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TESTING UNEMPLOYMENT HYSTERESIS WITH MULTI-FACTOR PANEL UNIT ROOT: EVIDENCE FROM OECD COUNTRIES[1]

Abstract. Hysteresis is a dominant feature of unemployment in numerous countries. According to the hysteresis hypothesis, it is a well-known fact that high unemployment may persist and remain an economic threat in the long run if policy measures are not taken. In this study, it is tested whether the unemployment rates for 10 selected countries of the Organisation for Economic Co-operation and Development (OECD) (Belgium, Canada, Czech Republic, Estonia, France, Japan, Netherlands, Spain, Britain and the USA) contain unit root or not, in other words, whether the hysteresis effect is valid for these countries. For this purpose, this study utilises the concept of the multi-factor panel unit root test proposed by Pesaran, Smith and Yamagata. This method measures cross-section dependence through factors. The test analyses whether the unit root is valid or not, using information about a sufficient number of additional explanatory variables. The characteristic of these additional variables is that they must share a common factor with the variable whose stationarity is tested. It is accepted that this common factor causes cross-sectional dependence. We have taken tax wedge, trade union density and minimum wage as factors that cause cross-sectional dependency and affect unemployment hysteresis. In this test developed by the authors, in the case of a multi-factor error structure, the test procedure is completed by using the information contained in 3 additional variables. The study explores not only the validity of unemployment hysteresis but also the factors that affect the rigidity of the unemployment rate. However, the research was unable to encompass the entire OECD countries and all times because of the lack of data. The results showed that the hysteresis is valid for 10 selected OECD countries.

Keywords: unemployment, hysteresis, tax wedge, trade union density, minimum wage, panel data, cross-section Augmented Dickey-Fuller, multifactor, unit root, OECD

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Анализ гистерезиса безработицы методом тестирования единичных корней в панельных данных для стран ОЭСР

Аннотация. Во многих странах гистерезис является основным фактором безработицы. Согласно гипотезе гистерезиса, в отсутствие должных политических мер сохранение высокого уровня безработицы в долгосрочной перспективе угрожает экономическому развитию государства. В данной статье проверяется наличие единичного корня для безработицы в 10 избранных странах Организации экономического сотрудничества и развития (Бельгия, Канада, Чехия, Эстония, Франция, Япония, Нидерланды, Испания, Великобритания и США). Цель исследования — определить, присутствует ли в этих странах эффект гистерезиса. Для анализа данных использован предложенный Песараном, Смитом и Ямагатой метод тестирования единичных корней в панельных данных, измеряющий кросс-зависимость факторов. Используя информацию о достаточном количестве дополнительных объясняющих переменных, тест анализирует, действителен ли единичный корень. Дополнительные переменные должны иметь общий множитель с переменной, стационарность которой проверяется, поскольку общий фактор является причиной кросс-зависимости. В качестве факторов, вызывающих кросс-зависимость и влияющих на гистерезис безработицы, рассмотрены такие показатели, как налоговый клин, плотность профсоюзов и минимальная заработная плата. В случае ошибки в многофакторной структуре процедура тестирования завершается с использованием информации, содержащейся в трех дополнительных переменных. Проанализировано как присутствие гистерезиса безработицы, так и влияющие на безработицу факторы. Отсутствие данных не позволило оценить ситуацию во все странах ОЭСР в различные временные периоды. Из полученных данных следует, что эффект гистерезиса присутствует во всех 10 избранных странах ОЭСР.

Ключевые слова: безработица, гистерезис, налоговый клин, плотность профсоюзов, минимальная заработная плата, панельные данные, расширенный тест Дики — Фуллера, мультифакторность, единичный корень, ОЭСР

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Introduction

Since the dawn of the era of industrial capitalism, one of the biggest and deepening problems that humanity has been trying to overcome is unemployment. The economic consequences of persistent unemployment and high rates are an issue emphasised by governments and all economic units, as they are directly related to the performance of many macroeconomic variables. One of the main characteristics of unemployment is its downward rigidity in some countries or regions. Therefore, there are contradictions as to whether the hysteresis is valid or what affects the hysteresis. In the literature on unemployment, hysteresis has mostly been associated with the stationarity of the series. It is stated various studies that for an unemployment series with I(0) there is no hysteresis and the tendency to natural unemployment rate is fast. For series without I(0), the existence of hysteresis is valid.

