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. A variable measuring the convergence towards European purchasing power parity is shown to be crucial for explaining inflation and unemployment behavior in the more recent regime. It points to the importance of being on a sustainable ppp level when fixing the exchange rates.

Preliminary! Comments welcome!

1 Introduction[1]

The post Bretton Woods period can be divided into two distinctly different periods regarding European macroeconomic behavior: the pre-EMS period of the seventies up to the beginning of the eighties characterized by high inflation rates, relatively high unemployment rates, frequent devaluations, volatile real growth rates, capital regulations, high nominal interest rates, but low or even negative real interest rates; the strong EMS period of the eighties until the beginning of the present monetary union characterized by low inflation rates, almost fixed exchange

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rates, capital deregulation, modest growth rates, very high unemployment rates, decreasing nominal interest rates, but relatively high real interest rates.

There seem to be a general consensus 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 this period. For example, Olivier Blanchard has published extensively on various aspects on European unemployment in the last decades. See for example Blanchard (1998), Blanchard (2000a, 2000b, 2000c) and references therein. The approach of the above mentioned papers is very different from the empirical VAR approach taken here. In Blanchard (2000a) a theoretical model consisting of a standard production function with labor augmented technological progress, a neoclassical labor demand function and a wage setting relation is used as a framework for doing simulations with calibrated parameters. The idea is to infer from the simulations whether (negative) shocks to technological progress and real interest rates can generate high and persistent unemployment rates under various assumptions of the model parameters. In Blanchard (2000b) the effect of changes in the deregulation of product and labor markets on the equilibrium rate of unemployment is similarly investigated based on simulations and calibration. Blanchard (2000c) then studies the effect of long-term unemployment on search behavior in the labor market and its effect on the hiring/firing function and the vacancy/unemployment curve. The theoretical models seem to be able to explain some but not all aspects of the high Europen unemployment. In particular, the length of the unemployment duration remains a puzzle.

For example, in the above 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 the present paper labor productivity, being one of the variables in the VAR system, turns out to play a crucial role in the wage-price-unemployment drama. In the transition period towards an integrated Europe with large internal price imbalances, competitivness was largely achieved by producing same output with less labor. Thus, productivity improved and unemployment rose.

Furthermore, the 'hard EMS' put a stopper on the previously frequent devaluations and realignments in a period when many of the member states had not yet reached a sustainable purchasing power parity level. The paper demonstrates the importance of being on the ppp level when exchange rates become fixed. It argues that this was not the case at the start of the 'hard EMS' and attempts to estimate the effect of the convergence towards sustainable European ppp levels on unemployment

and inflation.

Finally, institutional rigidities are likely to have a different impact on unemployment in different macroeconomic regimes. Thus, it seems important to investigate if and how European wage-price-and unemployment dynamics changed as a result of the increased European integration. The motivation for investigating European wage-price-unemployment dynamics separately for the pre-EMS period and the (hard) EMS period is to shed some light on this important issue.

The organization of the paper is as follows: Section 2 gives an analytic framework for discussing adjustment towards sustainable European ppp levels. Section 3 discusses a simple economic framework consisting of three static steady-state relations and three dynamic adjustment relations. Section 4 introduces the econometric models, presents the data, gives an econometric motivation for the sample split, and investigates long-run price homogeneity. Section 5 introduces the final model based on a nominal to real transformation and discusses the choice of rank. Section 6 presents results on weak exogeneity, common trends, and the long-run impact of a shock. Section 7 reports cointegration properties for the two regimes and compares the structures of identified steady-state relations. Section 8 reports the estimated wage-price-unemployment dynamics and Section 9 summarizes the results and concludes.

2 Convergence to sustainable European ppp levels

In the absence of trade barriers a sustainable external balance requires not only equal inflation rates, but also equal price levels, *i.e.* purchasing power parity between the countries should be approximately satisfied. The Stuttgart Summit in 1983 made a binding decision to put an end to the previously frequent devaluations and realignments among the member states and, thus, signalled a political wish to move towards the EMU.

2.1 Inflation divergence and ppp convergence

Inherent in the idea of creating a monetary union is the convergence of prices in the member states towards a common European price level. Generally this is understood as a convergence of inflation rates. Figure 1 illustrates that such a convergence has indeed taken place. The upper panel demonstrates visually 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. Until 1992, when the level of German inflation rate was finally reached, these countries exhibited higher inflation rates than the remaining countries in Figure 1.

Convergence of inflation rates does not necessarily imply sustainable purchasing power parity levels. If the member states at the start of the EMS were on very different ppp levels relative to each other (as clearly was the case for the northern and central European countries compared to the southern European countries) then inflation rates would first have to diverge to reach a common sustainable level. To illustrate this point a simple model for price adjustment in a two country world is developed and discussed below.

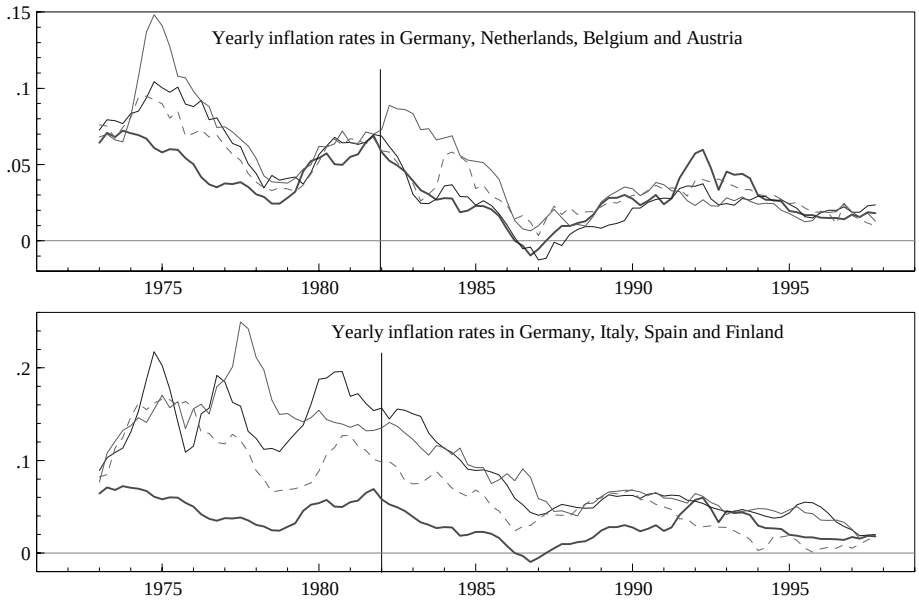

Figure 1. Yearly inflation rates, 1972-1987, in Germany (bold face), Netherlands, Belgium, Austria, Finland, Italy and Spain.

To be able to discuss convergence towards European ppp levels we need a measure for when a member state is in a sustainable steady-state.

Definition 1 *Purchasing power is assumed to be at a sustainable parity level when* $ppp_t = (p_1 - p_2 - s)_t \sim I(0)$, *where* p_{1t} *is the price of country 1,* p_{2t} *of country 2,* s_t *the spot exchange rate and* $t = 1, ..., T_1$.

Note that this condition is not unambiguous in the sense that different sample periods can produce different orders of integration (Juselius and MacDonald, 1999). Thus, the statement $ppp_t \sim I(0)$ is interpreted as 'real exchange rates have fluctuated around a constant mean in a sample $t = 1, ..., T_1$ covering a homogeneous exchange rate regime'.

Assume now that $ppp_t \sim I(1)$, i.e. it has not been on the sustainable level in the sample period. Econometrically, this would be consistent

with $(p_1 - p_2)_t \sim I(1)$, $s_t \sim I(1)$, i.e. the stochastic path of the exchange rate has not mirrored the stochastic path the price differential. Stated differently, some of the permanent shocks to the price differential are not the same as the ones to the spot exchange rate. Empirical tests have almost exclusively found real exchange rates to be nonstationary (ref.).

A nonstationary *ppp* suggests an imbalance in the goods market which, in the absence of trade barriers, is likely to show up in the trade balance of the two countries. This again will influence the amount of capital flows needed to restore the balance of payments and, thus, is likely to influence the interest rate spread between the two countries (Juselius and MacDonald, 1999).

