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Does Hysteresis in Unemployment Occur in OECD Countries? Evidence from Parametric and Non-Parametric Panel Unit Roots Tests

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ABSTRACT

This study tests the hysteresis hypothesis of unemployment in fourteen OECD countries by examining the stationarity of unemployment rates using several panel unit root tests. Empirical results show that the hysteresis hypothesis cannot be rejected for majority of the OECD when the tests are conducted on the basis of individual countries. However, rejection is obtained when cross-country interdependence in unemployment rates is incorporated in the estimation. Therefore, it is crucial to consider the cross-country labor markets interdependence when testing the hysteresis hypothesis as the labor market institutions and the stabilization policy of the labor markets in these OECD countries can play an important role in maintaining the unemployment to sustainable levels.

Keywords: Unemployment, Hysteresis Hypothesis, Panel Unit Root Test, Parametric Test, Non-Parametric Test, OECD

INTRODUCTION

Hysteresis in unemployment hypothesis postulates that cyclical fluctuations have permanent effects on the level of unemployment. According to Blanchard and Summers (1996), the proponent of this hypothesis, recessions can have a permanent impacts if they change the characteristics or altitude of those who lost their jobs as a results of recessions. According to this hypothesis, persistent high unemployment leads to an increase in the long-term natural rate of unemployment, which is

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determined in the labor market. Unemployment may continue to persist due to strong labor union that tends to maintain high wage and therefore reduces employment. On the other hand, hysteresis in unemployment may also be caused by anticipation of inflation, and according to the Phillips Curve, downwards pressure on inflation lead to sustained high unemployment. Accordingly, increase in actual unemployment needed to decrease inflation may lead to an increase in the natural rate of unemployment, and thus long-lasting unemployment costs.

If the hysteresis hypothesis holds, then unemployment dynamic tends to be a non-stationary or unit root process that does not revert to its long run equilibrium. It has important policy implications. High level of unemployment, if left unattended by the government, may persist and continue to be a serious social and economic problem. If the unemployed ones are unemployed for such a long time, they loose their valuable skills and become incompetence and therefore remain unemployable. Thus, unemployment has negative impacts on economic growth, social stability, individual's self-confidence, income distribution and individual morale or altitude (Blanchard and Wolfers, 1987). Due to its importance, an extensive empirical literature has developed around the topic of unemployment hysteresis hypothesis, since the influential work of Blanchard and Summers (1996).

Hysteresis in unemployment is commonly identified by conventional unit root tests (Cross, 1995). For example, Blanchard and Summers (1986), Brunello (1990), Neudorfer *et al*. (1990), and Røed (2002) applied the Dickey-Fuller (DF) type tests to examine if unemployment series contains a unit root. In the past, a substantial amount of effort has been spent to test the hysteresis hypothesis in unemployment using data

from Organization for Economic Co-operation and Development (OECD) countries[1].

Generally, these studies are unable to reject the null hypothesis of stationary unemployment, suggesting the presence of hysteresis in unemployment in most of the OECD countries. For instance, using Augmented Dickey-Fuller (ADF) and KPSS (Kwiatkowski *et al*., 1992) unit root tests, Røed (2002) found evidence of hysteresis for all the ten OECD countries under study, with the exception of the United States, whereby the finding favors the natural rate hypothesis[2]. This finding is in line with the results obtained from Perron's (1989) unit root test performed by Mitchell (1993). Using quarterly data covering the period of 1960 to 1991, Mitchell detected the existence of hysteresis in all the fifteen OECD countries under examination including the United States. Earlier on, Blanchard and Summers (1986) had also performed the DF and ADF unit root tests on the annual (1953-1984) unemployment series for a smaller number of OECD countries. Their results suggested the presence of hysteresis in unemployment for France, Germany, United Kingdom, but not for the United States.

Despite the consistent findings of hysteresis in unemployment for the majority of the OECD countries, the low power of these tests against the stationary alternatives, when the process is near-integrated, is a well-known problem for small sample (Cochrane, 1991; DeJong *et al*., 1992; Rapach and Wohar, 2002; Baharumshah *et al*., 2005). One way to circumvent the problem is to perform panel analysis, which allows the pooling of data and the consideration of cross-country economics interactions[3]. In particular, Holmes (2002) demonstrates that by exploiting

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[1] The OECD is an international organization of those developed countries that accept the principles of representative democracy and a free market economy.