Given the risk of the hysteresis hypothesis being valid, the most appropriate policy for governments is to prevent the rise of unemployment before it occurs, because it may be a very difficult possibility for employment to return to its previous level after unemployment rates increase. Many factors in the literature that can cause hysteresis counted. Efficiency wages literature (begins with Leibenstein (1957)), existence of unions (Blanchard, Summers, 1986), skill deterioration (Layard, Bean, 1989) and insider-outsider theory (Blanchard, Summers, 1986) are some of the important causes of hysteresis according to the literature. As mentioned before, there are several debates over the validity of hysteresis and the factors that affect it. However, there are very few studies examining the presence of hysteresis and the variables that cause it together with the unit root test. In this respect, this research makes an important contribution.

Panel unit root tests first appeared in the literature in the early 2000s and are developing very rapidly. Two types of tests, first generation and second generation, have been developed in the panel unit root frame. The first-generation tests were developed based on the assumption that there is no cross-sectional dependency between variables. If there is a correlation between the variables, the asymptotic properties of the statistics of these tests may be affected. For this reason, second generation tests have been developed that take into account the presence of correlation between variables. In order to overcome the cross-sectional dependency problem, three main approaches have been proposed in the literature (Zeren, İşlek 2019). In the first approach, bootstrap sampling was used in the distribution of test statistics under the assumption of cross-sectional dependence. In the second approach, the correlation between units is modelled with the help of common factors. In the third approach, it is suggested to add factors to the model instead of estimating the factors. First, Pesaran (2007) added the cross-sectional mean of the lagged levels of the variable considered to the augmented Dickey — Fuller (ADF) regression and the first differences of each series as a factor. However, if there is more than one common factor, size distortions were observed in this test statistic. For this reason, Pesaran, Smith and Yamagata (2013) developed this test for a multi-factor error structure.

For this purpose, it is aimed to test the hysteresis hypothesis with the multi-factor unit root test by using the information about additional factors that may affect unemployment for 10 selected countries of the Organisation for Economic Co-operation and Development (OECD). These factors are trade union density, minimum wage and tax wedge, and they share a common factor with unemployment rates. In addition, this test gives strong results even when these factors cause cross-sectional dependence with unemployment rate. The next section of this study, conducted to test the validity of hysteresis for OECD countries, describes the relevant literature. The third chapter presents the data set and the econometric method, and the fourth chapter gives the empirical findings. Finally, the study is completed with the results and evaluation section.

Literature Review

The unemployment hysteresis is an important indicator of whether the economic situation after a shock will improve rapidly. Important macroeconomic indicators such as economic growth, economic development, inflation and foreign trade are closely related to unemployment. As in many fields of economics, there are intense discussions about the validity and reasons of hysteresis. Driven by these discussions, many studies in the literature examine the rigidity of the unemployment rate. These studies are divided into two as whether hysteresis is valid and not valid. In countries where hysteresis is valid, economic policies cannot be efficient. On the other hand, a rapid recovery is expected after the shock situations experienced in countries where hysteresis is not valid. This situation expresses the rapid return to the unemployment rate, which does not accelerate inflation, known as NAIRU (non-accelerating inflation rate of unemployment) in the literature.

Data and Methods

Economic indicators are often affected by more than one explanatory variable. This is why it is necessary to use information in different factors when conducting unit root tests for many economic indicators such as hysteresis, sustainability or convergence. Therefore, panel unit root test was used for the multi-factor error structure suggested by Pesaran, Smith and Yamagata (2013) in the hysteresis test for OECD countries. Trade union density, minimum wage and tax wedge were determined as factors and the existence of hysteresis was tested in 10 OECD countries using annual unemployment rates for the period 2000–2018. The analysed data were accessed from the World Bank[1] and OECD[2] official databases. As a result, it was concluded that the hysteresis determined by the selected factors is valid for 10 selected OECD countries.

