On the relative stickiness of wages and prices in Western Europe and the United States: A structural VAR approach

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1. Introduction

The evolution of unemployment in Europe over the last 40 years has been the subject of an intense debate among economists worldwide. Any attempt to explain this evolution, however, must take into account the following set of factors (Blanchard (2004)):

- High unemployment is not a European trait. Until the end of the 1960s, unemployment was very low in Europe and the talk then was of the 'European unemployment miracle'. The miracle came to an end in the 1970s, when unemployment steadily increased. It kept increasing in the 1980s. It appeared to turn around in the mid-1990s, but the decline is on hold. For the European Union (EU) as a whole (before the new enlargement) the unemployment rate is still very high, around 8.0 %.

- The evolution of the average European unemployment rate hides large cross-country differences. In four large continental countries – France, Germany, Spain, and Italy – the unemployment rate has come down from its peak around the mid 1990s but remains very high, around 10 % (the Spanish unemployment rate has been cut in half since its peak, but is still above 10 %). In a number of smaller countries, notably Ireland and the Netherlands, unemployment increased until the early 1980s, but has decreased for most of the time since then. Unemployment is below 5 % in both countries today. In a number of other countries, notably Sweden and Denmark, unemployment has remained consistently low – except for a high cyclical rise in unemployment at the start of the 1990s, especially in Sweden. Unemployment is around 6 % in both countries today.

- At a given unemployment rate, individual unemployment duration is substantially longer, flows in and out of unemployment substantially lower, in Europe than in the United States (US). And the increase in European unemployment reflects an increase in duration rather than an increase in flows. In Germany and Italy for example, more than half of the unemployed today have been unemployed for more than one year.

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- If one takes the change in inflation as a rough indicator of whether the rate of unemployment is above or below the non-accelerating inflation rate of unemployment (NAIRU or 'natural rate (of unemployment)'), one must conclude that, apart from cyclical movements in the early 1980s and early 1990s, the broad movements in the unemployment rate have reflected movements in the natural rate. In particular, over the last few years, inflation has declined only slightly, suggesting that the natural rate today is lower than, but close to, the actual unemployment rate.

It seems to be common sense among economists that reforming the labor market institutions in the EU member states (reducing real and nominal rigidities) is imperative for increasing the degree of resilience of these economies to adverse macroeconomic shocks. Furthermore, the formation of the Economic and Monetary Union (EMU) is often taken to put further demands on the flexibility of wages and prices in these economies, in order to compensate for the lack of national instruments (exchange rate, fiscal and monetary policies) to deal with economic disturbances. For instance, if wages are too rigid, the necessary adjustment in labor markets will come slowly and with considerable economic and social costs. Moreover, asymmetries and differences in labor market performance across European countries may increase, and this may in turn lead to a stronger pressure for monetary policy to be concerned with output stability alongside price stability.

The US labor market has been much less subject to collective intervention by unions or government than that of other Western European countries. It is commonly argued that these differences are a key to understanding the higher levels of European unemployment rates generally associated with stickier nominal/real wages and prices.

Some of those main differences between labor markets in the US and Western Europe can be summarized as follows (Bertola *et al.*, (2001)):

- *Wage Setting*: Collective bargaining plays a much smaller role in determining worker's wages in the US, with its low rate of collective bargaining coverage and predominantly single-firm bargaining units in the union sector, than in Western European countries, particularly those in Central and Northern Europe, where wage agreements are made at the industry or even the economy level.

- *Minimum Wage levels*: Minimum wage levels are higher relative to average wages in Western European countries than they are in the US (OECD (1998)).

- *Unemployment Benefit System*: The unemployment insurance benefits are much more generous in the Western European countries than in the US, and while these benefits usually run out after 6 months in the US, unemployed workers can collect for much longer periods in the Western European countries.

- *Lay off Legislation*: It is much more expensive and administratively cumbersome for firms in Western European countries to lay off workers or employ temporary

workers than it is in the US (OECD (1999)). Also, the government is typically a much more important employer in the European countries than in the US. While the public sector's share of employment has been falling steadily in the US since the 1970s, largely as the result of a strong private employment growth, the opposite is true in most other European countries.

As already mentioned, the existence of the differences above are frequently associated with the presence of stickier nominal/real wages and prices in Western European labor markets, resulting in higher levels of unemployment rates.

However, it should be acknowledged that some of those differences (e.g., the high incidence of government employment or the generosity of unemployment benefits) may be in part a response to higher unemployment rates in Western European countries. In other words, one difficulty with such an argument is that, during the 1960s and early 1970s, with basically the same differences in labor market institutions between the US and other Western European countries, there was no such an issue of European unemployment. Instead, it was the US that was the high unemployment country. Thus it cannot be true that interventionist institutions, though maybe responsible for nominal/real wage and price rigidities, produce high unemployment rates all the time. Nevertheless, consideration of the vast differences in labor markets between the US and Western European countries has suggested a plausible interpretation of the relationship between these institutions and the unemployment disparities that have prevailed since the early 1970s. This view essentially posits an interaction between labor market institutions and labor market shocks (Blanchard and Wolfers (2000)). According to this view, when interacted with unfavorable labor market institutions, adverse shocks could have long-lasting effects on the natural rate of unemployment (the 'hysteresis' hypothesis). Consequently, the institutional design and structural characteristics of Western European labor markets have assumed a central stage in many economic policy debates, with wage and price setting mechanisms and their associated (nominal and real) rigidities typically figuring prominently in the analysis.

