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HYSTERESIS IN UNEMPLOYMENT: NEW EVIDENCE FROM 19 EURO AREA COUNTRIES

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Abstract

This paper utilizes the degree of permanent effects in unemployment rates using a wide array of unit-root testing methods for 19 Euro Area countries over the 1983M1-2019M7 period. First and foremost, we examine the theoretical context of linear hysteresis through the implementation of univariate unit-root tests. Since this may contain some potential issues, we also take into account the presence of structural breaks in unemployment. Moreover, we quantify the initial results within the context of panel unit-root tests whether the hysteresis effects in unemployment are still prevailing for the sample. Our findings show that, in general, we cannot reject the hysteresis hypothesis for the 19 Euro Area countries against the alternative of a natural rate even after controlling for structural breaks. The results are thus compatible with the views on the existence of path-dependence of steady-state equilibrium unemployment.

Keywords: hysteresis, unemployment, univariate unit-root test, panel unit-root test, structural break

JEL Classification: C10, E20, E24

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1. Introduction

The post-1980s era has been witnessed to a pervasive unemployment problem across many countries. The academic discussions substantially point to the context and the quality of high and increasing unemployment rate for a given time span. Therefore, the relevant policy responses preparing to solve this issue basically entail a comprehensive inquiry of the conditions of labor markets in different kinds of economies. In that vein, one of the most critical ways to assess whether the unemployment puzzle roots mostly in lack of policy agenda prepared for the labor markets is to determine that the existing problems are *structural* or *cyclical* (Akdoğan, 2017: 1416). On the one hand, an efficient way to solve the *structural* unemployment problem is to conduct policy suggestions in connection with the change in the condition of the labor market. On the other hand, if the unemployment problem is *cyclical*, the long-run deviations from the equilibrium point could be restored by carrying out a relevant demand management policy. Therefore, cyclical deviations from the optimal level could evolve to a structural problem in unemployment which means that each policy tool should be eligible pursuant to the country-specific phenomena to a large extent.

In particular, the dynamic tendencies of unemployment are conceptually defined in *hysteresis* approaches in the relevant literature. Although the concept of hysteresis has been initially originated by Ewing (1881) to investigate the stress-thermoelectric quality of metals nexus, it was also expanded in the economic discipline by Samuelson (1965) to overcome the difficulties in modeling the benchmark economic theories which were inherently dynamic to the social components. Phelps (1972) also incorporated the hysteresis term into the unemployment theories to reveal the practical reasons behind the soaring unemployment level in Europe after 1960s and then Sachs (1986) inferred some implications about the hysteresis effects for policy regime. In that vein, the ongoing unemployment problem in Europe was presented by the classical arguments (Friedman, 1968, Modigliani, 2003) as temporary deviations from the natural level and thus theorized as a *natural* unemployment rate which is adaptive to the non-accelerated inflation rate of unemployment (NAIRU). However, according to Blanchard and Summers (1986), the only condition to use the word of hysteresis depends on the existence of *path-dependence* of steady-state equilibrium unemployment. Therefore, Blanchard and Summers (1986) remark the historical process of the actual unemployment rate and then criticize the unemployment theories (e.g., NAIRU) since most of them neglect to cover the country-specific and time-variant effects of an exacerbated shocks in unemployment over 1980s

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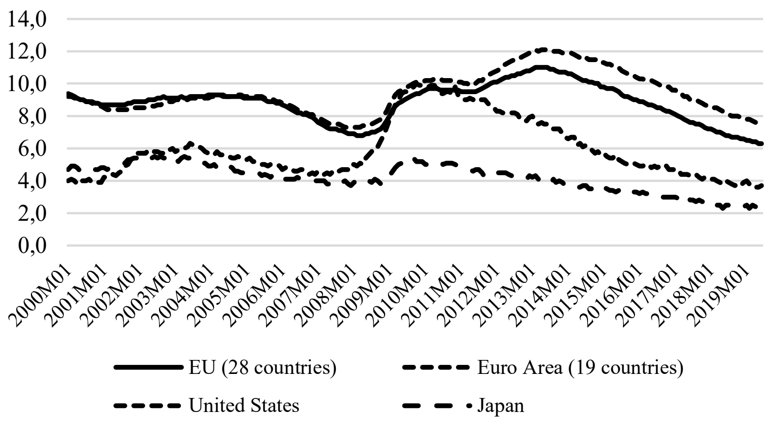
Europe. That assessment of a surge in the unemployment rates in 1980s Europe has also been validated in other countries mostly from the so-called emerging economies. In particular, the classical arguments towards the existence of temporary shocks in unemployment critically discussed by Blanchard and Summers (1986) in order to show that these shocks could be permanent in the long-run due to labor market rigidities and thus the demand management policies might be prepared to solve *path-dependent* long-run unemployment.

