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Wage, Price, and Unemployment Dynamics and the Convergence to Purchasing Power Parity in the Euro Area

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Abstract

The paper discusses the determination of wages, prices, productivity and unemployment in the Euro-wide area in the post Bretton woods period. The econometric results provide strong evidence on a regime shift at the start of the EMS and the empirical analysis is done separately for the two regimes. Two variables, measuring different aspects of the convergence towards European purchasing power parity, are shown to be crucial for explaining inflation and unemployment behavior in the more recent regime. The results point to the importance of being on a sustainable ppp level when fixing the exchange rates.

Keywords: European unemployment, PPP convergence, Balassa-Samuelsson effect, Cointegrated VAR

JEL classification: C3, J3, J5

1 Introduction[1]

This paper provides an empirical investigation into the wage, price and unemployment dynamics that have taken place in the Euro area since the 1970's. The aim is to shed new light on the following questions:

1. What was the impact of the increased economic integration within Europe on the wage-price-unemployment dynamics?

2. Why were European unemployment rates so high throughout this period?

We argue that any model claiming to answer these questions should also be able to explain why the pre-EMS period of the seventies up to the beginning of the eighties and the 'hard' EMS period of the eighties until the beginning of the present monetary union were so different in terms of macroeconomic behavior. For example why were inflation rates so persistently high, real growth rates so volatile, and real interest rates so low and even negative in the pre-EMS period, and why were inflation rates so persistently low, growth rates so modest, unemployment rates so persistently high, and real interest rates so high in the EMS period.

Previous research has in particular focussed on the question why European unemployment rates were so high and persistent in almost the whole post Bretton Woods period. Most of this research concludes that institutional factors, like high minimum wages, strong labor unions, generous social security systems, have played a major role for the high and persistent unemployment in the post Bretton Woods period (Blanchard, 2000a, 2000b, 2000c). The theoretical models seem to be able to explain some but not all aspects of the high European unemployment rates. In particular, the length of the unemployment duration remains a puzzle.

That institutional rigidities have played an important role for the high unemployment rates in the last three decades seems indisputable. But, contrary to most of the previous papers, this paper argues that institutional rigidities have had a very different impact on unemployment in the more regulated pre-EMS period than in the (hard) EMS period.

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The econometric tests show that reliable statistical inference on the European wage-price-unemployment dynamics can only be achieved if one allows for structural change between the two periods.

We find that the following key issues are crucial for understanding the macroeconomic behavior over the last three decades:

1. the slow convergence to a sustainable European purchasing power parity level, and
2. the slow equilibrium correction behavior in the internal and external price determination,

and that we need to understand:

1. the role of labor productivity in the wage-price-unemployment dynamics, and
2. the role of labor unions for wage setting in a regulated as compared to a deregulated Europe with a strong commitment to move towards a monetary union.

The deregulation of capital movements in the EMS economies, seems particularly important for understanding the differences between the two periods. The Exchange Rate Mechanism (ERM) within EMS was a response to the large exchange rate fluctuations that characterized the seventies. But devaluations and realignments were still frequent in the first years of the ERM and the idea of a credible exchange rates regime seemed somewhat illusory. The agreement to stop further devaluations and realignments at the Stuttgart meeting in 1983 was an attempt to restore the market's credibility in the European currencies, a prerequisite for a monetary union.

We argue in this paper that the exchange rates became essentially fixed in a period when many of the member states were not on a sustainable purchasing power parity level relative to each other and that the subsequent slow convergence towards sustainable PPP levels had a dominant effect on the European unemployment rates, wages and inflation rates.

The cointegrated VAR approach has been used here is very powerful for modelling this kind of slow market adjustment to the new macroeconomic steady-states activated by the ongoing European economic integration. Though very different from the one taken in the above mentioned papers by Blanchard, it is able to generate new empirical insight into how European wage-price-and unemployment dynamics have changed as a result of the increased European integration. Contrary to the more conventional approach the VAR model is not based on any prior assumption of the endogeneity/exogeneity status of the variables but treats all of them as potentially informative regarding the feedback dynamics. This is useful in particular if the conclusions from the theoretical models are sensitive to the exogeneity assumptions. For example, in the Blanchard papers the European productivity slowdown is taken as exogenously given and the wage-price-unemployment dynamics are analyzed for given shocks to technological progress. In contrast the present paper includes labor productivity as one of the system variables in the VAR and finds that it plays a crucial role for the wage-price-unemployment dynamics and that it is itself strongly influenced by it.

The organization of the paper is as follows: Section 2 discusses the implications of the Balassa-Samuelsson effect for the adjustment towards sustainable European PPP levels and provides an econometric framework for how to analyze it empirically. Section 3 presents a simple economic model consisting of three static steady-state relations and three dynamic adjustment relations. Section 4 introduces the econometric model, presents the data, investigates long-run price homogeneity, and motivates the sample split based on econometric testing. Based on a nominal to real transformation Section 5 presents the empirical model, reports a some misspecification tests and discusses the choice of rank. Section 6 presents results on weak exogeneity, common trends, and the long-run impact of shocks to the system. Section 7 reports cointegration tests for the two regimes and compares the two structures of identified steady-state relations. Section 8 presents a short-run dynamic adjustment model of the European wage-price-unemployment behavior in the two regimes. Finally, Section 9 summarizes the results and concludes.

2 Inflation divergence and PPP convergence

It is an important hypothesis of this paper that the high and persistent European unemployment rates in the last two decades were crucially related to the slow convergence towards sustainable European PPP levels. The aim of this section is, therefore, to discuss the implications of fixing the exchange rates at a time point when the member states were not yet on a sustainable PPP level with respect to each other. Section 2.1 discusses the implications in terms of the Balassa-Samuelsson effect and Section 2.2 provides a simple framework for how to model it econometrically. Section 2.3 illustrates the main points using historical price data as a description of the European experiment.

2.1 The Balassa-Samuelsson effect

Inherent in the idea of creating a monetary union is the convergence of prices in the member states towards a common European price level. When the EMS regime became effective in 1979 the member states seemed to have been on very different PPP levels as illustrated by the graphs in Figures A.1-A.2 in Appendix A. Not surprisingly the graphs show that the member states in Northern and Central Europe were on a much higher purchasing power level at the beginning of the EMS regime than the ones in Southern Europe.

This can be understood as the so called Balassa-Samuelsson effect predicting that a country's price level is positively related to the level of real per capita income. The rational for this is that productivity in the tradable sector tend to be higher in richer than in poorer countries, whereas productivity in the nontradable sector is more similar. Wage levels in the tradable sector are influencing wages in the nontradable sector so nontradables tend to be more expensive in rich countries. With other words one Dmk, say, converted to the local currency generally would go much further in a poor than a rich country reflecting large wage differences between the two countries.

The commitment by rich and poor European countries to move toward a monetary union was likely to initiate an adjustment process toward a common European productivity level and, thus to more similar price and wage levels. The convergence of prices has generally been understood as being equivalent to the convergence of inflation rates. We will demonstrate below that inflation convergence does not necessarily imply convergence to sustainable PPP levels and that inflation rates would, in general, first have to diverge in order to reach a common sustainable PPP level. In the convergence period there seem to have been two important adjustment mechanisms explaining the behavior of inflation rates and unemployment rates:

1. The gradual elimination of the large wage (and price) differences between poorer (Southern Europe) and richer member states (Central and Northern Europe) which prevailed at the start of the integration process. When the remaining trade barriers were removed (in particular for agricultural products) the demand for imports from the poorer countries increased in the richer countries. As a consequence, the latter experienced rising standards of living as well as increasing prices, while the former run into balance of payments problems.

2. The gradual elimination of the large differences in productivity between European countries measured as output per worked hour

towards the highest productivity level. At the beginning of the integration process Germany was the strongest economy and the productivity adjustment in Europe was essentially towards the German level of productivity.

As the subsequent empirical results will show, the intraeuropean price- and productivity adjustment was crucial for the development of prices, wages and unemployment rates in the EMU convergence period of the eighties and the nineties.

2.1.1 The econometrics of the PPP convergence

This section illustrates the econometrics behind the convergence towards a sustainable common purchasing power parity level by a simple model for price adjustment in a two country world given by (1) below. It is assumed that purchasing power is at a sustainable parity level when ppp_t is empirically stationary, where $ppp_t = (p_1 - p_2 - s)_t$, p_{1t} is the log CPI price of country 1, p_{2t} of country 2, and s_t the log spot exchange rate.

This definition is, however, not unambiguous in the sense that different sample periods can produce different orders of integration (Juselius, 1999). Therefore, $ppp_t \sim I(0)$ is interpreted to mean that 'real exchange rate has fluctuated around a constant mean in the period $t = 1, ..., T$ covering a homogeneous exchange rate regime'. Empirical analyses of real exchange rates have exhibited substantial persistence (Lothian, 1997, MacDonald, 1995, Rogoff, 1996) and empirical tests have frequently found the *ppp* terms to be nonstationary in flexible exchange rate regimes.

In the period preceding the hard ERM European real exchange rates were not on a sustainable level relative to each other in the sense that movements in the exchange rate did not mirror the movements in the corresponding CPI price differential. Econometrically we find that $ppp_t \sim I(1)$ together with $(p_1 - p_2)_t \sim I(1)$ and $s_t \sim I(1)$[2] (Juselius, 1975, Juselius and MacDonald, 2000a, 2000b) implying that permanent shocks to the price differentials were fundamentally different from the ones to the spot exchange rates in the pre-EMS period.

A nonstationary ppp_t signals an imbalance in the goods market which, in the absence of trade barriers, is likely to result in trade deficits. This will influence the amount of capital needed to restore the balance of payments and is, therefore, likely to influence the interest rate spread between the two countries (Juselius and MacDonald, 2002a, Goldberg and Frydman 2002). Since interest differentials are likely to disappear

[2] Even $ppp_t \sim I(1)$ together with $(p_1 - p_2)_t \sim I(2)$ and $s_t \sim I(2)$ has been found Juselius and MacDonald, 2002a and 2002b,.

in a monetary union, a nonstationary ppp_t cannot be maintained by compensating capital inflows. The convergence to a common sustainable purchasing power parity price level in a fixed exchange rate regime should, therefore, to be achieved by adjustment in prices as illustrated below:

$$\begin{aligned}\Delta^2 p_{1t} &= c_{11}(\widetilde{\Delta p_1} - \widetilde{\Delta p_2})_{t-1} + c_{12}\Delta ppp_{t-1} + c_{13}(\widetilde{\Delta p_2} - a_1\widetilde{ppp})_{t-1} + \varepsilon_{1t} \\ \Delta^2 p_{2t} &= c_{21}(\widetilde{\Delta p_1} - \widetilde{\Delta p_2})_{t-1} + c_{22}\Delta ppp_{t-1} + c_{23}(\widetilde{\Delta p_2} - a_1\widetilde{ppp})_{t-1} + \varepsilon_{2t} \\ \Delta ppp_t &= c_{31}(\widetilde{\Delta p_1} - \widetilde{\Delta p_2})_{t-1} + c_{32}\Delta ppp_{t-1} + c_{33}(\widetilde{\Delta p_2} - a_1\widetilde{ppp})_{t-1} + \varepsilon_{3t}\end{aligned} \tag{1}$$

where the notation $\widetilde{x}$ denotes $x - \overline{x}$, i.e. a deviation from the sample average. Assume first that $p_{1,t} \sim I(2)$, $p_{2,t} \sim I(2)$ consistent with nonstationary inflation rates, i.e. $\Delta p_{1,t} \sim I(1)$, $\Delta p_{2,t} \sim I(1)$. If $ppp_t = (p_1 - p_2 - s)_t \sim I(1)$, $(p_1 - p_2)_t \sim I(1)$, $s_t \sim I(1)$, then $(\Delta p_1 - \Delta p_2)_t \sim I(0)$ and $\Delta s_t \sim I(0)$. All components in (1), except for ppp_t and $\Delta p_{2,t}$ in the second bracket, are stationary. For the system to be balanced, either $(\Delta p_2 - a_1 ppp)_t$ must be a stationary cointegration relation or ($c_{13} = 0$, $c_{23} = 0$, $c_{33} = 0$). Thus, the nonstationarity of ppp_t cannot be accounted for by a stationary inflation spread, but needs an additional non-proportional increase (decrease) in one of the inflation rates.