The interaction between shocks and institutions can be better understood first noting that since the early 1970s, there have been a variety of real and nominal shocks to which labor markets in all countries have been exposed, including the slowdown in productivity growth dating from the early 1970s, the oil price increases of the 1970s and early 1980s, the fall in the relative demand for unskilled labor since 1980, and disinflation in the 1980s and 1990s (Layard *et al.* (1991)). It has been hypothesized that the flexible US labor market was able to accommodate these shocks by letting absolute and relative real wage levels to adjust, allowing its unemployment rate to stay low. In contrast, in most other Western European countries, labor market institutions kept overall real wages rising and prevented unskilled workers' relative wages from falling as fast as they did in the less restricted US market (in some cases preventing any fall in low skilled workers' relative pay), thus producing sharp increases in unemployment in these countries (Blanchard and Wolfers (2000)).

To illustrate the basic argument, consider the impact of a real shock like productivity. From the 1960s to the 1990s, annual growth in total factor productivity in the OECD fell from 5-6 % to 1-2 % (Blanchard and Wolfers (2000)). In the relatively flexible US labor market, real wages were allowed to grow more slowly and even to decline, thus mitigating the adverse effect of productivity decline on unemployment. On the other hand, in many OECD countries, the more rigid labor market institutions kept real wages growing at their customary pace instead; this led to higher unemployment in these countries. Conversely, when productivity growth is unusually rapid, real wages may adjust more quickly in flexible labor markets like in the US than in rigid labor markets like in Western European countries, implying that employment should actually grow by more in the countries with interventionist institutions. This kind of interaction may indeed play a role in explaining the low unemployment observed in the 1960s in a large part of Europe.

Another very important issue in comparing different labor markets is not only how real shocks can affect real and nominal wages in the long run but also to explain how purely nominal disturbances may produce short-term effects in nominal/real wages and unemployment. In the classical paradigm, in which wages and prices are perfectly flexible, a positive nominal (aggregate demand) disturbance will cause nominal wages and prices to rise in the same proportion, leaving real wages unchanged. Thus, employment would also be unaffected. Consequently, many business cycle theories posit the existence of wage and/or price stickiness to explain how (nominal) aggregate demand disturbances generate real macroeconomic effects. According to these theories, the failure of nominal wages or prices to fully adjust in the short run to purely nominal disturbances explains why shocks to aggregate demand will cause both employment and output to temporarily deviate from their natural rates.

If, for example, prices are free to adjust but nominal wages are sticky, a positive aggregate demand shock will cause prices to rise and real wages to temporarily fall below market-clearing levels. The fall in real wages will stimulate employment as the aggregate demand shock induces movement along a stable labor demand curve. Consequently, sticky-wage models predict a negative correlation between aggregate demand shocks and real wages.

If, on the other hand, wages are flexible while output prices are sticky, aggregate demand disturbances and real wages will tend to be positively correlated in the short run. In sticky-price models, imperfectly competitive firms may resist adjusting output prices in response to changes in demand, perhaps due to 'menu costs'. Instead, increases in demand are met by corresponding increases in output. This requires an increase in labor inputs, which, in turn, requires an increase in the real wage rate if wages are flexible and the labor supply curve is positively sloped. Thus, when prices are sticky but wages are flexible, a positive aggregate demand shock is associated with an increase in real wages.

It may be that neither prices nor wages are fully flexible. If prices and wages both exhibit stickiness we would expect real wages to be positively correlated or negatively correlated with aggregate demand shocks depending, to a large extent, on whether prices or wages

are stickier. Thus, knowledge of the direction of the short-run response of real wages to aggregate demand disturbances would offer important evidence on the relative stickiness of nominal wages and prices.
Against this background, estimating the degree of real/nominal wage and price rigidities in Western Europe and the US (the benchmark country) has become the central topic of a great variety of articles in recent years (see, for example, Pichelmann *et al*. (2004)). The precise quantification of these rigidities is no doubt a fundamental 'first step' for any posterior study aiming at the more efficient redesigning of labor market institutions in a given country. However, the relative importance of wage and price stickiness in the mechanism of transmission of real and nominal shocks to those economies still remains a fundamental unsettled issue (Spencer (1998)).

The purpose of this paper is twofold: by exploiting the evidence on the behavior of nominal and real wages for a set of Western European countries and the US, we attempt to assess the relative importance of nominal wage and price stickiness in the transmission of nominal (aggregate demand) shocks, as well as the role played by real wage stickiness in the transmission of real (aggregate supply) shocks for those economies.

The mechanisms of transmission of shocks to the real economy (and the dynamic influence of real and nominal rigidities on them) can be suitably investigated via the structural VAR approach originally developed by Blanchard and Quah (1989). In this paper a bivariate structural VAR (in the moving average form) is estimated, with real and nominal wages as endogenous variables. The movements in real and nominal wages are decomposed in two types of non-correlated shocks: real shocks (e.g. technological shocks, endowments, oil shocks) and nominal shocks (e.g. an increase in government expenditures, money supply and decrease in interest rate). Nominal shocks are identified by restricting them to have no long-run effects on real wages, but possibly affecting nominal wages in the long run. Real shocks may affect both real and nominal wages in the long run. The restriction imposed on nominal shocks is indeed sufficient to identify these two sources of shocks.

The interpretation of disturbances with permanent effects as supply disturbances, and of disturbances with transitory effects as demand disturbances is motivated by a traditional Keynesian view of fluctuations: in the long run, when prices and wages can be considered perfectly flexible, real variables are neutral to nominal shocks.

From the estimation of the bivariate structural VAR, impulse response functions can be constructed in order to estimate the dynamic effects of these shocks on real and nominal wages. The construction of impulse response functions also allows a qualitative evaluation about the role of rigidities in the transmission of shocks to wages. A quantitative analysis of the relative contribution of real and nominal shocks to real and nominal wage variability can be carried out through the variance decomposition of the estimated structural VAR predictions. From this analysis it will also be possible to conjecture how effective supply or demand side government policies can be in promoting real economic effects.

The remaining of this paper is organized as follows. Section 2 explains the structural VAR methodology and points out the existence of a key problem of identification that was overlooked in the seminal paper of Blanchard and Quah (1989). Section 3 presents and discusses the empirical results. Special attention is devoted to the lack of robustness in some of the VAR estimations when the sample range is changed, apparently attributed to the long-run restriction imposed on nominal shocks. Section 4 presents the final conclusions.