Unemployment hysteresis suggests that unemployment cannot return to the natural rate level after it has increased for some reason. Many factors that cause the hysteresis to be valid have been widely discussed in the literature. Some of these return as costs to society through price rigidities and some through wage rigidities. In other words, when there is a shock that increases unemployment, unemployment returns to its previous level either late or not at all due to these factors. Coordination failures (Cooper, John, 1988), efficiency wage theory (Akerlof, Yellen, 1990) and insider-outsider theory (Lindbeck, Snower, 1989) are some theories that try to explain hysteresis. Apart from these, some control variables that are thought to define hysteresis have also been extensively discussed in the literature. Tax wedge, trade union density and minimum wage are important variables among them. One important study that deals with tax wedge and trade union density variables is the Stockhammer and Sturn's study (2011). The unemployment-increasing effects of minimum wage developments are also discussed extensively in the literature. In this study, these

[1] https://databank.worldbank.org/home.aspx.

[2] https://data.oecd.org.

Table 1

Literature Review

Author(s)	Period	Method	Findings
Blanchard and Summers (1986)	1853-1984	Conventional unit root tests	While hysteresis is not valid for France, Germany, the UK, it is valid for the USA
Neudorfer, Pichelmann and Wagner (1990)	1951Q1–1986Q4	ADF unit root test	Hysteresis is valid for France
Brunello (1990)	1955-1987	ADF unit root test	Hysteresis is valid for Japan
Mitchell (1993)	1960Q1–1991Q3	ADF and PP unit root tests	Hysteresis is valid for 15 selected OECD countries
Røed (1996)	1970Q1–1994Q4	ADF unit root test	Hysteresis is valid for 16 selected OECD countries
Song and Wu (1998)	1960Q1–1992Q2	LLC unit root test	Hysteresis is not valid for 15 selected OECD countries
Arestis and Mariscal (1999)	1960Q1-1997Q2	Unit root tests that allow for structural breaks	Hysteresis is not valid for only 4 out of 26 selected OECD countries
Papell, Murray and Ghiblawi (2000)	1955-1997	Unit root tests that allow for structural breaks	Hysteresis is not valid for only 1 out of 16 selected OECD countries
León-Ledesma (2002)	1985Q1–1999Q4	IPS unit root test	Hysteresis persists more in EU countries than the USA
Fève, Hénin and Jolivaldt (2003)	1966Q1-1999Q1	FADF unit root test	Hysteresis is not valid for only 8 out of 21 selected OECD countries
Smyth (2003)	1982Q2–2002Q1	LLC and IPS unit root tests	Hysteresis is not valid for 6 states of Australia
Camarero and Tamarit (2004)	1956–2001	ADF and SURADF unit root tests	Hysteresis is not valid for 19 selected OECD countries
Chang et al. (2005)	1961–1999	Panel SURADF unit root test	Hysteresis is not valid for only 2 out of 10 selected European countries
Camarero, Carrion-i-Silvestre and Tamarit (2005)	1991M1–2003M11	Unit root tests that allow for structural breaks	Hysteresis is not valid for 9 European countries
Camarero, Carrion-i-Silvestre and Tamarit (2006)	1956–2001	Unit root tests that allow for structural breaks	Hysteresis is not valid for 19 selected OECD countries
Christopoulos and León-Ledesma (2007)	1988Q1-1999Q4	Second generation panel unit root test	Hysteresis is not valid for selected 12 EU countries
Lee and Chang (2008)	1855-2004	Unit root tests that allow for structural breaks	Hysteresis is not valid for 14 central OECD countries
Romero-Ávila and Usabiaga (2008)	1976–2004	Unit root tests that allow for structural breaks	Hysteresis is valid for Spain
Camarero, Carrion-i-Silvestre and Tamarit (2008)	1991M1–2003M11	Unit root tests that allow for structural breaks	Hysteresis is not valid for 8 selected Central and Eastern European countries
Yılancı (2009)	1923-2007	Unit root tests that allow for structural breaks	Hysteresis is valid for Turkey
Lee, Lee and Chang (2009)	1960-2004	Unit root tests that allow for structural breaks	Hysteresis is not valid for 19 selected OECD countries
Gomes and da Silva (2009)	1981-2002	Unit root tests that allow for structural breaks	Hysteresis is valid for the six metropolitan cities of Brazil
Lee (2010)	1960-2008	Non-linear unit root test	Hysteresis is valid for 6 out of 29 selected OECD countries
Lee, Wu and Lin (2010)	1976-2004	Unit root tests that allow for structural breaks	Hysteresis is valid for 9 selected Asian Countries
Chang (2011)	1960-2009	Fourier unit root test	Hysteresis is not valid for only 6 out of 17 selected OECD countries