In the pre-EMS period we assume that $p_{1,t} > p_{2,t} + s_t$, where subscript 1 denotes a high PPP member state, 2 a low PPP member state. To achieve a sustainable PPP level in terms of the CPI, the following conditions should be satisfied:

$$\overline{\Delta p}_1 = \pi_0 - a_1\overline{ppp} \text{ and } \overline{\Delta p}_2 = \pi_0 + a_1\overline{ppp}, \tag{2}$$

where an overbar denotes the sample average and π_0 is the desired inflation rate after convergence. Hence, average inflation rates should be allowed to diverge until ppp_t has converged towards its stationary level[3].

Therefore, to eliminate the imbalances in intra-European PPP levels that exsisted at the beginning of the EMS period, the above model suggests that high PPP member states should have lowered their CPI prices, and low PPP member states increased them. The subsequent results suggest that price adjustment took place primarily in the poorer member states by price and wage increases (and increasing consumer prices) but, due to downward price rigidities, not by lowering prices (and wages) in the richer member states. The latter seemed to have regained competitiveness by keeping real wages relatively constant while

[3]Note, however, that the statistical properties of model (1) would be different in the new stationary regime, i.e. $\Delta p_{1,t} \sim I(0)$, $\Delta p_{2,t} \sim I(0)$ and $ppp_t \sim I(0)$.

at the same time increasing labor productivity i.e. by producing the same output with less labor.

Because of institutional rigidities (mostly in the labor market) the European PPP convergence was more complicated than the above price adjustment model. As the cointegration results of Section 7 show, the convergence took place through the adjustment of real wages, consumer price, labor productivity and trade competitiveness towards a European level.

2.1.2 The European experience

At the beginning of the eighties when the 'hard EMS' signalled a political move towards the present EMU, the price levels of the European countries measured for example by the 'big Mac' index represented very different purchasing power. When the EMU was finally realized in 1999 the European price convergence should ideally have been completed. The Exchange Rate Mechanism (ERM) within the European Monetary System (EMS) which preceded the EMU specified the maximum departure from parity in the convergence period ($\pm 6\%$ for Italy and Spain and $\pm 2\%$ for the rest).

The graphs in Appendix A illustrate the relative development of European consumer prices denoted in Dmk. Figure A.1 shows that the upward price adjustment in low PPP member states, like Italy and Spain, was quite fast consistent with the predictions from model (1). As a matter of fact, prices continued to increase even after sustainable PPP levels had been achieved. This can be explained by the continuing strength of the labor unions in these countries, due to more flexible exchange rate arrangements and the slow speed of capital deregulation. Figure A.2 shows that richer member states like Netherlands, Belgium, Austria and France reached the German PPP level at the beginning of the eighties, after which they experienced almost stagnating prices. The variable $pppconv_t$, defined in Appendix A and shown Figure 1, upper panel, is an aggregate measure of the price convergence in the EMS period.

As discussed above, not just European price adjustment was important, but even more so the productivity adjustment. Figures A.3 and A.4 illustrate the relative state of trade competitiveness between some of the European member states. The graphs demonstrate a relative lack of competitiveness in the seventies and beginning of the eighties for the high PPP countries, Germany, France, Netherlands and Belgium and fairly competitive prices in the low PPP countries, Italy, Spain, Finland and Austria. Figure 1, lower panel shows the variable, $tradecomp_t$, measuring the aggregate effect of large departures from intraeuropean trade-competitiveness. A definition of the variable is found in Appendix

A.

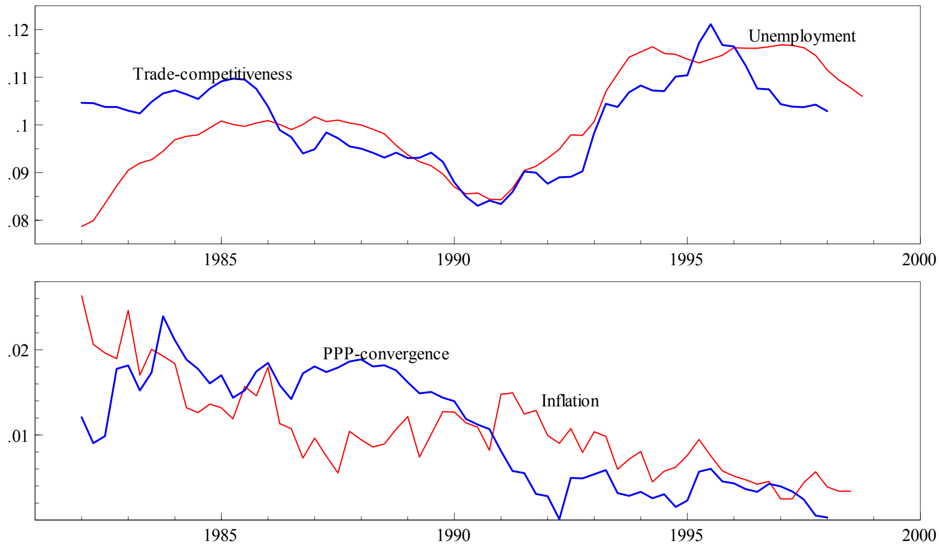

Figure 1: The development of the trade-competitiveness variable and European unemployment (upper panel) and the PPP-convergence variable and inflation rate.

Figure 2 illustrates the convergence of inflation rates in the present EMU member states towards a common low European inflation rate of approximately 2%. The upper panel demonstrates the close co-movements of the inflation rates in Netherland, Austria and Belgium with the German inflation rate (in bold face). The lower panel shows the corresponding convergence in the 'devaluation' countries, Italy, Spain, and Finland. The latter countries exhibited higher CPI inflation rates than the other member states until 1992, when they reached the level of German inflation rate. But the collapse of the hard EMS and the associated large devaluations in 1992-94 suggest that the member states were not on a sustainable PPP level at this stage and that the financial market had spotted the lack of balance.

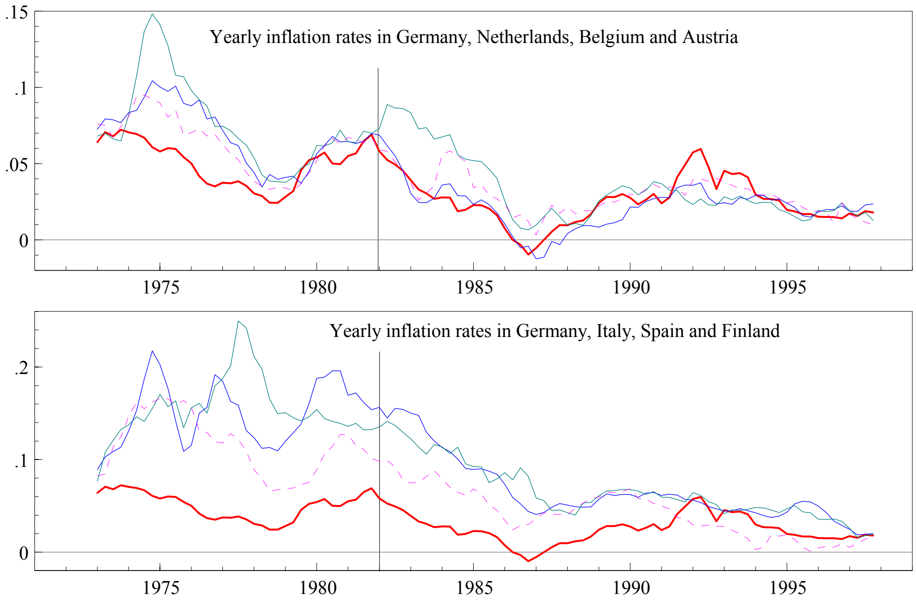

Figure 2. Yearly inflation rates, 1972-1987, in Germany (bold face), Netherlands, Belgium, Austria, Finland, Italy and Spain.

3 Economic relations

This section introduces a simple framework for analyzing wage, price and unemployment dynamics for the Euro-wide area in the post Bretton Woods period. The interpretation of the subsequent empirical results are based on three simple economic relations describing a steady-state relation for output prices, consumer prices, and real wages, respectively. The finding of persistent behavior away from the above static relations gives the motivation for three dynamic steady-state relations describing inflation rate adjustment towards long-run static steady states, a Phillips-curve relation, and a relation between unemployment and trend-adjusted productivity.

3.1 Static long-run relations

Output prices, p_y, corrected for productivity*,* q*,* are assumed to be determined by nominal wages, w, and import prices p_y^* :

$$p_{y,t} - q_t = \omega_1 w_t + \omega_2 p_{y,t}^* + v_{1,t} \tag{3}$$

where $v_{j,t}$ is a residual to relation j, and $\omega_1 + \omega_2 = 1$ implies mark-up pricing and lower case letters, in general, denote logarithmic values.

Consumer prices, p_c, are assumed to be homogeneously determined by the price of domestically produced consumer goods p_{yt} and imported goods p_y^* (denoted in domestic currency):

$$p_{ct} = \omega_3 p_{yt} + (1 - \omega_3) p_y^* + v_{2,t}. \tag{4}$$

Nominal wages w are assumed to be determined primarily by collective wage bargaining and related to output prices p_y, consumer prices p_c, productivity q, and unemployment rate u. Assuming log-linearity and long-run price homogeneity the hypothetical long-run aggregate real wage relation becomes:

$$w_t - p_{yt} = a_0 + a_1(p_{yt} - p_{ct}) + a_2 q_t + a_3 u_t + v_{3,t} \tag{5}$$

where $0 \geq a_1 \geq -1$, $0 \leq a_2 \leq 1$, and $a_3 \leq 0$. The special case, $a_1 = -1$, implies that nominal wages have followed consumer prices, an indication of strong bargaining power of labor unions, whereas $a_1 = 0$ indicates strong bargaining power of the employers. The intermediate cases imply different degrees of strength between employers and employees. The assumption $a_2 = 1$, implies that wage earners are fully compensated for productivity gains. A negative coefficient to unemployment implies less wage pressure when unemployment rate is high, whereas a zero coefficient indicates strong insider effects.

3.2 Dynamic adjustment behavior

The empirical motivation for distinguishing between static and dynamic steady-state relations derives from the econometric analysis of I(1) versus I(2) data. For example, if $\{w_t, p_{yt}, p_{ct}\} \sim I(1)$ empirically, then (3) - (5) should correspond to cointegrating relations implying that $v_{1,t}$, $v_{2,t}$ and $v_{3,t}$ would be stationary. If, on the other hand, $\{w_t, p_{yt}, p_{ct}\} \sim I(2)$ empirically (as we find) and, hence, $\{\Delta w_t, \Delta p_{yt}, \Delta p_{ct}\} \sim I(1)$ then (3) - (5) would generally correspond to $CI(2,1)$ relations and the residuals $v_{1,t}$, $v_{2,t}$ and $v_{3,t}$ would be I(1) and, thus, be drifting away from the assumed steady-states. The representation of the VAR model for I(2) data (Johansen, 1995) shows that the I(1) equilibrium errors and the I(1) growth rates can be combined into stationary multi-cointegrating relations.

Remark 1 *When nominal variables are I(2), nominal growth rates are generally needed in the cointegrating relations to achieve stationarity. The multicointegrated relations between variables in levels and differences can often be interpreted as dynamic steady-state relation.*

Under the assumption of long-run price homogeneity the following result holds:

Remark 2 *If* $\{w_t, p_{yt}, p_{ct}\} \sim I(2)$*,* $(w - p_y)_t \sim I(1)$ *and* $(p_y - p_c)_t \sim I(1)$*, then* Δw_t*,* Δp_{ct}*, and* Δp_{yt} *are pair-wise cointegrating. Therefore, the nominal* $I(1)$ *trend, defined as the first difference of the nominal* $I(2)$ *trend, can be described by any of the three growth rates.*

Although any of the nominal growth rates, $\Delta w_t, \Delta p_{yt},$ or Δp_{ct}, can be used for multicointegration, the interpretation of the estimated dynamic steady-state relations will differ depending on the choice. Since the focus will be on the wage-price-unemployment dynamics and how these are related to European competitiveness in an increasingly competitive world $\Delta p_{y,t}$ has been chosen as a measure of nominal growth in the subsequent empirical analyses.