2. Identification of Shocks

2.1. Method

Following Lastrapes (2002), let z_t denote the n x 1 vector of stationary endogenous variables (in our case nominal and real wages). Assume that z_t is generated by the structural model:

$$z_t = D(L)v_t = \left(D_0 + D_1 L + D_2 L^2 + \ldots\right)v_t, \tag{1}$$

where v_t is an n x 1 vector of white noise shocks with the contemporaneous covariance matrix normalized to the identity matrix. The corresponding reduced form can be written as:

$$z_t = C(L)e_t = \left(I + C_1 L + C_2 L^2 + \ldots\right)e_t, \tag{2}$$

where $e_t \equiv D_0 v_t$, $E\left(e_t e_t^{'}\right) = \Sigma$, and $C(1) = \sum_{i=0}^{\infty} C_i = D(1)D_0^{-1}$.

The objective of the empirical work is to obtain estimates of $C(L)$ and Σ, which are directly estimable from the data record of z_t, and then to identify the structural parameters of interest, $D(L)$. Since the mapping from reduced to structured form is not unique, some exogenous restrictions must be imposed in (1) to achieve this identification.

From the correspondence between structural and reduced form, it is straightforward to show that the parameters of interest depend on $D(1)$:

$$D(1)\left(D(1)\right)' = C(1)\Sigma\left(C(1)\right)', \tag{3}$$

$$D_0 = (C(1))^{-1} D(1) \tag{4}$$

and

$$D_i = C_i D_0, \text{ for } i = 0\ldots\infty. \tag{5}$$

It is worth noting that $D(1)$ is not yet fully identified from equation (3). This identification problem must be solved with the help of economic theory instead. In our case, the imposition that nominal shocks have no long-run effects on real wages requires the matrix $D(1)$ to be lower triangular. Therefore, $D(1)$ can be uniquely identified as the Cholesky factor of $C(1)\Sigma(C(1))'$.

Once $D(1)$ is identified from (3) and from the long-run neutrality restriction on nominal shocks, D_0 can be obtained from equation (4). By the same token, all the parameters of the structural VAR(1) can be estimated recursively from equation (5).

2.2. A Note on Blanchard and Quah (1989)

In their seminal paper Blanchard and Quah (1989) propose an informal argument for the identification of the structural VAR(1), which they claim is "indeed correct". Instead of trying to identify the long-run matrix $D(1)$, the authors focus their analysis on the identification of D_0. From the correspondence between the structural and reduced form, the authors can easily show that $D_0 D_0^{'} = \Sigma$, which imposes three (non-linear) equations for the four unknown elements in the full matrix D_0 that must be identified (see also Plasmans (2005), p. 177). A fourth (linear) equation comes up from a long-run restriction, in the same spirit of the traditional Keynesian long-run neutrality condition applied for the matrix $D(1)$ above. With four equations and four unknowns (the four elements in D_0), Blanchard and Quah (1989) claim that the matrix D_0 is uniquely identified. However, since there are three non-linear equations in the system proposed by the authors, the solution is not unique. Therefore, D_0 is obviously not uniquely identified.

3. Empirical Results

3.1. Data

The data set consists of quarterly observations from 1963:1 to 2004:1 on real wages and nominal wages for the US, the United Kingdom (UK), France, Italy, the Netherlands and Belgium. The nominal wage rate is the average hourly earnings in manufacturing, which is deflated by the Consumer Price Index (CPI) to obtain the real wage rate. Data is taken from the OECD ('Main Economic Indicators').

Both real and nominal wages are non-stationary for all countries. Each of the two series was examined for the existence of a unit root using the Augmented Dickey-Fuller (ADF) test. Tests of co-integration offer no evidence that real and nominal wage rates are cointegrated; otherwise, a long-run restriction would be implied and should be taken into account. Thus the estimation of a VAR model in the first differences (in logs) for real and nominal wages seems to be a good specification for all countries. Table 1 reports the

results for the ADF tests on the original nominal and real wage series for all countries, where it is verified that the null of first-order integration of nominal and real wages cannot be rejected (although sometimes marginally) at the 5 % level.
Several criteria were used to help choose the length of lags in the estimated VAR equations for each country, including Likelihood Ratio (LR) tests, as well as the Akaike and Schwartz information criteria. Table 2 presents the most appropriate number of lags estimated for each country's VAR, according to these criteria.

In order to examine the possibility of exogenous shifts in the endogenous variables, two period-specific dummies were tested for its significance. The first dummy accounted for the first and second oil shocks, covering the period of 1973 to 1985, the year when the international price of oil finally returned to its historical levels. The second dummy accounted for the euro-zone creation in 1999, which could also have exogenously affected nominal and real wages in Western European countries. It turned out that none of the coefficients belonging to these dummies is significantly different from zero (for all countries) and, therefore, the dummies were disregarded in the VAR specifications.

Table 1. Augmented Dickey-Fuller tests for nominal and real wages

Country	Wage series	Number of lags	ADF-test statistic	Critical value (5%)
US	Nominal wages	4	-2.3754	-2.8795
	Real wages	2	-2.2808	-2.8792
UK	Nominal wages	4	-2.4121	-2.8795
	Real wages	6	-0.8283	-2.8798
France	Nominal wages	3	-0.5158	-2.9029
	Real wages	4	-2.8205	-2.8795
Italy	Nominal wages	4	-1.6930	-2.8795
	Real wages	5	-2.8654	-2.8795
Netherlands	Nominal wages	5	-2.5609	-2.8795
	Real wages	7	-2.1828	-2.8837
Belgium	Nominal wages	4	-2.7783	-2.8794
	Real wages	4	-2.5465	-2.8794

Table 2. Estimated VARs in first differences: Results for the best number of lags for each country

Bivariate VAR	Lags
US	3
UK	5
France	4
Italy	3
Netherlands	5
Belgium	4

Note: Estimations are based on the Akaike and Schwartz information criteria as well as on LR tests.