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Author(s)	Period	Method	Findings
Yıldırım (2011)	1923-2010	Unit root tests that allow for structural breaks	Hysteresis is valid for Turkey
Koçyiğit Bayat and Tüfekçi (2011)	1923-2010	Non-linear unit root test	Hysteresis is valid for Turkey
Mednik, Rodriguez and Ruprah (2012)	1980-2005	Unit root tests	Hysteresis is valid for most of the selected 13 Latin America countries
Furuoka (2012)	1980-2009	MADF and SURADF unit root tests	Hysteresis is not valid for 12 East Asia-Pacific countries
Özcan (2012)	1971-2006	Unit root tests that allow for structural breaks	Hysteresis is valid for most of the selected 23 OECD countries
Ayala, Cuñado and Gil-lana (2012)	1980-2009	Unit root tests that allow for structural breaks	Hysteresis is not valid for only 2 out of 16 selected Latin America countries
Srinivasan and Mitra (2012)	1955–2010	Kalman filter	Hysteresis is not valid for France and Germany
Dritsaki and Dritsaki (2013)	1984-2010	Panel unit root test	Hysteresis is valid for Greece, Portugal and Ireland
Doğru (2014)	1980-2012	SURADF and CADF unit root tests	Hysteresis is not valid for 12 selected Euro countries
Furuoka (2014)	1990–2009	Non-linear unit root tests	Hysteresis is not valid for 5 selected Asia-Pacific countries
Bolat, Tiwari and Erdayi (2014)	2000M1–2013M1	Unit root tests that allow for structural breaks	Hysteresis is not valid for 17 selected EU countries
Saraç (2014)	2005:01-2013:07	Linear and Non-linear unit root tests	Hysteresis is not valid for Turkey
Cheng et al. (2014)	1960-2011	Fourier unit root test	Hysteresis is not valid for only Portugal and Spain in the PIIGS countries
García-Cintado, Romero-Ávila and Usabiaga (2015)	1976-2014	Unit root tests that allow for structural breaks	Hysteresis is not valid for Spain
Özkan and Altınsoy (2015)	1988-2014	Fourier unit root test	Hysteresis is valid for Turkey
Munir and Ching (2015)	1980-2009	Panel unit root test	Hysteresis is not valid for 11 selected Asian countries
Bayrakdar (2015)	2000-2013	Unit root tests that allow for structural breaks, and do not allow for structural breaks	Hysteresis is not valid for Turkey
Marjanovic, Maksimovic and Stanisic (2015)	2000-2012	Kalman filter	Hysteresis is valid for most of the transition economies
Çekiç (2016)	1923-2007	Fourier unit root test	Hysteresis is valid for Turkey
Bekmez and Özpolat (2016)	1991-2014	Panel unit root tests that allow for structural breaks	Hysteresis is valid for 8 out of 17 selected OECD countries
Klinger and Weber (2016)	1960:1-2015:6	Simultaneous unobserved components model with Markov switching	Hysteresis is valid for Germany, but it is not valid for the USA
Kahyaoğlu et al. (2016)	2001Q1-2015Q4	Fourier unit root tests	Hysteresis is valid for Turkey
Güriş, Tiftikçigil and Tıraşoğlu (2017)	1970–2014	Non-linear unit root test	Hysteresis is not valid for Turkey
Koçbulut and Bolat (2017)	2004Q1-2016Q1	Panel unit root tests that allow for structural breaks, and do not allow structural breaks	Hysteresis is not valid for 7 Balkan countries
Akdoğan (2017)	1983Q1-2004Q2	Unit root tests that allow for structural breaks and non-linear unit root tests	Hysteresis is not valid for most countries in testing for 31 European countries, USA and Japan