The adjustment relation determining producer inflation $\Delta p_{y,t}$ is assumed to describe equilibrium-correcting behavior with respect to real wages, $w - p_y$, the internal price wedge, $p_y - p_c$, and the external price wedge, $p_y - p_y^*$. Furthermore, as discussed in the previous section, the European wage-price-unemployment dynamics are assumed to have been strongly influenced by the convergence of prices and productivity towards a common European sustainable steady-state level. Therefore, in the EMS period (6) needs to be augmented with two additional variables, $pppconv_t$ and $tradecomp_t$, defined in Appendix A, measuring the absolute deviation from purchasing power parity in the Euro countries :

$$\begin{aligned}\Delta p_{yt} = {} & a_5 + a_6(w - p_y)_{t-1} + a_7(p_y - p_c)_{t-1} + a_8(p_y - p_y^*)_{t-1} \\ & + a_9 pppconv_t + a_{10} tradecomp_t + v_{4,t}\end{aligned} \tag{6}$$

where $a_6 > 0$, $a_7 < 0$, and $a_8 < 0$ is consistent with equilibrium correction behavior. In the pre-EMS period, the convergence variables are assumed to be zero and in the EMS period $a_9 > 0$ describes a downward sloping convergence trend in European inflation rate and $a_{10} < 0$ describes downward pressure on European inflation when there are large intraeuropean departures in trade-competitiveness.

The speed of adjustment towards sustainable European steady-state price levels is assumed to be influenced by institutional rigidities in the domestic labor market. This effect is captured by a 'Phillips curve' type relationship and a relationship between unemployment and trend-adjusted productivity.

The Phillips curve relation between price inflation and unemployment is assumed to be:

$$\Delta p_{yt} = a_{10} + a_{11} u_t + v_{5,t} \tag{7}$$

where $a_{11} < 0$ for (7) to be interpreted as a Phillips curve.

Remark 3 *When inflation and unemployment are cointegrated nonstationary variables, the short-run Phillips curve should be interpreted as a dynamic steady-state relation.*

The relationship between *unemployment and trend-adjusted productivity* is assumed to be:

$$u_t = a_{12}(q_t - b_1 t) + v_{6,t}, \tag{8}$$

where $a_{12} > 0$. This assumption is related to the way q_t is measured in the empirical analysis, namely $q_t = y_t - e_t$, where y_t is GDP output and e_t is aggregate employment. Thus, q_t can increase either as a result of an increase in aggregate output with constant employment or of a decrease in aggregate employment with constant GDP. In the first case one would expect a drop in unemployment, in the second case a rise. Here, we assume that the trend in (8) is a proxy for the growth in GDP and in aggregate employment associated with the trend in technological progress (which should not cause unemployment to rise, except possibly in the short run) whereas the deviation of productivity from this trend is assumed to be related to the second effect causing a rise in unemployment. Thus, labor productivity is improved by laying off a fraction, λ, of the work force (the least productive part) and producing the same output with the reduced work force $(1 - \lambda)e$.

Remark 4 *Relation (8) is assumed to capture labor market behavior in a transition period, for example when an economy moves from a lower to a higher state of technological development, or from a regulated to a deregulated economy.*

For the EMS period we assume hypothetically that departures from intraeuropean trade-competitiveness and the PPP convergence have influenced the relationship between inflation and unemployment, i.e.:

$$\begin{aligned} \Delta p_t &= a_{14}u_t + a_{15}pppconv_t + a_{16}tradecomp_t + v_{5t} \\ &= a_{14}(u_t - \bar{u}_t) + v_{5t} \end{aligned} \tag{9}$$

The stationarity of the residual v_{5t} would indicate that the nonaccelerating inflation rate of unemployment, $\bar{u}_t$, can be measured by:

$$\bar{u}_t = a_{14}^{-1}(a_{15}pppconv_t + a_{16}tradecomp_t) \tag{10}$$

4 The data and the statistical model

The empirical analyses are based on the following basic data vector

$$x_t' = [w, p_y, p_c, q, er, u]_t, \; t = 1970{:}1,...,1998{:}1$$

which consists of seasonally adjusted variables collected from the quarterly Euro-wide database described in Fagan, Henry, and Mestre (2001), defined as follows (their original names are given in brackets):

$w =$ the log of the compensation to the employees (WIN),

$p_c =$ the log the consumer price index (PCD),

$p_y =$ the log of the GDP deflator (YED),

$q =$ the log of labor productivity (Lprod) calculated as real GDP per total employment (YER/LNN),

$er =$ the log of Eurowide real exchange rates relative to US, Japan and UK (EER) denoted in the domestic currency, i.e. $er = \sum_{i=1}^{11} w_i eer_i$ where eer_i is the real effective exchange rate of country i w.r.t. US, Japan and UK and w_i is the weight of country i measured as $w_i = GDP_i / \sum_{i=1}^{11} GDP_i$ in 1995 (See also Appendix A).

$u =$ the unemployment rate (URX) calculated as the proportion of the unemployed in the labor force (UNN/LFN).

Graphs of the data are given in the Appendix B. Figure B.1 shows the graphs of the European wage inflation (Δw_t), consumer price inflation (Δp_{ct}), GDP price inflation (Δp_{yt}), and real wage growth rates ($\Delta(w - p_y)_t$. The nominal growth rates exhibit typical nonstationary behavior, indicating that price levels are $I(2)$ or near $I(2)$ variables. The decline in price inflation since the first oil price shock in 1973 until the end of the eighties is pronounced. Nominal wage growth has similarly declined steadily with two extraordinary large drops in 1984:2 and 1993:1. Real wage growth declined steadily during the seventies, after which it seems to have fluctuated around a constant level.

Figure B.2 shows the graphs of the real wage ($w_t - p_{y,t}$), the internal price wedge ($p_{y,t} - p_{c,t}$) and real effective exchange rate (er_t). All three variables are trending, real wages and real exchange rates strongly so, justifying a time trend in the model. Two of the variables, labor productivity and unemployment rate, will play a crucial role in the subsequent empirical analysis. Figures B:3 and B:4 focus on the behavior of these variables and their components. The big swing in the unemployment rate during the EMS period illustrates the very prolonged European business cycle that ended in the mid-nineties.

A baseline VAR(2) model with a linear trend in the cointegration space and three dummy variables seemed to be a satisfactory description of the variation in the data:

$$\Delta x_t = \Gamma \Delta x_{t-1} + \alpha\beta' x_{t-1} + \alpha\gamma_1 t + \Phi D_t + \mu + \varepsilon_t \tag{11}$$

where $\mu = \alpha\gamma_0 + \alpha_\perp \delta_0$ is unrestricted, so that γ_0 is an intercept in the cointegrating relations and δ_0 measures linear growth rates, the linear time trend is restricted to be in the cointegration space and D_t is a vector of three dummy variables, accounting for the first oil shock and the two large wage drops sticking out in Figure B:1.

Parameter constancy was checked using the recursive test procedures in Hansen and Johansen (1999). At around 1981-83, which coincides with the beginning of the hard EMS, the model showed strong econometric evidence of non-constancy as illustrated in Figure 3.

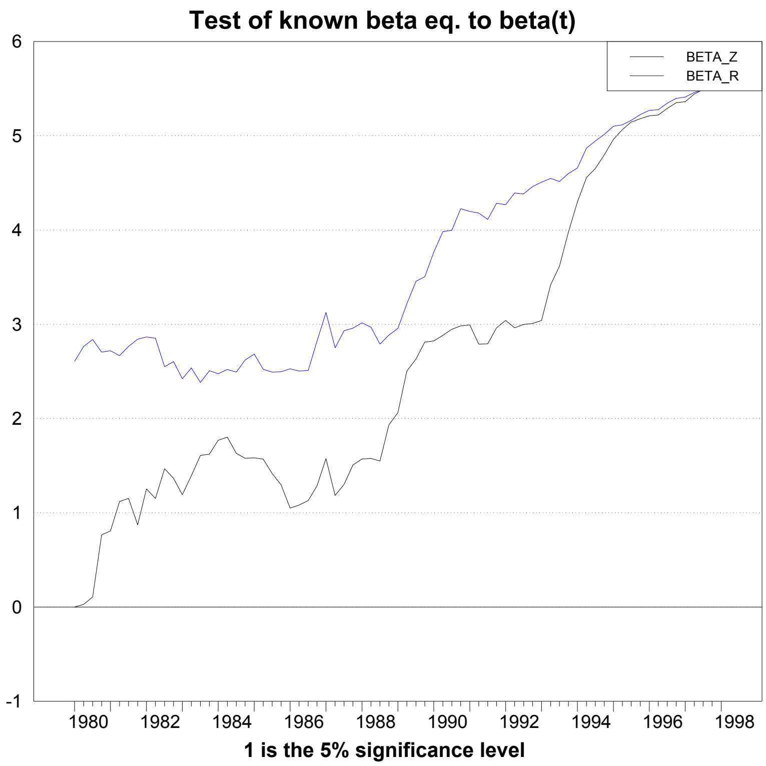

Figure 3. The graphs of the recursively calculated test statistic for constant β scaled with the 5% test value. All values > 1.0 reject constancy.

The graphs are based on the recursively calculated test of constant β suggested by Hansen and Johansen (1999). The hypothesis that β_{T_s}, $T_s =$1980:1 is in the 95 % confidence bands around $\hat{\beta}_t$ was strongly rejected for all $t = T_s$, ...,1998:1and the sample was divided in the following sub-periods: 1970:2 - 1980:1 and 1982:1 - 1998:1[4]. The years 1980 and 1981, whether included in the former or latter sub-period produced instability in the short-run adjustment parameters and were, therefore, omitted altogether. This suggests that agents needed a few years to learn how to act in the new regime.

The nominal variables, w, p_y, p_c, were found to be approximately integrated of order two, and, hence, nominal price and wage growth rates were I(1). Kongsted (2002) shows that under long-run price homogeneity the nominal system $[w, p_y, p_c, q, u, er, t]$ can be transformed into the real-nominal system $[w - p_y, p_y - p_c, \Delta p_y, u, er, t]$ without loosing information.

The price homogeneity hypothesis can be formulated as $R\beta = 0$ where β is $(p \times r)$ and R is $(1 \times p)$ given by:

$$R = [1, 1, 1, 0, 0, 0, 0]$$

i.e. the homogeneity restriction is imposed on all cointegration vectors. It can be tested by a LR test approximately distributed as $\chi^2(3)$ (see Johansen and Juselius, 1992). Note that it is a test on cointegrating vectors that are $CI(2,1)$. Since price homogeneity is often assumed to be found only over fairly long periods, it was first tested based on the full sample ignoring the evidence of parameter non-constancy. It was, however rejected in the full period (based on the test statistic 27.0, p-value = 0.00), but not rejected when based on the first period, 1970:2 - 1980:1, (3.65, p-value 0.30) and borderline not rejected in the second period, 1982:1 - 1998:1 (7.72, p-value = 0.05). Thus, when performing the analysis separately for the two regimes the nominal to real transformation seems acceptable and the subsequent analyses will be based on the I(1) model.

5 Specification tests and the choice of rank in the I(1) model

Given long-run price homogeneity the transformed system

$$x_t = [wr_t,\ \Delta p_t, q_t, u_t, pp_t, er_t] \tag{12}$$

where $wr_t = w_t - p_{yt}$, $pp_t = p_{yt} - p_{ct}$, and $\Delta p_t = \Delta p_{yt}$, contains only I(1) variables. All subsequent analyses for the first period are based on this data vector. For the second period the variables, $tradeconv_t$ and $pppconv_t$, measuring the convergence towards a European purchasing power parity is included as weakly exogenous variables.

