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Abstract

This paper applies a set of unit root and cointegration tests with non-linear error-correction mechanisms to a subset of the OECD countries to investigate the empirical conclusions of some of the labor market models in the literature. I generally find that the unemployment rate, productivity, and real wages have a unit root even if one controls for threshold effects. This finding justifies the use of a cointegration approach to assess the existence of a long-run equilibrium among the variables of interest. For roughly half of the OECD countries in the sample, the unemployment rate, real wages, and productivity trend together over time. For four countries (i.e, Germany, Japan, Sweden, and the US) the adjustment to the long run relationship appears mostly asymmetric. Also, an impulse response function analysis suggests that real wages and productivity adjust faster to the long-run equilibrium, while shocks to unemployment take longer to extinguish. Also, according to the sign of the shocks, the unemployment rates respond differently. These findings suggest that a proper analysis of the behavior of productivity, real wages, and unemployment should consider non-linear adjustment mechanisms to long-run equilibrium since a liner approach would be biased.

Keywords: Unemployment, Wages; Collective bargaining; Hysteresis
JEL-Classification: E24; J52

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1 Introduction

This paper investigates the various implications of some of the main labor market models in the literature through the use of a set of unit root and cointegration tests with asymmetric error-correction mechanisms. In contrast to just a linear approach, this asymmetric framework treats differently the positive and negative shocks to a system formed by productivity, real wages, and unemployment rates. Furthermore, this framework allows for new insights regarding the nature of the nonlinearity in the data. Specifically, it provides an alternative to the general approach of treating nonlinearity as arising from structural change. A short summary regarding the alternative theoretical representations for productivity, real wages, and unemployment is provided below. The interested reader is referred instead to Blanchard (2005) and Layard et al. (2005) who provide extensive surveys of the literature.

First, Bruno and Sachs (1985) suggest that differences in nominal and real rigidities (e.g., as those during the 1970's) can explain why unemployment increases differ across countries. Another line of research highlights the persistence effects of adverse shocks caused by productivity slowdowns (e.g., similar to those of the 1980's). On one hand, Bean and Dreze (1990) suggest that capital accumulation is one cause of the persistence effects. On the other hand, Snower (1985) and Blanchard and Summers (1986) advance the role of insiders in the collective bargaining process as the source for these persistence effects. This line of thought led to the reconsideration of the NAIRU concept (Phelps (1972) and Friedman (1968)), suggesting that unemployment at the extreme exhibits hysteresis, where temporary shocks have permanent effects. On the same lines, Layard and Nickell (1987) suggest that duration effects (i.e., changes of the skills, motivations and search behavior determined by an unemployment spell) can trigger long term unemployment. However, the different pattern of the unemployment rate during the 1990's revived the structuralist theories of unemployment (Phelps (1995)). The low and fairly constant level of inflation during this period suggests that unemployment has settled at a higher natural level with causation attributed to institutional frictions. However, these findings do not fit all the OECD countries adequately (Blanchard (2005)).

This paper applies the models of Enders and Granger (1998) and Enders and Siklos (2001) to test these findings from a nonlinear perspective. More specifically, based on the threshold autoregressive model of Tong (1983), Enders and Granger (1998) proposes a threshold autoregressive unit root test (abbreviated TAR for short) where the adjustment process depends on the location of the previous level of a series relative to a threshold value or time trend (i.e., on whether a shock moves the system in positive or negative territory). A momentum threshold autoregressive unit root test (abbreviated MTAR for short) looks at the adjustment of the previous growth rate of a series relative to a threshold value or linear trend. Similarly, Enders and Siklos (2001) apply the TAR and MTAR tests to the regression residuals from a system of possibly cointegrated variables allowing thus for cointegration testing in an asymmetric framework. These tests can then be adapted as follows.

For instance, real wage rigidity is one key ingredient of these models. If TAR and MTAR unit root tests implied stationarity, an F-test for the null of symmetric adjustment coefficients would provide a way to assess the differences in real wage rigidities across countries. However, I find that in most OECD countries real wages have stochastic trends even when I allow for asymmetric adjustment from a linear trend. The same conclusion is found for productivity. Also, even if one controls for possible threshold effects around a level the unemployment rate has a unit root. This evidence supports the hysteresis hypothesis of Blanchard and Summers (1986). Furthermore, the persistence effects due to capital accumulation as in Bean and Dreze (1990) or Hellwig and Neumann (1987) suggest that productivity, real wages, and unemployment have common trends. However, I find evidence of cointegration only for five[1] out of thirteen countries using TAR method and four[2] using MTAR approach. For four[3] out of six countries one can strongly reject the null of symmetric adjustment, suggesting that a linear approach would be biased.

According to Layard and Nickell (1987), an increase in unemployment increases the unemployment spell and thus lowers the pressure on wages. In the countries where coin-

[1]These countries are Germany, Japan, Spain, Sweden, and UK

[2]These countries are Japan, Spain, UK, and the US

[3]The countries with asymmetric adjustment to long run equilibrium are Germany, Japan, Sweden, and the US

tegration holds, the evidence suggests that this assumption is confirmed. Therefore, after an initial shock (e.g. positive and/or negative) to real wages due to either productivity or unemployment innovations, the positive regime dominates irrespective of the sign of the shocks. Hence, any disturbance from the initial equilibrium induces real wages to move higher. Further, one can note that shocks to unemployment have a bigger impact than shocks to real wages. Thus, one unit productivity, real wages, and unemployment shocks positively affect real wages approximately between 0.01% and 4.5%. Moreover, the effect of unemployment on real wages appears asymmetric and depends upon the sign of the shocks. However, productivity, real wages, and unemployment shocks have a big and permanent impact on unemployment (e.g., in Sweden's case, after a productivity shock unemployment settles to a level that is 180% lower than the initial one). Overall, after its own shocks real wages revert faster to long run equilibrium than unemployment does after its own shocks.

Previous work has only considered error correction models with symmetric adjustment (Jacobson et al. (1998); Lee (2000)). Also, empirical applications of the threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) unit root and cointegration tests have been limited to the US and Canada (Dibooğlu and Enders (2001)) and to some OECD countries (León-Ledesma (2002)). Also, the latter considers only the case of unemployment rates. Regarding the asymmetric behavior of the system formed by productivity, real wages, and unemployment rates, Dibooğlu and Enders (2001) find evidence for the case of Canada but not for US. This finding is different from the one in this paper, but this may be due to the shorter sample they use. Furthermore, numerous empirical studies have investigated the hysteresis hypothesis. The empirical findings are mixed, but in general, compared to the earlier[4] empirical research, more recent[5] studies find less support for unemployment hysteresis. However, these latter studies generally treat nonstationarity as arising only from the presence of one or more structural breaks in the data. Moreover, they do so only for the unemployment rates but not for real wages. Therefore the approach followed by the present paper suggests an alternative source for the nonlinearity of the

[4]See Neudorfer et al. (1990); Mitchell (1993); Jaeger and Parkinson (1994)

[5]See Song and Wu (1998); Arestis and Mariscal (2000); Papell et al. (1998)

variables of interest that is characterized by threshold adjustment rather than structural change.