Over the past four decades, the persistence in unemployment has been considered as one of the most serious economic problem facing Euro Area countries, as well as the other countries. For instance, Fig. 1 presents the total unemployment in the European Union, Euro Area, United States, and Japan. All the data presenting in the following figures are seasonally adjusted and are organized by the monthly series for the 2000(M1)-2019(M6) period.

There are couple of reasons for analyzing the unemployment hysteresis in the context of those countries in the light of economic downturns over time. First, the economic shocks have more intense effects on the unemployment hysteresis in emerging economies relative to high-income countries mostly due to lack of employment opportunities. The group of emerging countries has similar dynamics in case of a change in employment level where the labor market rigidities are more prone to restrict employees to switch from one job to another. Any kind of negative impulses in *path-dependent* long-run equilibrium unemployment could rather fail to adopt a new economic environment for current employees.

Figure 1. Unemployment in the EU, Euro Area, United States, and Japan (monthly average, seasonally adjusted, percent)



Source: Eurostat

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Second, the evidence of hysteresis may not support short-run policy applications to increase the aggregate demand due to the differential characteristics of employees. A potential factor that would state whether the economic disruptions would have negative long-term effects on working conditions is the level of self-employment. On the one hand, self-employed workers are relatively more open to the unemployment shocks since they have isolated from much of the opportunities in which the other employees could largely be benefited from the economic outputs provided by policymakers and thereby are supported by stabilization policies. On the other hand, the deviations from the optimal unemployment level could well change the income level of self-employed workers and thus could lead to aggregate demand shocks and labor market distortions. As these negative conditions maintain, they could also lead to an emergence of parallel shocks in aggregate supply along with a negative change in equilibrium unemployment.

Third, the hysteresis in unemployment can provide a partial understanding if the pattern of employment structure is not equally distributed within the economy. That kind of a labor market structure may put forward the application of different types of policies that are mostly specific to the existing conditions resulted from the shocks. For instance, the implication of the same type of policy reform in the case of labor market distortions could not suffice to adjust the deviations in the optimal unemployment level. Therefore, the policymakers should be well-equipped with the policy tools which are heterogeneous for employees having different characteristics.

In contrast to the traditional view which argues that there is no connection between the history of aggregate demand shocks and the long-run level of unemployment as well as the potential output, one should thus look at the demand-side driven factors to analyze the inner dynamics of the economic downturns and to reveal the potential effects of demand-side policies on the level of unemployment and productive activities. Several reasons can be ranged for the case of employment sluggishness in the post-1980 period. Some of them, for example, can be classified as follows: (i) wage rigidities (Hall, 2005; Shimer, 2012), (ii) job polarization and disappearance of middle-income jobs (Jaimovich and Siu, 2012), (iii) decrease in union power (Berger, 2012), and (iv) heterogeneity of unemployment appeal (Wiczer, 2013).

Similar to those reasons, Røed (1997: 398-405) also ranges the sources of hysteresis as follows: (i) path-dependence and the formation of preferences, (ii) insider-outsider effects in wage determinations, (iii) depreciation of skills and search effectiveness, (iv) path-dependent stigma effects, (v) labor hoarding and

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labor market rigidities, (vi) firing costs and voluntary quits, (vii) institutional effects of cyclical unemployment, (viii) capital formation, and (ix) increasing returns and co-ordination failures.

Most of the empirical literature about the hysteresis in unemployment has basically implemented the unit-root tests to determine which kind of approach perfectly explains the whole story. According to Mednik et al., (2012), the distinction for the hypotheses between *linear hysteresis* and *general hypothesis* is much extreme for the former one relative to the latter one. For instance, Cross et al. (1999) note that the key implications of general hysteresis can be divided into two cases as *remanence* ("…reversal of a shock will not be followed by a return to the status quo ante…") and *selective memory* ("…in dominated extremum values being wiped").

