81 (0.50)	***20.49 (0.01)
	1	***117.09 (0.00)	*8.61 (0.06)	21.62 (0.16)	4.88 (0.62)	***21.45 (0.00)
b) EMU S&L	2	**15.77 (0.01)	0.16 (0.75)	7.16 (0.64)	1.13 (0.76)	*8.64 (0.08)
	1	***60.79 (0.00)	0.98 (0.37)	4.86 (0.88)	1.74 (0.60)	6.50 (0.19)

Note 1: Critical values: *** - 1 %; ** - 5 %; * - 10 %; (*p* values).

Similarly, the comprehensive evidence from Saikkonen and Lütkhepohl test strongly suggests that rk (Π) = 1. For example, the value of 16.19 in column 3 in the test with two LD included in the test procedure for LWEU28 and LPEU28 clearly suggests rejection of H_0 that rk (Π) = 0 in favor of H_1 that rk (Π) = 1, with LR statistic being significant at 1 percent l.s. Likewise the value of LR statistic of 60.79 and *p* value of 0.00 in column 3 are significant at 1 percent l.s., thus on the basis of this value one may clearly reject the H_0 that rk (Π) = 0 in favor of H_1 that rk (Π) = 1. In summary, on the basis of overall results of cointegration tests, it can be clearly argued that there is sufficient evidence to proceed subsequent analysis with one cointegration relation included in the VECM model, i.e. rk (Π) = 1. Notably, when the testing procedure with intercept plus trend is applied it is evident that on the basis of the respective test statistic one may not reject H_0. Nonetheless, on the basis of overall results produced by cointegration tests, it can be clearly argued that there is sufficient evidence to proceed subsequent analysis with one cointegration relation included in the VECM model, i.e. rk (Π) = 1.

Number of lagged differences – prior to running the VECM regression it is necessary to determine the number of LD by utilizing relevant information criteria. The test results on suggested number of LD have been presented in Table 6.2. First of all when impulse dummies im08q1 and im09q1 are not included in the VECM model for EU28 then all four criteria AIC, FPE, HQC and SC suggest using one LD, ($VECM^{EU28}$). In contrast, when impulse dummies are included then the AIC suggests using 9, FPE and HQC two, whereas SC suggests using one LD, ($VECM^{EU28}_{IM}$). On the other hand, when impulse dummies im08q1 and im09q1 are not included in the VECM model for EMU then the first three criteria, AIC, FPE and HQC, suggest using eight LD, whereas the SC suggests using zero LD, ($VECM^{EMU}$). Conversely, when the impulse dummies are included in the VECM model then the AIC and FPE suggest using eight, HQC two and SC zero LD, ($VECM^{EMU}_{IM}$). The reason for inclusion of an impulse dummy is that a shift in the mean of the original series is converted to an impulse in the differenced series.

Table 6.2

Determination of the optimal number of lagged differences

Model	AIC	FPE	HQC	SC
(1)	(2)	(3)	(4)	(5)
$VECM^{EU28}$	1	1	1	1
$VECM^{EU28}_{IM}$	9	2	2	1
$VECM^{EMU}$	8	8	8	0
$VECM^{EMU}_{IM}$	8	8	2	0

Normally, whereas AIC overestimates the number of LD it is the SC that provides the most consistent estimates. Nonetheless, taking into account the comprehensive evidence provided by information criteria as well as by cointegration tests, one LD for endogenous variables will be used in $VECM^{EU28}$, whereas two LD in $VECM^{EU28}_{IM}$, $VECM^{EMU}$ and $VECM^{EMU}_{IM}$. Additionally, zero lags of LQEU28 will be fitted in EU28 models, whereas one lag of LQEMU in EMU models. In these model specifications LWEU28 and LPEU28, as well as LWEMU and LPEMU, have been set as endogenous variables, whereas LQEU28 and LQEMU have been set as exogenous variable, given that values of wages and prices are determined within the system whereas the value of productivity is determined outside the system. Furthermore, quarterly seasonal dummies (S1, S2, and S3) and trend (t) have been fitted in the model. Intercept term is not included in the models as in the first place it is explicitly absent in the mathematical model.

Interpretation of estimated coefficients of cointegration matrix - It has to be emphasized that the first coefficient in the cointegrating relation β_1 has been normalized to 1 by JMulTi, i.e. $\beta_1 = 1$. With this normalization, one may also verify whether the estimated cointegrating relation β_2 is close to what one would expect on the basis of prior considerations by using the asymptotic distribution of the second coefficient. In general, the *loading coefficients a* are also to some extent arbitrary because they are determined by normalization of cointegrating vectors, though their *t* ratios can be interpreted in the usual way as being "conditional on the estimated cointegration coefficients". Thus, they can be used to assess if the cointegration relations resulting from this normalization enter a specific equation significantly. The estimators of the parameters associated with LD of the variables (short-run parameters) may be interpreted in the usual way. Their *t* ratios are asymptotically normal under these assumptions. The same is not necessarily true for the parameters associated with deterministic terms as their *t* ratios are provided just for completeness (Lütkhepohl and Krätzig, 2004; Lütkhepohl and Krätzig, 2005).