The paper is structured as follows: section 2 gives a short summary of the labor market models, the implications of which I want to test using the TAR and MTAR unit root and cointegration tests; section 3 describes the empirical results; section 4 discusses the dynamic non-linear adjustments for the countries for which the evidence supports cointegration; section 5 concludes.

2 Theoretical Framework

2.1 Assumptions

I follow Blanchard (2005) in outlining the economic relationships among the variables of interest. Specifically, considering firms with constant returns to labor and competitive markets, the wages paid by firms in a world without frictions are given by:

$$\frac{W_t}{P_t} = w_t = q_t \tag{1}$$

where W_t is nominal wages, P_t is the price level, w_t is real wages and q_t is productivity. Blanchard (2005) assumes a random walk process for productivity and introduces frictions by assuming that whenever a shock occurs, expected productivity adjusts gradually to actual productivity:

$$E(q_t) = \lambda E(q_{t-1}) - (1 - \lambda)q_t \tag{2}$$

The parameter λ is taken as given in equation (2). In the literature, λ has been derived using Bayesian learning in an environment in which agents (i.e. firms and workers) have to assess whether shocks are temporary or permanent (see Blanchard (2005)). In this framework, by taking expectations in (2), (1-λ) denotes the speed at which real wages adjust to the initial level after a productivity slowdown. Bruno and Sachs (1985) note that when the adjustment is slow, the adverse productivity shocks may have longer and lasting effects, causing unemployment to rise. They argue that differences in real and nominal rigidities can explain why the response in unemployment levels differs across countries experiencing similar shocks. I test this implication by allowing real wages to display asymmetric adjustment to the pre-shock level. As I show below in more detail, this is achieved by employing the Threshold Autoregressive unit root test that treats positive and negative shocks differently.

The design of persistence mechanisms for unemployment has been another major development in the literature. Specifically, these mechanisms consider the implications that capital accumulation and collective bargaining have on real wages. Blanchard (2005) shows that assuming a Cobb-Douglas production function under perfect competition, real wages become a function of employment (and the unemployment rate, consequently), capital stock, and marginal product of labor (or productivity level):

$$w_t = (\alpha - 1)(n_t - k_t + q_t) + q_t \tag{3}$$

Here w_t denotes real wages (in logarithm), n_t denotes employment (in logarithm), k_t is the log of capital stock, and q_t is log productivity. Expression $\alpha - 1$, as Blanchard (2005) shows, is a parameter of the Cobb-Douglas production function. The interpretation given is that for a certain level of the capital stock, the higher the level of employment (or the lower the unemployment level), the lower the productivity and paid real wages (i.e., Blanchard (2005)). However, the opposite effect occurs if one agrees that lower unemployment translates into tighter labor markets. Hence, in a cointegrated system, a positive shock that lowers the unemployment rate can either lower or increase real wages given a certain level of the capital stock. Also, it is not warranted that real wages adjust to the equilibrium level in the same way after positive and negative shocks. By treating the positive and negative shocks differently, the TAR and MTAR cointegration tests allow for a direct way of testing these implications. Specifically, when the two tests suggest that the regression residuals (as in a Engle-Granger cointegration framework) are stationary, then one can check the direction and significance of the adjustment coefficients by means of a simple F-test.

On the same lines, Blanchard and Summers (1986) argue that insiders (i.e., workers who are already hired and part of the bargaining process) dominate the collective bargaining process. Insiders do so by setting wages in their favor and hence negatively affect the employment chances of the disenfranchised workers. In other words, when the wage setting process is carried out only between firms and employed workers, then the unions care only about the employment prospect of the ones already hired. Then, the wages reflect a given level of unemployment. Whenever shocks lower or increase the employment level, wages and unemployment also change to new levels. Therefore, while they both follow a random walk, temporary innovations have permanent effects on wages and unemployment. However, this so called "hysteresis" hypothesis has been labeled as too strong. It says that changes in the unemployment rate have no implications on firms' and workers' bargaining power. Once one allows outsiders to have some weight in the insiders' objective function or firms to have some bargaining power, then the wage does not rise to fully offset reductions in the number of insiders. Thus, the unit root hypothesis for real wages and the unemployment rate weakens; they may display persistence but not random walk behavior. These assumptions can be tested empirically by means of the TAR and MTAR unit root tests.

Finally, Layard and Nickell (1987) suggest that unemployment spells adversely affect the skills and search behavior of the unemployed causing an increase in their duration as jobless workers and therefore leading to unemployment persistence. This mechanism suggests that because of the fear of becoming unemployed, currently employed workers accept a lower wage level on the short term due to the high unemployment; however, this pressure on wages is likely to diminish as more workers became unemployable due to the loss of skill and motivation. In a cointegrated system, this implies that negative unemployment shocks to real wages last only for a short period of time and are eventually reversed. I extend this framework to allow the speed of decline to differ according to the sign of the shocks.

Therefore, an analysis of the variables of interest such as real wages, the unemployment rate, and the productivity level both separate and as a system offers the possibility of testing the main ingredients of the theoretical models discussed above. Next I discuss the

TAR and MTAR unit root and cointegration tests.

2.2 TAR and MTAR Unit Root and Cointegration Tests

A natural representation of the labor market equilibrium that has been tested before in different forms by many economists like Hall (1986), Hall (1989), Mehra (1991), Nyomen (1992), Bruno and Piselli (1997), Jacobson et al. (1998) and Lee (2000) is given by:

$$\delta_0 + \delta_1 w_t + \delta_2 q_t + \delta_3 u_t = \mu_t \tag{4}$$

where in addition to the variables already introduced, μ_t is a disturbance term. Note that there is not a predetermined sign of the correlations among our variables of interest since this is not a structural relationship (Dibooğlu and Enders (2001)). Standard unit root tests suggest that our variables of interest are I(1). However, in contrast to these tests, Enders and Granger (1998) develop a class of models that test for unit root in the presence of asymmetric adjustment. The threshold autoregressive (TAR) model is represented by:

$$\Delta x_t = \begin{cases} \rho_1 x_{t-1} + \varepsilon_t, & \text{if } x_{t-1} \geq \tau_{TAR} \text{ ;} \\ \rho_2 x_{t-1} + \varepsilon_t, & \text{if } x_{t-1} < \tau_{TAR}. \end{cases} \tag{5}$$

where $x_t \in \{w_t, u_t\}$. The x_t process is "threshold" stationary if $-2 < (\rho_1, \rho_2) < 0$ and the threshold is such that long-run equilibrium occurs at the point $x_t = \tau_{TAR}$. The adjustment process can be written as:

$$\Delta x_t = I_t \rho_1 [x_{t-1} - \tau_{TAR}] + (1 - I_t) \rho_2 [x_{t-1} - \tau_{TAR}] + \varepsilon_t \tag{6}$$

where

$$I_t = \begin{cases} 1, & \text{if } x_{t-1} \geq \tau_{TAR}; \\ 0, & \text{if } x_{t-1} < \tau_{TAR}. \end{cases} \tag{7}$$

Enders and Granger (1998) suggest that the threshold should be obtained by employing the "consistent" method of Chan (1993): search over all values of τ_{TAR} such that the sum of squared residuals is minimized. Of course, in order to ensure the white-noise property of the residuals, the test should be augmented with lags until the autocorrelations of the residuals fail to show any significance. The momentum threshold autoregressive unit root test (MTAR) is similar to the TAR model except for the way the Heaviside indicator is specified:

$$I_t = \begin{cases} 1, & \text{if } \Delta x_{t-1} \geq \tau_{MTAR}; \\ 0, & \text{if } \Delta x_{t-1} < \tau_{MTAR}. \end{cases} \tag{8}$$

Thus, the decay depends on the previous period's change in x_{t-1}.