3.2. Impulse Response Functions

We now turn to the dynamic effects of nominal (aggregate demand) and real (aggregate supply) shocks using the estimated structural VAR models. The dynamic effects of a one-period (one-unit) shock are measured by the impulse response functions. Figure 1 displays the estimated impulse response functions of real and nominal wage rates for each country. Each plot shows the dynamic response of nominal or real wages to both nominal and real shocks.

3.2.1 The Dynamic Effects of Nominal Shocks on Real and Nominal Wages

According to the results reported in Figure 1, with the exception of the UK, Belgium and the US, a positive aggregate demand shock is followed by a sharp decline in the real wage rate for all countries, which only rather slowly returns to its pre-shock level. This appears to be consistent with the claim that nominal wages are stickier than consumer prices for these countries. Thus, if consumer prices are sticky in the face of aggregate demand shocks, it appears to be the case that nominal wages are even stickier. The countercyclical real wages seem to indicate that sticky nominal wages have played a relatively more important role than sticky prices in transmitting aggregate demand shocks to the real economic activity in those Western European countries. This countercyclical pattern is conflicting with the results reported by Moore and Pentecost (2005) for a particular set of European economies, using a bivariate structural VAR approach being similar to the one used in this paper, but working with monthly data instead.

For the US the picture is quite different. According to Figure 1 real wages are positively affected by a one-unit aggregate demand shock, suggesting that consumer prices are

relatively stickier than nominal wages. Just the opposite as the results reported for the Western European countries, the American procyclical real wages would indicate that sticky prices have played a more important role than sticky wages in transmitting aggregate demand shocks to the US economy. This pattern is identical to the pattern reported by Gamber and Joutz (1993) for the real wage response to aggregate demand shocks in the US.

For the nominal wage rate itself, the plots show a quite expected procyclical behavior with nominal shocks for all countries. Its is worth noting that, according to the plots in Figure 1 for the case of the US, nominal wages seem to be relatively more sensitive to nominal shocks than to real shocks. This is in accordance with the view of relatively stickier prices than nominal wages for the American economy and relatively stickier nominal wages than prices for the Western European economies.

Results in Figure 1 also reveal that real wages seem to be relatively more resilient to nominal shocks in the US, with the effect of a one-unit nominal shock being nullified after approximately 10 years, whereas the dynamic effects of nominal shocks in European countries' real wages show a more persistent pattern.
With the exception of the UK and Belgian cases (which will be elaborated further in the text) the scale of real wage responses to nominal shocks seems to be larger in Western Europe than in the US. In the case of the former it ranges from 0 % to -1.5 %, whereas in the case of the latter it picks over 0.23 %. It is, therefore, evident that the effect of nominal shocks on real wages is much larger in Western European countries than in the US.

3.2.2 The Dynamic Effects of Real Shocks on Real and Nominal Wages

The impulse response functions reported in Figure 1 also reveal that real wages, as it would be expected from economic theory, are procyclical with aggregate supply shocks for all countries. The same is valid for nominal wages, with the exception of the US (in the long run). The plots also seem to suggest that the US is more resilient to aggregate supply shocks than the Western European economies, with real wages reaching very closely their new equilibrium levels in less than two years. This result is consistent with the view that in the 1960s the more flexible American labor market produced more unemployment than in the more interventionist Western European labor markets, where real wages used to adjust to new productivity levels with a relatively larger delay.

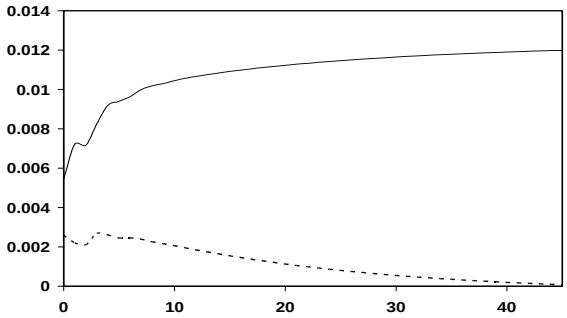
It is also evident from Figure 1 that the effect of real shocks on real wages is much larger in Western European countries than in the US. In the case of the latter it ranges from 0 % to 1.2 %, whereas in the case of European countries it can reach values as high as 3.5 % (case of France).

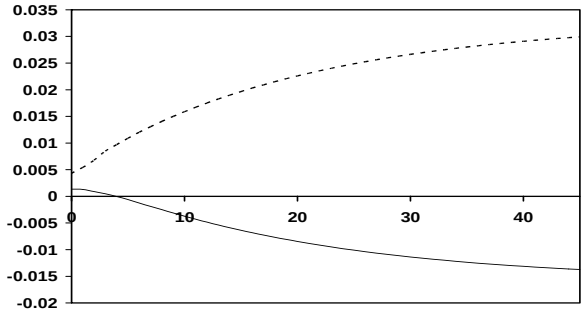
The long-run countercyclical nominal wages observed for the US seem to indicate that consumer prices are even more countercyclical under a real shock; i.e., in the domain of

downward rigidities, it seems to be the case that nominal wages are relatively downward-stickier than prices in the US.

Figure 1. Impulse Response Functions (real shock-continuous line; nominal shock-dotted line) for the period 1963:1-2004:1.