[4] Many empirical studies have found a significant European regime shift around these dates (see for example, Juselius, 1998 and references therein)

Table 1: Misspecification tests and characteristic roots

	1970:2-1980:1					
	Multivariate tests					
Res. autocorr. LM_1	$\chi^2(36)$	$=$	54.5	p-val. $= 0.02$		
LM_4	$\chi^2(36)$	$=$	36.1	p-val. $= 0.46$		
Normality: LM	$\chi^2(12)$	$=$	11.7	p-val. $= 0.47$		
	Modulus of the 6 largest characteristic roots					
Unrestricted VAR:	0.93	0.93	0.91	0.67	0.67	0.63
$r = 4$	1.00	1.00	0.80	0.80	0.62	0.62
The trace test	6.8	20.6	42.0	75.2	121.9	195.2
Trace 90%	(10.6)	(23.0)	(39.1)	(59.0)	(82.7)	(110.0)
	rw	q	Δp_y	u	pp	er
$\hat{\alpha}_3(t - ratios)$	0.4	**-4.8**	1.1	-0.8	0.3	**4.9**
$\hat{\alpha}_4(t - ratios)$	-1.0	-0.4	**2.6**	**-4.5**	**3.8**	-0.1
R^2	0.37	0.66	0.72	0.58	0.69	0.80
	1982:1-1998:1					
	Multivariate tests					
Res. autocorr. LM_1	$\chi^2(36)$	$=$	37.4	p-val. $= 0.40$		
LM_4	$\chi^2(36)$	$=$	33.4	p-val. $=0.59$		
Normality: LM	$\chi^2(12)$	$=$	11.3	p-val. $= 0.50$		
	Modulus of the 6 largest characteristic roots					
Unrestricted VAR:	0.98	0.98	0.90	0.90	0.66	0.43
$r = 4$	1.0	1.0	0.89	0.89	0.80	0.45
	rw	q	Δp_y	u	pp	er
$\hat{\alpha}_3(t - ratios)$	**2.6**	-1.5	0.6	**-2.0**	-0.5	**-4.6**
$\hat{\alpha}_4(t - ratios)$	-0.2	-1.1	**-4.0**	**6.0**	**-2.1**	0.4
R^2	0.69	0.73	0.76	0.78	0.69	0.55

Table 1 reports some multivariate misspecification tests for each subperiod, which show that model (11) is an acceptable description of the data.

The the choice of cointegration rank is crucial as it not only determines the number of stationary components of the vector process, but also the number of common driving trends. In the present data we expect at least two common trends originating from permanent shocks to prices and productivity. Because a time trend is explicitly included in the model, there is at the outset one deterministic trend not directly influencing the cointegration rank. This time trend is likely to account for average growth rates in real wages, the internal and external price wedge, and productivity. Furthermore, trend-adjusted productivity looks like an I(1) variable (cf. Figure B.2 in Appendix B), which suggests an additional stochastic trend on top of the deterministic linear productivity trend.

Based on these considerations, the preferred candidate is $\{r = 4, p - r = 2\}$[5]. This hypothesis will be checked against the following information: (i) the roots of the characteristic polynomial, (ii) the trace tests, and (iii) the t-statistics of the adjustment coefficients.

The roots of the characteristic polynomial of the VAR model provide useful information about the rank, in particular when there are $I(2)$ or near $I(2)$ components in the data. The number of unit roots in the characteristic polynomial is $s_1 + 2s_2$, where s_1 and s_2 are the number of $I(1)$ and $I(2)$ common trends respectively. The nominal analysis (not reported here) indicated that nominal wages and the two prices shared one common I(2) trend. If the nominal to real transformation (12) correctly removes the I(2) trend there would be no $I(2)$ components left in the data and the number of unit roots (or near unit roots) would be $p - r$.

Because of the sample split the degrees of freedom are quite low and the trace test has to be interpreted with caution. While in the first period the trace test does not reject the preferred hypothesis, the acceptance of $r = 4$ is only borderline, and $r = 3$ could as well have been chosen. In the second period the standard trace test is not valid because of the inclusion of the EMU convergence variables as weakly exogenous in the model.

When choosing $r = \widehat{r}$ one can make an error of type I or type II. In the first case one would introduce a unit root in the cointegration model by incorrectly accepting the $\widehat{r}'th$ relation. In the second case the $(\widehat{r} + 1)'th$ relation would be left out even if it is stationary and has explanatory power. To examine this we have reported the t ratios of $\hat{\alpha}_3$ and $\hat{\alpha}_4$ in Table 1, where values greater than 2 are in bold face. For the first period the choice of $r = 3$ would have ignored some quite significant information in the fourth vector affecting inflation, unemployment, and the price wedge. It essentially describes a positive relationship between inflation and unemployment, i.e. the stagflation behavior of this period. As this was an important feature of the seventies we choose $r = 4$. For the second period the fourth relation essentially describes a Phillips-curve relation between inflation and unemployment entering significantly in the equations for unemployment, inflation and the internal price wedge. To achieve comparability and because the fourth relation seemed to contain information relevant for a Phillips curve relationship we choose $r = 4$ in both periods.

[5]Note that in the EMS period there are additionally two trends measuring the Euro convergence.

Table 2: Testing for weak exogeneity

r		rw	q	Δp	u	pp	er	$\chi^2(r)$
				1970:2-1980:1				
3		**2.4**	20.0	14.3	**6.8**	10.0	27.0	7.8
4	$\rightarrow$	**3.0**	24.2	20.2	14.3	16.1	25.0	9.5
				1982:1-1998:1				
3		**6.6**	30.0	8.8	**1.8**	13.3	**2.6**	7.8
4	$\rightarrow$	12.0	36.5	32.9	25.9	24.9	18.8	9.5

Insignificant test values are in bold face.

6 Weak exogeneity, common stochastic trends, and cointegration

Subsection 6.1 investigates possible changes in long-run weak exogeneity properties and 6.2 takes a closer look at these common stochastic trends and how they have influenced the data through the long-run impact matrix

6.1 Weak exogeneity

Because all inference in the cointegrated VAR model is crucially related to the choice of r it is useful to report the test results not only for the preferred choice but also for the closest alternative choice of r. Therefore, as a sensitivity analysis the tests of weak exogeneity (Johansen and Juselius, 1991) are reported in Table 2 for the two alternatives $r = 3$ and $r = 4$.

For the first period the test results show that the weak exogeneity of real wages is invariant to the choice of r, whereas unemployment would have been weakly exogenous for $r = 3$, but not for $r = 4$. Consistent with the discussion above we find that the choice of $r = 4$ instead of 3, increases the test value for inflation, unemployment and the price wedge. In the second period real wages, unemployment and real exchange rate would have been weakly exogenous for $r = 3$, but not for $r = 4$. Since the forth cointegration relation essentially describes the stagflation relation in the first period and the Phillips-curve relation in the second period this is an interesting results pointing to the importance of the inflation-unemployment relation for the wage-price-unemployment dynamics. It can also be noted that in both periods labor productivity and output-prices are strongly adjusting, whereas real exchange rates (the external wedge) is strongly adjusting in the first period, but less strongly so in the second the second period. Summarizing these findings:

Result 5 *Shocks to real wages have acted as a pushing force in the first* *but not in the second regime.*

Result 6 *Labor productivity and output prices are strongly adjusting independently of regime.*

6.2 Common stochastic trends

By inverting the cointegrated VAR model one can express the variables of the system as functions of the errors, the exogenous variables, *tradecomp* and *pppconv*, a deterministic time trend and a component Z containing the effects of initial values, the short-run dynamic effects of the exogenous variables, and the dummies:

$$x_t = C\Sigma_{i=1}^{t}\varepsilon_i + \gamma_1 t + \gamma_2 tradecomp + \gamma_3 pppconv + C^*(L)\varepsilon_t + Z \quad (13)$$

where C is a $p \times p$ matrix. For a given cointegration rank r, C has reduced rank $p-r$ and one can decompose $C = \beta_\perp(\alpha'_\perp\Gamma\beta_\perp)^{-1}\alpha'_\perp = \widetilde{\beta}_\perp\alpha'_\perp$where $\widetilde{\beta}_\perp = \beta_\perp(\alpha'_\perp\Gamma\beta_\perp)^{-1}$ and $\beta_\perp, \alpha_\perp$are $p \times p-r$ matrices. It is straightforward to interpret $\hat{\alpha}'_\perp\Sigma\varepsilon_i$ as an estimate of the underlying common stochastic trends generated by permanent shocks to the variables of the system and $\widetilde{\beta}_\perp$ as the corresponding weights to the variable. However, the $\widetilde{\beta}_\perp$ and $\alpha_\perp$ are not uniquely identified without imposing at least $p-r-1$ identifying restrictions and a normalization on each vector. Similarly, when Ω is not a diagonal matrix, ε_t can be expressed as Be_t where B, for example, can be defined by the Cholesky decomposition $BB' = \Omega$.

The purpose here is to give a tentative interpretation of the $p-r$ stochastic trends based on the cumulated residuals from the cointegrated VAR model by imposing identifying restrictions on the $\alpha_\perp$, but leaving $\hat{\varepsilon}_t$ unchanged.

In the first period the data can be represented by $p-r=2$ autonomous stochastic trends and one deterministic time trend:

$$\begin{bmatrix} rw_t \\ q_t \\ \Delta p_t \\ u_t \\ pp_t \\ er_t \end{bmatrix} = \begin{bmatrix} -0.3 & \mathbf{1.4} \\ \mathbf{-1.2} & \mathbf{1.1} \\ \mathbf{0.4} & \mathbf{0.1} \\ \mathbf{0.2} & \mathbf{-0.1} \\ \mathbf{-1.0} & \mathbf{0.2} \\ \mathbf{1.4} & 0.1 \end{bmatrix} \begin{bmatrix} \alpha'_{\perp.1}\Sigma\varepsilon_i \\ \alpha'_{\perp.2}\Sigma\varepsilon_i \end{bmatrix} + \begin{bmatrix} 0.0101 \\ 0.0073 \\ 0.0002 \\ 0.0012 \\ 0.0002 \\ 0.0150 \end{bmatrix} t + ... \quad (14)$$

where $\alpha'_{\perp.1} \approx [0, 0, \mathbf{1.0}, 0, \mathbf{-1.3}, 0]$ and $\alpha'_{\perp.2} \approx [\mathbf{1}, 0, 0, 0, 0, 0]$. Thus the first stochastic trend is roughly generated by shocks to inflation rate, noticing that $\Delta p_t - pp_t = (p_{c_t} - p_{y_{t-1}}) \simeq \Delta p_t$, and the second stochastic trend $\alpha'_{\perp.2}\Sigma\varepsilon_i = \Sigma\varepsilon_{rw_i}$ consists of cumulated shocks to the weakly exogenous real wage.

For the second period we have similarly two stochastic trends and a deterministic time trend. Furthermore, the two convergence variables were added to the system as a weakly exogenous variable and, hence, act as stochastic trends by assumption. The following representation describes the system for the second period:

$$\begin{bmatrix} rw_t \\ q_t \\ \Delta p_{y,t} \\ u_t \\ pp_t \\ er_t \end{bmatrix} = \begin{bmatrix} \mathbf{1.6} & \mathbf{1.2} \\ \mathbf{0.2} & \mathbf{0.3} \\ \mathbf{0.5} & \mathbf{-0.2} \\ \mathbf{-0.9} & \mathbf{-0.3} \\ \mathbf{-1.4} & -0.0 \\ \mathbf{-8.9} & -0.1 \end{bmatrix} \begin{bmatrix} \alpha'_{\perp.1}\Sigma\varepsilon_i \\ \alpha'_{\perp.2}\Sigma\varepsilon_i \end{bmatrix} + \begin{bmatrix} 0.0052 \\ 0.0048 \\ 0.0000 \\ -0.0003 \\ 0.0007 \\ 0.0079 \end{bmatrix} t + \begin{bmatrix} -2.2 & - \\ -1.6 & - \\ 0.8 & 3.4 \\ - & 2.0 \\ - & - \\ 1.0 & - \end{bmatrix} \begin{bmatrix} comp_t \\ conv_t \end{bmatrix} + ... \tag{15}$$

where $\alpha'_{\perp.1} \approx [0, 0, \mathbf{1}, 0, \mathbf{-1.2}, 0]$ and $\alpha'_{\perp.2} \approx [\mathbf{1}, \mathbf{0.5}, 0, 0, 0, 0]$. The two stochastic trends are very similar to the ones of the first period: the first one is almost identical describing cumulated shocks to inflation rate and the price wedge, and the second to real wages and labor productivity instead of exclusively to the real wage in the first period.