[2] Those countries are Austria, Belgium, Canada, Germany, Japan, New Zealand, Norway, Sweden and United Kingdom. Annual data ranging from 1960 to 1995 are examined in Røed (2002).

[3] The other way is to allow for structural break(s) in the tests. See for instance, Mitchell (1993) and Arestis and Mariscal (1999, 2000).

the cross-country variation of the data in estimation, panel analysis can yield higher test power than the conventional unit root tests. With special reference to the study of unemployment, it has been pointed out in Song and Wu (1998) that:

"The panel-based procedure pools cross-section time series data and evaluates the null hypothesis that the unemployment rate in each country contains a unit root against the alternative hypothesis that all unemployment rate series are stationary. This allows one to use a larger number of data points in the test and to exploit cross-country variations of the data to improve estimation efficiency. As the null hypothesis imposes the cross-equation restriction on the first-order autoregressive coefficients, the panel test can yield higher power than standard tests for individual time series."

Due to its potential usefulness, recent studies have adopted panel analysis to investigate the stationarity of unemployment rate in United States and some European countries (Song and Wu, 1997; Leon-Ledesma, 2002). For example, Song and Wu (1997) employed the Levin and Lin (1992) test and demonstrated that found that unemployment rates in the United States are stationary[4]. Their finding was confirmed by Leon-Ledesma (2002) by using the Im *et al*. (1997) test. In the context of OECD, Song and Wu (1998) reported no evidence of hysteresis in unemployment for the quarterly data (1972-1992) of 15 OECD countries under study based on Levin and Lin (1992) panel unit root test[5].

Nonetheless, the study on the stationarity of unemployment rate by using the panel analysis is still limited in the literature. To explore hysteresis of unemployment issue using panel analysis in the spirit of Song and Wu (1998), this study examines the stationarity of unemployment rate using several panel unit root tests. In this context, the stationarity of fourteen OECD economies' unemployment rates are examined. This study differentiates itself from Song and Wu (1998) in threefold.

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[4] See Levin *et al*. (2002) for the revised and published version of Levin and Lin (1992).
[5] Austria, Australia, Belgium, Canada, Denmark, Finland, Germany, Japan, Luxembourg, Netherlands, South Korea, Sweden, Switzerland, United Kingdom, and the United States.

First, apart from the Levin *et al*. (2002) test, alternative panel unit root tests due to Maddala and Wu (1999), Choi (2001) and Im *et al*. (2003) are considered in this study for cross-validation. In this regard, Im *et al*. (2003) test improves over Levin *et al*. (2002) test and therefore could give more reliable results. It is important to note that while Im *et al*. (2003) and Levin *et al*. (2002) tests are parametric in nature, Maddala and Wu (1999) and Choi (2001) are non-parametric tests, which could avoid misleading results if the model specification does not capture the characteristic of the unemployment dynamic. Second, it employs the more recent data set to get an updated finding. Third, this study utilizes monthly data to see if data frequency matters in the testing of hysteresis in unemployment.

The rest of this study is organized as follows. Section 2 describes the data and methodology employed in this study. Section 3 presents and discusses the findings of this study. The last section concludes this study.

DATA AND METHODOLOGY

This study analyses the stationarity of unemployment rates for selected OECD economies, namely Australia, Belgium, Canada, Denmark, Finland, Germany, Japan, Luxembourg, Netherlands, South Korea, Sweden, Switzerland, United Kingdom, and the United States. The monthly data set for these countries are taken from the International Financial Statistics, and it covers from the January of 1993 to the May of 2007. For this purpose, several panel unit root tests due to Maddala and Wu (1999), Choi (2001) and Im *et al*. (2003), in addition to the Levin *et al*. (2002) unit root test, are adopted in this study.

Im *et al.* (2003) proposed a *t*-bar statistic, which is based on the average of the individual ADF *t*-statistics, to examine the unit root hypothesis for panels[6]. For a sample of *N* groups observed over *T* time periods, the panel unit root regression of the conventional ADF test can be expressed as:

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \sum_{j=1}^{p_t} \gamma_{ij} \Delta y_{it-j} + e_{it}, \quad i = 1,...,N, \quad t = 1,...,T \tag{1}$$

where y_{it} is the unemployment series, $\Delta y_{it} = y_{it} - y_{it-1}$, α_i, β_i and γ_{ij} are the parameters to be estimated, and e_{it} stands for disturbance terms. The subscript t denotes time period, whereas subscript i represents the individual country. Note that the intercept term, α_i captures the country-specific effects, and to incorporate the time-specific effects, a trend component may be added to Equation (1).