In a monetary union interest differentials are likely to disappear and a nonstationary *ppp* cannot be maintained by compensating capital inflows. Thus, the convergence to a common sustainable purchasing power parity price level has essentially to be achieved by diverging inflation rates. A simple model describing an equilibrium-error-correcting price adjustments between a high and a low income member state illustrates the idea:

$$\begin{aligned}
\Delta^2 p_{1t} &= c_{11}(\widetilde{\Delta p}_1 - \widetilde{\Delta p}_2)_{t-1} + c_{12}(\widetilde{\Delta p}_2 - a_1\widetilde{ppp})_{t-1} + \varepsilon_{1t} \\
\Delta^2 p_{2t} &= c_{21}(\widetilde{\Delta p}_1 - \widetilde{\Delta p}_2)_{t-1} + c_{22}(\widetilde{\Delta p}_2 - a_1\widetilde{ppp})_{t-1} + \varepsilon_{2t} \\
\Delta ppp_t &= c_{31}(\widetilde{\Delta p}_1 - \widetilde{\Delta p}_2)_{t-1} + c_{32}(\widetilde{\Delta p}_2 - a_1\widetilde{ppp})_{t-1} + \varepsilon_{3t}
\end{aligned} \tag{1}$$

where the notation $\widetilde{x}$ denotes $x - \overline{x}$, i.e. a deviation from the sample average. Assume first that $p_1 \sim I(2)$, $p_2 \sim I(2)$ consistent with nonstationary inflation rates, i.e. $\Delta p_1 \sim I(1)$, $\Delta p_2 \sim I(1)$. If, as before, $ppp = (p_1 - p_2 - s) \sim I(1)$, $(p_1 - p_2) \sim I(1)$, $s \sim I(1)$, then $(\Delta p_1 - \Delta p_2) \sim I(0)$ and $\Delta s \sim I(0)$. All components in (1), except the *ppp* term and Δp_2 in the second bracket, are stationary. Hence, either $(\Delta p_2 - a_1 ppp)$ must be a stationary cointegration relation or $(c_{12} = 0,\ c_{22} = 0,\ c_{32} = 0)$. Otherwise the system will not be balanced.

Proposition 2 *In a fixed exchange rate regime, a nominal convergence towards a common sustainable ppp level has to take place through diverging inflation rates.*

The nonstationarity of the *ppp* cannot be accounted for by the stationary inflation spread, but needs an additional non-proportional increase (decrease) in one of the inflation rates.

In the initial sample, $1 - T_1$, assume that $p_1 > p_2 + s$, and $\overline{\Delta p}_1 > \overline{\Delta p}_2$, and $\overline{ppp} > 0$. To achieve a stationary *ppp* with zero mean the following conditions should be satisfied:

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

where π_0 is the desired inflation rate after convergence. Hence, average inflation rates should be allowed to diverge until *ppp* has converged towards its sustainable level. Note, however, that the statistical properties of model (1) in the new regime have changed in the following sense $\Delta p_1 \sim I(0)$, $\Delta p_2 \sim I(0)$ and $ppp \sim I(0)$.

2.2 The European experience

According to the above framework, high ppp countries would have to lower their prices. i.e. to experience negative inflation rates, and/or low ppp countries would have to increase their prices to eliminate imbalances between intra-European ppp levels.

Because of downward price rigidities negative inflation rates are empirically rare. Instead, "high ppp" member states like Germany and France have experienced declining inflation rates and slow price level adjustment. As will be subsequently demonstrated most of the adjustment seemed to take place through productivity improvements, essentially by producing the same output with less labor. The resulting high unemployment rate weakened labor unions and put a stopper on further wage increases, thus further reducing inflation rate.

The upward price adjustment in low ppp member states, like Italy and Spain, was faster. As a matter of fact, price inflation seemed to have continued well after sustainable ppp levels had been achieved.[2] The decline in exports to the high ppp member states (a demand effect due to the economic slowdown in the high ppp countries, later also a price effect) resulted in an economic slowdown also in the low ppp countries. The accumulated macroeconomic imbalances were spotted by financial markets and a speculative attack on the Italian lire and the Spanish peseta forced the currencies to devalue and brought them back to more sustainable ppp levels.

Figure 1 demonstrated that the inflation rates in the present EMU member states did converge towards a common low European inflation rate level π_0, and that inflation rates in Spain and Italy, two low price EU countries, were higher than in the 'Dmk' economies. The question is whether the inflation rate divergence was large enough to achieve ppp convergence. The collapse of the hard EMS and the associated large devaluations in 1992 suggest that all member states were not on a

[2]This can partly be explained by labor unions still being strong in these countries, which can be related to more flexible exchange rate arrangements and the speed of capital deregulation being slow.

sustainable ppp level at that time and that speculative financial markets had spotted it.

2.3 Measuring the European ppp convergence

This subsection will suggest an aggregate measure of imbalances in European ppp levels. As a background Figures 2 and 3 show a selection of European real effective effective exchange rates[3] measured as the deviation from a base year value (1990:2≈100) taken from the OECD leading indicator data base.

Figure 2 illustrates the development of the four largest Euro economies and Figure 3 the 'Dmk' economies together with Finland[4]. When discussing the graphs it should be kept in mind that it is no easy task to determine whether a country is on the ppp level or not. The graphs in Figure 2 and 3 are based on the assumption that the member states were approximately on the ppp level in the beginning of the nineties. The strong devaluations of the Italian, Spanish and the Finnish currency in the period 1991-1993 indicate that, at least for these countries, this may not have been the case.

At the start of the EMS in 1979 Figure 2 exhibits declining prices (improvement in competitiveness) for Germany and France, being high price countries, and increasing prices (worsening of competitiveness) for Italy and Spain, being low price countries. Germany seemed 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. 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.

[3]The OECD real exchange rates are overall indicators of international trade and competitiveness (Durand, et.al., 1992) and provide an average measure of a country's competitive position on the home market as well as on the export markets using the implicit price deflator as a proxy for producer prices.

[4]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.

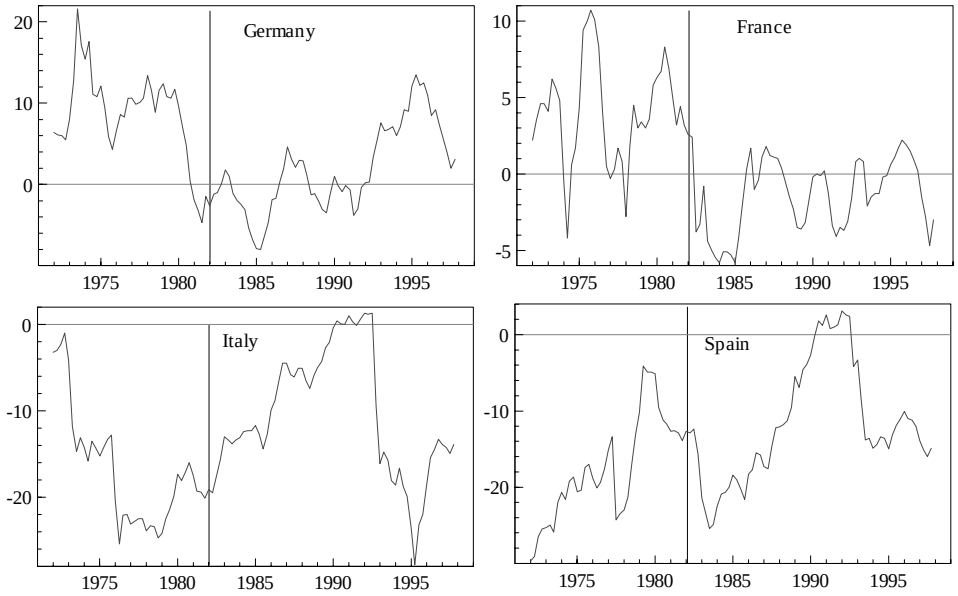

Figure 2. The development of real effective exchange rates measured as deviation from parity.

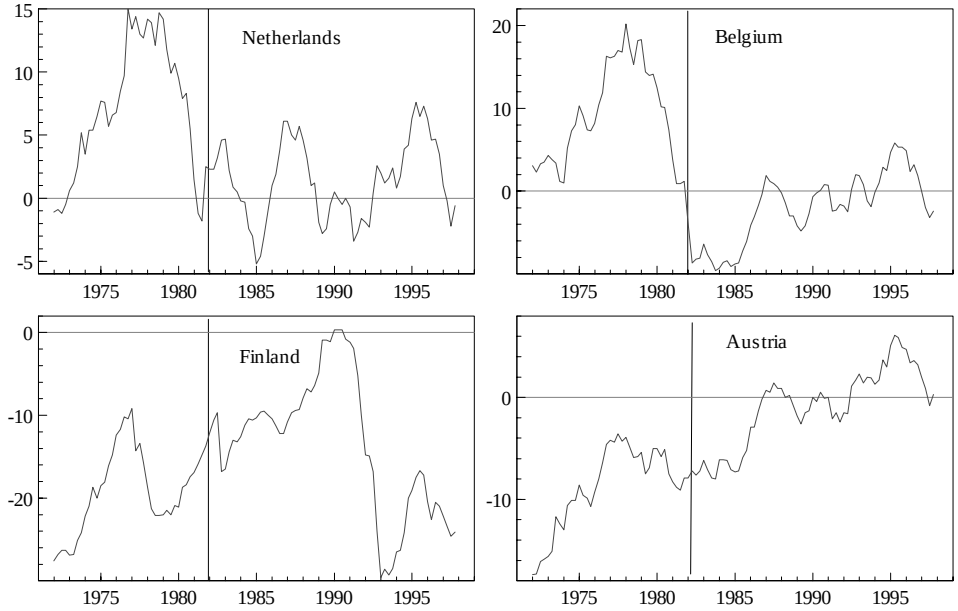

Figure 3. The development of real effective exchange rates measured as deviation from parity.