Athough the sample includes data from 2000:Q1 to 2014:Q4, i.e. 60 observations, only 58 observations from 2000:Q3 to 2014:Q4 have been used in $VECM^{EU28}$, whereas 57 observations from 2000:Q4 to 2014:Q4 have been used in the other VECM models, as one, respectively two LD, have been fitted in the models, and additionally one observation has been lost due to the first difference transformation. Full results have been presented in Table 6.3, respectively $VECM^{EU28}$ in column 2 and $VECM^{EU28}_{IM}$ in column 3, and in Table 6.4, respectively $VECM^{EMU}$ in column 2 and $VECM^{EMU}_{IM}$ in column 3. Specifically, all VECM regressions have been performed using the Two Stage (S2S) procedure, i.e. Johansen procedure in the first stage and Feasible Generalized Least Squares (FGLS) procedure in the second stage. Additionally, the System Sequential Elimination of Regressors (SER) procedure utilizing SC has been employed in order to eliminate those regressors that lead to the largest reduction of the respective information criteria. Consequently, all the coefficients with t ratios lower than two have been eliminated or restricted to zero in the second stage of estimation, (see Lütkhepohl and Krätzig, 2004; Lütkhepohl and Krätzig, 2005).

Table 6.3

VECM estimated coefficients for EU28

Model	$VECM^{EU28}$		$VECM^{EU28}{}_{IM}$	
(1)	(2)		(3)	
α_{11}	***-0.06 [-5.53]		***-0.01 [-12.10]	
α_{21}	***0.01 [6.92]		***0.08 [3.32]	
β_{11}	1.00 [0.00]		1.00 [0.00]	
β_{12}	***-0.654 [-22.34]		***-1.230 [-31.23]	
(1)	(2a)	(2b)	(3a)	(3b)
	$DLWEU28_t$	$DLPEU28_t$	$DLWEU28_t$	$DLPEU28_t$
$DLWEU28_{t-1}$	***-0.49 [-4.54]	-	***-0.46 [-5.36]	-
$DLPEU28_{t-1}$	-	**0.26 [2.11]	-	-
$DLWEU28_{t-2}$	n/a	n/a	-	***0.23 [3.21]
$DLPEU28_{t-2}$	n/a	n/a	-	**0.16 [2.33]
$LQEU28_t$	***0.02 [6.09]	-	-	***0.02 [3.41]
im08q1	n/a	n/a	***0.02 [5.79]	-
im09q1	n/a	n/a	**-0.01 [-2.33]	***-0.01 [-3.89]
S_1	-	***-0.00 [-3.52]	-	-
S_2	-	***0.01 [4.75]	-	***0.01 [8.88]
S_3	-	***-0.01 [-4.638]	-	-0.00 [-3.15]
trend (μ_1)	-	***0.00 [-2.94]	***0.00 [-6.13]	***0.00 [-2.78]

Note 1: *** - significant at 1%; ** - 5%; * - 10%. [*t* ratios]. n/a - not applicable. IM subscript indicates that im08q1 and im09q1 have been included in the model.

Table 6.4

VECM estimated coefficients for EMU

Model	$VECM^{EMU}$		$VECM^{EMU}_{IM}$	
(1)	(2)		(3)	
α_{11}	***-0.07 [-3.75]		***-0.06 [-4.06]	
α_{21}	***0.157 [2.66]		***0.15 [2.89]	
β_{11}	1.00 [0.00]		1.00 [0.00]	
β_{12}	***-0.981 [-176.30]		***-0.971 [-239.62]	
(1)	(2a)	(2b)	(3a)	(3c)
	$DLWEMU_t$	$DLPEMU_t$	$DLWEMU_t$	$DLPEMU_t$
$DLWEMU_{t-1}$	***-0.32 [-2.93]	***-0.35 [-3.05]	-	-
$DLPEMU_{t-1}$	***0.34 [2.75]	**0.28 [2.49]	-	-
$DLWEMU_{t-2}$	-	-	-	**0.24 [2.21]
$DLPEMU_{t-2}$	-	***0.44 [5.63]	-	***0.37 [5.87]
$LQEMU_t$	***-0.17 [-3.63]	***0.01 [3.18]	***-0.21 [-4.20]	-
$LQEMU_{t-1}$	***0.17 [3.64]	-	***0.21 [4.21]	***0.00 [2.78]
im08q1	n/a	n/a	***0.01 [2.67]	**0.01 [2.45]
im09q1	n/a	n/a	***-0.01 [-3.04]	***-0.01 [-4.03]
S_1	***-0.01 [-3.87]	-	***-0.01 [-4.15]	-
S_2	**-0.00 [-2.38]	***0.01 [9.29]	**-0.00 [-2.42]	***0.01 [10.33]
S_3	***-0.01 [-3.95]	***-0.00 [-2.83]	***-0.01 [-3.72]	-
trend (μ_1)	-	***0.00 [-3.18]	-	***0.00 [-3.06]