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Author(s)	Period	Method	Findings
Özpence and Ergen (2017)	2005:01-2016:11	LM unit root test	Hysteresis is valid for Turkey
Meng, Strazicich and Lee (2017)	1983Q1-2013Q3	Fourier unit root test and RALS unit root test	Hysteresis is valid for only 4 countries out of 14 OECD countries
Furuoka (2017)	2000-2014	Fourier unit root test	Hysteresis is valid for 4 Scandinavian countries
Dursun (2017)	2001Q1-2016Q2	Fourier unit root test	Hysteresis tested made for Central and Eastern EU countries is valid for only Poland and Hungary
Marques, Lima and Troster (2017)	2000:01-2015:10	Panel unit root test	Hysteresis is valid for 29 OECD countries
Caporale and Gil-Alana (2018)	1960-2010	Fourier unit root test	Hysteresis is valid for 11 selected African countries
Albulescu and Tiwari (2018)	1965-2013	Unit root tests	Hysteresis is valid for 8 selected EU countries
Tekin (2018)	2005-2017	Fourier unit root tests	Hysteresis is valid for Turkey
Xie et al. (2018)	2000:1–2016:8	Fourier quantile unit root tests	Hysteresis is valid for only 2 out of 9 Eastern European countries
Yaya, Ogbonna and Mudida (2019)	1991-2017	Fourier unit root test	Hysteresis is valid for only 7 out of the selected 42 African countries
Öztürk (2020)	2005:01-2019:08	Unit root tests that allow for structural breaks and do not allow for structural breaks	Hysteresis is valid for Turkey
Khraief et al. (2020)	1980-2013	Non-linear unit root test	Hysteresis is valid for only 4 out of the selected 29 African countries
Pata (2020)	1991Q1-2019Q2	Fourier panel unit root test	Hysteresis is valid for only 3 out of the selected 15 OECD countries
Bayat, Temiz and Konat (2020)	1923-2019	Fourier unit root test	Hysteresis is valid for Turkey
Omay, Özcan and Shahbaz (2020)	1976-2017	Unit root tests that allow for structural breaks and unit root tests that are non-linear	Hysteresis is valid for only 3 out of 50 USA states

Source: Created by the authors.

three variables were included in the model in line with the literature.

Until now, various methods have been developed to determine the unit root. Each of these methods has advantages and weaknesses against each other. One of the most up-to-date methods in the literature is the cross-sectionally augmented panel unit root test (CIPS) method developed by Pesaran et al. (2013). The main element in this approach is to include a adequate number of additional indicators that may cause the existence of a unit root. In other words, in addition to the series to be examined in terms of unit root, factors that will cause this unit root are also included in the analysis. This method developed by Pesaran, Smith and Yamagata (2013) is the augmentation of the method developed by Pesaran (2007) in terms of multifactor error structure. It is also based on the simple average of cross-sectionally augmented Sargan and Bhargava (1983) statistics (CBS). This test provides significant advantages over other unit root tests in the literature (Pesaran, Smith, Yamagata, 2013). First, as mentioned before, other indicators that are thought to cause a unit root in the series are also included in the analysis. Second, Monte-Carlo simulations have proven to yield strong results even with low number of observations. Finally, Pesaran, Smith and Yamagata (2013) have proved that the test shows healthy results also in the presence of high cross sections.

First-generation tests assume that there is no correlation between cross-section units (Levin, Lin, Chu, 2002). However, studies in the literature have revealed that there is a tendency to act together among economic variables. It would be unrealistic to assert cross-section independence for cases where cross-section units are generally affected by the same type of shock. It causes rejection of the null hypothesis in panel unit root tests of the cross-sectional dependency problem. According to Baltagi and Pesaran (2007), "Cross section dependence can arise due to the spatial or spillover effects, or could be due to the unobserved (or unobservable) common factors”

For the aforementioned reasons, ignoring the existing cross-sectional dependence may lead to incorrect results in the test results (Bottaso, Castagnetti, Conti, 2013). For this reason, panel unit root tests that take this effect into account have also been introduced to the literature. These tests, called second-generation panel unit root tests, take into account the dependence between cross-sections. One of them is the test introduced to the literature by Pesaran, Smith and Yamagata (2013). This test completes the test procedure by adding the variables that are believed to be cointegrated with the series whose stationarity is examined to avoid cross-sectional dependence in the model. The common economic conditions of the country or country communities can be effective on economic indicators. Most macroeconomic theories postulate the presence of the same unobserved common factors (such as shocks to technology, tastes, and fiscal policy). Economies will inevitably be affected by the changes and developments of these conditions, which are likely to be gathered under a single roof. In the case of panel datasets from economics and finance, where economic agents are often faced with common economic environments, the necessity of having such additional variables seems quite reasonable (Pesaran, Smith, Yamagata, 2013). For this reason, it is useful to use the information in some additional variables or factors when examining the stationarity of unemployment hysteresis in terms of making more accurate interpretations. Therefore, considering that there are many factors affecting hysteresis, it is important to test using some factors that may affect unemployment hysteresis in this context.