However, for series like real wages and productivity it is more likely that the threshold or the attractor is a linear time trend. Thus for real wages and productivity, the threshold is modified to $\tau_{TAR} = \tau_0 + \tau_1(t-1)$.

The cointegration tests in Enders and Siklos (2001) follow the same general pattern. The test for common trends among real wages, productivity and the unemployment rate is performed by checking whether the residuals μ_t in equation (4) are "threshold" or "momentum" stationary. Hence we can write:

$$\Delta\mu_t = I_t\rho_1'[\mu_{t-1} - \tau_{TAR}'] + (1 - I_t)\rho_2'[\mu_{t-1} - \tau_{TAR}'] + \varepsilon_t \tag{9}$$

where:

$$I_t = \begin{cases} 1, & \text{if } \mu_{t-1} \geq \tau_{TAR}'; \\ 0, & \text{if } \mu_{t-1} < \tau_{TAR}'. \end{cases} \tag{10}$$

Further, Enders and Granger (1998) show that if the alternative hypothesis of stationarity is accepted, it is possible to test for symmetric versus asymmetric adjustment because ρ_1' and ρ_2' converge to multivariate normal distributions (however this assumes that the threshold is known). If ρ_1' and ρ_2' are statistically different from each other then, after a positive shock, μ_{t-1} will be above the threshold and the adjustment is $\rho_1'\mu_{t-1}$, while after a negative innovation, μ_{t-1} is below the threshold and the adjustment is $\rho_2'\mu_{t-1}$. We can similarly write the formulas for cointegration with MTAR adjustment.

The general procedure is to regress one of the variables on the other two, save the residuals, and then check whether they are stationary with non-linear adjustment around a threshold value by means of TAR and MTAR unit root tests. Enders and Granger (1998) suggest that in practice, to have a sufficient number of observations in both regimes one should trim the first and last 15% of the sample. The optimal lag length is determined via the minimization of the BIC criterion and further checks of the residuals to ensure their white-noise property. Finally, if the hypothesis of stationarity is accepted then the restriction that the adjustment process is actually symmetric (i.e., $H(0) : \rho_1 = \rho_2$) can be tested by employing the usual F-test. However, Enders and Falk (1998) and Hansen (1997) show that the OLS standard errors of ρ_1 and ρ_2 are inflated and thus inference regarding their estimates is not straightforward.

3 Empirical Results

The dataset was obtained from several sources detailed in the Appendix. The countries for which sufficient information was available, beginning with the first quarter of 1960, are: Australia, Austria, Denmark, Finland, France, Germany, Japan, Netherlands, Norway, Spain, Sweden, UK, and US. Although the data contained sufficient information for Canada, I left it out as it has already been considered by Dibooğlu and Enders (2001). For Finland and Japan I have information on all variables from 1960:1 to 2005:2. For the rest the data varies, although starting with 1984:1 there is full information on each variable for all countries. Some of the variables[6] displayed strong seasonal patterns, hence, they have been seasonally adjusted using the Tramo/Seats procedure available in Eviews 4.1. On the sample under analysis, a standard Dickey-Fuller test finds that all variables have a unit root. However, because of space considerations these have not been included.

Next, I test for unit roots using the TAR and MTAR tests that have been discussed above. Following the economic intuition, I assume that unemployment rates adjust around a level, while real wages and productivity adjust around a linear time trend. Table 1 shows the results for the unemployment rate, Table 3 shows those for the real wages and Table 2 shows the results for productivity.

[6]Seasonally adjusted series are: Austria - q_t, u_t; Finland - u_t; France - q_t; Norway - q_t; Spain - q_t, w_t; Sweden - q_t, u_t; UK - q_t

[Insert Table 1]

[Insert Table 2]

[Insert Table 3]

With the exception of Sweden and the US, for which the TAR statistic is significant at the 5% and 10% significance level respectively, all the other restrictions of ρ_1 and ρ_2 being jointly zero are not binding at any significance level. Therefore, even if one allows for asymmetric adjustment, unemployment rates have a unit root. The same conclusion is found for real wages and productivity. All TAR statistics for real wages (with the exception of those for Japan and Netherlands) are not significant at conventional significance levels, finding that implies nonstationarity. With momentum adjustment, only in the US do real wages display a nonlinear deterministic trend. These results bring overwhelming evidence in favor of nonstationarity for unemployment, real wages, and productivity in OECD countries. These results support the "hysteresis" hypothesis.

Next I estimate equation (4) by applying the TAR and MTAR tests to the residuals from the regression of real wages on productivity and the unemployment rate. Given the unit root properties of our variables of interest even after controlling for the possibility of a threshold adjustment, this approach seems justified.

Table 4 reports the results from the cointegration tests using both methods.

[Insert Table 4]

The second column reports the number of lags such that the residuals display white-noise properties and the third and fourth columns contain the TAR and MTAR statistics together with their statistical significance. TAR test brings evidence of cointegration for five of the countries under study, while the MTAR approach reduces this number to five. With the exception of Germany, Netherlands, Spain, and the US for which three and four lags respectively are necessary to make the residuals behave as white-noise processes, the other countries do not require additional lags. Tables 4 and 5 highlight several interesting estimates of the equilibrium relationships for the countries for which cointegration is confirmed. The second column identifies the threshold values of the residuals resulting from the cointegrating relationship, the next two display the speed of adjustment coefficients to the long run equilibrium after positive and negative shocks, the fourth and fifth show the F-test for symmetric adjustment with the associated p-values, while the last column contains the estimated long-run relationships. The long-run equilibrium is the same irrespective of the method used. The countries for which cointegration using TAR approach holds are: Germany, Japan, Spain, Sweden, and the UK, while for Germany and Sweden the MTAR method no longer suggests that the variables considered trend together over time. Additionally, using the MTAR method, cointegration is also confirmed for the US.

In Table 5 the estimated F-statistic for the null of symmetric adjustment is significant at the 1% level for three out of the six countries for which the TAR test suggests cointegration: Germany, Japan, and Sweden.

[Insert Table 5]

However, since the MTAR test fails to find evidence of cointegration for Germany and Sweden, the countries that maintain the asymmetric adjustment to the long run equilibrium with different growth and decay differentials are Japan and the US. Nevertheless, several interesting facts emerge regarding the size of the speed of adjustment coefficients. For the countries for which the evidence supports asymmetric adjustment using the TAR approach, in two cases (i.e., Germany and Japan) positive shocks are eliminated more quickly than negative ones (i.e., sixteen and eight times more respectively), and only for Sweden do negative shocks diminish more quickly (i.e., approximately twenty times faster). This is not surprising given that Sweden has long been known for its strong unions and early centralized bargaining system or, as Blanchard (2005) puts it, as a "poster child for the case of corporatism." Also, both Spain and UK display faster adjustment after negative shocks, although the adjustment after negative shocks is not significantly different from the adjustment after positive ones. Given that the unemployment rates in these countries have had sustained downward trends beginning with the 1990's (whereas countries like Germany and Japan have had strong upward ones), it appears that countries with either very centralized or very decentralized bargaining systems cope better with adverse shocks than ones with intermediate ones (i.e., in line with Calmfors and Driffill (1988) findings). The MTAR approach has mixed results.