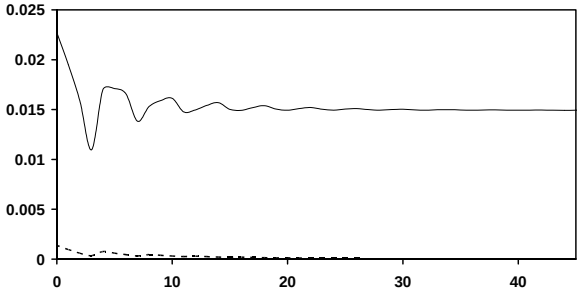
Real Wages (US)

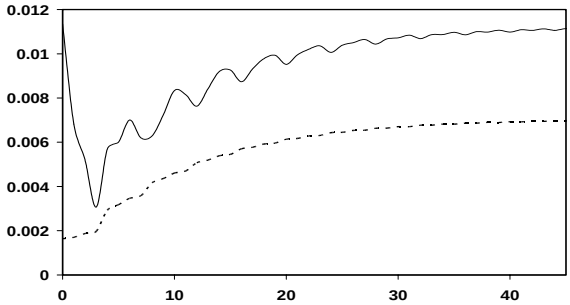




Nominal Wages (UK)

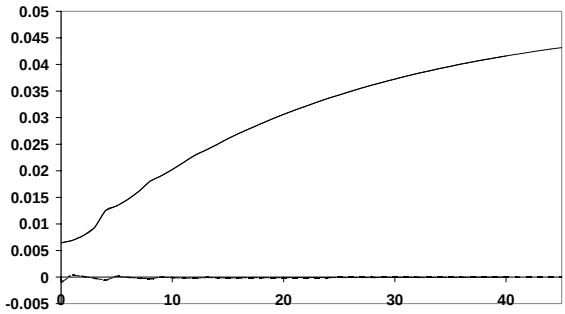
Real Wages (UK)

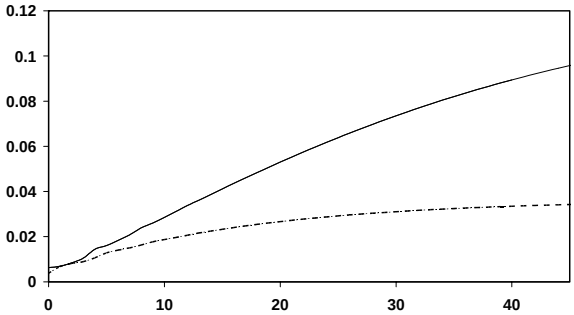




Nominal Wages (Belgium)

Real Wages (Belgium)

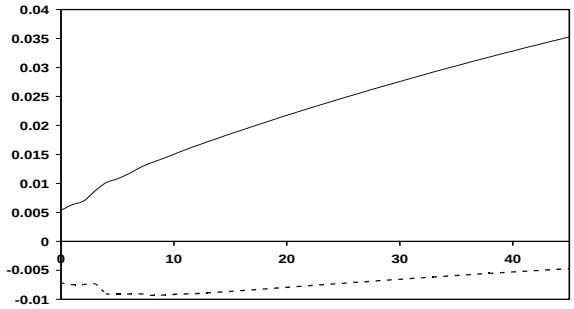




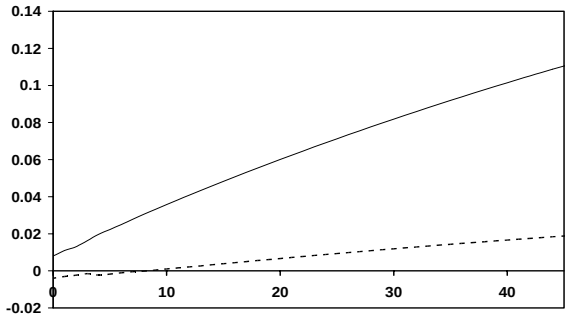
Nominal Wages (US)

Figure 1. Impulse Response Functions (Real Shock-Continuous Line; Nominal Shock-Dotted Line) for the Period 1963:1-2004:1.

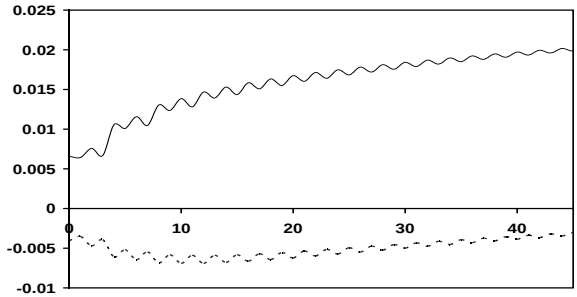
Real Wages (France)



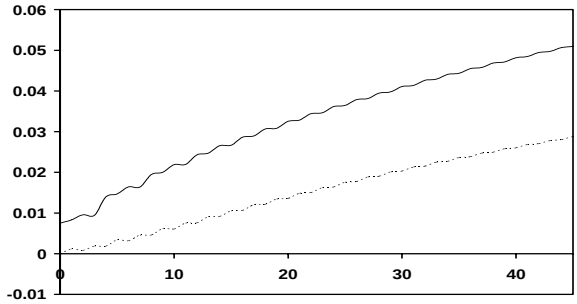
Nominal Wages (France)



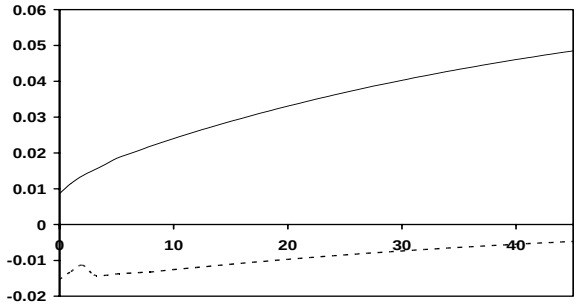
Real Wages (Netherlands)



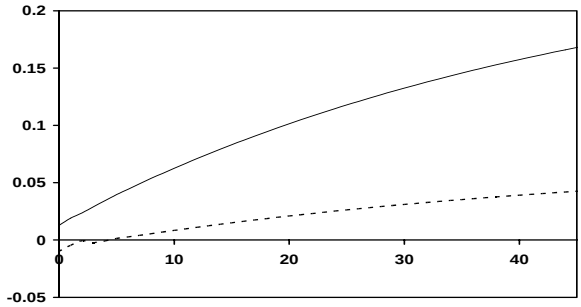
Nominal Wages (Netherlands)