Figure 3 suggests that the Netherlands and Belgium experienced a

similar price convergence as Germany and that they 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. Finland shows a steady increase in prices since the beginning of the EMS until the devaluations started in 1990.

To summarize, the graphs suggest that a real exchange rate convergence did take place in the first five years of the EMS in accordance with the hypothetical scenario discussed above. Nevertheless, after first converging, the low price countries seem to have been unable to stop further price increases and lost previous competitiveness.

Figures 2 and 3 were based on the development of trade-weighted implicit price indices with parity assumed to hold in the beginning of the nineties. As a complement, Figures 4 and 5 show the development of purchasing power parity with respect to German CPI assuming parity at the end of the period.

Figure 4 shows the development for the devaluation countries, Italy, Spain, and Finland. At the end of the period, both Italy and Spain seemed to be at a similar parity level as at the beginning of the hard EMS in 1983[5]. From 1983-1992 they moved away from parity until the devaluations in 1992-93 restored parity. Finland was quite far away from parity and moved further away until the large devaluations in 1990-91 restored competitiveness. Figure 5 shows the development for Netherlands, Belgium, Austria, and Ireland, of which the first three have followed German price levels fairly closely since the hard EMS. Ireland experienced a 10% relative price decrease in 1993, which may be an explanation of the subsequent boost in employment and growth.

[5]Italy adopted the broad $\pm 6\%$ bands of the ERM in 1979 and Spain joined the EMS as late as 1989.

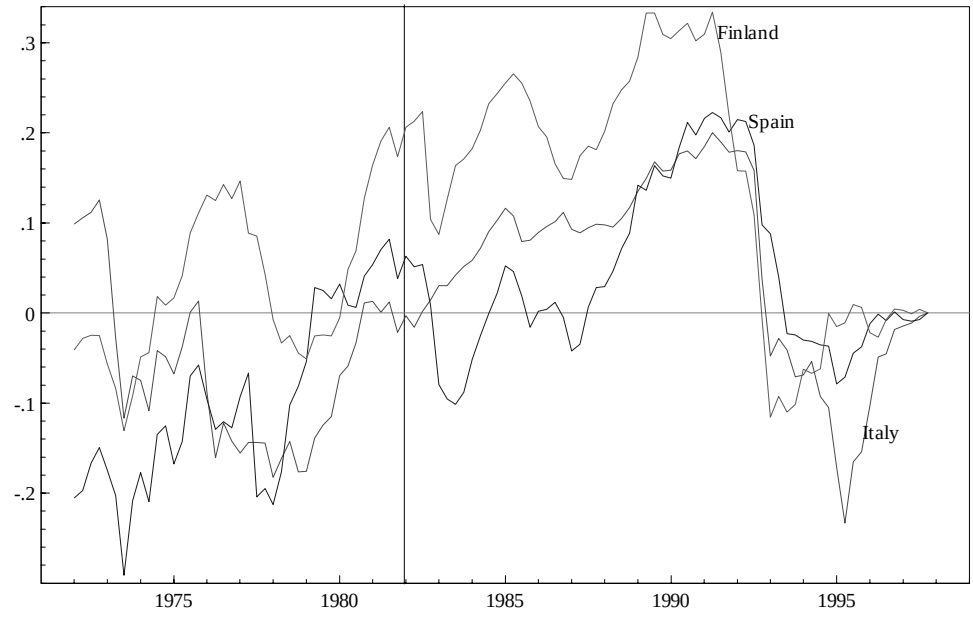

Figure 4. Deviation from purchasing power parity with respect to German CPI for Italy, Spain and Finland.

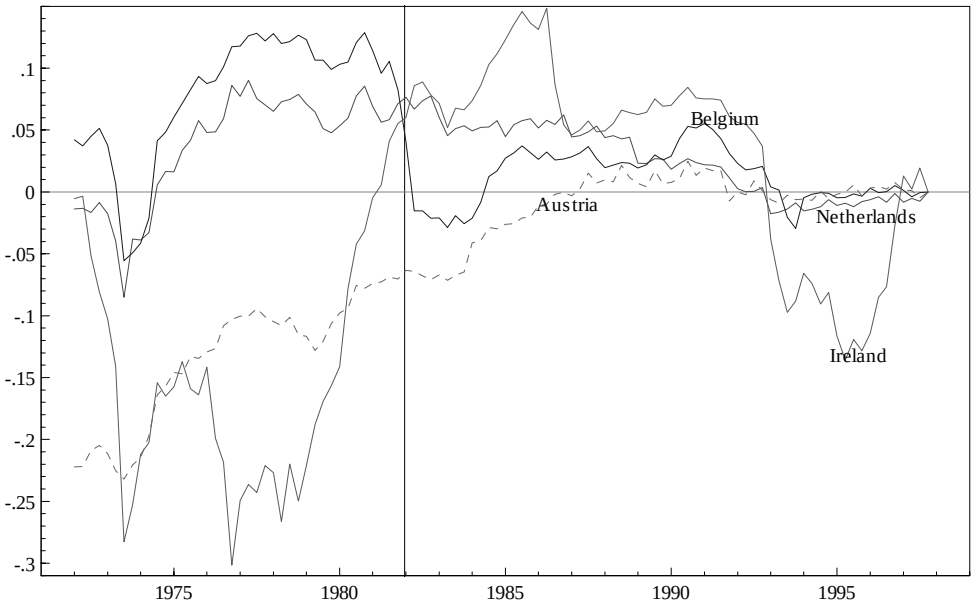

Figure 5. Deviation from purchasing power parity with respect to German CPI for Netherlands, Austria, Belgium, and Ireland.

The subsequent empirical analyses of the aggregated euro-wide area need an EMU purchasing power parity variable that summarizes the overall effect of the convergence towards sustainable European ppp levels. It is difficult (possibly impossible) to measure such a convergence with any reasonable precision and the variable $conv_t$ described below should only be considered a very coarse proxy. It has been created as $conv_t = \sum_{i=1}^{11} w_i \left| wer_{i_t} - 100 \right|$, where w_i is the weight of country i measured as $w_i = GDP_i/GDP_{eurowide}$ in 199? and wer_{i_t} is the trade-weighted real effective exchange rate of country i at time t, with parity denoted by 100 taken from the OECD leading indicator data base.

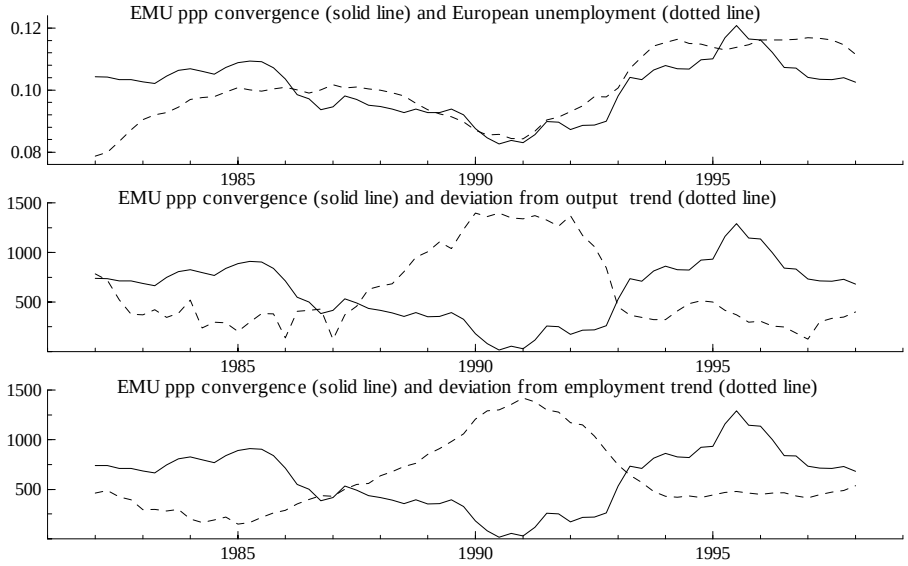

Figure 6. Convergence towards purchasing power parity in the Euro area in the period 1982-1998 relative to aggregate unemployment, deviation from European trend output and employment.

Figure 6 relates the variable, $conv_t$, to European unemployment rate, to the output gap defined as $(y - b_1 t)$, and to the deviations of aggregate employment from trend $(e - b_2 t)$. The co-movement of unemployment and the ppp convergence is quite striking as is the counter-cyclical movements of the convergence variable with both the output-gap and the employment-gap.

3 Economic relations

In this section I will discuss 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 will be based on the following three simple economic relations

describing (1) producer prices based on mark-up pricing, (2) consumer prices as homogeneously related to the price of domestically produced goods and of imported goods, and (3) a real wage relation based on collective wage bargaining. In addition results will be discussed based on three adjustment relations, motivated by the finding of persistent behavior away from the above static relations. They are (1) a dynamic steady-state relation describing inflation rate adjustment towards long-run static steady states, (2) a Phillips-curve relation, and (3) a relation between unemployment and productivity deviation from trend.