[Insert Table 6]

In Table 6 we see that in Japan's case a positive shock is eliminated more quickly than a negative one, while in the US's case a negative shock is eliminated more quickly. Next, I perform the error correction specification and the impulse response functions that should add more light on the findings so far.

4 Asymmetric Error Correction of Real Wages and Unemployment

As part of the same economic community that eventually led to the formation of the European Union, the OECD European countries have aimed for real convergence, common policies and institutions. However, some countries have been more successful than others at lowering their unemployment levels while keeping other macro variables in check. Given our discussion above, one way these differences may appear is through the fact that in half of the countries under analysis labor productivity, real wages and unemployment do not trend together over time, while in the other half they do. Among the latter, almost half display asymmetric adjustment, while the other half does not.

The first box contains the TAR error correction representation, while box 2 displays the MTAR one.

[Insert Box 1]

[Insert Box 2]

For comparison purposes, even for the countries for which the F-test favors the symmetric adjustment mechanism I report the error-correction with asymmetric speed of adjustment coefficients. Several facts are worth noting. In box 1, in three out of five cases the real wage grows more quickly after negative deviations from the long-run equilibrium than it does after positive ones. In all cases, the speed of adjustment coefficients after negative deviations have the correct sign, while for positive deviations only Japan and Sweden's have the correct sign; in the rest, the sign of the coefficients suggests that after a positive shock there are further departures from the long-run equilibrium. This suggests limited downward real wage flexibility for Germany, Sweden, and the United Kingdom.

In contrast, in box 2, in three out of four cases the correction to equilibrium after an increase over last period's real wage growth is greater than the adjustment after a negative deviation. Moreover, none of the speed of adjustment coefficients after negative shocks seem to be significantly different from zero. The positive adjustment coefficients in four cases[7] have the desired sign, while the adjustment coefficients after negative deviations suggests that in two cases[8] there are further reductions of the real wages. This shows that the form of the Heaviside indicator (i.e. level versus first difference) matters for the sign and direction of the speed of adjustment coefficients.

In box 1 none of the adjustment coefficients of the unemployment rate to its natural rate after an increase from its previous level appears significant; moreover, in four out of six cases the sign suggests further departure from equilibrium. When the unemployment rate suddenly decreases the adjustment coefficient is significant only for Spain. However, its magnitude suggests a quick reverse to the long-run equilibrium.

The same situation occurs in box 2. The speed of adjustment coefficients after positive deviations are significant only for Sweden, while the ones for negative deviations (with the exception of Spain), do not seem to be different from zero. Although a thorough interpretation is difficult, at least for positive shocks the unemployment rate deviations seem to be more persistent than those for real wages. Overall, both the AIC and the BIC criterions favor TAR error correction mechanisms over the MTAR ones. In other words, the asymmetric properties of the system of equations are based on the different adjustment from the previous level and not from its previous growth rate.

Focusing only on the countries with asymmetric adjustment, it seems that overall productivity and real wages close the gap after deviations from the long run equilibrium, while unemployment does not seem to be as responsive. This lines up with the initial findings of Dibooğlu and Enders (2001).

These results are once again confirmed by the impulse response functions[9] of real

[7]These countries are Japan, UK, and the US

[8]These are Japan and Spain

[9]I allow for a one time positive and negative unit shock respectively. However, it is possible to generalize the impulse response functions to allow for the effects of any ensuing shocks.

wages and unemployment using the Choleski decomposition. The order of decomposition is $q_t \rightarrow w_t \rightarrow u_t$ (i.e. labor productivity precedes real wages which precede the unemployment rate). Assuming that the system is in long run equilibrium, I find that positive and negative shocks affect the behavior of real wages and unemployment differently.

Productivity shocks, irrespective of their sign, ultimately appear to move real wages to a higher level. Roughly three years after the initial productivity shock, real wages are 1% to 6% higher. It appears that the positive regime dominates. Thus, a negative productivity shock negatively affects real wages up to three quarters. Once the impulse response function enters positive territory, real wages appear to settle around a higher level. This confirms again the downward real wage rigidities that we found for Germany and Sweden. Real wages own shocks are quickly extinguished. In general it takes about one year to achieve convergence to the initial equilibrium. Somewhat surprisingly, any unemployment shock appears to have a positive effect on real wages. This result differs from the implications of equation (2), which suggests the opposite. A possible explanation is that shocks which lower unemployment lead to tighter labor markets, thus pushing wage costs higher. Alternatively, these results support the arguments of Layard and Nickell (1987), who argue that higher unemployment increases the unemployment spell, which in turn causes a loss in the skills of an applicant. They show that this process can lower the downward pressure on real wages. Therefore, as the theoretical arguments and the impulse response functions suggest, shocks to unemployment on average cause real wages to go up. Nevertheless, this upward effect does not appear very strong. Three years out, about 96% to 99% of the initial shock is eliminated. Also note that the effect of a shock on real wages is asymmetric and depends upon its sign. Thus, at least for unemployment shocks, positive shocks to real wages appear stronger. Excluding Germany, for which positive and negative shocks are almost indistinguishable, for Japan and the US, positive shocks up to four quarters are higher than negative ones. For Japan there is almost no response until the second quarter. This fact strengthens the arguments of Layard and Nickell (1987).

Overall, shocks to unemployment seem to have a significant and permanent effect. Thus, with the exception of Japan (for which unemployment own shocks and productivity shocks are extinguished in one and three years, respectively), for the rest the impulse response functions converge to levels which are different from zero. Thus, after a unit productivity shock, unemployment decreases by about 16% in Germany and 180% in US. In Germany, a negative productivity shock induces fairly large swings in the unemployment rate, while in the US a negative shock causes unemployment to rise for almost six quarters. After this period, the unemployment starts to decrease. For Sweden, productivity shocks cause unemployment to grow at levels which are about 50% higher. In this case, a positive productivity shock lowers unemployment up to four quarters. Beyond this period unemployment tends to go up again. Note again the asymmetry in the path of the positive and negative disturbances. In general, adverse productivity shocks seem to have a bigger impact on unemployment than positive ones. Positive real wage shocks appear to induce more applicants to enter the job market and get hired. This effect reaches a maximum at two and three quarters after the initial shock and is strongest for the US labor market where, even three years after the initial shock, unemployment is down by almost 150%. Unemployment own shocks also do not die out but converge to a level that is different from zero. Thus, twelve quarters out, unemployment is 50% higher in Sweden and 100% lower in the US. In Germany, this level is about 25% lower.

To summarize, the response of real wages to shocks that increase the unemployment rate suggests that, in line with the findings of Layard and Nickell (1987), duration effects tend to lower the downward pressure on real wages. Adverse productivity shocks appear to have a bigger impact than positive ones. Initially, increases in real wages seem to attract more workers to the job market. However, the offsetting effect is higher wage costs for firms. Thus, unemployment can be higher or lower depending on which effect is stronger (e.g., for instance in Germany and the US unemployment ends up lower, while in Japan and Sweden it ends up higher). Alternatively, increases of the unemployment rate such that it is persistently above its natural rate are, according to Hellwig and Neumann (1987), a result of real wage increases possibly due to workers' demands. In almost all cases, the impulse response functions are different with respect to the sign of the initial shocks. Therefore, just a symmetric representation would be inappropriate.