Real Wages (Italy)



Nominal Wages (Italy)



3.3. Variance Decomposition

In order to further assess the contributions of aggregate demand and aggregate supply shocks to fluctuations in real and nominal wages, the Forecast Error Variance (FEV) decomposition is reported in Table 3. The numbers reported there are estimates of the percentage of the variance of the *k*-step(-ahead) forecast error for each variable in the model contributed by aggregate demand shocks. The identifying restrictions require the percentage of real wage fluctuations explained by aggregate demand shocks to approach zero as the forecast horizon increases. As revealed in Table 3, this is basically the case for all countries (except for the UK and Belgium), but only in a rather slow pattern. This is in agreement with the plots shown in Figure 1, where it can be seen that the impact of nominal shocks on real wages are quite persistent for these countries.

The variance decomposition results indicate that aggregate demand shocks play a more important role for real wage fluctuations in Western European countries than in the US. Given the significant and persistent contribution of nominal shocks on real wage fluctuations, these results seem to suggest that demand side policies might be effective for employment growth in Western European countries. The low contribution of nominal shocks for real wage fluctuations in the US was also reported in Spencer (1998) and Gamber and Joutz (1993).

The results in Table 3 also reveal that nominal shocks are relatively more important for nominal wage fluctuations in the US than in Western European countries. This result seems to be consistent with the idea of relatively less sticky nominal wages in the US than in Western European countries.

Table 3. Percentage of Forecast Error Variance (Nominal and Real Wages) explained by Aggregate Demand Shocks for the Period 1963:1-2004:1

	US		UK		France	
k	Real wage	Nom. wage	Real wage	Nom. wage	Real wage	Nom. wage
1	17.29	91.52	0.38	1.78	63.53	19.07
	(3.96E-05)	(2.18E-05)	(5.29E-04)	(1.52E-04)	(8.13E-05)	(8.96E-05)
4	17.12	91.49	0.40	2.20	60.80	15.88
	(4.20E-05)	(2.86E-05)	(6.03E-04)	(1.67E-04)	(8.95E-05)	(1.18E-04)
8	17.11	88.61	0.41	2.46	58.85	13.40
	(4.23E-05)	(3.50E-05)	(6.13E-04)	(1.69E-04)	(9.27E-05)	(1.49E-04)
12	17.17	86.37	0.41	2.57	57.52	12.03
	(4.24E-05)	(3.93E-05)	(6.16E-04)	(1.72E-04)	(9.49E-05)	(1.77E-04)
20	17.28	84.15	0.41	2.63	55.58	10.57
	(4.25E-05)	(4.42E-05)	(6.17E-04)	(1.74E-04)	(9.84E-05)	(2.25E-04)
40	17.36	82.83	0.41	2.66	52.46	9.11
	(4.26E-05)	(4.77E-05)	(6.17E-04)	(1.75E-04)	(1.05E-04)	(3.17E-04)

	Italy		Netherlands		Belgium	
k	Real wage	Nom. wage	Real wage	Nom. wage	Real wage	Nom. wage
1	74.21	37.28	28.01	2.54	6.84	36.56
	(3.21E-04)	(3.21E-04)	(6.04E-05)	(5.85E-05)	(4.47E-05)	(6.27E-05)
4	72.98	33.29	28.04	3.33	5.81	31.49
	(3.41E-04)	(4.21E-04)	(8.43E-05)	(8.14E-05)	(5.83E-05)	(9.04E-05)
8	71.55	28.66	29.03	7.13	6.00	30.35
	(3.48E-04)	(5.25E-04)	(9.97E-05)	(9.89E-05)	(6.72E-05)	(1.23E-04)
12	70.74	26.04	29.88	10.26	5.65	27.67
	(3.53E-04)	(6.08E-04)	(1.11E-04)	(1.13E-04)	7.32E-05	1.52E-04
20	69.56	23.17	30.99	14.44	5.15	23.05
	3.59E-04	7.35E-04	(1.27E-04)	(1.34E-04)	8.08E-05	2.03E-04
40	68.02	20.54	32.02	18.85	4.77	18.07
	(3.69E-04)	(9.11E-04)	(1.45E-04)	(1.63E-04)	8.72E-05	2.73E-04

3.4. Robustness

The dynamic effects of nominal shocks on real wages for the case of Belgium and the UK were indeed quite unexpected. According to the plots in Figure 1, nominal wages would be as sticky as consumer prices for these countries, indicating an unrealistic perfect flexibility of nominal wages and consumer prices for these countries.

A possible explanation for this apparent 'puzzle' could lie in the assumptions made in the Blanchard-Quah (1989) scheme (aggregate demand shocks as the only temporary shocks), associated with the sample period chosen for the VAR estimations. Indeed, it is quite acceptable that the period 1963:1-1973:4 (pre-OPEC period) was, as assumed by the identification restrictions, dominated by aggregate demand shocks, whereas there were important temporary real shocks during the post-OPEC period 1973:4-2004:1 (with the two oil price shocks in 1973 and 1979). Consequently, the Blanchard and Quah (1989) methodology for identifying aggregate demand shocks, though useful in the pre-OPEC period, becomes less reliable in the post-OPEC period since the so-called demand shocks in the later period are, in fact, contaminated by important temporary aggregate supply shocks. Investigating the dynamic impacts of nominal shocks on real wages for the US economy using a trivariate VAR, Spencer (1998) reports the same problem in his findings.

In an attempt to examine the plausibility of this interpretation, new VAR estimations were carried out for the UK and Belgium, but this time for two sub-samples: 1963:1-1973:4 (pre-OPEC period) and 1973:4-2004:1 (post-OPEC period). The choice of the break point indicates the first OPEC oil price shock but is also near the date of the breakdown of the Bretton Woods system and the period during which the puzzling productivity slowdown began. It could be that, especially for these two countries, the impact of temporary real shocks on wages (during the post-OPEC period) cancels out the negative effect of a nominal shock on real wages, resulting in an apparently flat (at level zero) impulse response function.