In the following lower cases will denote logarithmic values.

3.1 Static long-run relations

Output prices, p_y, are assumed to be determined by mark-up pricing on nominal wages and import prices p_y^* :

$$p_{yt} = \omega_1 w_t + \omega_2 p_y^* + v_{1t} \tag{3}$$

where v_{1t} is a residual and $\omega_1 + \omega_2 = 1$ implies long-run price homogeneity.

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

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

where v_{2t} is a residual and homogeneity is assumed.

Nominal wages w are assumed to have been determined primarily by collective wage bargaining and are related to the producer 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:

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

where v_{3t} is a residual and $1 \geq a_1 \geq 0$, $a_2 = 1$, 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 $a_1 = 1$ would be an indication of 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, a zero coefficient might indicate strong insider-outsider effects.

3.2 Dynamic adjustment behavior

If $\{w_t, p_{yt}, p_{ct}\} \sim I(1)$ empirically, then nominal wage and price growth would be stationary and (5) - (4) are likely to be cointegrating relations. Hence, we would expect v_{1t}, v_{2t} and v_{3t} to 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 (5) - (4) are likely to be non-stationary and the residuals v_{1t}, v_{2t} and v_{3t} would be drifting away from the assumed steady-states.

Proposition 3 *To achieve stationarity, we need in general to introduce a measure of nominal growth in the cointegrating relations of the VAR model. These are the dynamic steady-state relations.*

Proposition 4 *Given that long-run price homogeneity is empirically accepted and $(w-p_y)_t$ and $(p_y-p_c)_t$, are $I(1)$ variables, then $\Delta w_t, \Delta p_{ct}$, and Δp_{yt} are pairwise cointegrating and, hence, must contain the same stochastic $I(1)$ trend, which is equivalent to the first difference of the $I(2)$ trend.*

In this case the choice of any of the three growth rates, $\Delta w_t, \Delta p_{yt}$, or Δp_{ct} will do econometrically, but the interpretation of the results 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 I have chosen Δp_{yt} as a measure of nominal growth rates.

The adjustment relation determining producer inflation Δp_y is assumed to describe equilibrium error-correcting behavior towards a sustainable real wage level and a sustainable internal and external price wedge:

$$\Delta p_{yt} = a_5 + a_6(w - p_y)_{t-1} + a_7(p_y - p_c)_{t-1} + a_8(p_y - p_y^*)_{t-1} + v_{4t} \quad (6)$$

where v_{4t} is a residual and $a_6 > 0$, $a_7 < 0$, and $a_8 < 0$ is consistent with equilibrium correction behavior.

Furthermore, the European wage-price-unemployment dynamics are likely to have been strongly influenced by the nominal and real convergence towards a common European sustainable steady-state level. This has been a dominant feature of the European experience in the last two

decades and is likely to have significantly affected the behavior of the data. For the price-wage-unemployment dynamics the convergence towards a EMU purchasing power parity seems particularly relevant. This is the motivation for augmenting (6) with one more equilibrium error-correction mechanism, $conv_t$, measuring the absolute deviation from purchasing power parity in the Euro countries, in the EMS period:

$$\Delta p_{yt} = a_5 + a_6(w - p_y)_{t-1} + a_7(p_y - p_c) + a_8(p_y - p_y^*)_{t-1} + a_9 conv_t + v_{4t} \tag{7}$$

The speed of adjustment towards a sustainable real wage level, a sustainable internal price wedge, and a sustainable European purchasing power parity price level is likely to be strongly influenced by institutional rigidities in the domestic labor market. This effect is assumed to be 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:

$$\Delta p_{yt} = a_{10} + a_{11} u_t + v_{4t} \tag{8}$$

where v_{4t} is a residual and $a_{11} < 0$ for (8) to be interpreted as a Phillips curve.

Remark 5 *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:

$$u_t = a_{12}(q_t - b_1 t) + v_{5t}, \tag{9}$$

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 (9) 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 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 6 *Relation (9) is not assumed to be a structural relation, but is instead 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.*

Excess employment due to previous institutional rigidities (for example strong labor unions) is likely to be reduced in a deregulated and, hence, more competitive setting.

If both v_{4t} and v_{5t} are $I(0)$, then Δp_{yt}, u_t, and $(q_t - b_1 t)$ share one common trend, and u_t and $(q_t - b_1 t)$ would also be cointegrating. If $v_{4t} \sim I(1)$, Δp_{yt} and u_t may still share the same common stochastic trend, but there is at least one more stochastic trend influencing either of the two variables, or both. In this case we would expect an adjustment relation which accommodates both (8) and (9). For the EMS period we expect additionally that the EMU ppp convergence has influenced the level of unemployment. The following relation contain all possibilities:

$$u_t = a_{14}(q_t - b_1 t) + a_{15}\Delta p_t + a_{16} conv_t + v_{5t} \tag{10}$$

where the stationarity of the residual v_{5t} is an indication of whether the combined relation can be assumed to be a dynamic steady-state relation in the empirical model.

4 The statistical model and the data

The empirical investigation is based on the cointegrated VAR approach using the basic data vector:

$$x_t = [w, p_y, p_c, c, er, u]_t$$

where t = 1970:1, ...,1998:1 and

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 price of domestic output (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 199?.

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

All variables are seasonally adjusted and collected from the quarterly Euro-wide database (their original names are given in brackets) described in Fagan, Henry, and Mestre (2001). Graphs of the data are given in the Appendix.

Figure A.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 a pronounced feature. 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 A.2 shows the graphs of the real wage ($w - p_y$), the internal price wedge ($p_y - p_c$) and real effective exchange rate (er). 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. Figure A:3 and A:4 focus on the behavior of these variables and their components. The big cyclical swings in the EMS period illustrate the very prolonged European 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 approximately describe 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 A: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 7.

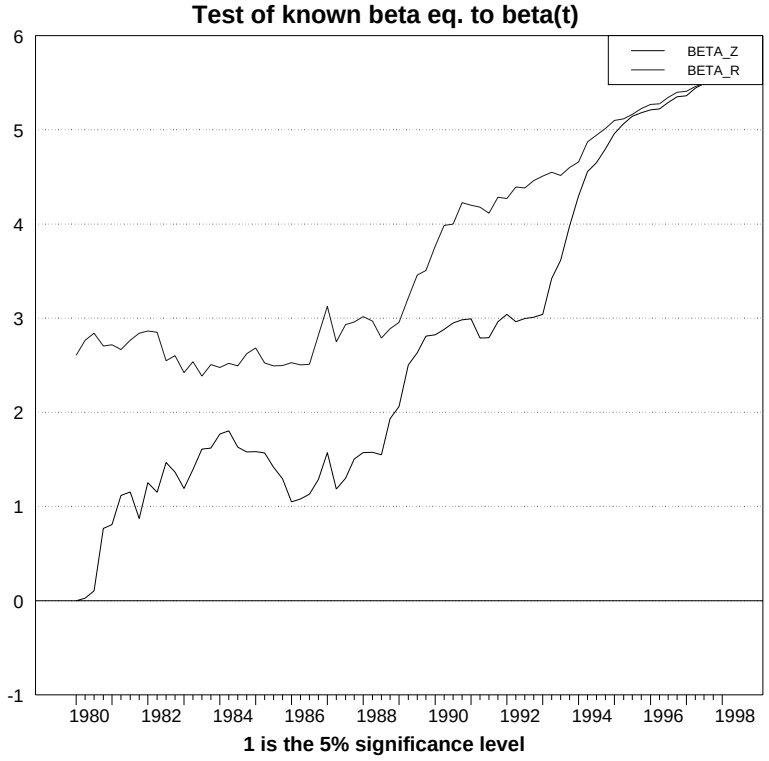

Figure 7. The graphs of the recursively calculated test statistic for constant β scaled with the 5% test value. All values > 1.0 reject constancy.

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 $\tilde{\beta}_t$ was strongly rejected for all $t = T_s$, ...,1998:1. Numerous empirical studies have found a significant European regime shift around these dates. The sample was divided in the following sub-periods: 1970:2 - 1980:1 and 1982:1 - 1998:1. The years 1980 and 1981, whether included in the former or latter sub-period produced instability in the short-run adjustment parameters[6] and were, therefore, omitted altogether. This suggests that agents needed a few years to learn how to act in the new regime.

[6]The instability was much less pronounced in the long-run cointegration properties.

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). This raises the question whether long-run price homogeneity between the nominal variables is statistically acceptable, so that the nominal system $[w, p_y, p_c, q, u, er, t]$ can be transformed into the equivalent real form $[w - p_y, p_y - p_c, \Delta p_y, u, er, t]$. 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 was accepted in the first period, 1970:2 - 1980:1, (3.65, p-value 0.30) and borderline accepted in the second period, 1982:1 - 1998:1 (7.72, p-value = 0.05). Thus, it seems reasonably safe to transform the data so that the subsequent analysis can be performed in the I(1) model separately for the two regimes.

Based on the two sample periods it is now possible to ask in what sense the increased economic integration and the association to the ERM have changed the mechanisms of the European wage setting. This will be done in the subsequent sections.