5 Conclusions

Using a set of unit root and cointegration tests with asymmetric adjustment I test the implications of some of the main labor market models developed in the literature. Even after adjusting for non-linear effects around a threshold level and time trend respectively, I find that, in general, in OECD countries unemployment, real wages, and productivity have a unit root. These findings support the implications of the "hysteresis" hypothesis. However, the results of the paper only partially support the capital accumulation theories of Bean and Dreze (1990), who suggest labor productivity, real wages, and unemployment have common trends. For more than half of the countries for which the variables of interest are cointegrated, the adjustment to long-run equilibrium is achieved in a non-linear fashion. Hence, allowing only for linear error-correction mechanisms would be biased.

The response of real wages and unemployment rates differ according to the sign of the shocks. I find that for countries with strong welfare systems like Sweden and UK, negative deviations from the long run equilibrium are eliminated more quickly than positive ones; for intermediate ones (e.g., Germany) positive deviations are eliminated faster. This aligns with previous findings (i.e. Calmfors and Driffill (1988)). It also appears that negative shocks have a bigger impact than positive ones. I further find that, according to Layard and Nickell (1987), shocks that lead to higher unemployment and duration effects like those mentioned in the introductory section lower the downward pressure on real wages. Also, temporary shocks to unemployment seem to have a bigger impact and more persistence than those to real wages. On the short term (i.e., up to two and three quarters), positive real wages shocks appear to lower unemployment. This could indicate a higher labor force participation due to the increased attractiveness of the labor market. The offsetting effect is an increase in the wage costs of firms that can in turn raise unemployment. Thus, unemployment rates can end up higher or lower, depending on which effect is stronger. In some countries, real wages shocks lower unemployment (i.e., Germany and the US), while in others the unemployment rate goes up (i.e., Japan and Sweden). Hence, I find mixed evidence for the results of Hellwig and Neumann (1987), who argue that real wage increases due to workers' demands cause unemployment to rise above its natural level.

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Appendix

Data Sources

w = Nominal Wage/CPI;
q = Real GDP/Employment

1. Australia:
   - w=Wages:Weekly Earnings*/CPI:2000=100**
   - q=GDP VOL.(2000=100)*/Civilian Employment: 2000 = 100**
2. Austria:
   - w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
   - q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100*
3. Denmark:
   - w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
   - q=Ind. Prod.(SA),(2000=100)*/Employment: Manufacturing (Thousands)**
4. Finland:
   - w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
   - q=Ind. Prod. (SA):(2000=100)*/Civilian Employment: 2000=100**
5. France:
   - w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
   - q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100***
6. Germany:
   - w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
   - q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100*
7. Japan:
   - w=Wages:Monthly Earnings*/CPI:All Cities*
   - q=Ind.Prod. SA*/Mfg. Employment, SA: 2000=100*
8. Netherlands:
   - w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
   - q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100*
9. Norway:

- w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
- q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100**

10. Spain:

- w=Hourly Wages*/CPI (No specifics available)*
- q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100*

11. Sweden

- w=Avg. Hrly. Earnings (manufacturing,SA,units 2000=100**/CPI:2000=100**
- q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100**

12. UK:

- w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
- q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100**

13. US:

- w=Hourly Earnings (manufacturing,SA),units 2000=100**/CPI:2000=100**
- q=GDP VOL.(2000=100)*/Civilian Employment: 2000=100**

* Source: IFS CD-ROM:65ey,September 2005; ** Source: OECD Main Economic Indicators, VOL 2004 release 04;*** Source: OECD Employment and Labor Market Statistics, VOL. 2004 release 04;
The Unemployment Rates have been obtained from the Global Insight database with the exception of those for Australia*** Canada** and US**.

Boxes and Tables

Box 1: Dynamic Adjustment using TAR Error-Correction

- Germany:

$$\Delta q_t = -0.103\Delta q_{t-1} + 0.353\Delta w_{t-1} - 0.002\Delta u_{t-1} + 0.159^{***} zplus_{t-1} - 0.013 zminus_{t-1}$$

$$\Delta w_t = -0.007\Delta q_{t-1} + 0.241\Delta w_{t-1} - 0.0004\Delta u_{t-1} + 0.012 zplus_{t-1} - 0.018 zminus_{t-1}$$

$$\Delta u_t = 0.543\Delta q_{t-1} - 0.264\Delta w_{t-1} + 0.560\Delta u_{t-1} + 0.137 zplus_{t-1} + 0.619 zminus_{t-1}$$

$zplus_t = I_t(w_t - 0.364 - 0.454q_t - 0.017u_t)$; $zminus_t = (1 - I_t)(w_t - 0.364 - 0.454q_t - 0.017u_t)$ AIC = -3512.4638; BIC = -3465.42685

- Japan:

$$\Delta q_t = 0.584\Delta q_{t-1} - 0.003\Delta w_{t-1} + 0.006\Delta u_{t-1} + 0.012 zplus_{t-1} - 0.014 zminus_{t-1}$$

$$\Delta w_t = 0.061\Delta q_{t-1} + 0.039\Delta w_{t-1} + 0.030\Delta u_{t-1} - 0.188^{***} zplus_{t-1} - 0.041 zminus_{t-1}$$

$$\Delta u_t = -1.338\Delta q_{t-1} - 0.089\Delta w_{t-1} + 0.187\Delta u_{t-1} + 0.026 zplus_{t-1} - 0.066 zminus_{t-1}$$

$zplus_t = I_t(w_t - 0.774 - 0.014q_t - 0.041u_t)$; $zminus_t = (1 - I_t)(w_t - 0.774 - 0.014q_t - 0.041u_t)$ AIC = -3470.7296; BIC = -3423.0028

- Spain:

Δq_t = 0.089Δq_{t-1} + 0.071Δw_{t-1}+ 0.002Δu_{t-1} + 0.255$^{***}zplus_{t-1}$ + 0.112$zminus_{t-1}$

Δw_t = 0.248Δq_{t-1} - 0.377Δw_{t-1}+ 0.001Δu_{t-1} + 0.136$^{***}zplus_{t-1}$ - 0.111$^{**}zminus_{t-1}$

Δu_t = 0.225Δq_{t-1} - 6.136Δw_{t-1} + 0.853Δu_{t-1} - 1.046$zplus_{t-1}$ - 5.020$^{***}zminus_{t-1}$

$zplus_t = I_t(w_t - 0.368 - 0.745q_t + 0.007u_t)$; $zminus_t = (1 - I_t)(w_t - 0.368 - 0.745q_t + 0.007u_t)$ AIC = -1970.7256; BIC = -1933.0627

- Sweden:

Δq_t = -0.037Δq_{t-1} + 0.100Δw_{t-1}+ 0.006Δu_{t-1} + 0.026$zplus_{t-1}$ - 0.057$zminus_{t-1}$

Δw_t = 0.304Δq_{t-1} -0.118Δw_{t-1}- 0.003Δu_{t-1} - 0.074$zplus_{t-1}$ - 0.209$^{***}zminus_{t-1}$