m^0 represents the actual number of factors and the model for the CIPS test is as follows:

$$\Delta y_{it} = \beta_i \left(y_{it-1} - \alpha'_{iy} d_{t-1} \right) + \alpha'_{iy} \Delta d_t + u_{it}, \qquad (1)$$

where $d_t = (1, t)'$ and it represents a 2×1 dimensional vector consisting of the constant term and the linear trend. Under the $\beta_i \leq 0$ assumption, the multi-factor error structure is expressed as follows:

$$u_{it} = \gamma'_{iy} f_t + \varepsilon_{iyt}, \qquad (2)$$

where f_t expresses the effect of common factors that are not observed as in Pesaran (2007) and has a dimension of $m^0 \times 1$. γ'_{iy} is the factor loading vector and ε_{iyt} is the error term of the equation. The following equation is obtained from the equations (1) and (2).

$$\Delta y_{it} = \beta_i \left(y_{it-1} - \alpha'_{iy} d_{t-1} \right) + \alpha'_{iy} \Delta d_t + \gamma'_{iy} f_t + \varepsilon_{iyt}. \qquad (3)$$

Under the assumption that y_{it} has a unit root and is not cointegrated between units, the hypothesis is as follows:

$$H_0 : \beta_i = 0, \textit{for all } i,$$

$$H_1 : \beta_i < 0, \textit{for } i = 1, 2, \ldots, N_1$$

$$\text{and for } \beta_i = 0; i = N_1 + 1, N_{2+1}, \ldots, N.$$

Under the null hypothesis, equation (3) is redefined as follows:

$$y_{it} = y_{i0} + \alpha'_{iy} d_t + \gamma'_{iy} s_{ft} + s_{iyt}, \qquad (4)$$

where y_{i0} is a certain initial value, $s_{ft} = f_1 + f_2 + \ldots + f_t$ and $s_{iyt} = \varepsilon_{iy1} + \varepsilon_{iy2} + \ldots + \varepsilon_{iyt}$. If $m^0 > 1$, the presence of k additional observations x_{it} is taken into account. It is assumed that these observations depend on the same common factor s_{ft} and the $k \times 1$ dimensional additional regressors follow a general linear process as follows.

$$\Delta x_{it} = A_{ix} \Delta d_t + \Gamma_{ix} f_t + \varepsilon_{ixt}, \qquad (5)$$

where $x_{it} = \left(x_{i1t}, x_{i2t}, \ldots, x_{ikt} \right)'$, $\Gamma_{ix} \left(\gamma_{ix1}, \gamma_{ix2}, \ldots, \gamma_{ixk} \right)$, $A_{ix} = \left(\alpha_{ix1}, \alpha_{ix2}, \ldots, \alpha_{ixk} \right)$. ε_{ixt} is the error term of the equation and is independent from first equation. Equation (5) is rewritten as follows:

$$x_{it} = x_{i0} + A_{ix} d_t + \Gamma_{ix} s_{ft} + s_{ixt}, \qquad (6)$$

where $s_{ixt} = \sum_{s=1}^{t} \varepsilon_{ixs}$ and unit root test was created as in Pesaran (2007) by using the information of additional variables.

$$\Delta y_{it} = b_i y_{it-1} + c'_i \bar{z}_{t-1} + h'_i \Delta \bar{z}_t + g'_i d_t + v_{it}. \qquad (7)$$