The evidence provided by the values of *t* statistics suggests that cointegration relations resulting from normalization of cointegration vectors enter significantly in all the equations of respective model specifications. Furthermore, the very high *t* statistics and low *p* values of respective cointegration coefficients, β_2, indicate that estimated coefficients are highly statistically significant and thus provide robust evidence in favor of a strong long-run equilibrium relationship between wages and prices in EU28 and EMU. For example, on the basis of estimated loading coefficients of $VECM^{EU28}_{IM}$ model in column 3 it can be argued that cointegration relation resulting from normalization of cointegration vector enters significantly in both equations. The loading coefficient α_1 = -0.01 for the wage equation has *t* statistic of -12.10, and the other loading coefficient α_2 = 0.08 for the price equation has a *t* statistic of 3.32, and both are significant at 1 percent l.s. Specifically, by selecting $LWEU28_t$ and $LWEMU_t$ as the first variable in respective models, it means that coefficients of these variables in cointegration relation have been normalized to 1 in the maximum likelihood estimation procedure. Consequently, the respective models from Table 6.3 can be simply expressed as,

$VECM^{EU28}$: $\quad LWEU28_t = 0.654\ LPEU28_t + ec_t$ (6.1)
[-22.34]

$VECM^{EU28}_{IM}$: $\quad LWEU28_t = 1.230\ LPEU28_t + ec_t$ (6.2)
[-31.23]

$VECM^{EMU}$: $\quad LWEMU_t = 0.981\ LPEMU_t + ec_t$ (6.3)
[-176.30]

$VECM^{EMU}_{IM}$: $\quad LWEMU_t = 0.971\ LPEMU_t + ec_t$ (6.4)
[-239.62]

where ec_t are error correction terms and the numbers in brackets show t ratios. For instance, taking into account that logs of variables have been used, the relation in formula (6.2) expresses the elasticity of wages on prices, hence the coefficient of 1.23 is the estimated wage elasticity. Accordingly, if the log of prices increases by 1 percent it is expected that the log of wages would increase by 1.23 percent. Importantly, this coefficient is statistically significant at 1 percent l.s. The corresponding price elasticity is calculated as $1 / \beta_2 = 1 / 1.23 = 0.81$ whereas the equation can be expressed as,

$VECM^{EU28}_{IM}$: $LPEU28_t = 0.81\ LWEU28_t + ec_t$ (6.2A)

When the coefficients associated with lagged variables for $VECM^{EU28}$ are analyzed, it results that only the coefficients which estimate the impact of $DLWEU28_{t-1}$ on $DLWEU28_t$ and of $DLPEU28_{t-1}$ on $DLPEU28_t$, are statistically significant at 1 percent, respectively 5 percent l.s. Furthermore, the estimated productivity coefficient of $LQEU28_t$ indicates a statistically significant though very small impact of productivity on wages with coefficient value of 0.02 having a *t* statistic of 6.09. The evidence associated with coefficients of lagged variables for $VECM^{EU28}_{IM}$ indicates that coefficients which estimate the impact of $DLWEU28_{t-1}$ on $DLWEU28_t$, and of $DLWEU28_{t-2}$ and $DLPEU28_{t-2}$ on $DLPEU28_t$, are statistically significant at 1 percent, respectively 5 percent l.s. The estimated productivity coefficient of $LQEU28_t$ indicates a statistically significant though very small impact on $DLPEU28_t$ with coefficient value of 0.02 having a *t* statistic of 3.41.Additionally, im08q1 is significant in the first equation only, whereas im09q1 is significant in both equations.

For $VECM^{EMU}$ the coefficients that estimate the impact of $DLWEMU_{t-1}$ and $DLPEMU_{t-1}$ on $DLWEMU_t$, as well as of $DLWEMU_{t-1}$, $DLPEMU_{t-1}$ and $DLPEMU_{t-2}$ on $DLPEMU_t$, are statistically significant. Moreover, the estimated coefficients of $LQEMU_{t-1}$ indicate a statistically significant impact on $DLWEMU_t$ and $DLPEMU_t$. The evidence related to coefficients of lagged variables for $VECM^{EMU}_{IM}$ indicates that coefficients which estimate the impact of $DLWEMU_{t-2}$

and $DLPEMU_{t-2}$ on $DLPEMU_t$ are statistically significant. On the other hand, im08q1 and im09q1 are significant in both equations. The other coefficients of deterministic terms, such as those of seasonal dummies and trend are presented just for completeness. In contrast, all other coefficients have been restricted to zero as their *t* ratios had low values, thus during the SER procedure have been eliminated in the second stage of VECM estimation when FGLS procedure was employed. All other coefficients of respective models can be interpreted similarly.