However, the defining feature of a linear hysteresis hypothesis depends on the fact that dominated extremum values are not prevalent and the tandem shocks having an equal magnitude will cancel each other if the directions of these shocks have opposite effects. In that case, at the outset, one should be well-defined the pattern of unemployment just before the application of unit-root testing whether it implies persistence or not. According to this breakpoint in defining the adjustment process of equilibrium unemployment, there is a very slow adjustment of unemployment in case of persistence whereas the equilibrium unemployment will automatically rise if the country has a prolonged period of historically-high unemployment in case of hysteresis (León-Ledesma and McAdam, 2004: 383).

Further, *partial hysteresis* means that the unit-root is high but below one and *pure hysteresis* implies that unit-root equals one (Layard et al., 1991). Even if this is one case of the story on hysteresis, León-Ledesma and McAdam (2004: 384), by contrast, also argue that "…hysteresis as a unit-root should not necessarily be understood as a 'true' description of the underlying data generating process but as a local approximation during a sample period." Therefore, unemployment should not have a unit-root over longer time span in the context of unemployment rates are necessarily bounded.

In this paper, we empirically discuss the linear hysteresis term as identified by the presence of unit-roots in unemployment and hence we follow the empirical framework which applies a battery of univariate and panel unit-root tests. In addition, given that the presence of unit-roots or full persistence in unemployment, we will also investigate whether there exist structural breaks in monthly series to determine the effects of

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some potential break dates on unemployment. In particular, the existence of such a unit-root in the series means that at least one type of economic issue has a negative and permanent effect on unemployment (Galí, 2015).

In consideration of both univariate and panel unit-root tests, we ask for to reveal possible sources of that unit-root for the series having a non-stationary path. In that vein, the contribution of this paper is to test for unit-roots in unemployment employing time-series with and without the structural breaks proposed by Dickey and Fuller (1981), Phillips and Perron (1988), Kwiatkowski et al. (1992), Zivot and Andrews (1992), and Clemente et al. (1998), and using panel unit-root tests described by Hadri (2000), Choi (2001), and Im et al. (2003). In particular, the panel procedure provides for a higher degree of heterogeneity in the cross-section dynamics (León-Ledesma, 2000: 2).

According to Mednik et al. (2012), the literature on traditional unit-root tests has itself also enhanced in the context of several factors, mostly due to coping with a number of problems that lead inaccurate findings for the presence of unemployment hysteresis. First, if the process is near integrated, then the traditional testing method of unit-root will have low power (Bai and Ng, 2004). Second, if the sample is small, the conventional unit-root test will also have low power. So, by proceeding with empirical strategy, we determine both univariate and panel unit-root tests considering structural breaks.

This paper tests hysteresis effects on unemployment employing panel data obtained from Eurostat database for 19 Euro Area countries using monthly series over the 1983M1-2019M7 period. The hysteresis in unemployment addressed is important for several reasons. First, the countries from the Euro Area have different labor market structures and employment dynamics, as well as different macroeconomic policy regimes. Second, many of the sample countries from the Euro Area have similar historical dynamics of unemployment with the other economies, especially the high-income and upper-income countries. Therefore, if there exist a persistence or hysteresis in unemployment in those countries, it may give critical signals for the common reasons behind a surge in the unemployment rate over time, which are mostly stemmed from economic disturbances. Third, analyzing hysteresis in unemployment in case of the countries from the Euro Area provides a rationale to compare the long-run trends in unemployment rates among other countries, which exhibits stationary process. Table 1 provides the summary statistics on the basis of seasonally adjusted monthly data for unemployment rates.

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Table 1. Summary statistics (unemployment rate, monthly, seasonally adjusted)

Country	*Period*	*No. of obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Austria	1995M1 - 2019M7	295	4.89	0.62	3.6	6.3
Belgium	1986M4 - 2019M7	400	8.02	1.14	5.5	10.1
Cyprus	2000M1 - 2019M7	235	7.85	4.37	3	16.8
Estonia	2000M2 - 2019M6	233	9.12	3.60	3.9	19.3
Finland	1988M1 - 2019M7	379	9.11	3.27	2.9	17.6
France	1983M1 - 2019M7	439	9.27	0.95	6.7	11
Germany	1991M1 - 2019M7	343	7.29	2.15	3	11.2
Greece	1998M4 - 2019M6	255	15.3	6.69	7.3	27.8
Ireland	1983M1 - 2019M7	439	10.7	4.58	3.9	17.1
Italy	1983M1 - 2019M1	439	9.47	1.67	5.8	13.1
Latvia	1998M4 - 2019M7	256	11.7	3.67	5.4	20.6
Lithuania	1998M1 - 2019M7	259	11.1	4.12	4	18.3
Luxembourg	1983M1 - 2019M7	439	3.69	1.48	1.4	6.6
Malta	2000M1 - 2019M7	235	6.14	1.19	3.4	8.5
Netherlands	1983M1 - 2019M7	439	5.94	1.67	3.1	9.5
Portugal	1983M1 - 2019M7	439	8.63	2.95	4.8	17.5
Slovakia	1998M1 - 2019M7	259	13.6	3.83	5.3	19.7
Slovenia	1996M1 - 2019M7	283	6.96	1.51	4.2	10.9
Spain	1986M4 - 2019M7	400	16.8	4.87	7.9	26.3
Euro Area	*1998M4 - 2019M7*	*256*	*9.48*	*1.27*	*7.3*	*12.1*