In this test, the null hypothesis of hysteresis in unemployment exists for all countries ($H_0 : \beta_i = 0$, for all i) is tested against the alternative that there is no hysteresis in unemployment for all countries ($H_1 : \beta_i < 0$, for all i). To test the hypothesis, Im *et al.* (2003) proposed a standardized *t*-bar ($\bar{t}$) statistic given by:

$$\frac{\sqrt{N}(\bar{t} - \mu)}{\sqrt{\sigma^2}} \rightarrow N(0,1) \tag{2}$$

where $\bar{t}$ is the average of the estimated individual ADF *t*-statistic for testing $\beta_i = 0$ for a all *i*. μ and σ^2 represent the mean and variance of the ADF *t*-statistics, which can be obtained from simulation and they are available in the Table 2 of Im *et al.* (2003). The symbol "$\rightarrow N(0,1)$" refers to asymptotically distributed as standard normal distribution.

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[6] See also Im *et al* . (1997) for its working paper version.

Earlier on, Levin *et al.* (2002) propose a unit root test, which assumes that the β_i coefficients are the same for all unemployment rates [$\beta_i = ... = \beta_N = \beta$ in Equation (1)] and test the null hypothesis of $H_0 : \beta = 0$ against the alternative hypothesis of $H_A : \beta < 0$ using the test statistic, $t = \hat{\beta}/se_{\hat{\beta}}$, where $\hat{\beta}$ is the OLS estimate of β and $se_{\hat{\beta}}$ is the standard error of $\hat{\beta}$[7]. Im *et al.* (2003) unit root improves over that of Levin *et al.* (2002) in the sense that it does not imposed the restrictive assumption of homogeneity. The homogeneity assumption is relaxed in Im *et al.* (2003) unit root to cater for heterogeneity and serial correlation errors across countries, which is more reflective of the actually situation. Therefore, it could provide more robust results as compared to Levin *et al.* (2002) test. Hence, the better finite sample performances of Im *et al.* (2003) test as compared to the Levin *et al.* (2002) test as revealed by simulation study performed by the former comes with no surprise. Nonetheless, Im *et al.* (2003) test can only be performed using the same lag length across all the individual ADF regressions. In this junction, the Maddala and Wu (1999) and Choi (2001) Fisher tests can be performed on different lag lengths in the individual ADF regressions. Another advantage of the Fisher test is that it does not require balanced panel as in the case of the Im *et al.* (2003) test.

Maddala and Wu (1999) proposed a Fisher test statistic solely based on joining the *p*-value of the test statistic from the individual unit root tests. The test is non-parametric and is based on Fisher (1932). Similar to Im *et al.*, (1997), this test allows for different first-order autoregressive coefficients and has the same null and alternative hypothesis in the estimation procedure. The Fisher test statistic, $p(\chi^2)$ is written as follows:

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[7] Song and Wu (1998) adopted this test, based on its earlier version proposed in Levin and Lin (1992).

$$p(\chi^2) = \quad p(\chi) = -2\sum_{j=1}^{N}\log(\pi_j) \qquad (3)$$

where π_j is the *p*-value of the test statistic for *j*. The Fisher test statistic $p(\chi^2)$ is a chi-squared distribution with $2N$ degree of freedom.

Choi (2001) extends the Fisher test statistics of Maddala and Wu (1999) by demonstrating that:

$$Z = \frac{1}{\sqrt{N}}\sum_{j=1}^{N}\phi^{-1}(\pi_j) \rightarrow N(0,1) \qquad (4)$$

where ϕ^{-1} is the opposite of the standard collective distribution function.