The null hypothesis is tested depending on the t — ratio of the EKK estimate of the b_i coefficient in the equation (7) and where is $\bar{z}_t = N^{-1} \sum_{i=1}^{N} z_{it}$ for $z_{it} = \left(y_{it}, x_{it} \right)'$. For the CSB test statistic under the assumed null hypothesis containing the unit root, the model is as follows:

$$\Delta y_{it} = \alpha'_{iy} \Delta d_t + \gamma'_{iy} f_t + \varepsilon_{it}, \qquad (8)$$

where d_t and f_t are as defined above. If the value of m^0 is greater than one, the presence of x_{it} is taken into account with an additional observation that is assumed to be affected by the same k common factor. ε_{it} is the error term. The CSB test statistic is as follows:

$$CSB_i \left(N, T \right) = T^{-2} \sum_{t=1}^{T} \hat{u}_{it}^2 / \hat{\sigma}_i^2, \qquad (9)$$

where $\hat{u}_{it}$ represents the sum of errors and $\hat{\sigma}_i^2$ represents the variance. The CSB test statistic based on the average of the individual test statistics is shown as follows:

$$CSB = N^{-1}\sum_{i=1}^{N} CSB_i\left(N,T\right). \qquad (10)$$

According to the CIPS test statistics that give results for the panel presented in Table 2, it was found that the unemployment series in both the intercept only model and the intercept and trend model contains unit root and therefore the hysteresis hypothesis is valid. According to the CADF test statistics, which gives individual results, it is seen that in the intercept only model, Estonia and the Netherlands are stable at 5 % and 10 %, respectively. The multi-factor unit root test results presented by Pesaran, Smith and Yamagata (2013) are presented in Table 3.

According to findings in Table 3, it is concluded that the unemployment series has unit root in both intercept only and intercept and trend model for the multifactor test performed by including trade union density, minimum wage and tax wedge factors. In addition, as a result of the two-factor test, it can be said that the series has a unit root, as well. Finally, only in the case of trade union density included, the series has no unit root in both intercept only and intercept and trend models.

It has been said before that the advantage of the cross-sectionally augmented panel unit root test is that the control variables are also included in the unit root equation. In Table 2, there are statistics in which there are no control variables and only unemployment values are interpreted. In Table 3, control variables are included. Looking at Table 2, it is seen that there is hysteresis in both intercept only values and intercept and trend values. In Table 3, it is seen that the hysteresis hypothesis is not valid in many cases depending on the number of factors. This invalidation of hysteresis as a result of the inclusion of factors has important practical implications.

First, hysteresis was invalidated as a result of adding only the union density variable in the single factor model. In other cases, hysteresis still appears to be valid. According to this result, it can be said that unions have a significant effect on preventing unemployment hysteresis. However, since cointegration or causality analysis was not performed, it cannot be said whether the increase or decrease in the unionisation rate prevents hysteresis. Since the purpose of this study was only to check the validity of hysteresis, cointegration and causality analyses were not performed. In this respect, it is thought to be a good starting point for future research.

According to the CIPS statistics in the two-factor model, only tax-wedge and union density together invalidate hysteresis at the 5 % significance level. In all other cases, hysteresis appears to be valid. Finally, hysteresis seems to be valid in all cases in the three-factor model.

Conclusions

Unemployment is one of the most important problems faced in human history in the last few centuries. Many public opinion polls found that people were more afraid of unemployment than serious illnesses or death. Rigidity is the worst possible scenario in the unemployment phenom-

Table 2

Pesaran (2007) cross-section Augmented Dickey-Fuller (CADF) and cross-sectionally augmented panel unit root (CIPS) test results

Intercept Only			Intercept and Trend	
Belgium	–1.953		Belgium	–1.670
Canada	–2.254		Canada	–2.112
Czech Republic	–1.304		Czech Republic	–3.301
Estonia	–3.488**		Estonia	–3.221
France	0.515		France	–0.657
Japan	–1.179		Japan	–2.919
Netherlands	–3.248*		Netherlands	–3.176
Spain	–1.914		Britain	–1.807
United Kingdom	–1.660		United Kingdom	–1.484
USA	–0.329		USA	1.605
CIPS Test Stat.	%1 %5 %10		CIPS Test Stat.	%1 %5 %10
-1.656	–2.60 –2.34 –2.21		–1.881	–3.15 –2.88 –2.74

Source: Source: Created by the authors.

Note: Critical values for 1 %, 5 % and 10 % levels of significance of CADF test with only intercept are -4.35, -3.43, -3.00 and with trend and intercept are -4.97, -3.99, -3.55 respectively. The symbols * and ** denote the 10 % and 5 % levels of significance respectively.