Δu_t = -0.227Δq_{t-1} - 1.920Δw_{t-1} + 0.648Δu_{t-1} - 0.613$zplus_{t-1}$ - 1.154$zminus_{t-1}$

$zplus_t = I_t(w_t - 0.267 - 0.787q_t + 0.013u_t)$; $zminus_t = (1 - I_t)(w_t - 0.267 - 0.787q_t + 0.013u_t)$

- United Kingdom:

Δq_t = A_{12}(L)Δq_{t-1} +$A_{21}(L)\Delta w_{t-1}$+ $A_{13}(L)\Delta u_{t-1}$ + 0.0464$zplus_{t-1}$ +0.0571$zminus_{t-1}$

Δw_t = $A_{21}(L)\Delta q_{t-1}$ + $A_{22}(L)\Delta w_{t-1}$+ $A_{23}(L)\Delta u_{t-1}$ - 0.0578$zplus_{t-1}$ - 0.1317$zminus_{t-1}$

Δu_t = $A_{31}(L)\Delta q_{t-1}$ + $A_{32}(L)\Delta w_{t-1}$ + $A_{33}(L)\Delta u_{t-1}$ + 0.1752$zplus_{t-1}$ - 4.034$zminus_{t-1}$

$zplus_t = I_t(w_t + 0.100 - 1.130q_t + 0.003u_t)$; $zminus_t = (1 - I_t)(w_t + 0.100 - 1.130q_t + 0.003u_t)$ AIC = -3184.5749; BIC=-3084.5705

Box 2: Dynamic Adjustment using MTAR Error-Correction

- Japan:

Δq_t = 0.619Δq_{t-1} + 0.003Δw_{t-1}+ 0.007Δu_{t-1} + 0.004$zplus_{t-1}$ - 0.009$zminus_{t-1}$

Δw_t = -0.151Δq_{t-1} + 0.012Δw_{t-1}+ 0.015Δu_{t-1} - 0.177$^{***}zplus_{t-1}$ + 0.024$zminus_{t-1}$

Δu_t = -1.214Δq_{t-1} - 0.063Δw_{t-1} + 0.193Δu_{t-1} - 0.011$zplus_{t-1}$ - 0.031$zminus_{t-1}$

$zplus_t = I_t(w_t - 0.774 - 0.014q_t - 0.041u_t)$; $zminus_t = (1 - I_t)(w_t - 0.774 - 0.014q_t - 0.041u_t)$ AIC = -3470.5665; BIC = -3422.8398

- Spain:

Δq_t = 0.128Δq_{t-1} + 0.164Δw_{t-1}+ 0.001Δu_{t-1} + 0.346$^{***}zplus_{t-1}$ + 0.064$zminus_{t-1}$

Δw_t = 0.314Δq_{t-1} - 0.307Δw_{t-1}+ 0.0001Δu_{t-1} + 0.005$zplus_{t-1}$ + 0.036$zminus_{t-1}$

Δu_t = 1.289Δq_{t-1} - 5.849Δw_{t-1} + 0.845Δu_{t-1} - 5.734$^{***}zplus_{t-1}$ - 0.590$^{***}zminus_{t-1}$

$zplus_t = I_t(w_t - 0.368 - 0.745q_t + 0.007u_t)$; $zminus_t = (1 - I_t)(w_t - 0.368 - 0.745q_t + 0.007u_t)$ AIC = -1965.9087; BIC = -1928.2458

- United Kingdom:

Δq_t = A_{12}(L)Δq_{t-1} +$A_{21}(L)\Delta w_{t-1}$+ $A_{13}(L)\Delta u_{t-1}$ - 0.0074$zplus_{t-1}$ +0.1102$^{**}zminus_{t-1}$

Δw_t = $A_{21}(L)\Delta q_{t-1}$ + $A_{22}(L)\Delta w_{t-1}$+ $A_{23}(L)\Delta u_{t-1}$ - 0.0951$zplus_{t-1}$ - 0.0880$zminus_{t-1}$

Δu_t = $A_{31}(L)\Delta q_{t-1}$ + $A_{32}(L)\Delta w_{t-1}$ + $A_{33}(L)\Delta u_{t-1}$ + 0.1148$zplus_{t-1}$ - 1.8997$zminus_{t-1}$

$zplus_t = I_t(w_t + 0.100 - 1.130q_t + 0.003u_t)$; $zminus_t = (1 - I_t)(w_t + 0.100 - 1.130q_t + 0.003u_t)$ AIC = -3177.6506; BIC = -3077.6461

- United States:

  Δq_t = 0.074Δq_{t-1} +0.129Δw_{t-1}-0.000 Δu_{t-1} - 0.016$zplus_{t-1}$ -0.025**$zminus_{t-1}$

  Δw_t = 0.052Δq_{t-1} + 0.207Δw_{t-1}+ 0.002Δu_{t-1} -0.030**$zplus_{t-1}$ -0.024$zminus_{t-1}$

  Δu_t = -4.527Δq_{t-1} -3.233Δw_{t-1} + 0.606Δu_{t-1} + 0.303$zplus_{t-1}$ + 0.527$zminus_{t-1}$

  $zplus_t = I_t(w_t - 0.855 - 0.099q_t - 0.012u_t)$; $zminus_t = (1 - I_t)(w_t - 0.855 - 0.099q_t - 0.012u_t)$

* Significance at the 10% level; ** Significance at the 5% level; *** Significance at the 1% level

Tables

Table 1: Results from TAR and MTAR Unit Root tests - Unemployment Rate

UR	Lags†	TAR	TAR - $H(0)$:$\rho_1=\rho_2$	MTAR	MTAR - $H(0)$:$\rho_1=\rho_2$
Australia	1	2.34337	n.a.	0.30299	n.a.
Austria	0	0.56903	n.a.	1.11689	n.a.
Denmark	1	2.68453	n.a.	2.34898	n.a.
Finland	2	4.31286	n.a.	1.71133	n.a.
France	1	4.22101	n.a.	0.15942	n.a.
Germany	1	4.65617	n.a.	1.95860	n.a.
Japan	4	2.29123	n.a.	0.08008	n.a.
Netherlands	1	3.06332	n.a.	2.43406	n.a.
Norway	2	4.96928	n.a.	1.62977	n.a.
Spain	1	1.36946	n.a.	1.37896	n.a.
Sweden	1	6.92789**	11.560***	0.64380	n.a.
UK	5	2.00386	n.a.	1.97291	n.a.
US	2	5.10341*	3.81511*	2.10172	n.a.