Regarding these influential factors on unemployment, two central questions can be presented to figure out the validity of hysteresis effects in unemployment in the Euro Area. First, is the unemployment hysteresis statistically valid for the Euro Area? Second, is there a significant effect of economic disturbances on equilibrium unemployment? Those questions addressed have crucial meanings in the context of economic discipline for the following reasons, which are the basis of the empirical investigations of the hysteresis effects on unemployment. First, they provide a way for us to make a clear distinction for the theoretical validity between NAIRU and the hysteresis. Second, they sort out the negative influencing factors on unemployment rooted in economic disturbances which are mainly unique for each country's own features and thereby may not be generalized to expound the concept of hysteresis on the basis of the Euro Area. Third, the answers to these questions will lead to favor the policymakers since they may have some crucial implications for labor market reforms and social protection networks, as well as social cohesion in the Euro Area.

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Following the above-mentioned strategies about the unit-root testing, our findings show that the hysteresis hypothesis is statistically significant for both univariate and panel unit-root tests. The main contribution of these findings to the relevant literature is that the presence of unit-root and the hysteresis hypothesis are all investigated at a level of both time-series and panel contexts using seasonally adjusted monthly average data of unemployment. Having provided motivation for the study, the rest of the paper is structured as follows. The second section devotes to the explanation of two sub-sections which include the explanation of unit-root testing procedures. On the one hand, we provide a theoretical detail for univariate unit-root tests and on the other hand, we summarize the theoretical underpinnings for panel unit-root tests. The third section presents the empirical results for the unit-root tests. The last section will conclude the article.

2. Unit-Root Testing Procedure

2.1 Univariate unit-root tests

Univariate unit-root tests will consider both pure unit-root tests (i.e., without structural breaks) and the extended unit-root tests (i.e., with structural breaks). On the one hand, pure time-series unit-root tests will be based on the analyses of Dickey and Fuller (1981), Phillips and Perron (1988) and Kwiatkowski et al. (1992), which ignore the structural breaks. On the other hand, the extended versions of time-series unit-root tests will include the methods provided by Zivot and Andrews (1992) and Clemente et al. (1998), which include the effects of structural breaks.

Primarily, the traditional method in unit-root testing for time-series is based on applying the Augmented Dickey-Fuller (ADF) test advocated by Dickey and Fuller (1981) and the Phillips-Perron (1988) test to the unemployment series in order to determine whether the hysteresis exists or not. In addition to these two methods, some of the other studies also use Lagrange multiplier (LM) unit-root testing procedure pioneered by Kwiatkowski et al. (1992) to investigate the same issue for time-series. However, none of them consider the effects of structural changes in the series. While the lack of considering structural breaks in the series is one of the major problems of these conventional unit-root tests, they are also criticized due to their low explanation power in small samples (Song and Wu, 1998). Here we represent an ADF (p) test regression in Eq. (1) as follows:

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$$\Delta unemp_t = \mu + \beta t + \o unemp_{t-1} + \sum_{k=1}^{p} \gamma_k \Delta unemp_{t-k} + u_t \qquad (1)$$

where $unemp_t$ indicates the unemployment rate, $\Delta unemp_{t-k}$ are used to approximate the autoregressive moving-average (ARMA) structure of the errors, μ is a constant term, t is the linear time trend, and u_t is a white-noise, serially uncorrelated and homoscedastic error term. The idea behind including the lags into the regression is actually to correct for the presence of serial correlation in the auxiliary regression.