Table 3:

Pesaran, Smith and Yamagata (2013) Panel Unit Root Test Results for Multifactor Error Structure

Model	GDP_{it}	*p*	[N, T]	*CIPS*	*CSB*
	k = 1				
Intercept Only	$\overline{Uni}$	2	[9,19]	-5.137^{***}	0.106^{***}
	$\overline{MinWage}$	2	[9,19]	–1.553	0.211
	$\overline{Tax}$	2	[9,19]	–1.967	0.279
Intercept and Trend	$\overline{Uni}$	2	[9,19]	-3.178^{***}	0.084^{***}
	$\overline{MinWage}$	2	[9,19]	–1.541	0.132
	$\overline{Tax}$	2	[9,19]	–0.742	0.110
	k = 2				
Intercept Only	$\overline{MinWage}, \overline{Tax}$	2	[9,19]	–1.551	0.211
	$\overline{Uni}, \overline{MinWage}$	2	[9,19]	–1.554	0.212
	$\overline{Tax}, \overline{Uni}$	2	[9,19]	-2.660^{**}	0.135
Intercept and Trend	$\overline{MinWage}, \overline{Tax}$	2	[9,19]	–1.533	0.132
	$\overline{Uni}, \overline{MinWage}$	2	[9,19]	–1.544	0.132
	$\overline{Tax}, \overline{Uni}$	2	[9,19]	-2.727^{*}	0.054
	k = 3				
Intercept Only	$\overline{Tax}$, $\overline{Uni}$ and $\overline{MinWage}$	2	[9,19]	–1.552	0.211
Intercept and Trend	$\overline{Tax}$, $\overline{Uni}$ and $\overline{MinWage}$	2	[9,19]	–1.536	0.132

Source: Source: Created by the writers.

k is the number of factors, p is the suitable lag length. ***, ** and * symbols stand for 1 %, 5 % and 10 % levels of significance respectively.

For the intercept only model the critical levels for 1 %, 5 % and 10 % levels of significance respectively are like this:

$k = 1$ *CIPS* → –2.44, –2.18, –2.03; *CSB* → 0.130, 0.170, 0.194.

$k = 2$ *CIPS* → –2.71, –2.29, –2.08; *CSB* → 0.086, 0.114, 0.133.

$k = 3$ *CIPS* → –2.59, –2.34, –2.20; *CSB* → 0.049, 0.066 0.079.

For the intercept and trend model the critical levels for 1 %, 5 % and 10 % levels of significance respectively are like this:

$k = 1$ *CIPS* → –2.88, –2.57, –2.42; *CSB* → 0.056, 0.066, 0.073

$k = 2$ *CIPS* → –3.43, –2.77, –2.52; *CSB* → 0.036, 0.043, 0.048.

$k = 3$ *CIPS* → –2.92, –2.62, –2.47; *CSB* → 0.019, 0.023, 0.026.

enon, which both ruins the lives of individuals and has serious consequences for the economies of countries. Therefore, the most important step in the fight against unemployment is to prevent the increase in unemployment strictly. However, if this is not possible, in other words, if unemployment is already increasing, the first thing that can be done according to the literature is to quickly put into effect expansionary fiscal policies aimed at reducing unemployment. Otherwise, the phenomenon of hysteresis occurs in unemployment due to reasons such as loss of talent, strengthening of the insider's outsider approach or losing hope from finding a job, and unemployment cannot return to the natural rate level for many years. This situation leads to a vicious circle and loss of efficiency in the economy. In the light of these evaluations, unemployment should be constantly monitored closely and intervened quickly when necessary.

In this study, it was tested whether unemployment rates for 10 selected OECD countries contain unit root or not, i. e. whether hysteresis is valid for these countries. For this purpose, the unit root test, which deals with the multi-factor error structure situation proposed by Pesaran, Smith and Yamagata (2013), was applied to the unemployment series. In this test, the information obtained by 3 additional variables is used to explain the main series to deal with the multi-factor error structure. These variables are trade union density, minimum wage and tax wedge. Because unemployment rates are often extremely affected by these selected factors. The unemployment rate series and the other 3 factors included in the model have been accessed from the OECD official database. As a result of the analysis conducted with annual data, it was found that the unemployment rate series contains unit root, that is, hysteresis is valid for selected 10 OECD countries.

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