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 variable, $conv_t$, measuring the convergence towards a European purchasing power parity is included as a weakly exogenous variable.

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

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_{yc}	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	$\chi^2(36)$	=	33.0	p-val. = 0.61		
LM_4	$\chi^2(36)$	=	44.5	p-val. = 0.14		
Normality: LM	$\chi^2(12)$	=	17.3	p-val. = 0.14		
	Modulus of the 6 largest characteristic roots					
Unrestricted model:	0.86	0.86	0.84	0.84	0.70	0.70
$r = 4$	1.0	1.0	0.88	0.88	0.68	0.51
	rw	q	Δp_y	u	pp	er
$\hat{\alpha}_3(t-ratios)$	**2.1**	0.5	**-4.5**	**2.1**	**-3.2**	**-3.9**
$\hat{\alpha}_4(t-ratios)$	0.5	0.8	1.3	**-3.1**	1.3	**-2.5**
R^2	0.58	0.57	0.60	0.71	0.46	0.40

The choice of cointegration rank is crucial for all subsequent results. It determines the number of components of the vector process that enter the explanatory part of the model, but also the number of common trends[7]. The fewer the common stochastic trends the more cointegration between the variables of the model.

In the present data set we expect at least two common trends originating from permanent shocks to prices and to 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 real and nominal growth trends in real wages, the internal and external price wedge, and pro-

[7]Economic theory is often more informative about the number of common trends than of the number of cointegration relations.

ductivity. Furthermore, trend-adjusted productivity looks like an I(1) variable (cf. Figure A.2), suggesting a stochastic productivity trend on top of the deterministic linear trend.

Based on these considerations, our preferred hypothesis is $\{r = 4, p - r = 2\}$. 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 should be no $I(2)$ components left in the data and the number of unit roots (or near unit roots) should 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. In the first period the trace test is consistent with with our preferred hypothesis, but the test result is borderline accepted, 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 variable as a weakly exogenous variable 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 is left out even if it is stationary and has explanatory power. To examine this we have reported all the t ratios of $\hat{\alpha}_3$ and $\hat{\alpha}_4$ greater than 2 in Table 1. 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. An examination of this vector revealed that it essentially described the stagflation behavior of this period (a positive relationship between inflation and unemployment). As this is an important feature of the seventies we choose $r = 4$. For the second period the fourth relation, essentially describing a negative relation between inflation and unemployment, seems to enter significantly in the equations for unemployment and real exchange rate. To achieve comparability and because the fourth relation seemed to contain information relevant for a Phillips curve relationship we choose $r = 4$ and the subsequent analyses are based on $r = 4$ in both periods.

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		8.3	22.7	12.0	8.8	12.3	**5.2**	7.8
4	$\rightarrow$	8.5	23.2	20.6	16.0	18.1	13.4	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 the choice of r was not completely straightforward, we report the test results of weak exogeneity for $r = 3$ and $r = 4$. The tests of weak exogeneity, $R\alpha = 0$, where R is a unit vector, is approximately distributed as $\chi^2(r)$. The results are reported in Table 2.

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 is 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 exchange rates would have been weakly exogenous for $r = 3$, but not for $r = 4$. It can also be noted that productivity is the variable most strongly adjusting in both periods followed by real exchange rates (the external wedge) and inflation rate in the first period and the internal price wedge and inflation in the second period. Summarizing the important findings:

Result 7 *Shocks to real wages have acted as a pushing force in the first but not in the second regime.*

Result 8 *Productivity is 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 variable, *conv*, a deterministic time trend and a component R containing the effects of initial values, the short-run dynamic effects of $\Delta conv_t$ and the dummies:

$$x_t = C\Sigma_{i=1}^{t}\varepsilon_i + \gamma_1 t + \gamma_2 conv + C^*(L)\varepsilon_t + R \tag{13}$$

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 in each column. 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 there are $p-r=2$ stochastic trends and one deterministic time trend driving the system consistent with the following representation:

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

where bold face indicates $|t-ratio| > 2.5$, italics $1.6 < |t-ratio| < 2.5$, $-$ $|t-ratio| < 1.6$, $\alpha'_{\perp.1} = [0, 0, \mathbf{1.0}, 0, \mathbf{-1.1}, 0]$ and $\alpha'_{\perp.2} = [\mathbf{1}, 0, 0, 0, 0, 0]$. 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 ppp convergence variable was

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	**1.4**	-	-	-	-	-
q	**0.9**	-	-	-	*2.1*	-
Δp_y	-	-	*0.4*	-	*-0.4*	*0.4*
u	*-0.1*	-	*0.2*	-	*-0.4*	-
pp	-	-	*-1.1*	-	*1.4*	*-0.1*
er	-	-	*1.3*	-	*-1.5*	*0.1*
t	0.0097	0.0071	0.0002	0.0012	0.0002	0.0150
			1982:1-1998:1			
	$\hat{\varepsilon}_{rw}$	$\hat{\varepsilon}_{q}$	$\hat{\varepsilon}_{\Delta p}$	$\hat{\varepsilon}_{u}$	$\hat{\varepsilon}_{pp}$	$\hat{\varepsilon}_{er}$
$\hat{\sigma}_{\varepsilon}$	0.0040	0.0032	0.0017	0.0010	0.0021	0.0214
rw	**0.6**	**0.7**	*1.6*	-	*-1.7*	-
q	**0.2**	*0.2*	-	-	-	-
Δp_y	-	*0.1*	**0.5**	-	**–0.5**	**-**
u	*0.1*	*-0.1*	**-0.9**	-	**1.0**	-
pp	-	*-0.3*	**-1.9**	-	**2.0**	-
er	*2.5*	-	**-12.2**	-	**13.0**	-
t	0.0043	0.0049	-0.0002	0.0003	0.0006	0.0083

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

added to the system as a weakly exogenous variable and, hence, generates a stochastic trend by assumption. The following representation describes the system for the second period:

$$\begin{bmatrix} rw_t \\ q_t \\ \Delta p_t \\ u_t \\ pp_t \\ er_t \end{bmatrix} = \begin{bmatrix} \mathbf{-1.6} & \mathbf{0.56} \\ - & \mathbf{0.21} \\ \mathbf{-0.5} & 0.01 \\ \mathbf{0.9} & 0.09 \\ \mathbf{1.9} & 0.13 \\ \mathbf{12.3} & 2.26 \end{bmatrix} \begin{bmatrix} \alpha'_{\perp.1}\Sigma\varepsilon_i \\ \alpha'_{\perp.2}\Sigma\varepsilon_i \end{bmatrix} + \begin{bmatrix} 0.0043 \\ 0.0049 \\ -0.0002 \\ 0.0003 \\ 0.0006 \\ 0.0083 \end{bmatrix} t + \begin{bmatrix} - \\ - \\ * \\ * \\ - \\ - \end{bmatrix} [conv_t] \tag{15}$$

where $\alpha'_{\perp.1} = [0, 0, \mathbf{1}, 0, \mathbf{-1}, 0]$ and $\alpha'_{\perp.2} = [\mathbf{1}, \mathbf{0.5}, 0, 0, 0, 0]$. Thus the first stochastic trend describes cumulated shocks to inflation rate and the second to real wages and labor productivity.

The nominal trend in the first period influences productivity negatively, inflation and unemployment positively and the internal price

wedge and real exchange rates negatively, i.e. inflationary shocks lead to depreciation of the currency. The real trend increases real wages and productivity and has a small negative effect on unemployment. In the second period the nominal trend has a negative effect on real wages (no significant effect in period 1) no effect on productivity (a negative effect in period 1), positive effect on unemployment (stronger than in period 1) and a positive effect on the price wedge (a negative effect in period 1). The latter seems to indicate that price shocks have decreased profits in the first period but increased them in the second period. The real trend has increased real wages and productivity in both periods but less so in the more recent period. The real trend has also affected unemployment rate, the price wedge and the real exchange rates positively, but these effects are not very significant.

Result 9 *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 1.7% in the second. Productivity grew on average with 3% in the first period, i.e. less than real wages and with 2% in the second, i.e. more than real wages in the same period. The low real growth 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. The ppp convergence trend shows that both inflation and unemployment has followed a similar trend development.

Result 10 *The growth rate of real wages exceeded the growth rate of productivity in the seventies whereas in the EMS period the productivity growth exceeded real wage growth. Hence, profit share decreased in the first regime and increased in the second.*

The estimates of the long-run impact matrix C reported in Table 3 measures the long-run effects of an unanticipated shock $\varepsilon_{it},\ i = 1, ..., p$, on all variables of the system. Here ε_{it} are measured by the residuals from the cointegrated VAR model and their standard deviations are also reported in the table. To increase readability we have indicated coefficients with a t-ratio > 2.5 with bold face, a t-ratio $> 1.6 < 2.5$ with italics. Completely insignificant coefficients are not reported in the table.

7 Cointegration properties

In this section we impose such (over)identifying restrictions on the r cointegration relations that define four irreducible cointegration relations, the 'building blocks' of the combined steady-state relations of Section 8.