Since the ADF test is basically regressed through the selection of an optimal lag length, the estimation results will be biased if the chosen lag length is not suitable. Therefore, Phillips and Perron (1988) produced an alternative unit-root test (i.e., so-called the PP test) to solve the asymptotic problem in the ADF test. In this sense, Eq. (2) represents the regression form of PP test:

$$\Delta unemp_t = \mu + \beta t + \o unemp_{t-1} + u_t \qquad (2)$$

where u_t is *I(0)* and may be heteroskedastic. The null hypothesis of a unit-root is tested as $\o = 0$ against the stationary alternative hypothesis of $\o < 0$. However, similar to the ADF test, the PP test have also low testing power in case of explaining the differences between near-stationary and pure unit-root processes (DeJong et al., 1992).

Furthermore, the PP test also addresses the problem of serial correlation in the error term. However, the form of the auxiliary regression is slightly different in the PP test. Therefore, the main differences between the ADF and PP tests basically depend on their ways to deal with serial correlation and heteroskedasticity in the errors. The PP test ignores any serial correlation in the test regression, in which this direction leads us to argue that the PP test uses non-parametric correction to the *t*-statistic in order to produce robust estimators in the presence of serial correlation and heteroskedasticity. In this sense, the PP test has no need to specify the number of lags in contrast to the ADF test just because the test statistics are robust to serial correlation, which are produced by using the heteroskedasticity- and autocorrelation-consistent covariance matrix estimator advocated by Newey and West (1987). However, the PP test may suffer from severe size distortions if the autocorrelations of the error term are predominantly negative (Akay et al., 2011: 495). In order to compare the advantages of PP test over the ADF test, Schwert (1989) argues that the size distortion should be corrected.

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Although both of these two unit-root tests are for the null hypothesis that a time-series $unemp_t$ is integrated of order one, the stationary tests are for the null hypothesis that $unemp_t$ is integrated of order zero. One of the common testing procedure for the stationary process, the KPSS test, is pioneered by Kwiatkowski et al. (1992), where the series $unemp_t$ is trend stationary under H_0. In order to derive the KPSS test, the model can initially be represented as follows:

$$unemp_t = \mu + \beta t + \gamma_t + u_t \tag{3}$$

where γ_t is a pure random walk with innovation variance σ_t^2 and can be shown as follows:

$$\gamma_t = \gamma_{t-1} + \varepsilon_t \tag{4}$$

The null hypothesis of a stationary process is tested as $H_0\colon \sigma_t^2 = 0$, in which $unemp_t$ is *I(0)*. Since the KPSS test statistic is based on the LM statistic for testing the null hypothesis against the alternative that $H_a\colon \sigma_t^2 < 0$, we can produce LM statistic as follows (Kwiatkowski et al. 1992: 163):

$$LM = \sum_{t=1}^{T} S_t^2 / \hat{\sigma}_\varepsilon^2 \tag{5}$$

where the partial sum process of the residuals can be defined as $S_t = \sum_{i=1}^{t} e_i \ (t = 1,2, \dots, T)$.

The extended versions of unit-root tests are differentiated from the traditional unit-root tests since the former one considers the structural breaks in the series. First, Zivot and Andrews (1992) developed the initial foundations of Phillips and Perron's (1988) unit-root testing procedure allowing for an exogenous structural break by way of determining the breakpoint endogenously from the data[1]. Similar to the models proposed by Phillips and Perron (1988), the methodology of Zivot and Andrews (1992) is based on three different models, i.e., *Model A* includes a shift in intercept, *Model B* includes a change in slope, and *Model C* considers the change of both parameters. The null hypothesis ($\varnothing = 0$) suggests that the series are integrated without an exogenous structural break against the alternative. Therefore, for each of three models, the null hypothesis implies that the unemployment series can be denoted by a trend-stationary *I(0)* process with a possible break occurring at an unknown point in time. In particular, the unit-root tests advocated by Zivot and Andrews (1992) determine the breakpoint as the minimum *t*-statistic on the autoregressive $unemp_t$ variable, which emanates at time $1 < T_B < T$. So, the augmented regressions we use to test for a unit-root can be represented for Models A, B, and C in Eqs. (6), (7), and (8), respectively, as follows:

[1] Lumsdaine and Papell (1997) also extended the method provided by Zivot and Andrews (1992) which includes one structural break in the time-series through accommodating of two structural breaks.