The nominal trend in the first period influences productivity and the internal price wedge negatively, and inflation, unemployment and real exchange rates positively, i.e. inflationary shocks lead to higher unemployment and to an appreciation of the currency. The real wage trend increases real wages, productivity, and inflation and has a small negative effect on unemployment. In the second period the nominal trend has a positive effect on real wages (no significant effect in period 1), a negative effect on productivity (a negative effect in period 1), a positive effect on inflation (similar as in period 1), a negative effect on unemployment (a positive effect in period 1) and a negative effect on the price wedge (similar as in period 1), and a negative effect on real exchange rates (positive in period 1).

The real stochastic trend has increased real wages and productivity in both periods but less so in the more recent period. It has increased inflation in the first period, but lowered it in the second and lowered unemployment in both periods. The real trend has also affected the price wedge and the real exchange rates differently in the two periods, but these effects are not very significant.

Result 7 *The stochastic trends are similarly generated in both periods, but the weights with which they enter the variables are fundamentally different*

The difference is still more pronounced when comparing the linear growth rates for the two periods. Real wages grew on average with approximately 4% per year in the first period and with 2.8% in the second period. Productivity grew on average less than real wages, i.e. with 3% in the first period, and with 2% in the second. However, when the convergence trend *pppconv* is left out the linear growth in real wages was only 1.7% which gives some indication that real wages may have grown less than productivity in the second period. The low real growth rates in the second period reflects the modest growth rates and the general productivity slowdown that started in the mid-eighties and lasted for almost a whole decade. Both inflation and unemployment has been similarly affected by the PPP convergence trend.

Result 8 *The growth rate of real wages exceeded the growth rate of productivity in the seventies whereas in the EMS period the productivity growth seem to have exceeded real wage growth. Hence, profit share decreased in the first regime, but has increased in the second.*

The estimates of the long-run impact matrix $C = \widetilde{\beta}_{\perp}\alpha'_{\perp}$ reported in Table 3 measures the overall long-run impact of an unanticipated shock ε_{it}, $i = 1, ..., p$, on all variables of the system where ε_{it} are the residuals from the VAR model. Since the residuals are not normalized their standard deviations are also reported in the table. To increase readability coefficients with a t-ratio > 2.5 are reported in bold face, a t-ratio $> 1.6 < 2.5$ in italics.

7 Cointegration properties

In this section we impose (over)identifying restrictions on the r cointegration relations. These define four irreducible cointegration relations, used as the 'building blocks' of (possibly) more complicated steady-state relations in the short-run dynamic adjustment analysis of Section 8. When interpreting the estimated cointegration relations we will frequently refer to the hypothetical steady-state relations discussed in Section 3, albeit recognizing that there need not be a one-to-one correspondence between them. Table 4 reports the estimates of the four cointegration relations whith four over-identifying restrictions in each period. They were tested with a LR test distributed as $\chi^2(4)$ and accepted with a p-value of 0.51 in the first period and with 0.10 in the second.

7.1 Cointegration properties in the first regime

Result 9 *In the pre-EMS period it was not possible to find empirical support for a plausible long-run real wage relation (5) with equilibrium-correcting behavior in real wages.*

Table 3: Estimates of the long-run impact matrix C

			1970:2-1980:1			
	$\hat{\varepsilon}_{rw}$	$\hat{\varepsilon}_{q}$	$\hat{\varepsilon}_{\Delta p}$	$\hat{\varepsilon}_{u}$	$\hat{\varepsilon}_{pp}$	$\hat{\varepsilon}_{er}$
$\hat{\sigma}_{\varepsilon}$	0.0043	0.0036	0.0025	0.0008	0.0020	0.0093
rw	**1.41**	-0.02	-0.27	0.25	0.33	-0.02
q	**1.08**	-0.09	*-1.32*	1.25	1.61	-0.11
Δp_y	0.07	0.03	*0.43*	-0.41	-0.53	*0.04*
u	*-0.09*	0.01	*0.23*	-0.21	-0.28	*0.02*
pp	*0.17*	-0.07	*-1.06*	1.00	1.29	*-0.09*
er	0.06	0.10	*1.49*	-1.41	-1.82	*0.13*
t	0.0097	0.0071	0.0002	0.0012	0.0002	0.0150
			1982:1-1998:1			
	$\hat{\varepsilon}_{rw}$	$\hat{\varepsilon}_{q}$	$\hat{\varepsilon}_{\Delta p}$	$\hat{\varepsilon}_{u}$	$\hat{\varepsilon}_{pp}$	$\hat{\varepsilon}_{er}$
$\hat{\sigma}_{\varepsilon}$	0.0034	0.0026	0.0013	0.0009	0.0016	0.0185
rw	**0.93**	**0.81**	*1.51*	0.53	*-2.10*	*0.14*
q	**0.24**	*0.15*	0.15	0.06	-.24	*0.03*
Δp_y	**0.10**	**0.16**	**0.50**	0.16	–**0.65**	0.02
u	**-0.15**	**-0.29**	**-0.92**	-0.30	**1.18**	-0.03
pp	**0.24**	*-0.20*	**-1.36**	-0.40	**1.63**	0.01
er	**1.60**	-1.25	**-8.85**	-2.62	**10.58**	0.09
t	0.0052	0.0048	0.0001	-0.0003	0.0007	0.0079

Bold face indicates $|t - ratio|$ >2.5, italics 1.5 <$|t - ratio|$ <2.5.
All remaining entries have $|t - ratio|$ <1.6

We interpret this as evidence of excess wage claims imposed by strong labor unions. Labor unions were probably successful in achieving real wage increases in excess of productivity because of the possibility to devalue the domestic currency and because trade barriers reduced international competitiveness.

Result 10 *To restore lost competitiveness employers had to increase labor productivity.*

Evidence of this is found in the first cointegration relation describing trend-adjusted labor productivity as a positive function of real wages $(w - p_y)$ and the price wedge $(p_y - p_c)$. Though not directly interpretable as a real wage relation it can be seen as a modified version of (5). Labor productivity is strongly equilibrium-correcting to this relation, but not real wages.

Result 11 *Productivity was achieved by technological progress and by laying off workers.*

Table 4: Estimated long-run steady-state relations for 1970-80 and 1982-98

	rw	q	Δp	u	pp	er	$trend$	$comp$	$conv$
					1970:2-1980:1				
β_1'	-0.70 (63.4)	1.0	-	-	-1.40 (10.5)	-	-	-	-
β_2'	-	-0.03 (2.0)	-	1.0	-	-	0.001 ()	-	-
β_3'	-	-	1.0	-	-	-0.31 (17.4)	0.005 ()	-	-
β_2'	-	-	1.0	-0.32 (-4.4)	0.83 (13.6)	-	-	-	-
α_1'	-	$***$ ($-$)	-	$*$ ($-$)	-	-			
α_2'	-	$***$ (+)	$***$ ($-$)	$***$ ($-$)	$***$ ($-$)	$*$ ($-$)			
α_3'	-	$*$ (+)	-	-	$**$ (+)	$***$ (+)			
α_4'	-	-	$***$ ($-$)	$***$ ($-$)	$***$ ($-$)	-			
					1982:1-1998:1				
β_1'	1.0	-0.56 (-9.6)	-2.00 (-4.3)	2.21 (9.3)	1.0	-0.32 (13.4)	-	-	5.59 (3.8)
β_2'	-0.48 (-11.4)	1.0	-	-1.17 (-10.2)	-	0.04 (6.1)	-0.003 (13.6)	-	-
β_3'	-0.21 (-7.4)	-	1.0	-	-0.91 (-11.8)	0.18 (11.4)	-	-0.15 (-5.7)	-
β_4'	-	-	1.43 (16.7)	1.0	-	-	-	-0.18 (3.7)	0.90 (16.0)
α_1'	-	-	$***$ (+)	$***$ ($-$)	$***$ (+)	-			
α_2'	$*$ (+)	$***$ ($-$)	$-$	$***$ ($-$)	-	-			
α_3'	$*$ (+)	$-$	$***$ (+)	$**$ ($-$)	$**$ (+)	$*$ ($-$)			
α_4'	-	$*$ (+)	$***$ ($-$)	$**$ ($-$)	$***$ ($-$)	$*$ ($-$)			

*** indicates $|$t-ratio$|$>3.3, ** indicates {2.5$\leq$ $|$t-ratio$|$< 3.3}, and * indicates {1.6$\leq$ $|$t-ratio$|$< 2.5

Evidence for this can be found in the second cointegration relation describing a positive relationship between unemployment and trend-adjusted productivity, i.e. relation (8) with strong equilibrium-correcting behavior in the unemployment equation.

Result 12 *Devaluations were frequently used to as a means to avoid (or at least postpone) large scale firings.*

Evidence of this effect can be found in the third cointegration relation describing the dynamic price adjustment relation (6) where output inflation is positively related to the real exchange rate. The latter is equilibrium-correcting to this relation whereas productivity has increased and the price wedge decreased when the currency is devaluated.

Result 13 *The result of this wage-price-unemployment-productivity-devaluation spiral was stagflation. But, short-run Phillips curve effects can be found even in the stagflation regime.*

Evidence of this can be found in the forth cointegration relation describing a positive relationship between inflation and unemployment. See also Beyer and Farmer (2002). While inflation rate and the price wedge are equilibrium-correcting to the stagflation relation, unemployment is significantly affected but not equilibrium-correcting. Instead it is decreasing when producer price inflation is above its 'steady-state' value, i.e. evidence of a short-run Phillips curve effect.

7.2 Cointegration properties in the second regime

In the second period the identified long-run steady-state relations tell a different story which is more about weak labor unions, large-scale labor lay-offs, productivity adjustment and declining inflation.

Result 14 *A plausible wage relation (5) describing real consumer wages* $(w - p_c)$ *being positively related to labor productivity (though less than proportionally), negatively related to unemployment rate, and positively to real exchange rates was identified. However, unemployment rather than real wages were equilibrium-correcting to this relation.*

We interpret this to mean that labor unions were unable to enforce excess wage increases in the EMS regime because competitive devaluations were no longer possible and the goods market became increasingly competitive.

Result 15 *Competitiveness was improved by increasing labor productivity which was primarily achieved by labor layoffs.*

Evidence of this is found in the second cointegration relation describing deviation from trend productivity as a positive function of real wages, inflation and unemployment. Labor productivity is strongly equilibrium-correcting to this relation, whereas unemployment is significantly affected but not equilibrium-correcting. The latter is evidence of the widespread use of labor layoffs as a means to improve labor productivity, a typical feature of both regimes. But contrary to the pre-EMS period devaluations were no longer possible in the hard EMS. As a result unemployment rose steadily in the eighties and the nineties which can explain the weakening of the labor unions.

Result 16 *Price competitiveness seems increasingly important in the EMS regime.*

Evidence of this is found in the third cointegration relation measuring output-price inflation as dynamically adjusting to real wages, the internal price wedge, the real exchange rate. It is also significantly influenced by the *pppconv* variable measuring the convergence towards a sustainable European purchasing power parity. Real wages, the internal price wedge and real exchange rates are equilibrium-correcting, whereas price inflation is overshooting.

Result 17 *A conventional Phillips curve relationship (7) has replaced the stagflation relation between price inflation and unemployment, describing the pay-off between low inflation and high unemployment in the eighties and the nineties. Stationarity was achieved only after the latter were corrected for the effect of the two convergence variables. Thus, the latter can be interpreted as a measure of NAIRU in this period.*

Evidence of this is found in the fourth cointegration relation with equilibrium-correction behavior in both the inflation and unemployment equations. Productivity, the internal price wedge and real exchange rates are significantly affected by departures from this relation.

7.3 Illustrating the differences

The significance of the differences in the macroeconomic behavior in the two regimes are illustrated by Figures 4 - 7, where the four steady-state relations are graphed for each regime and extrapolated into the period of the other regime. There can be little doubt that the cointegration property is lost when extrapolating outside the sample period consistent with the strong rejection of the constancy of the cointegration space.