EMPIRICAL RESULTS AND DISCUSSIONS

For contrasting purpose, the conventional augmented Dickey-Fuller (ADF) and its improved version known as Generalized Least Squares Dickey-Fuller (DF-GLS, due to Elliott *et al*. 1996) unit root tests are included in this study. Table 1 summarizes the results of hysteresis hypothesis testing based on conventional unit root tests. Table 1 shows that the null hypothesis of unit root cannot be rejected for one-half (Belgium, Canada, Finland, Japan, Luxemburg, Sweden and United States) of fourteen OECD economic. The DF-GLS test, which has more power than ADF in detecting unit root (Ng and Perron, 2001), however, is able to identify only Germany, South Korea and Switzerland are flexible enough to easily revert to its long run equilibrium. Thus, based on the more robust DF-GLS test results, the hysteresis in unemployment hypothesis is supported by eleven out of the fourteen OECD countries under study. On the contrary, the hysteresis in unemployment hypothesis can be rejected for Germany, South Korea and Switzerland only. As rejection of the hypothesis implies evidence in favor of the natural rate hypothesis, this finding suggests that unemployment in these three countries is flexible enough to easily revert to its long-

run equilibrium determined by the labor market. Nonetheless, as pointed out earlier, univariate unit root tests suffer from power problem and hence the results obtained are not robust for policy implications. In this context, we resort to panel unit root tests for more reliable findings.

Table 1 Univariate Unit Root Tests for Fourteen OECD Countries

Countries	ADF	DF-GLS
Australia	-3.875 (12)** [t]	0.625 (13)
Belgium	-2.420 (12)	-2.340 (12)**
Canada	-2.435 (12) [t]	0.952 (13)
Denmark	-3.606 (13)** [t]	0.137 (12)
Finland	-0.817 (13)	0.598 (13)
Germany	-2.945 (12)**	-2.294 (12)**
Japan	-1.561 (13)	-0.700 (13)
South Korea	-3.000 (13)**	-3.069 (13)** [t]
Luxembourg	-2.901 (13) [t]	-0.580 (13)
Netherlands	-2.898 (12)**	-1.3584(12)
Sweden	-1.775 (13)	-0.866 (13)
Switzerland	-3.596 (13)***	-3.865 (13)***
United Kingdom	-3.480 (12)**	-0.357 (12)
United States	-2.742 (12)	-0.6740(13)
Critical Values (without trend)		
1%	-3.483	-2.580
5%	-2.885	-1.943
Critical Values (with trend)		
1%	-4.016	-3.509
5%	-3.438	-2.971

Notes: Asterisks (***) and (**) indicate the rejection of the null hypothesis of unit root at 1% and 5% significance levels respectively. The optimal lag lengths in ADF and DF-GLS tests are selected based on the modified Akaike's information criteria. [t] indicates that time-specific effect is included in the estimation.

The panel unit root tests results are presented in Table 2. It is observed from Table 2 that, after incorporating country-specific effects into account, the null hypothesis of unit root (implying existence of hysteresis in unemployment) can be rejected at less than one percent significance level based on the Levin *et al*. (2002) unit root test. It can be concluded that by incorporating cross-country variations, the unemployment series of all the fourteen OECD economics are stationary. In other words, the unemployment rates of these countries as a whole is mean-reverting in the long-run and therefore there is no evidence of hysteresis in unemployment in these

countries. This finding is cross-validated by Im *et al*. (2003) test, as well as the non-parametric Fisher test of Madalla and Wu (1999) and Choi (2001), which also consistently show evidence against the hysteresis in unemployment hypothesis at less than one percent significance level.

It is known from causal observations of Figure 1 that the unemployment rates differ from time-to-time in these OECD countries. Thus, it is reasonable to suspect that different country may follow different time path in achieving the equilibrium natural rate of unemployment. To see if time-specific effects matter, this study re-estimates the tests by incorporating both country- and time-specific effects but the above conclusion of no hysteresis in unemployment as mentioned earlier is not altered (see lower panel of Table 2).

Table 2 Panel Unit Root Tests for Fourteen OECD Countries

Test	Test Statistic [Probability]
Accounting for only Country-Specific Effects	
Levin *et al*. (2002)	-5.381 [0.000]***
Im *et al*. (2003)	-3.347 [0.000]***
Maddala and Wu (1999)	63.883 [0.000]***
Choi (2001)	-3.801 [0.000]***
Accounting for Country- and Time-Specific Effects	
Levin *et al*. (2002)	-4.570 [0.000]***
Im *et al*. (2003)	-1.822 [0.034]**
Maddala and Wu (1999)	43.359 [0.030]**
Choi (2001)	-1.538 [0.062]**

Notes: Asterisks (***), (**) and (*) denote the rejection of the null hypothesis of unit root at 1%, 5% and 10% significance levels respectively. The optimal lag lengths in all cases are selected based on modified Akaike's information criteria.