Diagnostic tests - Details of graphical tests (for $VECM^{EU28}_{IM}$ and $VECM^{EMU}_{IM}$) have been presented in appendix in Figure A6.1 and Figure A6.2. The formal diagnostic tests, (see Lütkhepohl and Krätzig, 2004), have been presented in Table 6.5 ($VECM^{EU28}$ in column 2, $VECM^{EU28}_{IM}$ in column 3, $VECM^{EMU}$ in column 4, and $VECM^{EMU}_{IM}$ in column 5). In summary, the visual inspection of the plots of residuals, standardized residuals, residual autocorrelation and cross-correlation raises no serious concerns on the statistical adequacy of $VECM^{EU28}_{IM}$ and $VECM^{EMU}_{IM}$. In particular, the standardized squared residuals indicate some high values in the residuals of all equations in each model, respectively the high values of residuals can be observed in 2008:Q1 and 2009:Q1 that are associated with the decrease in the level of productivity series. Specifically, the formal diagnostic tests enable a better comparison of models and of the impact of inclusion of impulse dummies in the respective models. Obviously the test results suggest that models with impulse dummies satisfy better the relevant diagnostic criteria.

Table 6.5

VECM models diagnostic tests

Model	$Vecm^{EU28}$	$Vecm^{EU28}_{IM}$	$Vecm^{EMU}$	$Vecm^{EMU}_{IM}$
(1)	(2)	(3)	(4)	(5)
VECM Model statistics	5.65 (0.58)	10.67 (0.47)	3.87 (0.69)	12.08 (0.28)
LM- Test for auto-correlation with 5 lags	29.03 *(0.09)	23.60 (0.26)	*29.04 (0.09)	13.28 (0.87)
TESTS FOR NONNORMALITY				
Doornik & Hansen	***93.38 (0.00)	3.59 (0.46)	2.64 (0.62)	2.54 (0.64)
Skewness	***26.21 (0.00)	0.44 (0.80)	1.94 (0.38)	1.02 (0.60)
Kurtosis	***67.18 (0.00)	3.14 (0.21)	0.70 (0.70)	1.53 (0.47)
Lütkepohl	***96.94 (0.00)	3.53 (0.47)	3.53 (0.47)	3.19 (0.53)
Skewness	***26.52 (0.00)	0.44 (0.80)	2.08 (0.35)	1.55 (0.46)
Kurtosis	***70.41 (0.00)	3.09 (0.21)	1.46 (0.48)	1.63 (0.44)
Jarque-Berra				
u_1	***93.94 (0.00)	2.40 (0.30)	0.59 (0.74)	1.80 (0.41)
u_2	(0.93) (0.63)	1.15 (0.56)	1.60 (0.45)	0.56 (0.76)
ARCH-LM TEST with 16 lags				
u_1	3.09 (0.99)	14.61 (0.55)	16.71 (0.40)	10.28 (0.85)
u_2	15.17 (0.51)	14.02 (0.60)	21.10 (0.17)	15.72 (0.47)
MULTIVARIATE ARCH-LM TEST with 5 lags				
VARCH LM test statistic	***72.92 (0.01)	43.42 (0.54)	56.76 (0.11)	42.23 (0.59)

Note 1: *** - significant at 1 %; ** - 5 %; * - 10 %. (*p* values).

Specifically, the VECM model statistics indicates whether any information is lost if restrictions are imposed by the SER procedure. Remarkably, it favors the models without impulse dummies, because the respective LR test values (*p* values) of these models are lower (higher) compared to models with impulse dummies included in the VECM models. Conversely, the Breusch-Godfrey test with 5 lags suggests that models with impulse dummies included in the model are more statistically robust. Particularly, the LM statistics of 29.03 and *p* value of 0.09 for $VECM^{EU28}$, respectively 29.04 and 0.09 for $VECM^{EMU}$, clearly indicate possible presence of residual autocorrelation if impulse dummies are excluded. Moreover, all the tests on non-normality (Doornik & Hansen; Lütkepohl; and Jarque-Bera), clearly reject $VECM^{EU28}$, whereas there are no obvious issues with the other three models. Finally, the ARCH-LM tests with 16 lags indicates no problems, whereas Multivariate ARCH-LM tests with 5 lags rejects the $VECM^{EU28}$ model and raises some concerns on $VECM^{EMU}$ model, with LM test statistics of 72.92 and 56.76 having *p* values of 0.01, respectively 0.11. In contrast, there are no concerns regarding potential statistical issues in the models with impulse dummies included in the model. In summary, it can be argued that comprehensive evidence clearly favors the models that use impulse dummies.