In table 4 we report the estimates of the four steady-state relations. Altogether four over-identifying restrictions have been imposed in the first period. They were tested with a LR test distributed as $\chi^2(4)$ and accepted with a p-value of 0.51. In the second period the 5 over-identifying restrictions were accepted with a p-value of 0.27.

7.1 Cointegration properties in the first regime

In the first period it was not possible to find empirical support for a plausible long-run real wage relation with equilibrium error-correcting behavior in real wages. We interpret this as evidence of wage hikes made possible by strong labor unions in this period.

Result 11 *Labor unions were successful in achieving real wage increases in excess of productivity in the first regime because of trade barriers and the possibility to devalue domestic currency. To restore competitiveness after excessive nominal wage increases imposed by strong labor unions, employers have to increase labor productivity.*

Evidence of this is found in the first relation describing labor productivity (output/employment) as a positive function of real wages $(w - p_y)$ and the price wedge $(p_y - p_c)$. Labor productivity is strongly error-correcting to this relation.

Result 12 *Productivity was achieved by technological progress and by laying off workers.*

Evidence for this can be found in the second relation describing a positive relationship between unemployment and the deviation of labor productivity from trend with strong error correcting behavior in the unemployment equation.

Result 13 *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 relation which describes real exchange rates positively related to producer price inflation. Real exchange rate is error-correcting to this relation whereas productivity increases and the price wedge decreases when the currency is devaluated.

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

				1970:2-1980:1				
	rw	q	Δp	u	pp	er	$trend$	$conv$
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	-0.76 (17.7)	-	3.0 (14.6)	1.0	-0.26 (12.9)	-	-
β_2'	-0.27 (5.3)	1.0	-1.11 (6.0)	-0.80 (-6.0)	-	-	-0.004 ()	-
β_3'	-	-	1.0	-	0.32 (7.1)	-	-	0.001 ()
β_4'	-	-	1.56 (19.0)	1.0	-	-	-	-0.002 ()
α_1'	$***$ ($-$)	$**$ ($+$)	$*$ ($+$)	-	$**$ ($+$)	$***$ ($+$)		
α_2'	-	$***$ ($-$)	$-$	$**$ ($-$)	$*$ ($-$)	$*$ ($+$)		
α_3'	-	-	$***$ ($-$)	$*$ ($+$)	$**$ ($-$)	-		
α_4'	-	-	$***$ ($-$)	$***$ ($-$)	$**$ ($-$)	$*$ ($-$)		

Result 14 *The result of this wage-price-unemployment-productivity-devaluation spiral is stagflation. Short-run Phillips curve effects can be found even in the stagflation regime.*

Evidence of this is found in the forth relation describing a positive relationship between inflation and unemployment, a phenomenon typical of the seventies. Though inflation rate and the price wedge are error-correcting to the stagflation relation unemployment is not. 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.

Result 15 *Labor unions were unable to enforce excessive wage claims in the second regime because competitive devaluations were no longer possible and the goods market became increasingly competitive.*

Evidence of this is that real wages are equilibrium-error-correcting towards a plausible real wage relation, describing real consumer wages $(w - p_c)$ being positively related to labor productivity (but less than proportionally), negatively related to unemployment rate, and positively to real exchange rates.

Result 16 *Competitiveness was improved by increasing labor productivity which was primarily achieved by labor layoffs.*

Evidence of this is found in the second relation describing deviation from trend productivity as a positive function of real wages, inflation and unemployment. Labor productivity is strongly error-correcting to this relation, whereas unemployment is not. The latter gives evidence of the widespread use of labor layoffs as a means to improve labor productivity, a typical feature of both the seventies and the eighties. But contrary to the seventies devaluations were no longer possible within the hard EMS and unemployment rose steadily. This is likely to explain the increased weakness of the labor unions in the eighties and the nineties.

Result 17 *Output-price inflation is error correcting towards the internal price wedge and towards the European purchasing power parity as measured by the variable* $conv_t$.

Evidence of this is found in the third cointegration relation with equilibrium-error-correction in the internal price wedge and inflation rate.

Result 18 *A conventional Phillips curve relationship between price inflation and unemployment describes the pay-off between low inflation and high unemployment when the latter has been corrected for the effect of the convergence towards European purchasing power parity.*

Evidence of this is found in the fourth cointegration relation with equilibrium error-correction in both inflation and unemployment.

7.3 Illustrating the differences

The significance of the differences in the macroeconomic behavior in the two regimes are illustrated by Figures 8 - 11, 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 8 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 9 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 8 and 9 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 9. 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 internal ppp convergence as described by the variable $conv_t$.

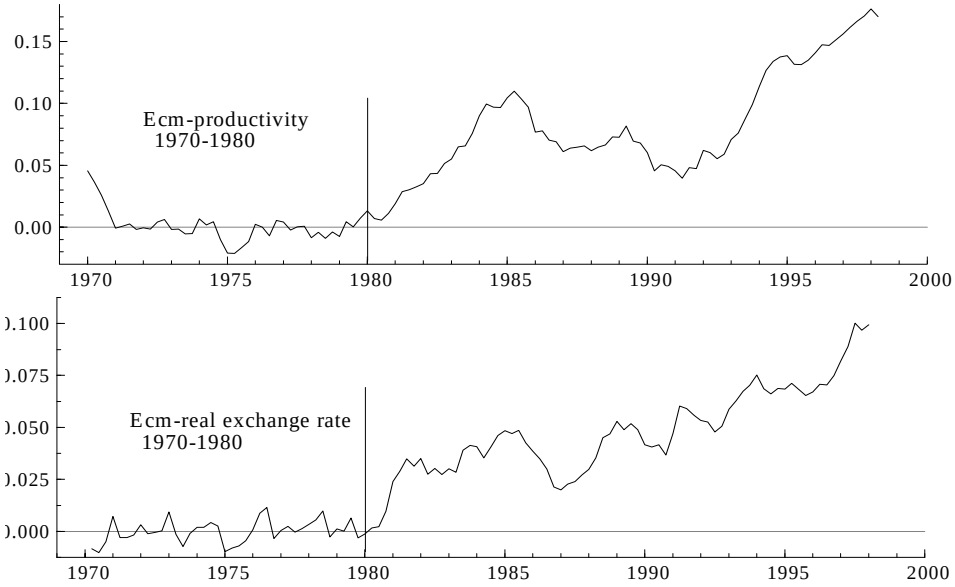

Figure 8. Forward extrapolation of $\beta_1' x_t$ and $\beta_3' x_t$ of Table 4.

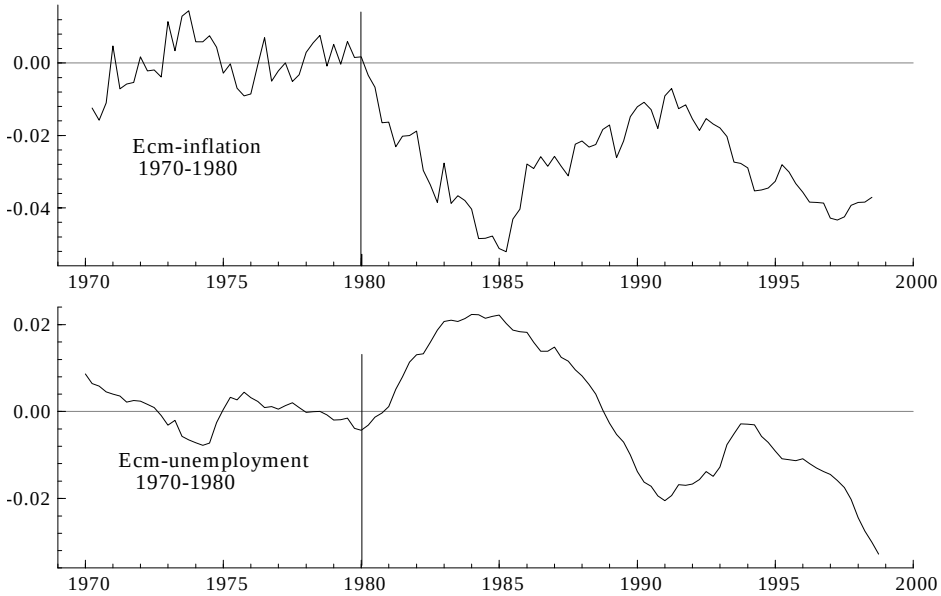

Figure 9. Forward extrapolation of $\beta_2' x_t$ and $\beta_4' x_t$ of Table 4.