Figure 4 shows that the level of labor productivity in the eighties and the nineties would have been well above its steady-state value if it were modeled by the productivity relation of the seventies. A similar conclusion can be reached for real exchange rates: compared to the mechanisms of the seventies real effective exchange rate would be overvalued in the more recent period. Figure 5 extrapolates the steady-state level of inflation rate in the seventies into the EMS period and demonstrates the dramatic drop experienced when the stagflation mechanism came to an end. The unemployment rate in most of the eighties would have been above the 'steady-state' level of the seventies and below the level in the nineties.

Altogether, Figures 4 and 5 suggest that the introduction of EMS caused a change in the linear growth rates and produced the very long business cycle swings strongly visible in Figure 5. The former effect can be explained by the change in the growth rates of real wages and productivity as demonstrated in (14) and (15). The long swings effect seems to be related to the intraeuropean trade-competitiveness $tradecomp_t$ and the convergence to sustainable European PPP levels, $pppconv_t$.

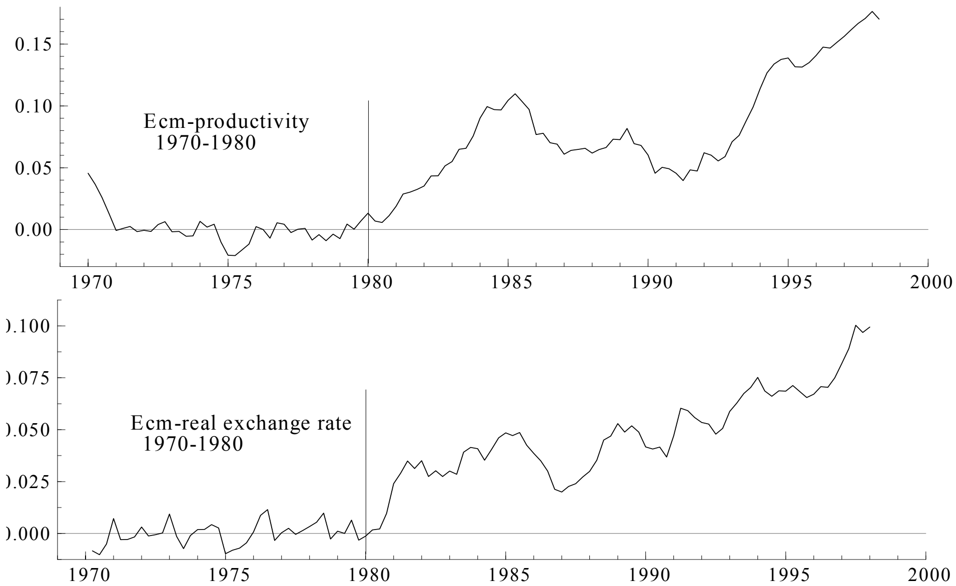

Figure 4. Forward extrapolation of $\beta_1' x_t$ and $\beta_3' x_t$ of Table 4.

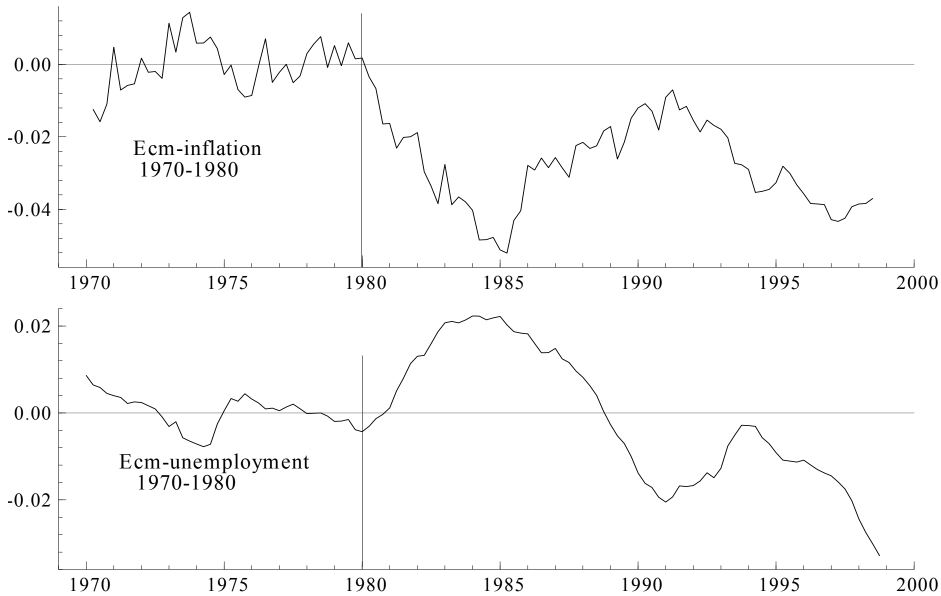

Figure 5. Forward extrapolation of $\beta_2' x_t$ and $\beta_4' x_t$ of Table 4.

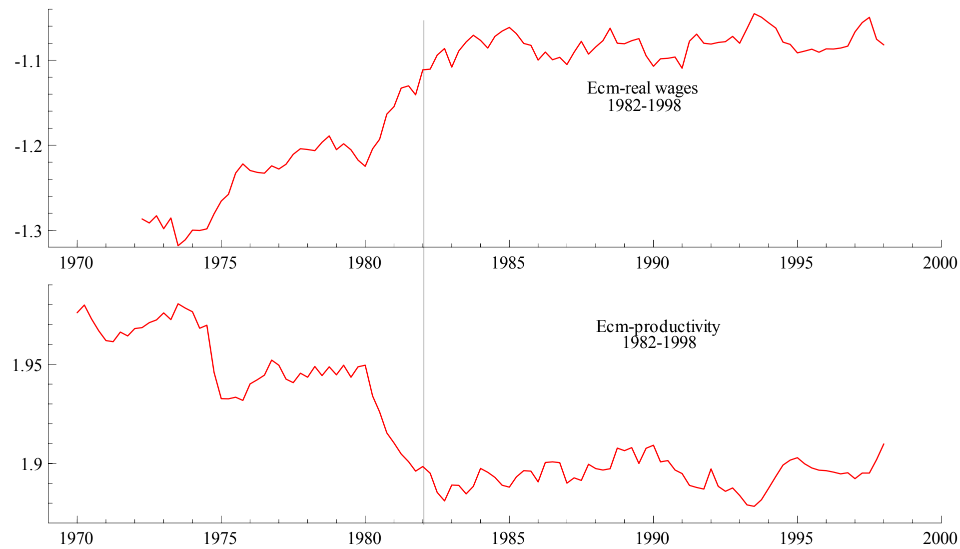

Figure 6. Backward extrapolation of $\beta_1' x_t$ and $\beta_2' x_t$ of Table 4.

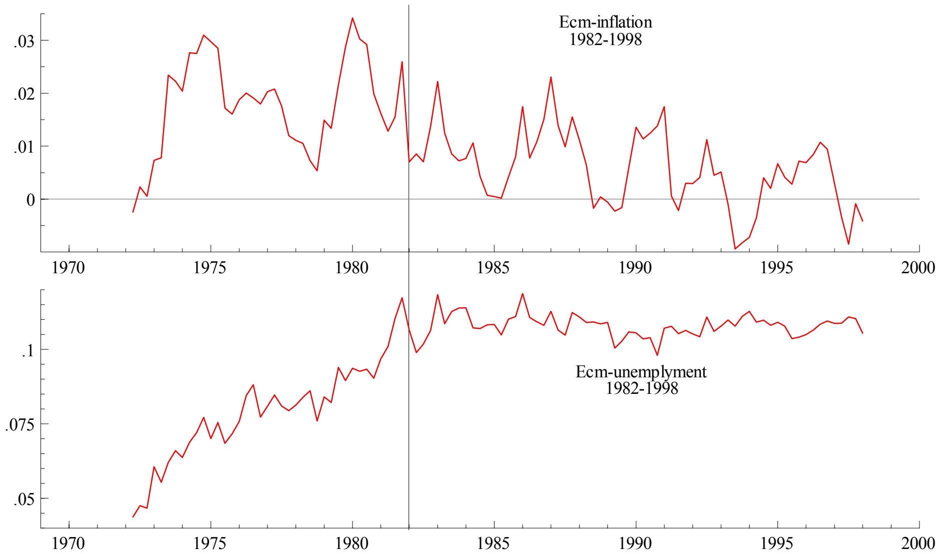

Figure 7. Backward extrapolation of $\beta_3' x_t$ and $\beta_4' x_t$ of Table 4.

Figures 6 and 7 show the extrapolations of the steady-state relations of the eighties and nineties backwards into the seventies. Figure 6 demonstrates that if the EMS regime had been working already in the seventies the steady-state level of real wages would have been well below and productivity above the steady-state levels of the more recent period. Figure 7 shows that inflation would have been above and unemployment below the steady-state levels of the eighties and the nineties.

Altogether, Figures 6 and 7 demonstrate a similar change in the linear growth rates comparable and a similar shift in the equilibrium means as discussed above. They seem to be related to the shift in the level of inflation rates and the change in productivity growth between the two periods.

8 The estimated wage and price dynamics

The unrestricted VAR model is, in general, heavily over-parametrized in the short-run adjustment parameters and needs to be simplified. This is done here by imposing zero restrictions on insignificant coefficients, while keeping the identified cointegration relations in Table 4 fixed at their estimated values.

In the pre-EMS period all lagged variables except for the price wedge were insignificant based on an F-test and removed from the system. The real wage was found to be strongly exogenous and was included as an exogenous variable in the system. In this simplified system 17 additional insignificant coefficients were set zero and tested with a likelihood ratio test. The zero restrictions were accepted based on $\chi^2(17) = 16.4(0.50)$.

In the EMS period all lagged variables except for the real exchange rate were found insignificant and removed from the system. The internal price wedge was not found to be equilibrium-correcting and was treated as exogenous to simplify the model. Two of the dummy variables, D8301 and D8601, became insignificant in the system after conditioning on the internal price wedge. In the simplified system altogether 16 over-identifying zero restrictions were imposed and accepted based on the LR test statistic $\chi^2(16) = 22.0\,(0.14)$. Table 5 reports the estimated coefficients of the simplified model.

In the pre-EMS period real wages were not equilibrium-correcting, but labor productivity was instead significantly equilibrium-correcting both to ecm1$(q-0.70rw-1.40pp)$ and to ecm2 $(u-0.034q-0.001t)$. The latter shows that unemployment and trend-adjusted productivity were co-moving as described by (8). Both the price wedge and inflation adjust negatively to $ecm2$, i.e. unemployment in excess of trend-adjusted labor productivity has resulted in less inflationary pressure and a narrowing of the internal price wedge. The latter has also adjusted negatively to $ecm3$ $(er - 3.2\Delta p_y + 0.014t)$, i.e. the price wedge has narrowed when the real exchange rate has been above its steady-state value. This suggests that profits, not prices, have adjusted in this regime which can be interpreted as evidence in favor of the pricing-to-market hypothesis in Krugman (1989). Real exchange rates have exclusively adjusted to ecm3.

Finally, inflation and the price wedge have been strongly equilibrium-correcting to ecm4 $(\Delta p_y - 0.32u + 0.83pp)$, the stagflation relation, whereas unemployment has been decreasing when inflation is above its steady-state value. The latter gives some evidence of a short-run Phillips curve effect but only as a short-run correction to deviations from the much stronger stagflation relation.

In the EMS period real wages are equilibrium correcting to ecm2, the productivity relation $(q-0.5rw-1.2u-0.04er-0.003t)$, and to ecm3, the inflation adjustment relation $(\Delta p_y-0.2rw-0.9pp+0.2er+0.15pppcomp)$, but are overshooting in ecm1, the real wage relation with less than full compensation for productivity gains and with strong negative unemployment effects $(w - p_c - 0.6q + 2.2u - 0.3er + 5.6pppconv - 2.0\Delta p_y)$.