Evaluation of theoretical assumptions - Subsequently, the values of estimated cointegration coefficients, β_2, of each model are going to be compared with the values that one would expect on the basis of prior theoretical considerations. In a simple theoretical model, the rational expectations approach assumes that people use all relevant information, in forming expectations of economic variables. For example changes in the price level as a result of increase in money stock, leave output and employment unchanged. Money and wages will rise, but since the real wage is unchanged, neither the quantity of labor supply, nor that demand will change, (see Muth, 1961; Sargent and Wallace, 1976). Nonetheless, there is a difference between how expectations are formed, and how are used. According to Akerlof *et al.* it is highly unlikely that the welter of interdependent, intuitively based decisions of a real economy will generate a coefficient of inflationary expectations on wage and price inflation that is always exactly one. Thus, provided that hypothesis of rational expectations holds true, H_0, then it is expected that wage elasticity is going to have the value of less than or equal to one, or else, if the value of wage (price) elasticity is greater (less) than one, then the assumption of near-rational wage-price setting behavior, H_1, is valid.

The hypothesis testing has been performed and presented in Table 6.6. Specifically, the evidence suggests that 1 percent increase in log-wages, on average and ceteris paribus, implies 1.53 percent increase in log-prices in $VECM^{EU28}$, respectively 0.81 percent in $VECM^{EU28}_{IM}$, 1.02 percent in $VECM^{EMU}$, and 1.03 percent in $VECM^{EMU}_{IM}$. Thus, it can be clearly argued that the value of cointegration coefficient, β_2, from $VECM^{EU28}_{IM}$ is greater than one, and equivalently, the value of price elasticity is 0.81, i.e. less than one. Conversly, it is difficult to reject the hypothesis, H_0, that the value of cointegration coefficient, β_2, from $VECM^{EMU}_{IM}$ is different from the expected value of one. Therefore, on the basis of comprehensive evidence presented in this paper, it can be clearly argued that the assumption of rational behavior in the wage-price relationship does not hold true in EU28. In contrary, the evidence suggests that there is a strong case in favor of near-rational wage-price setting behavior. In contrast, the opposite is true for EMU, in which case the value of estimated long-run cointegration coefficient, clearly suggests that hypothesis of rational expectations may not be rejected at any reasonable l.s..

Table 6.6

Testing the hypothesis on validity of rational vs. near-rational behaviour

Model	**VECM^{EU28}**	**VECM$^{EU28}_{IM}$**	**VECM^{EMU}**	**VECM$^{EMU}_{IM}$**
(1)	(2)	(3)	(4)	(5)
est. β_2	0.654	***1.230	0.981	0.971
std. of β_2	0.029	0.039	0.006	0.004
t statistic	-11.931	5.897	-3.167	-7.250

Note 1: Right-tail test: H_0: $\beta_2 \leq 1$, i.e. hypothesis of rational expectations is valid; H_1: $\beta_2 > 1$, i.e. H_0 is not true if $t > t_{a,df}$. Level of significance: *** - significant at 1 %; ** - 5 %; * - 10 %. Equivalently, the values of price elasticity are: 1.53, 0.81, 1.02 and 1.03.

The next puzzle is to identify the sources of differential wage-price setting behavior in EU28 and EMU. The evidence that may explain this puzzle is that the average level of wage moderation (i.e. decrease in the average rate of growth of wages) has been greater in EU28 than in EMU. Remarkably, the average rate of growth of wages in EU28 has decreased by 0.40 percent, whilst in EMU by 0.27 percent. Furthermore, the evidence presented in Table 6.7 shows the average quarterly rates of growth for respective period/subperiods, specifically the dynamicss in the equilibrium of wage, price and productivity relationship (equation). The results clearly indicate that the average rate of growth of wages (in the left hand side of equation), has been less than the sum of the average rate of growth of prices and average rate of growth of productivity (in the right hand side of equation). Based on these results it can be argued that there has been a certain degree of wage moderation in both EU28 and EMU. However, on average, the degree of moderation at all times has been greater in EU28 than in EMU, (column 3 and 5).