† Minimize BIC criterion; * Significance at the 10% level; ** Significance at the 5% level; *** Significance at the 1% level

Table 2: Results from TAR and MTAR Unit Root tests - Productivity

RW	Lags†	TAR	$\rho_1 x^+$	$\rho_2 x^-$	$\rho_1=\rho_2$	MTAR	$\rho_1 x^+$	$\rho_2 x^-$	$\rho_1=\rho_2$
Australia	1	2.465	n.a.	n.a.	n.a.	2.895	n.a.	n.a.	n.a.
Austria	1	1.905	n.a.	n.a.	n.a.	1.785	n.a.	n.a.	n.a.
Denmark	0	35.262***	-0.870***	-0.976***	0.228	35.058***	-0.914***	-0.934***	0.007
Finland	4	1.310	n.a.	n.a.	n.a.	3.625	n.a.	n.a.	n.a.
France	4	3.275	n.a.	n.a.	n.a.	2.706	n.a.	n.a.	n.a.
Germany	4	2.195	n.a.	n.a.	n.a.	2.960	n.a.	n.a.	n.a.
Japan	2	8.541**	-0.066**	-0.084***	0.289	3.655	n.a.	n.a.	n.a.
Netherlands	0	3.661	n.a.	n.a.	n.a.	3.712	n.a.	n.a.	n.a.
Norway	1	3.534	n.a.	n.a.	n.a.	3.539	n.a.	n.a.	n.a.
Spain	2	1.724	n.a.	n.a.	n.a.	1.566	n.a.	n.a.	n.a.
Sweden	1	0.262	n.a.	n.a.	n.a.	0.309	n.a.	n.a.	n.a.
UK	3	3.030	n.a.	n.a.	n.a.	3.017	n.a.	n.a.	n.a.
US	0	0.628	n.a.	n.a.	n.a.	0.181	n.a.	n.a.	n.a.

† Minimize BIC criterion; * Significance at the 10% level; ** Significance at the 5% level;
*** Significance at the 1% level

Table 3: Results from TAR and MTAR Unit Root tests - Real Wages

RW	Lags†	TAR	$\rho_1 x^+$	$\rho_2 x^-$	$\rho_1{=}\rho_2$	MTAR	$\rho_1 x^+$	$\rho_2 x^-$	$\rho_1{=}\rho_2$
Australia	0	1.537	n.a.	n.a.	n.a.	2.660	n.a.	n.a.	n.a.
Austria	5	0.568	n.a.	n.a.	n.a.	0.661	n.a.	n.a.	n.a.
Denmark	0	0.543	n.a.	n.a.	n.a.	0.643	n.a.	n.a.	n.a.
Finland	5	3.116	n.a.	n.a.	n.a.	1.895	n.a.	n.a.	n.a.
France	4	0.694	n.a.	n.a.	n.a.	1.487	n.a.	n.a.	n.a.
Germany	5	1.211	n.a.	n.a.	n.a.	1.091	n.a.	n.a.	n.a.
Japan	0	6.844**	-0.166***	-0.054	2.557	9.165**	-0.176***	0.021	6.928***
Netherlands	4	5.877*	-0.044*	-0.075**	0.718	6.101*	-0.072***	-0.035	1.132
Norway	0	2.267	n.a.	n.a.	n.a.	1.924	n.a.	n.a.	n.a.
Spain	8	0.798	n.a.	n.a.	n.a.	0.857	n.a.	n.a.	n.a.
Sweden	8	1.634	n.a.	n.a.	n.a.	1.736	n.a.	n.a.	n.a.
UK	3	2.602	n.a.	n.a.	n.a.	2.828	n.a.	n.a.	n.a.
US	4	2.815	n.a.	n.a.	n.a.	10.811***	0.010	-0.071***	15.582***

† Minimize BIC criterion; * Significance at the 10% level; ** Significance at the 5% level;
*** Significance at the 1% level

Table 4: Results from TAR and MTAR Cointegration Tests

Country	Lags†	TAR Cointegration	MTAR Cointegration
Australia	0	4.659	3.755
Austria	1	2.464	2.286
Denmark	0	5.173	2.654
Finland	0	2.222	3.357
France	3	3.185	2.053
Germany	4	8.506***	4.398
Japan	0	10.780***	8.788***
Netherlands	3	6.198	3.723
Norway	0	2.604	2.278
Spain	3	8.071***	8.863***
Sweden	0	9.965***	5.875
UK	0	8.896***	8.707***
US	3	4.629	7.178*

† Minimizes BIC criterion; * Significance at the 10% level; ** Significance at the 5% level; *** Significance at the 1% level

Table 5: Summary on TAR Cointegration Tests

Country	Threshold	$\rho_1\mu^+$	$\rho_2\mu^-$	ρ_1=ρ_2	P-value	Long-run eq.
Germany	0.062	-0.284***	-0.017***	11.96	0.0006	$w = 0.364 + 0.454q + 0.0179u$
Japan	0.066	-0.288***	-0.036	12.17	0.006	$w = 0.774 + 0.014q + 0.041u$
Spain	-0.0002	-0.232***	-0.320***	0.539	0.464	$w = 0.368 + 0.745q - 0.007u$
Sweden	-0.033	-0.063***	-1.361***	13.161	0.0004	$w = 0.267 + 0.787q - 0.013u$
UK	-0.004	-0.163***	-0.258***	0.883	0.349	$w = -0.100 + 1.130q - 0.003u$
US	n.a.	n.a.	n.a.	n.a.	n.a.	$w = 0.855 + 0.099q + 0.012u$

* Significance at the 10% level; ** Significance at the 5% level; *** Significance at the 1% level

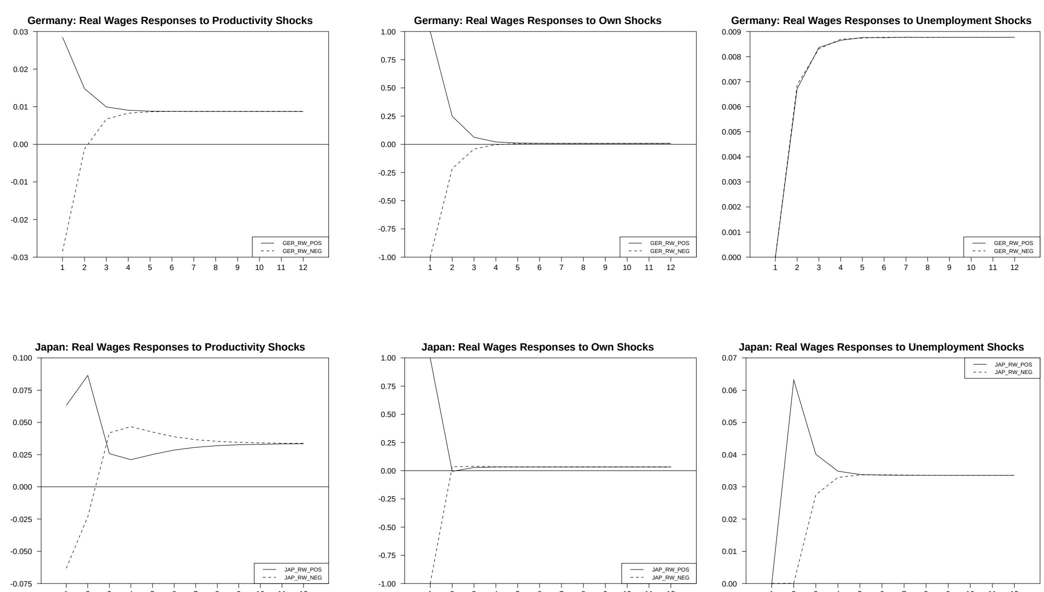
Table 6: Summary on MTAR Cointegration Tests