Figure 1 Plots of Unemployment Rates (percentage) for Fourteen OECD Countries
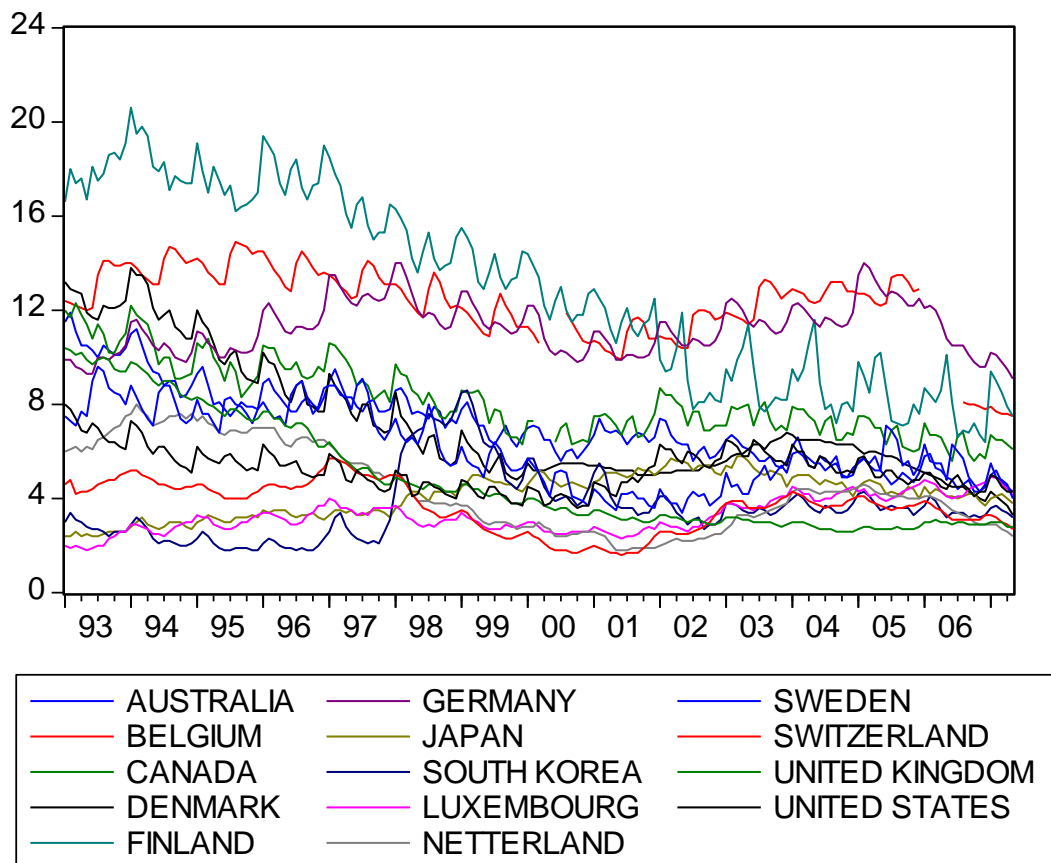
It is worth-mentioning that the current finding of no hysteresis in unemployment from the panel unit root tests is in sharp contrast to the finding of the non-stationary results from the conventional unit root tests, which do not allow for the consideration of regional interdependence in these unemployment rates. Nonetheless, this finding is in line with Leon-Ledesma (2002) who found that panel unit root tests are better than conventional unit root tests in the case of unemployment rates. In addition, using updated data set and different data frequency, this study is able to obtain finding that it is consistent with that of Song and Wu (1998). It indicates that the finding supportive of the natural rate hypothesis in Song and Wu (1998) for the OECD countries does not altered even with the inclusion of more recent sample period. Hence, it can be said that the unemployment rates in these countries are

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sustainable. Moreover, this finding demonstrates the data frequency does not matter in the testing of hysteresis of unemployment hypothesis.

Table 3 shows the descriptive statistics of the rates of unemployment for these OECD countries. It is obvious from the statistics that the unemployment rates in general tend to be higher in European countries than those non-European countries such as Japan, South Korea and the United States. The difference may arise due to different social institutions. For instance, European countries have better unemployment benefits than other countries and therefore equilibrium rates of unemployment tend to be more persistence at high level. To further investigate if this discrepancy leads to different estimated results, this study re-performs the panel analysis on the nine European countries, after leaving out Australia, Canada, Japan, South Korea and the United States. The results obtained from the sample of ten European countries are summarized in Table 4.