Table 6.7

Growth rates and equilibrium in wage, price and productivity equation

Period	**EU28** (gW = gP + gQ)		**EMU** (gW = gP + gQ)	
(1)	(2)	(3)	(4)	(5)
2000:Q1–2014:Q4	0.72 < 0.56 + 0.28	-0.12	0.62 < 0.48 + 0.17	-0.03
2000:Q1–2008:Q4	0.88 < 0.64 + 0.33	-0.09	0.73 < 0.56 + 0.21	-0.04
2009:Q1–2014:Q4	0.48 < 0.43 + 0.20	-0.15	0.46 < 0.36 + 0.13	-0.03

7. Conclusion

The purpose of this paper has been to analyze the pattern of relationship between wages and prices in EU28 and EMU during the period of time 2000:Q1-2014:Q2. The data clearly suggest that quarterly rates of growth of wages, prices, and productivity have all decreased in the post 2008 period. Undoubtedly, the evidence from VECM models strongly suggests that there is a strong long run equilibrium relationship between wages and prices in both EU28 and EMU. Moreover, the estimated wage (price) elasticity coefficients provide a stronger case for near-rational wage-price setting behavior in EU28. In contrary, the case of fully rational behavior is stronger in EMU. However, additional issue that this paper has attempted to investigate and explain is why in the post 2008 period the decrease in the rate of growth of wages has been higher than the decrease in the rate of growth of prices and productivity. Certainly, it is reasonable to argue that wage-setters in EU28 as well as EMU have not reacted with demand for higher real wages in the post 2008 period for several reasons. The first reasoning can rely on *Akerlof et al.* 2000 proposition that the rate of growth of inflation has still been modest, hence the wage and price setters have under-adjusted for that modest increase in the rate of growth of inflation as it has not been very salient and additionally the cost of engaging in such a behavior has been low. Second, reasoning can rely on Kromphardt and Logeay (2007) explanation that wage and price setters have unconditionally accepted the rigor of monetary policy authorities and have not tried to pursue a policy which raises inflation rate significantly above the target inflation rate of the monetary policy authorities. Third, reasoning can rely on Meager and Speckesser (2011) argument that by holding wage growth below productivity increases (or even reducing wages while productivity growth continues) can enhance level of competitiveness and improve the economic/employment situation.

It is also important to realize that there is another element that has had a significant impact on the path of wage and price setting dynamics. Specifically, that is the labor market flexibility. As evidence implies, it is very likely that a higher degree of flexibility, on average, in the wage-setting process in EU28 than in EMU, accounts for the former having higher (lower) wage (price) elasticity. The wage-price setting structure in EU28, on average, is arguably les rigid or more flexible than the one in EMU. This hypothesis may be factually corroborated by the evidence of greater level of wage moderation, on average, in EU28 than in the EMU. That flexibility of the wage-price setting process is attributable to more flexible and efficient labor market, which is considered as a precondition for higher employment, as well as fairer, more competitive and more productive economy. Additionally, that labor market flexibility may also entail an economy that is better able to adapt to the changing economic environment, and thus it is considered as a central element in determining the overall economic performance.

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Appendix
Table A4.1

Description of variables

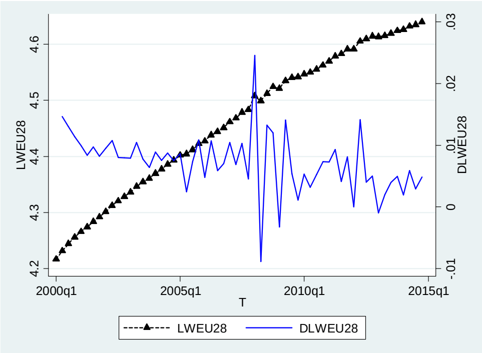
Variable	Description
(1)	(2)
$WEU28_t$	wages
$LWEU28_t$	log of WEU28
$DLWEU28_t$	first diff. of LWEU28
$PEU28_t$	Prices
$LPEU28_t$	log of PEU28
$DLPEU28_t$	first diff. of LPEU28
$QEU28_t$	productivity
$LQEU28_t$	log of QEU28
$DLQEU28_t$	first diff. of LQEU28
c *or* μ_0	constant or intercept
t *or* μ_1	trend term
s_1	second quarter
s_2	third quarter
s_3	fourth quarter
im08q1	im = impulse; 08 = year 2008; q1 = 1st quarter
im09q1	im = impulse; 09 = year 2009; q1 = 1st quarter
u_{1t} *and* u_{2t}	Residuals
ec_t	error correction term
$gWEU28_t$	rate of growth of wages
$gPEU28_t$	rate of growth of prices
$gQEU28_t$	rate of growth of productivity