The estimated impulse response functions, showing the effect of aggregate demand shocks on real wages for each sub-period, are given in Figure 2.

For the case of the UK, support for the relative stickiness of nominal wages is quite strong in the earlier sub-period and altogether disappears in the later sub-period. As can be seen in the figure for the pre-OPEC sub-period, a positive aggregate demand shock appears to cause real wages to fall sharply and then recover in a relatively volatile fashion. This contrasts with the corresponding estimated impulse response function for the full sample period in Figure 1, where nominal wages and consumer prices appear to be fully flexible. The estimated impulse response function for the post-OPEC period seems to indicate that, for that sample period, prices may be stickier relatively to nominal wages following an aggregate demand shock. Contrary to the evidence for the pre-OPEC period, the initial effect of an aggregate demand shock on real wages is positive and dies out, again, in a relatively volatile fashion. Thus the fact that, for the full sample period (Figure 1), results appear to suggest perfectly flexible nominal wages and prices for the

UK, seems to be a direct consequence of the importance of the 1974:1-2004:4 sub-period. The results reported for the first sub-period seems to be indeed the best surmise for relative nominal wage and price rigidities in the UK: nominal wages are stickier than consumer prices.

For the case of Belgium, results in Figure 2 for the first sub-period seem to give support to the relative stickiness of wages. A positive one-unit aggregate demand shock appears to cause real wages to fall sharply and then recover quite rapidly. This result contrasts with the corresponding estimated impulse response function for the full sample period (Figure 1), where, as in the case of the UK, nominal wages and consumer prices appear to be fully flexible. The estimated impulse response function for the post-OPEC period also seems to confirm the relative stickiness of nominal wages. However, in this case, a positive one-unit aggregate demand shock appears to cause real wages to fall less sharply and then recover quite sluggishly. There is no evidence that temporary real shocks could have influenced the results for the post-OPEC period (since temporary shocks still have a negative effect on real wages). Based on the results presented in Figures 1 and 2, it seems reasonable to conjecture that, for the case of Belgium, nominal wages are only slightly stickier than consumer prices.

Figure 2 also reports re-estimated impulse response functions for the US. In both sub-periods real wages are positively affected by a positive aggregate demand shock. Moreover, nominal wages seem to recover relatively more sluggishly in the post-OPEC period to their equilibrium level. Results for the other countries (not reported in the text) were qualitatively similar to the ones reported for the UK: a countercyclical real wage for the pre-OPEC period and a procyclical real wage for the post-OPEC period due to the stronger positive influence of temporary real shocks (mainly the two oil shocks).

Results reported in Figures 1 and 2 are very rich in insights regarding the mechanisms of transmission of shocks (real and nominal) to the real economy both in the US and in Western European countries.

In both types of economies real shocks are procyclical with real wages, but the US seems to be more resilient to those shocks than Western Europe (under a positive aggregate supply shock, real wages in the US reach relatively more quickly the new equilibrium level). This suggests that under a positive productivity shock, for example when productivity growth is unusually rapid, real wages adjust more quickly in flexible labor markets like in the US than in rigid labor markets like in the Western European countries, implying that employment should actually grow more in the countries with interventionist institutions (Bertola *et al.* (2001)). This could indeed have been the case in the 1960s, for the so called 'European employment miracle'.

Both types of economies also differ in the way they react to aggregate demand shocks. While the results indicate procyclical real wages for the case of the US ((Bils (1985) and Solon *et al.* (1994)), real wages seem to be countercyclical for the Western European economies.

Figures 1 and 2 also shed some light on the role played by shocks and institutions in the rise of European unemployment. One of the points discussed in Blanchard and Wolfers (2000) is concerned with the role played by European labor market institutions for the persistence of adverse temporary shocks during the last thirty years. The impulse response functions confirm that temporary shocks are more persistent in the Western European countries than in the US, with real wages in most Western European countries not recovering to their initial equilibrium level even after a period of 10 years. However, as can be seen from Figure 2, even the US, with more flexible labor market institutions, reveal some degree of persistence in the recovery of real wages to their initial equilibrium level.

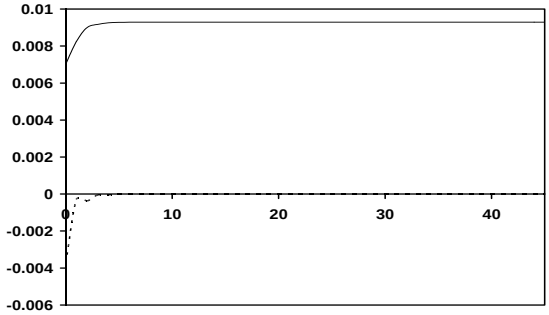
Since temporary shocks are most predominantly aggregate demand shocks in the pre-OPEC period and, for the case of Belgium and the UK, results in Figure 1 were not quite elucidative, variance decompositions are again computed for these countries, now using this first sub-period as a benchmark. Results in Table 4 reveal that, unlike the other Western European countries, nominal shocks are important for nominal and real wage fluctuations both in the UK and in Belgium, though real shocks seem to be relatively more important for wage fluctuations in both countries.