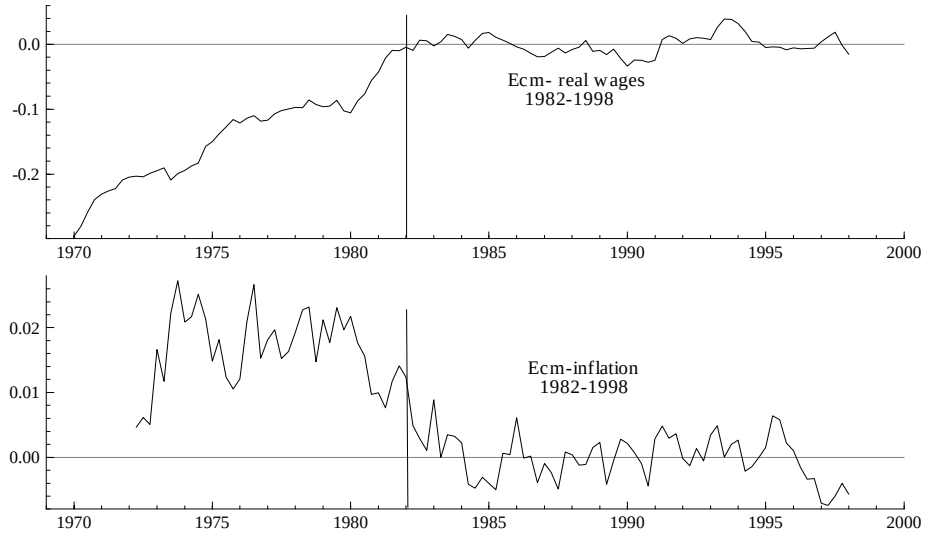

Figure 10. Backward extrapolation of $\beta_1' x_t$ and $\beta_3' x_t$ of Table 4.

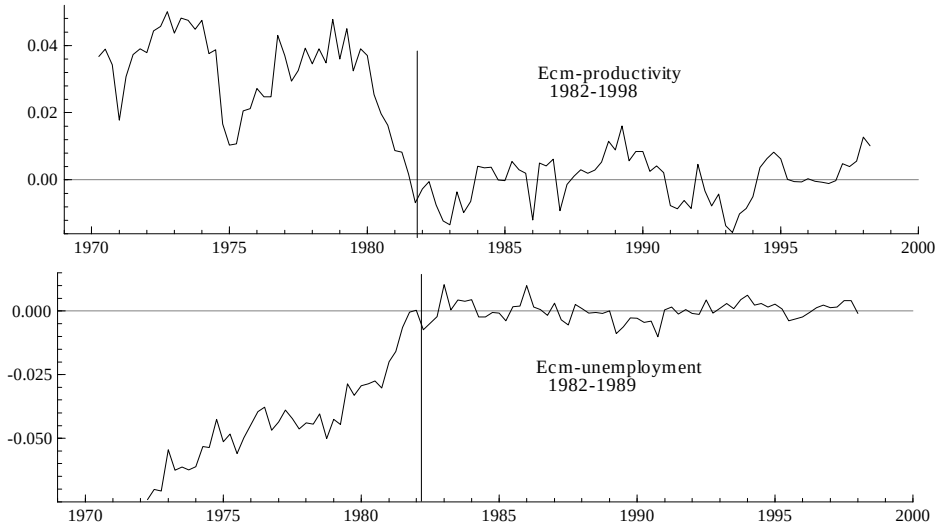

Figure 11. Backward extrapolation of $\beta_2' x_t$ and $\beta_4' x_t$ of Table 4.

Figures 10 and 11 show the extrapolations of the steady-state relations of the eighties and nineties backwards into the seventies. Figure 10 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 the inflation rate much above the steady-state levels of the more recent period. Figure 11 shows that productivity would have been above and unemployment below the steady-state levels of the eighties and the nineties.

Altogether, Figures 10 and 11 demonstrate a change in the linear growth rates comparable to the previous case and a shift in the equilibrium means, which primarily is related to the change in inflation growth rates between the two periods.

In the next section we will impose over-identifying restrictions on the short-run feed-back dynamics of the full system, keeping the identified cointegration relations fixed.

8 The estimated wage and price dynamics

The estimated wage-price-unemployment dynamics in Table 5 have been simplified by imposing zero restrictions on insignificant coefficients in the unrestricted VAR model, which, as a rule, is heavily over-parametrized in the dynamic adjustment structure.

In the first period all lagged variables except the price wedge were insignificant based on an F-test and, thus, removed from the system. Real wages were found to be strongly exogenous and was included as an exogenous variable in the system. In this simplified system 17 additional insignificant coefficients were tested to zero with a likelihood ratio test. The null hypothesis was accepted based on $\chi^2(17) = 16.4(0.50)$.

In the second period all lagged variables except for unemployment were found to be insignificant and removed from the system. The price wedge was found not to be error-correcting and was included as an exogenous variable to simplify the model. Altogether 20 over-identifying zero restrictions could be imposed on the simplified system based on the LR test $\chi^2(20) = 20.8.(0.41)$.

The dominance of the ecm-terms is quite striking in the simplified models. Only 3 parameters in the first period and 5 in the second period describing temporary short-run effects were significant out of the 36 estimated parameters of the unrestricted VAR.

In the seventies real wages were not equilibrium error-correcting and real wage shocks were essentially driving labor productivity. Evidence of this was shown in the common trends analysis of the previous section and is confirmed by the significant adjustment to ecm1$(q - 0.70rw - 1.40pp)$. Labor productivity is furthermore error correcting to ecm2 $(u - 0.034q - 0.001t)$, the latter describing the close co-movements of unemployment and the deviation from trend-adjusted productivity.

Hypothetically one would expect unemployment first to rise and then productivity to improve. However, unemployment is similarly error-correcting to ecm2, which suggests that the data are uninformative about the direction of causality. Nevertheless, unemployment is also significantly affected by ecm1 by a small negative coefficient (-0.07), i.e. there has been a (small) drop in unemployment when productivity is above

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	Δu_{t-1}	$ecm1_{t-1}$	$ecm2_{t-1}$	$ecm3_{t-1}$	$ecm4_{t-1}$	$D8402_t$	$D9301_t$
Δrw_t :	-	−0.92 (−2.6)	−0.12 (−2.7)	-	-	-	−0.014 (−3.6)	−0.019 (4−.4)
Δq_t :	-	−2.14 (−5.3)	0.13 (3.7)	−0.63 (−6.6)	-	-		−0.013 (−3.8)
$\Delta^2 p_t$:	0.36 (5.4)	-	0.05 (3.4)	-	−0.26 (−5.3)	−0.38 (−6.4)	-	-
Δu_t	-	0.35 (2.7)	-	−0.15 (−4.2)	-	−0.16 (−4.1)	-	-
Δer_t :	4.76 (5.3)	-	0.71 (3.2)	1.91 (3.7)	2.25 (2.8)	−1.46 (−1.7)	-	-

$ecm1 = rw + pp - 0.76q + 3.0u - 0.26er$
$ecm2 = q - 0.27rw - 1.11\Delta p_y - 0.80u - 0.004t$
$ecm3 = \Delta p_y + 0.32pp + 0.00094conv$
$ecm4 = u + 1.56\Delta p_y - 0.0018conv$

*) approximate t-values are given in brackets

its steady-state level. This may be interpretable as evidence of a more conventional effect of an increase in productivity on employment.

The effect on output-price inflation is unambiguous; labor productivity in excess of its steady-state value has decreased inflation and the internal price wedge has narrowed. The price wedge has also decreased when real exchange rates have been above their steady-state values suggesting that profits, not prices, have adjusted in this case. This is consistent with the hypothetical explanation in Krugman (1989). Real exchange rates are exclusively adjusting to ecm3 ($er - 3.18\Delta p_y + 0.0144t$), which describes a steady-state relation between deviations from trend-adjusted real exchange rate and inflation.

Finally, output-price inflation, the price wedge and unemployment are strongly affected by ecm4 ($\Delta p_y - 0.32u + 0.83pp$), the stagflation relation. The first two adjust in an error-correcting manner, but not unemployment which is decreasing when inflation is above its steady-state value, i.e. evidence of a short-run Phillips curve effect.

In the more recent period real wages were adjusting, though not very strongly so, to ecm1 ($rw + pp - 0.76q + 3.0u - 0.26er$), i.e to a real consumer wage relation ($w - p_c$) with less than full compensation for productivity gains (0.76) and with strong negative unemployment effects. Similar to the first period, productivity is strongly adjusting towards a steady-state that is positively related to real wages, inflation and unemployment. Thus, in this period ecm2 ($q - 0.27rw - 1.11\Delta p_y - 0.80u - 0.004t$), combines ecm1 and ecm2 of the previous period. Output-price inflation is dynamically error-correcting to ecm3 ($\Delta p_y + 0.32pp + 0.00094conv$), and ecm1, the real wage relation. Similar to the first period unemployment tends to decrease with ecm2, i.e. it has gone down when productivity is above its steady-state value. Furthermore, both inflation and unemployment are error-correcting towards ecm4 ($u + 1.56\Delta p_y - 0.0018conv$), a traditional Phillips curve relationship when the effect of the internal ppp convergence has been corrected for.

Finally, real exchange rate has been influenced by all four ecm's in an error-correcting manner to the first one, and positively (has appreciated) to the productivity and inflation, inflation-unemployment relations.