Note 1: Variables for EMU variables are named in similar way

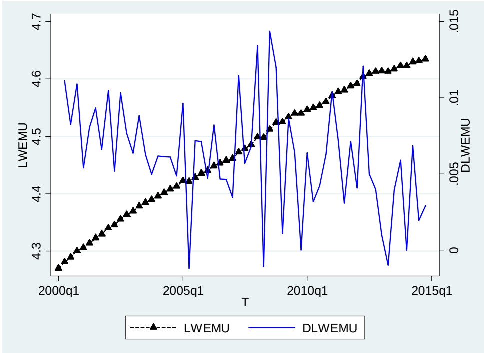
Figure A4.1

Plots of wage, price and productivity series

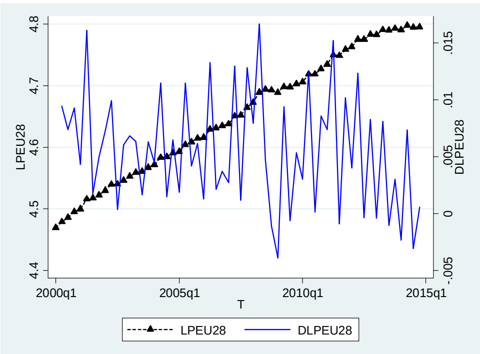
a) LWEU28 & DLWEU28



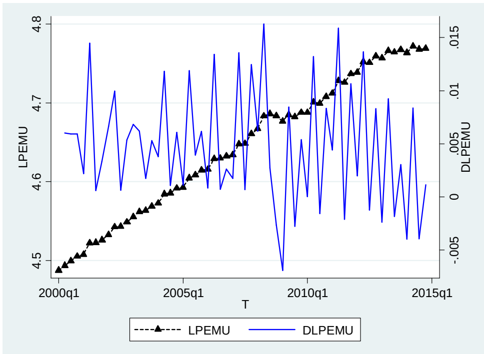
a) LWEMU & DLWEMU



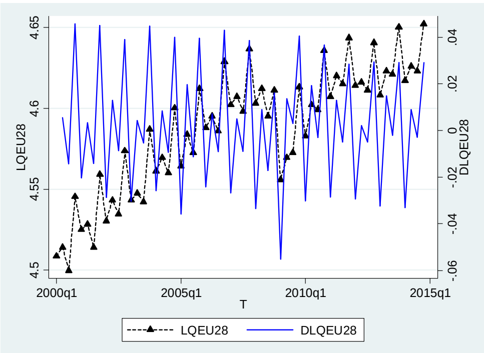
b) LPEU28 & DLPEU28



b) LPEMU & DLPEMU



c) LQEU28 & DLQEU28



c) LQEMU & DLQEMU

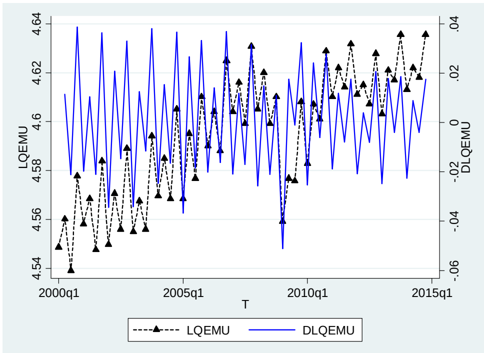
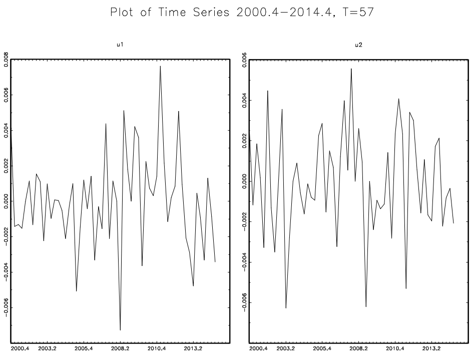


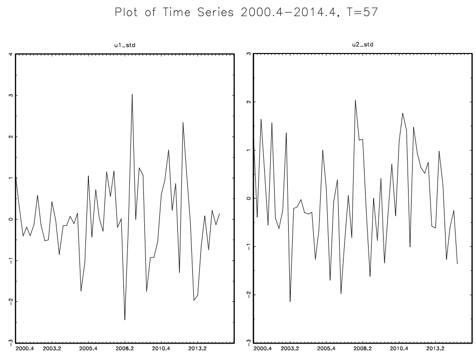
Figure A6.1

Plots of residuals of $VECM^{EU28}_{IM}$

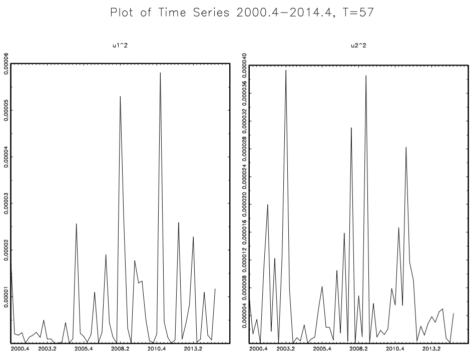
a) residuals



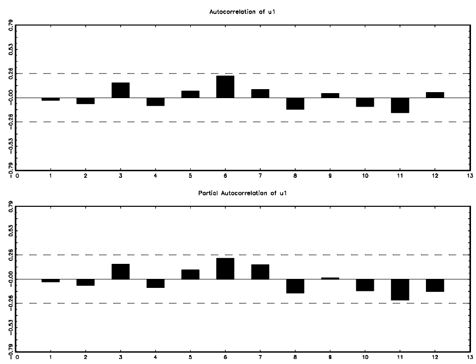
b) standardized residuals u_{1t} & u_{2t}