Table 4. Percentage of Forecast Error Variance (Nominal and Real Wages) explained by Aggregate Demand Shocks for the Period 1963:1-1973:4

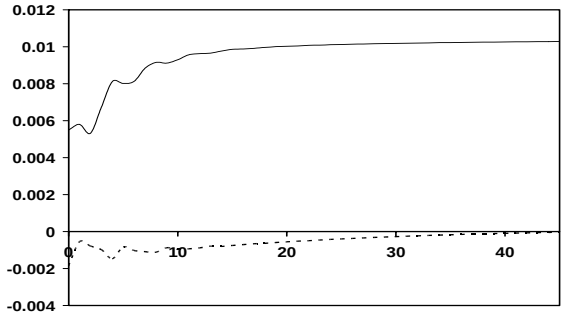
	UK		**Belgium**	
k	Real wage	Nom. Wage	Real wage	Nom. wage
1	4.54	2.48	33.59	14.31
	(1.60E-04)	(1.62E-04)	(7.65E-05)	(1.23E-04)
4	14.42	15.08	33.42	14.31
	(1.86E-04)	(1.95E-04)	(7.72E-05)	(1.25E-04)
8	19.78	18.66	33.42	14.31
	(2.02E-04)	(2.26E-04)	(7.72E-05)	(1.25E-04)
12	22.59	19.92	33.42	14.31
	(2.12E-04)	(2.43E-04)	(7.72E-05)	(1.25E-04)
20	25.89	20.69	33.42	14.31
	(2.22E-04)	(2.61E-04)	(7.72E-05)	(1.25E-04)
40	28.89	20.64	33.42	14.31
	(2.32E-04)	(2.77E-04)	(7.72E-05)	(1.25E-04)

Figure 2. Impulse Response Functions (Real Shock-Continuous Line; Nominal Shock-Dotted Line) for the Periods 1963:1-1973:4 and 1974:1-2004:1.

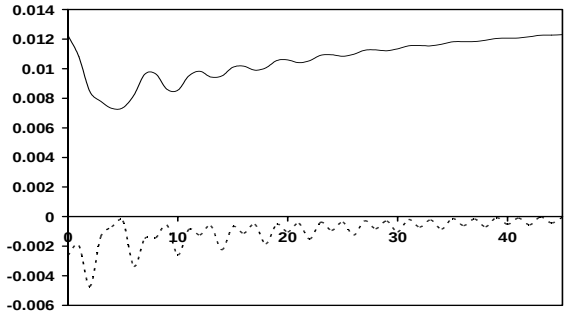
Real Wages (Belgium: 1963:1-1973:4)



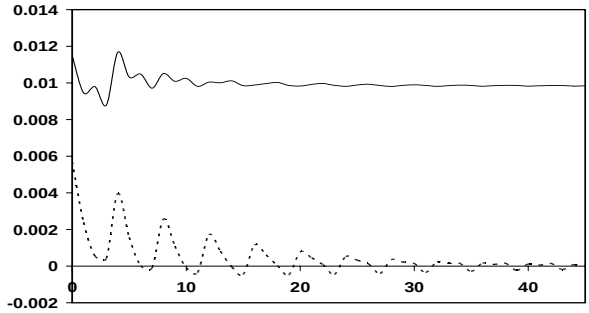
Real Wages (Belgium: 1974:1-2004:1)



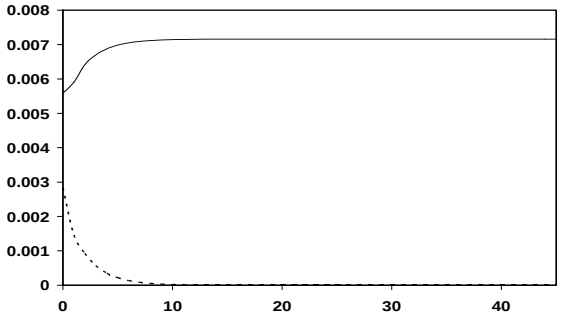
Real Wages (UK: 1963:1-1973:4)



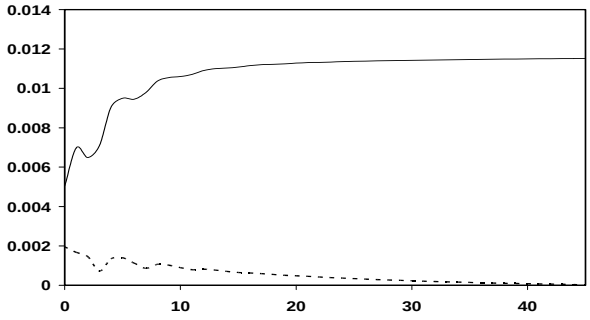
Real Wages (UK: 1974:1-2004:1)



Real Wages (US: 1963:1-1973:4)



Real Wages (US: 1974:1-2004:1)



4. Conclusions

Using a structural VAR model and an identification strategy due to Blanchard and Quah (1989), this paper examines the response of real and nominal wages to aggregate supply shocks in the US and a number of Western European countries during the last forty years. Results suggest that a positive shock to aggregate demand causes real wages to fall temporarily in all Western European countries, supplying evidence that nominal wages are stickier than prices. For the US, results suggest that sticky prices have been more important than sticky nominal wages in transmitting aggregate demand shocks to real economic activity in the last forty years.

When the full sample period is divided at the point of the first OPEC oil price shock, the Blanchard and Quah (1989) identification scheme fails to appropriately isolate aggregate demand shocks in the post-1973 sub-period, especially for Belgium and the UK. This reflects the increased importance of temporary real shocks, especially the oil price shocks in the 1970s.

Overall, the US economy seems to be more resilient to shocks than the Western European economies. Either under a nominal or a real shock, real wages in the US seem to recover relatively more quickly to their new equilibrium level. Moreover, the effect of nominal and real shocks on real wages is quantitatively much larger in the Western European countries than in the US.

Results also seem to give support to the hypothesis of interaction between shocks and institutions raised by Blanchard and Wolfers (2000). According to the Blanchard and Wolfers (2000) hypothesis, more interventionist labor markets would be less resilient to adverse real shocks (like the oil price shocks in the 1970s), mainly due to the existence of more rigid labor contracts. According to the results shown in this paper, the persistence of predominantly temporary real shocks seems to be larger in Western European countries than in the US, especially in the post-OPEC period when the productivity slowdown became more evident in the European economies.

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