Productivity is strongly equilibrium-correcting to ecm2 describing that labor productivity has increased with real wages, unemployment and real exchange rates. It is noteworthy that unemployment is also strongly affected by ecm2 but not in an equilibrium-correcting way. Although unemployment and trend-adjusted productivity have been co-moving it is only productivity that has been adjusting, consistent with the hypothesis that shocks to unemployment have driven the increase

Table 5: An estimated short-run adjustment structure for each period

1970:2-1980:1							
	Δrw_t	Δpp_{t-1}	$ecm1_{t-1}$	$ecm2_{t-1}$	$ecm3_{t-1}$	$ecm4_{t-1}$	$D7303$
Δq_t :	0.63 (5.3)	-	-0.29 (−3.3)	0.45 (2.1)	-	-	-
Δu_t :	-	0.26 (4.2)	-0.07 (−3.7)	-0.44 (−4.5)	-	-0.18 (−3.7)	-0.002 (−2.8)
Δpp_t :	-	0.55 (3.2)	-	-0.63 (−2.6)	-0.03 (−2.3)	-0.58 (−4.7)	0.005 (2.4)
$\Delta^2 p_t$:	-	-	-	-1.23 (−5.2)	-	-0.84 (−6.8)	0.006 (1.8)
Δer_t :	-	-	-	-	-0.45 (−5.1)	-	0.082 (6.0)

$ecm1 = q - 0.70rw - 1.40pp$
$ecm2 = u - 0.034q - 0.001t$
$ecm3 = er - 3.18\Delta p_y + 0.0144t$
$ecm4 = \Delta p_y - 0.32u + 0.83pp$

1982:1-1998:1								
	Δpp_t	Δer_{t-1}	$ecm1_{t-1}$	$ecm2_{t-1}$	$ecm3_{t-1}$	$ecm4_{t-1}$	$D8402_t$	$D9301_t$
Δrw_t :	-	-	0.15 (2.2)	0.43 (4.9)	0.43 (2.9)	-0.28 (−1.7)	-0.018 (−4.1)	-0.018 (−4.1)
Δq_t :	-	-	-	-0.22 (−3.0)	-	0.29 (2.1)	-0.012 (−3.0)	-0.009 (−2.4)
$\Delta^2 p_t$:	0.48 (7.0)	-0.02 (−2.2)	0.10 (4.1)	$-$	0.17 (3.0)	-0.41 (−7.4)	-	-
Δu_t	-	-	-0.09 (−5.1)	-0.25 (−10.8)	-0.13 (−3.3)	-0.07 (−1.9)	0.002 (2.0)	-
Δer_t :	4.33 (4.4)	0.24 (1.9)	-0.62 (−2.0)	-	-2.75 (−3.9)	-	-	-

$ecm1 = rw + pp - 0.6q + 2.2u - 0.3er + 5.6pppconv - 2.0\Delta p_y$
$ecm2 = q - 0.5rw - 1.2u + 0.04er - 0.003t$
$ecm3 = \Delta p_y - 0.2rw - 0.9pp + 0.2er + 0.15tradecomp$
$ecm4 = u + 1.4\Delta p_y + 0.9pppconv - 0.18tradecomp$

*) approximate t-values are given in brackets

in labor productivity in this period. This interpretation is further confirmed by productivity being positively affected by ecm4, the modified Phillips curve relation $(u + 1.4\Delta p_y + 0.9pppconv - 0.18tradecomp)$.

Inflation rate is strongly equilibrium-correcting to ecm1 and ecm4 and also affected by ecm2 and ecm3. The combined effects show that inflation is significantly adjusting to real wages, the internal price wedge and the competitiveness variable (but not to the external price wedge) with the correct signs as given by the dynamic adjustment relation (6). Unemployment is also significantly equilibrium-correcting to ecm1 and ecm4 and strongly affected by ecm2 but, as already mentioned, not in an equilibrium-correcting manner. Real exchange rate has been influenced by ecm1 and ecm3 showing that the European currencies have depreciated when real wages and output price inflation have been above their steady-state values.

9 Summary results and conclusions

This paper has shed new light on the European price, wage and unemployment dynamics and how it changed as a result of the increased European integration by comparing the wage, price and unemployment dynamics of the pre-EMS period of the seventies with the EMS (pre-EMU) period of the eighties and the nineties.

The empirical behavior in labor market during the pre-EMS period was consistent with strong labor unions being able to enforce excess real wage claims. The results indicated that the reduced competitiveness was restored by improvements in labor productivity achieved by laying off part of the labor force, that competitive devaluations were frequently used as a short-run remedy for lost competitiveness and that the increase in consumer prices (as a consequence of higer import prices) resulted in further wage claims. The end result was that both inflation and unemployment, both I(1), were positively co-moving in a stationary stagflation relationship. Inflation in excess of this relationship had a negative effect on unemployment. Thus, even in the stagflation regime there was some evidence of short-run Phillips curve effects. Permanent shocks to real wages were the main driving force in this period and it was not possible to find empirical evidence of a plausible real wage relation with equilibrium error correction in the real wage equation. Most of the adjustment took place in productivity (defined as total GDP per total employment). The estimated feed-back dynamics showed that the productivity improvement was achieved by producing the same output with less labor.

The 'hard' EMS period of the eighties and the nineties was characterized by a strong Phillips-curve relationship between inflation and unemployment after having corrected for the intraeuropean competitiveness trend. A real wage relation with negative effects from unemployment was identified, with significant equilibrium-correction in the output price equation. Similar to the first period trend-adjusted productivity was positively related to real wages, unemployment and the external price wedge.

Thus, the first regime seems to be a story about strong labor unions, rigid institutions, productivity adjustment, devaluations and realignments, not as a cure but as a means to hide the symptoms of the illness. In the second regime the story is about increasingly weak labor unions, large-scale labor layoffs, and productivity adjustment. Excessive real wage claims seemed to have caused both price inflation and unemployment in the first period, but foremost unemployment and declining inflation in the second period. Competitiveness was largely achieved by producing the same output with less labor, evidenced by unemployment and trend-adjusted productivity moving together in the data. This can explain both the so called European productivity slow-down and the high levels of unemployment rate of this period.

Why are the stories so different? The paper argues that the high and persistent unemployment rates and the low inflation rates after fixing the intra-European exchange rates in 1983 are related to the very slow adjustment towards sustainable European PPP levels. This points to the crucial importance of being on a sustainable PPP level when fixing the exchange rates.

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11 Appendix A1: Measuring the European PPP convergence

To measure the impact on wages, prices, and unemployment of European price and productivity convergence two new variables have been constructed: the first variable, $pppconv_t$, is assumed to measure the aggregate impact of the convergence towards a more sustainable European PPP level, the other, $tradecomp_t$, the impact of intra-european departures in trade-competitiveness. Because most of the trade in Europe is between the member states we expect large absolute deviations from parity to have generated business cycles through their effects on the import and export demand.

The *pppconv* variable is defined as:

$$pppconv_t = \sum_{i=1}^{9} w_i \left| ppp_{i_t} - \widetilde{ppp}_{i,1998} \right|$$

where $ppp_{i,t} = p_{i,t} - p_{Ge,t} - s_{i,Ge}$, $p_{i,t}$ is the consumer price index of country i, $p_{Ge,t}$ is the German consumer price index, $s_{i,Ge}$ is the average Dmk exchange rate of country i, w_i is the weight of country i measured as $w_i = GDP_i/GDP_{eurowide}$ in 1995, $\widetilde{ppp}_{i,1998}$ is the PPP position of country i relative to Germany before entering the EMU estimated with the help of the BigMac index (the Economist), and $i = Fr, It, Sp, Ne, Be, Au, Po, Fi, Ir$[6].

The *tradecomp* variable is defined as:

$$tradecomp_t = \sum_{i=1}^{10} w_i \left| wer_{i_t} - 100 \right|$$

where wer_{i_t} is the trade-weighted real effective exchange rate of country i relative to the rest of the OECD, where 100 denotes average competitiveness of the OECD countries at each point of time t.

The GDP weights in 1995 for the member states are as follows:

Ge	Fr	It	Sp	Ne	Be	Au	Po	Fi	Ir
30.5	21.0	20.3	10.2	5.6	3.9	3.0	2.4	1.7	1.1

Figure A:1 shows the *ppp* development for France, Netherlands, Belgium, and Austria all of which have followed the German PPP levels fairly closely since the beginning of the eighties. Figure A:2 shows the *ppp* development for the devaluation countries, Italy, Spain, Finland and

[6]Luxenbourg as a very small country and Greece as a very recent member have been left out.

Ireland. At the beginning of the EMS in 1979 they were all at a lower PPP level compared to Germany but due to steadily increasing prices they reached parity levels already in the late eighties, but started to move away from parity. The devaluations in 1990-93 seemed to restored competitiveness by bringing the real exchange rate below the parity.

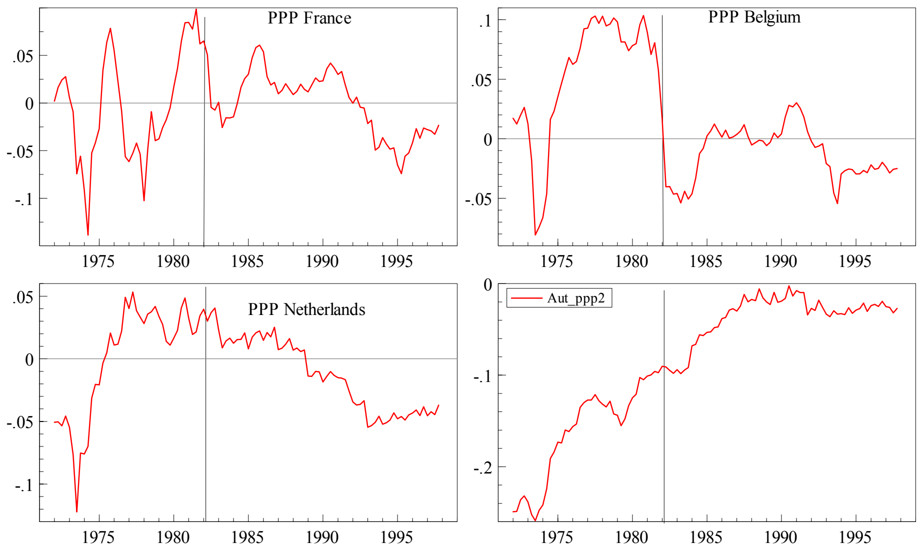

Figure A:1: The PPP development relative to German Dmk.

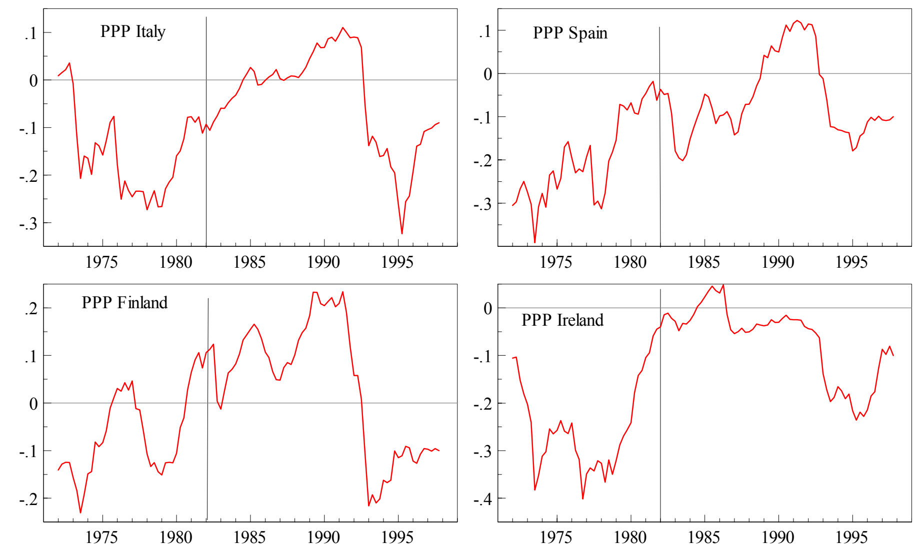

Figure A.2: The development of the PPP relative to German Dmk.

Figure A:3 illustrates the relative trade-competitiveness, wer_t, of the

'Dmk economies'. At the start of the EMS in 1979 they show declining prices i.e. improvement in competitiveness relative to the low price member states. Germany seems to have reached a steady-state level as early as 1983 but lost competitiveness after the reunification in 1991. France achieved her steady-state position around 1986 and seems to have fluctuated around this value since. Netherlands and Belgium experienced a similar price convergence as Germany and have managed to stay around the steady-state position since. Austria was a low price country at the beginning of the EMS and its prices have steadily increased all since. Though Austria has slowly lost competitiveness in this period, she has, nevertheless, been close to the steady state since 1987.