9 Summary results and conclusions

The wage-price-unemployment dynamics of the seventies were fundamentally different from those of the EMS period covering the eighties and the nineties. The former period can be characterized as a stagflation regime, in which strong labor unions were able to enforce excessive real wage claims. The latter reduced competitiveness, which was restored by improvements in labor productivity. This again was achieved by lay-

ing off part of the labor force. Under the threats of factory close-downs competitive devaluations were frequently used as a short-run remedy for lost competitiveness. Higher import prices resulted in higher consumer prices and further wage claims. Thus, both inflation and unemployment were co-moving like non-stationary variables tied together by a stationary stagflation relationship. Inflation in excess of this relationship had a negative effect on unemployment. Thus, even in the first regime there was 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) and the estimated feed-back dynamics showed that the productivity improvement was achieved by producing the same output with less labor.

The second regime was characterized by a strong Phillips-curve relationship between the nonstationary inflation and unemployment rates when the transition effect towards a sustainable ppp had been accounted for. A plausible real wage relation with strong negative effects from unemployment was identified, with significant equilibrium-error- correction in the real wage equation. Similar to the first period productivity was positively related to real wages and output prices with strong error-correction adjustment.

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.

Why are the stories so different? I have argued 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 levels of real exchange rates as a result of downward price rigidities. Thus, the same output was produced with less labor explaining both the so called European productivity slow-down and the high levels of unemployment rate of this period.

Conclusion 19 *This points to the crucial importance of being on a sustainable ppp level when fixing the exchange rates.*

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11 Appendix: Data

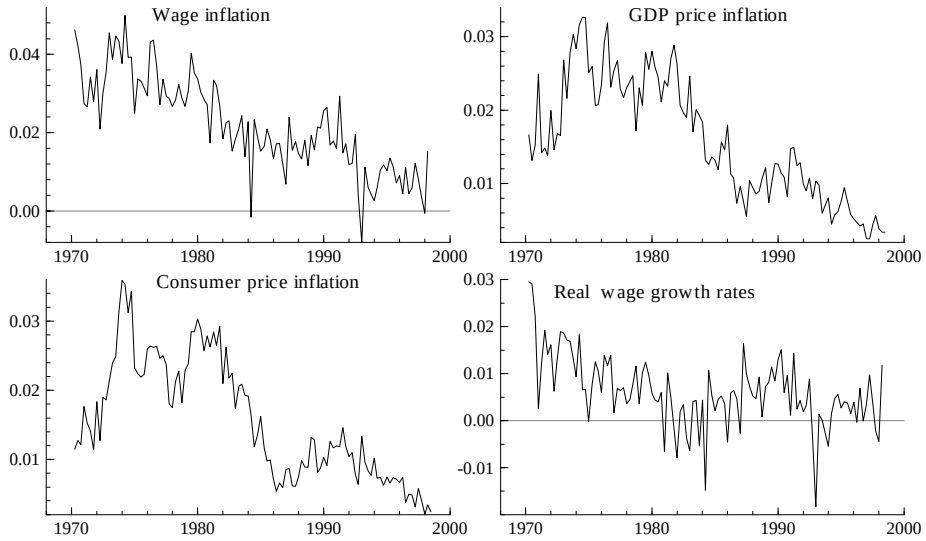

Figure A.1. Graphs of nominal wage and price growths and real wage growth.

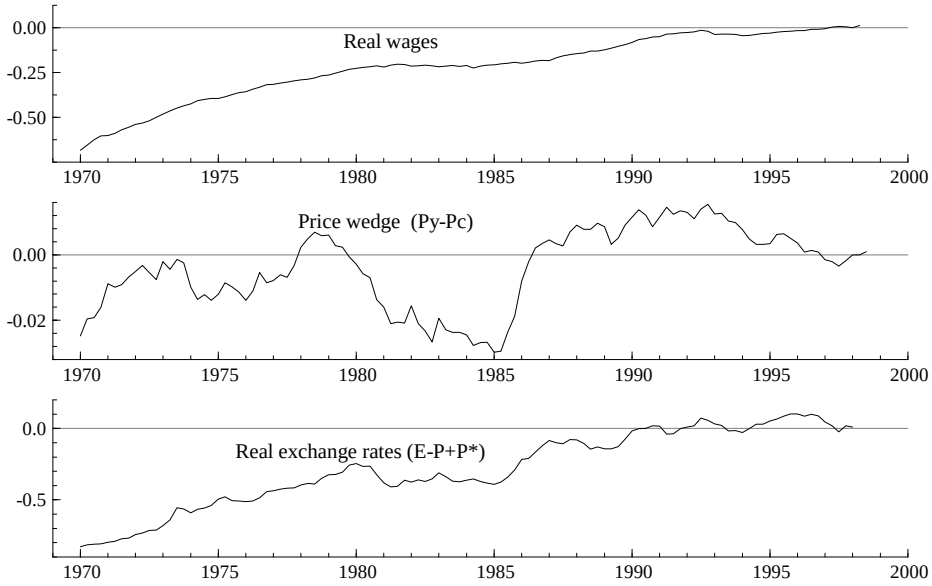

Figure A.2. Graphs of real wages, the internal price wedge, and the external price wedge.

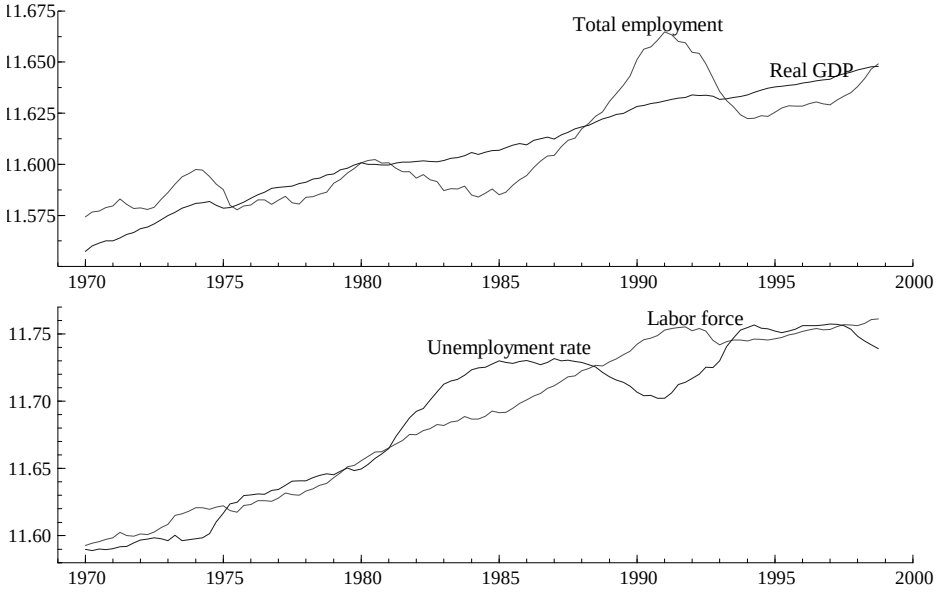

Figure A.3. Graphs of total employment and real GDP (upper panel) and the unemplyment rate and the labor force (lower panel).

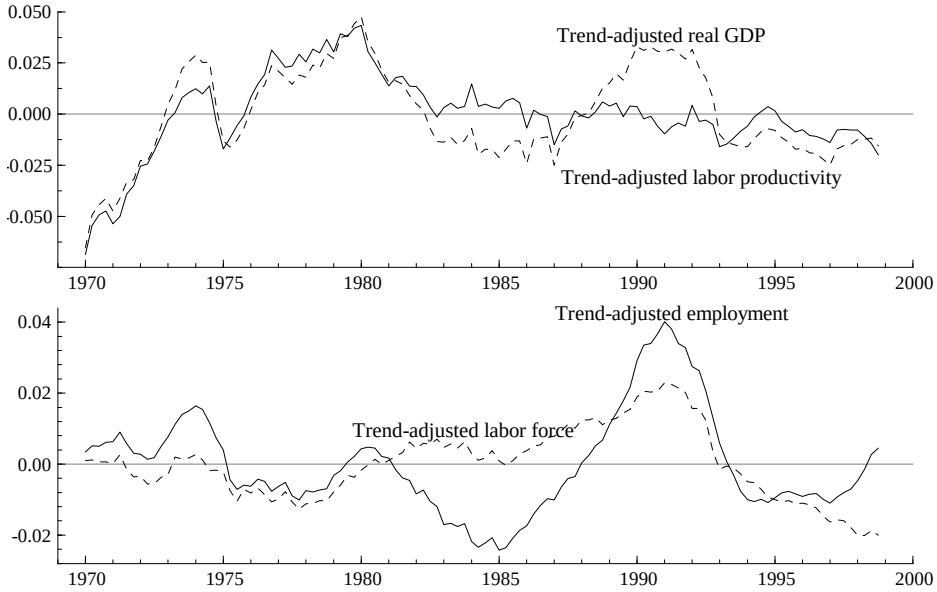

Figure A.4. Graphs of trend-adjusted real GDP and trend-adjusted labor productivity (upper panel) and trend-adjusted employment and trend-adjusted employment (lower panel).