c) standardized squared residuals u_{1t} & u_{2t}

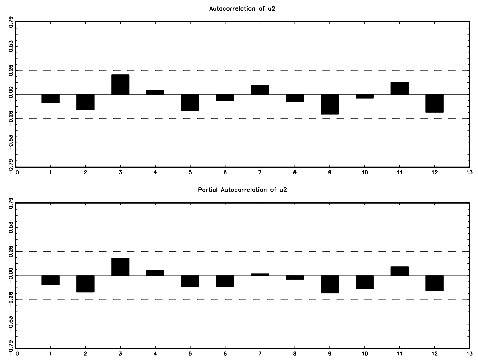


d) residual autocorrelation of u_{1t}



e) residual autocorrelation of u_{2t}

e) cross-correlations of residuals u_{1t} & u_{2t}



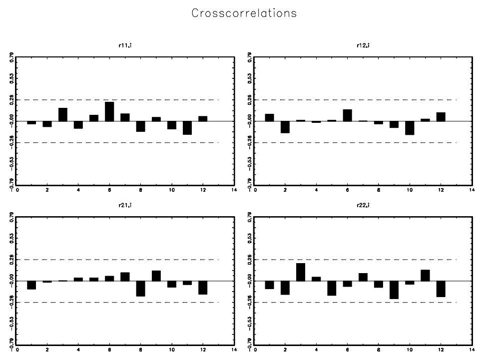
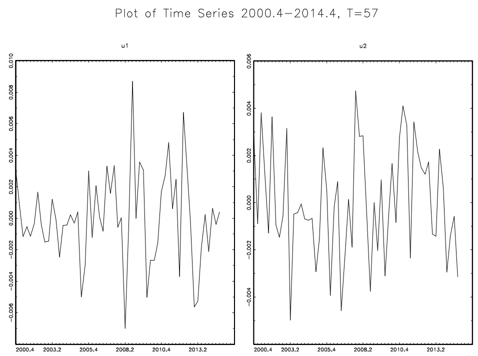


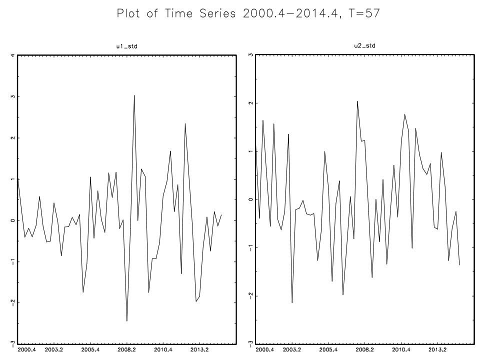
Figure A6.1

Plots of residuals of $VECM^{EMU}{}_{IM}$

a) residuals

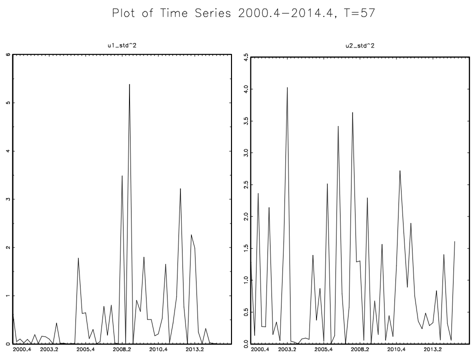
b) standardized residuals u_{1t} and u_{2t}

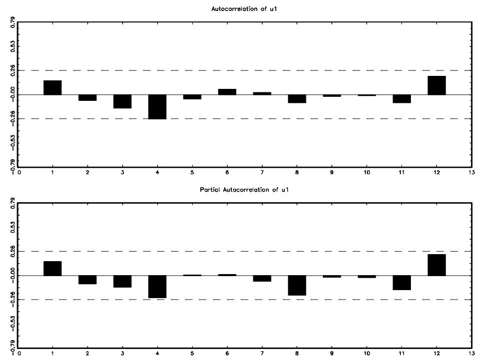




c) standardized squared residuals u_{1t} & u_{2t}

d) residual autocorrelation of u_{1t}





e) residual autocorrelation of u_{2t}

e) cross-correlations of residuals u_{1t} & u_{2t}