Table 3 Descriptive Statistics for Fourteen OECD Countries

Country	Mean	Median	Maximum	Minimum	Standard. Deviation
Australia	7.096	6.800	11.900	4.300	1.724
Belgium	12.291	12.600	14.900	7.500	1.636
Canada	8.212	7.800	12.300	5.600	1.611
Denmark	7.175	6.300	13.800	3.300	2.597
Finland	12.983	12.900	20.600	6.400	4.022
Germany	11.241	11.200	14.000	9.100	1.093
Japan	4.122	4.300	5.800	2.400	0.900
South Korea	3.645	3.400	8.600	1.800	1.486
Luxembourg	3.292	3.100	4.923	1.800	0.733
Netherlands	4.423	4.100	8.000	1.800	1.798
Sweden	6.115	5.700	9.600	3.400	1.621
Switzerland	3.651	3.700	5.700	1.600	1.033
United Kingdom	4.880	3.800	10.400	2.600	2.397
United States	5.225	5.200	8.000	3.600	0.880

It is evident from Table 4 that the null hypothesis of hysteresis in unemployment in the ten OECD countries can be rejected at one percent significance

level based on all statistics calculated based on the estimation model that accounts for country-specific effects. When both time-specific effects are country-specific effects are taken into account, the conclusion remain altered in quality, although somewhat weaker evidence against hysteresis in unemployment is detected[8]. All-in-all, this study finds evidence supportive the natural-rate hypothesis, rather than the hysteresis in unemployment hypothesis for the fourteen OECD countries in general and the nine European countries in specific.

Table 4 Panel Unit Root Tests for Nine European Countries

Test	Test Statistic [Probability]
Accounting for only Country-Specific Effects	
Levin *et al*. (2002)	-6.010 [0.000]***
Im *et al*. (2003)	-3.468 [0.000]***
Maddala and Wu (1999)	46.843 [0.000]***
Choi (2001)	-3.485 [0.000]***
Accounting for Country- and Time-Specific Effects	
Levin *et al*. (2002)	-4.634 [0.000]***
Im *et al*. (2003)	-1.388 [0.083]*
Maddala and Wu (1999)	25.736 [0.106]
Choi (2001)	-1.083 [0.139]

Notes: Asterisks (***), (**) and (*) denote the rejection of the null hypothesis of unit root at 1%, 5% and 10% significance levels respectively. The optimal lag lengths in all cases are selected based on modified Akaike's information criteria.

CONCLUSION

This study finds that the unemployment rates of the fourteen OECD economics under consideration are mean-reverting towards the long-run equilibrium determined in the labor market. It implies that the unemployment rates in these OECD countries are sustainable, and hence the hysteresis in unemployment hypothesis can be rejected for the OECD countries. Results of further analysis using the more homogenous data set

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[8] Levin *et al*. (2002) and Im *et al*. (2003) test statistics show that the null hypothesis can be rejected at one and ten percent significance levels respectively, whereas based on Maddala and Wu (1999) test statistic, the null hypothesis can only be marginally rejected at ten percent level. On the other hand, based on Choi (2001) test statistic, rejection can only be made at fourteen percent significance level.

which consists of nine European countries reveal that these rates are nonetheless mean-reverting. Hence, there is no evidence of hysteresis in unemployment for these European countries although majority of these countries are characterized by persistent high rates of unemployment. Overall, these findings signify that the labor market institutions and the stabilization policy of the labor markets in these OECD countries have played a successful role in maintaining the unemployment to sustainable levels (Graafland, 1989; Gustavsson and Osterholm, 2006).

Note that the hysteresis hypothesis cannot be rejected for majority of the OECD when the tests are conducted on the basis of individual countries. In sharp contrast, rejection is only obtained when cross-country interdependence in unemployment rates is incorporated in the estimation. The high degree of synchronization in business cycle among the OECD countries may be one of the factors that facilitate cross-country interdependence. Besides, mobility of labor forces across the labor markets of these OECD countries may have contributed in alleviating the pressures of unemployment in the domestic countries and thereby stabilizing the unemployment rates of domestic countries As such, in the course of hysteresis hypothesis testing, it is imperative to consider the cross-country labor markets interdependence for more robust conclusion. The macroeconomic implications that could be drawn from the panel analysis is that labor market institutions will be more effective and the labor market policies will work better under regional collaboration.

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