Figure A:4 illustrate the development of the 'devaluation' member states. The strong devaluations of the Italian, Spanish and the Finnish[7] currencies in the period 1991-1993 indicate that the preceding price development in these countries had pushed domestic prices above sustainable PPP levels. Finland shows a steady increase in prices since the beginning of the EMS period until the devaluation in 1990. For Italy and Spain the deterioration of competitiveness continued until approximately 1992 when speculative attacks forced them to devalue their currencies. At the end of the period the real exchange is approximately at the 1983 level for Italy and at the 1987 level for Spain.

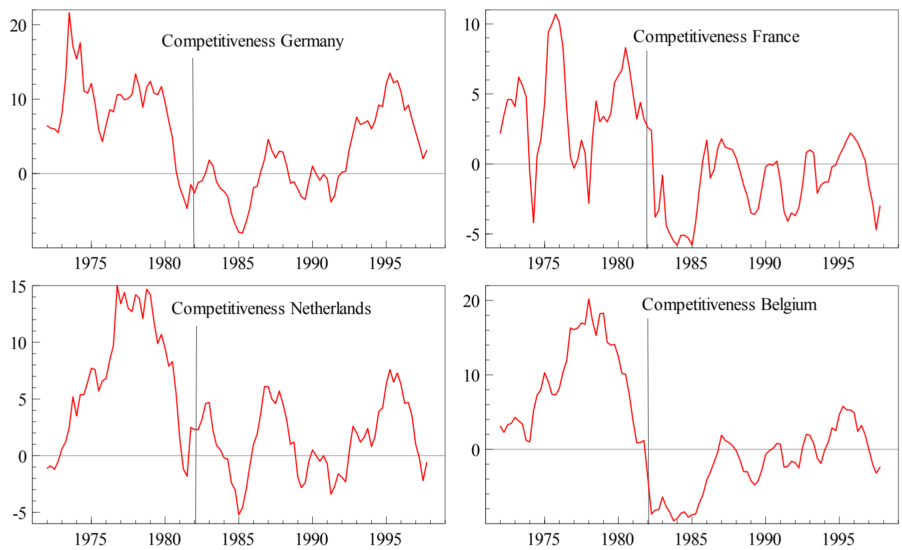

Figure A.3: The relative trade-competitiveness of the 'Dmk' economies.

[7] Finland is a recent member state which before joining, was forced to devalue its currency as much as 30%. Because of her trade with the former Sovjet Union she was partly sheltered from international competitiveness until the collapse of the former in 1987.

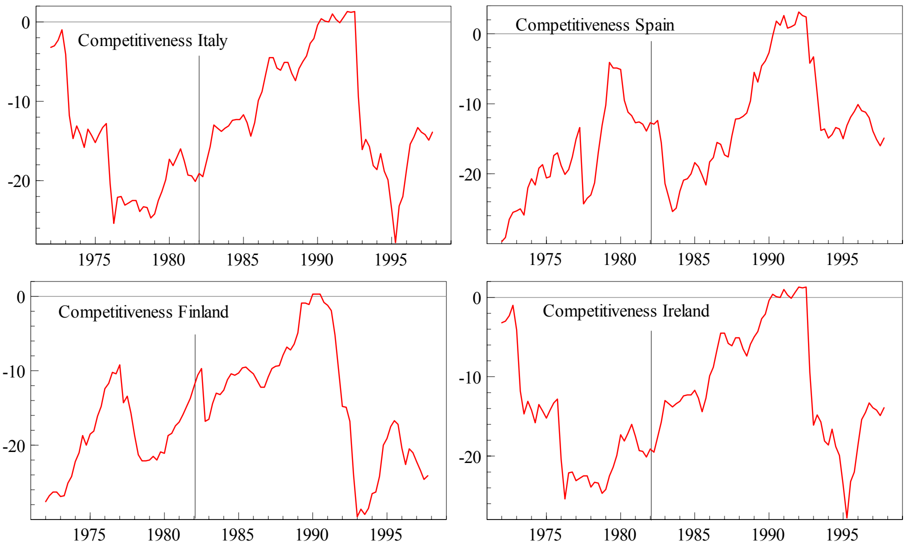

Figure A.4: The relative trade-competitiveness of the devaluation economies.

The graphs suggest that a PPP convergence did take place in the first decade of the EMS but that the low PPP member states seem to have been unable to stop further price increases and lost their relative competitiveness.

12 Appendix B: Data

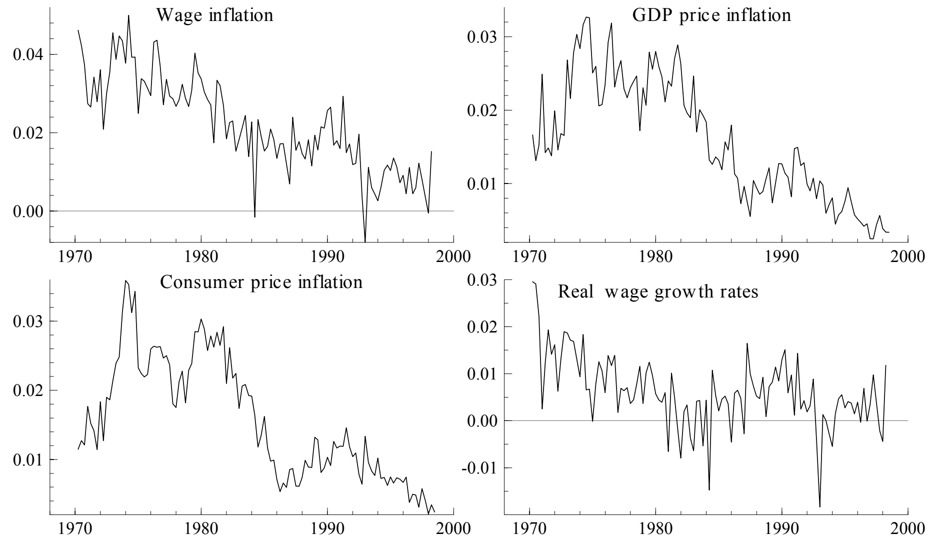

Figure B.1. Graphs of nominal wage and price growths and real wage growth.

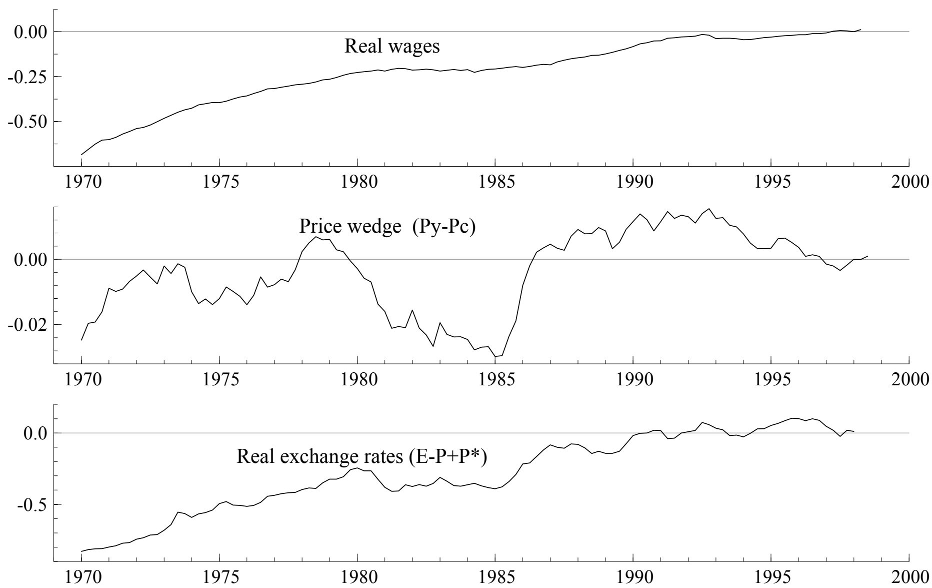

Figure B.2. Graphs of real wages, the internal price wedge, and the external price wedge.

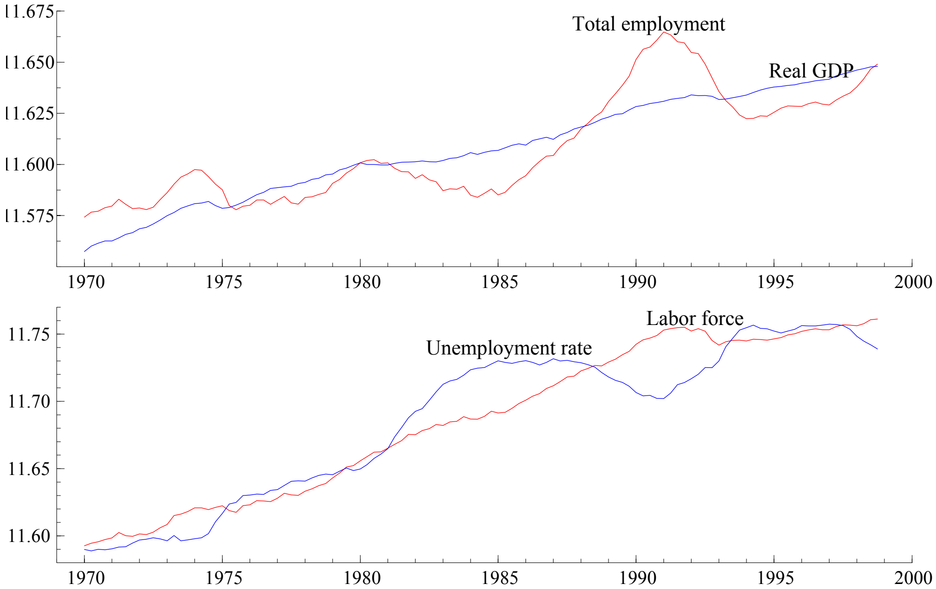

Figure B.3. Graphs of total employment and real GDP (upper panel) and the unemplyment rate and the labor force (lower panel).

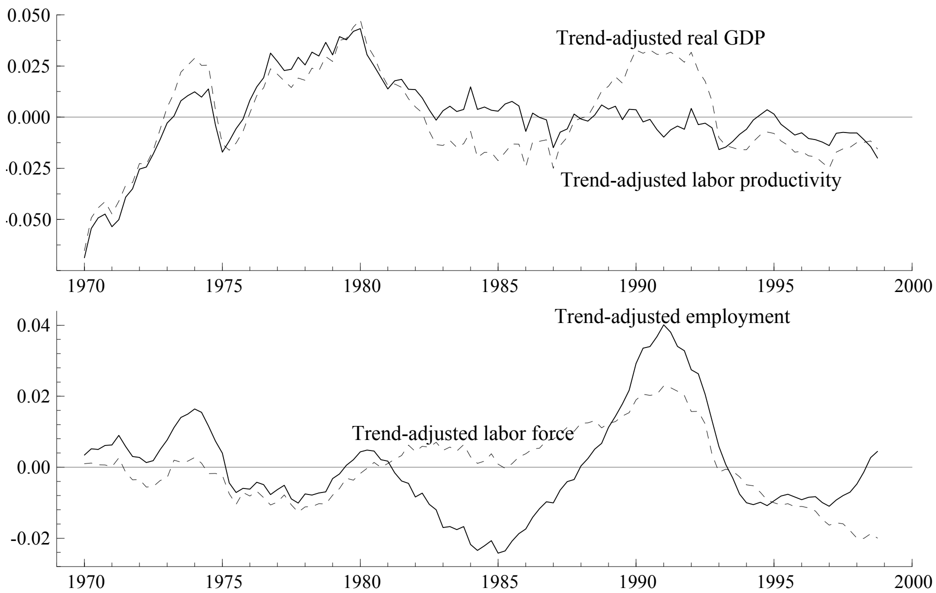

Figure B.4. Graphs of trend-adjusted real GDP and trend-adjusted labor productivity (upper panel) and trend-adjusted employment and trend-adjusted employment (lower panel).