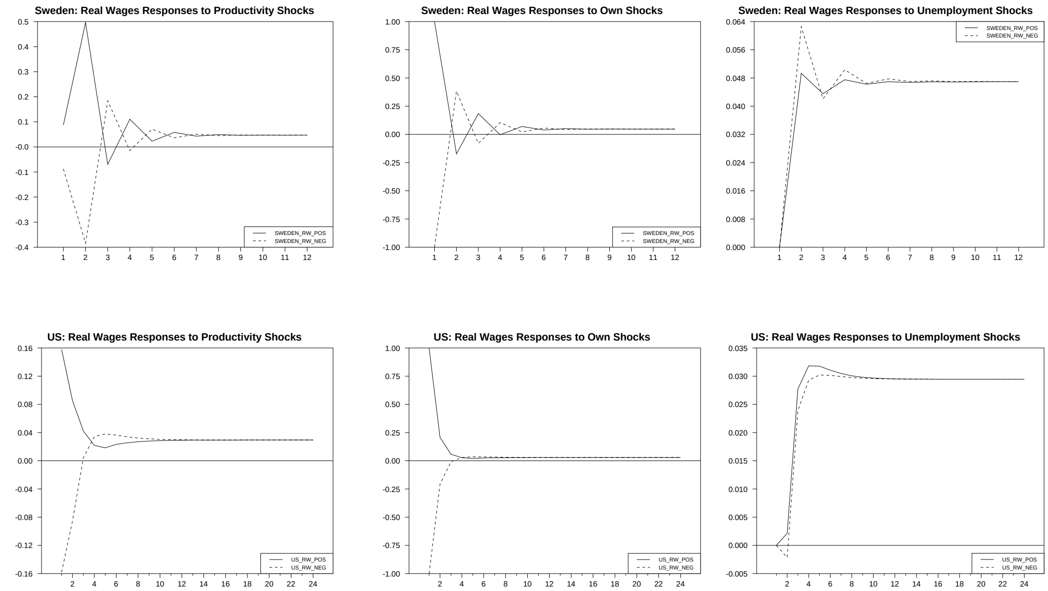
Country	Threshold	$\rho_1\mu^+$	$\rho_2\mu^-$	ρ_1=ρ_2	P-value	Long-run eq.
Germany	n.a.	n.a.	n.a.	n.a.	n.a.	$w = 0.364 + 0.454q + 0.0179u$
Japan	-0.017	-0.167***	0.028	6.196	0.013	$w = 0.774 + 0.014q + 0.041u$
Spain	-0.001	-0.350***	-0.184**	1.932	0.168	$w = 0.368 + 0.745q - 0.007u$
Sweden	n.a.	n.a.	n.a.	n.a.	n.a.	$w = 0.267 + 0.787q - 0.013u$
UK	0.0001	-0.180**	-0.224***	0.207	0.649	$w = -0.100 + 1.130q - 0.003u$
US	-0.023	0.009	-0.068***	8.831	0.003	$w = 0.855 + 0.099q + 0.012u$

* Significance at the 10% level; ** Significance at the 5% level; *** Significance at the 1% level

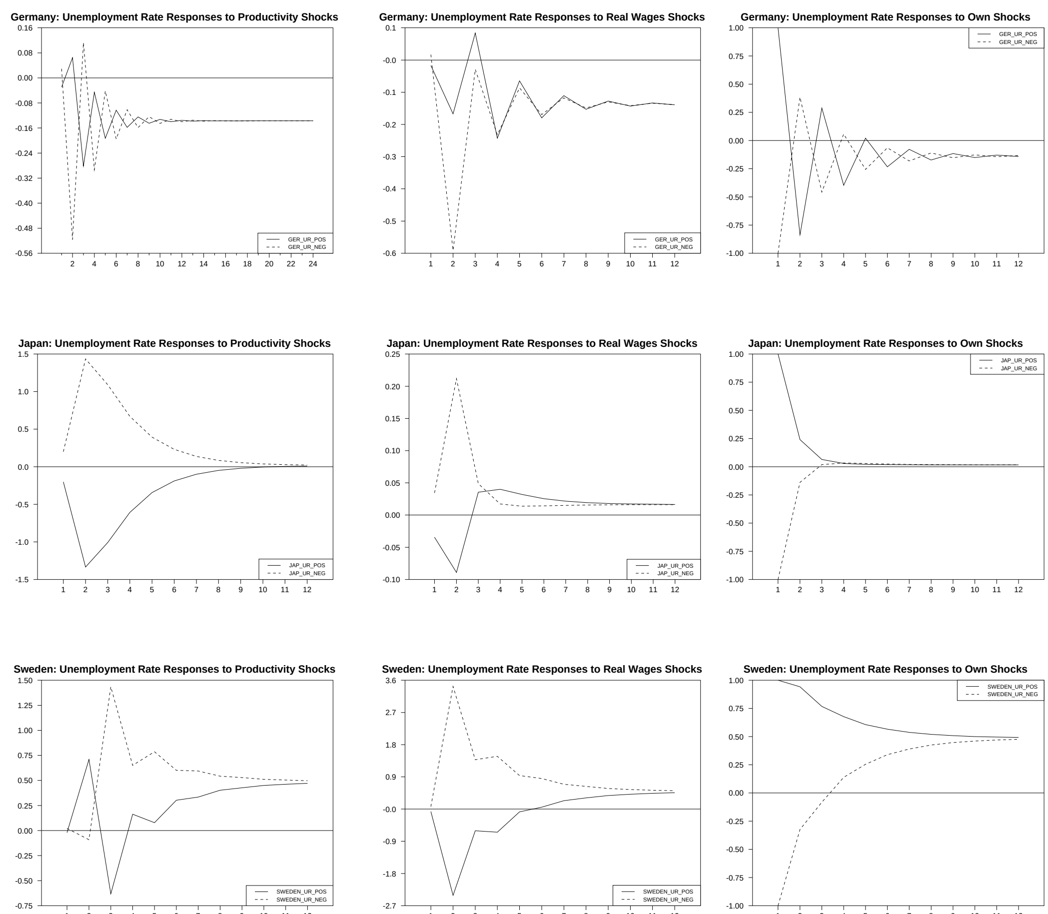
Graphs

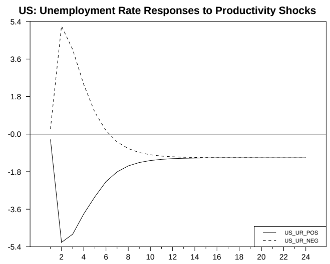
Real Wages Impulse Responses

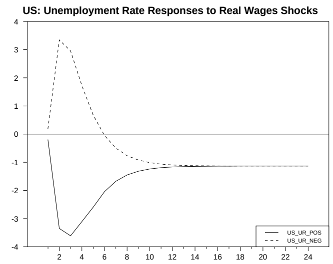


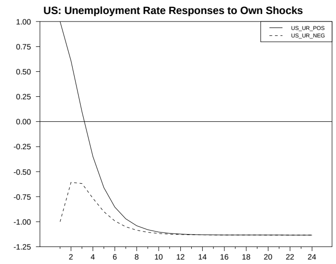


Unemployment Rate Impulse Responses




US: Unemployment Rate Responses to Productivity Shocks
US_UR_POS
US_UR_NEG


US: Unemployment Rate Responses to Real Wages Shocks
US_UR_POS
US_UR_NEG


US: Unemployment Rate Responses to Own Shocks
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