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$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{\lambda}) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^A \, \Delta y_{t-j} + \hat{e}_t \tag{6}$$

$$y_t = \hat{\mu}^B + \hat{\beta}^B t + \hat{\gamma}^B DT_t^*(\hat{\lambda}) + \hat{\alpha}^B y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^B \, \Delta y_{t-j} + \hat{e}_t \tag{7}$$

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{\lambda}) + \hat{\beta}^C t + \hat{\gamma}^C DT_t^*(\hat{\lambda}) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^C + \Delta y_{t-j} + \hat{e}_t \tag{8}$$

where DU_t is an indicator dummy variable for a mean shift emerging at each possible breakpoint and DT_t corresponds to trend shift variable (Waheed et al., 2006: 5). Formally, $DU_t(\lambda) = 1$ if $t > T\lambda$, 0 otherwise; $DT_t^*(\lambda) = t - T\lambda$ if $t > T\lambda$, 0 otherwise. In addition, Δ is the difference operator, k is the number of lags determined for each possible point for structural break and e is the random-walk error term. The Zivot-Andrews method posits that every unknown point in time is a potential break date and thus runs a regression for every possible break date sequentially. Δy_{t-j} is used to eliminate the autocorrelation problem in the model. However, Zivot-Andrews method regards the presence of the endpoints which is very critical since it leads to the emergence of the asymptotic distribution of the statistics to diverge towards infinity. Hence, some endpoints of the sample are ignored in the model to determine the exact region[2] (Waheed et al., 2006: 5).

Moreover, Clemente et al. (1998) allow for two potential endogenous breaks. On the one hand, the first approach, which is called as innovative outlier (IO), shows the suddenly occurred structural breaks where two breaks belong to the innovational outlier. On the other hand, the second approach, which is called additive outlier (AO), implies that the shifts are better, and the deterministic part of the variables is eliminated through additive outlier. In that case, while Eq. (9) refers to the IO model, Eq. (10) describes the AO model in which the minimal t-ratio for the $\rho = 1$ hypothesis is taken as follows:

$$y_t = \mu + \rho y_{t-1} + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + d_1 DU_{1t} + d_2 DU_{2t} + \sum_{i=1}^{k} c_i \, \Delta y_{t-i} + e_t \tag{9}$$

and

$$\tilde{y}_t = \sum_{i=0}^{k} \omega_{1i} DTB_{1t-i} + \sum_{i=0}^{k} \omega_{2i} DTB_{2t-i} + \rho \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \, \Delta \tilde{y}_{t-i} + e_t \tag{10}$$

[2] According to Zivot and Andrews (1992), the “trimming region” is specified as 0.15T, 0.85T.

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where DTB_{it} and DU_{it} are pulse variable and indicator dummy variable for a mean shift occurring in each possible breakpoint, respectively. Furthermore, TB_1 and TB_2 are the dates when the shifts in mean emerge. $DTB_{it} = 1$ if $t = TB_i + 1$ and 0 otherwise; $DU_{it} = 1$ if $t = TB_i > 1$ and 0 otherwise.

In the Clemente et al. (1998) test, the structural breaks of the time-series follow a first-order autoregressive process. Therefore, the testing hypotheses are based on a first-order autoregressive process. In that vein, to test the null hypothesis (H_0), the following model is used in Eq. (11):

$$H_0\text{: } y_t = y_{t-1} + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + u_t \qquad (11)$$

as against the alternative hypothesis (H_A) in Eq. (12):

$$H_A\text{: } y_t = \mu + d_1 DU_{1t} + d_2 DTB_{2t} + e_t \qquad (12)$$

2.2 Panel unit-root tests

The panel unit-root tests will be evaluated on the basis of three different methods: (i) Hadri LM stationary test, (ii) Im-Pesaran-Shin test (hereafter, IPS), and (iii) Fisher-type test. First, the null hypothesis in Hadri's (2000) stationary test refers to having no unit-root in panel series against the alternative of a unit-root. This panel stationary test is allowed for individual specific variances and correlation patterns (Hlouskova and Wagner, 2006). Further, it is based on a residual-led LM test where the residuals are obtained from the following regression:

$$\Delta y_{it} = \delta_{mi} d_{mt} + \varepsilon_{mi} \qquad (13)$$

In this regression, the residuals are denoted as $\hat{e}_{it}$ and their partial sum is expressed as $S_{it} = 1/T \sum_{j=1}^{t} \hat{e}_{ij}$. So, Hadri's LM test statistic is obtained as follows:

$$H_{LM,m} = \frac{1}{NT^2} \sum_{i=1}^{N} \sum_{t=1}^{T} \frac{S_{it}^2}{\hat{\sigma}_{ei}^2} \qquad (14)$$

where $\hat{\sigma}_{ei}^2 = 1/T \sum_{t=1}^{T} \hat{e}_{it}^2$. So, the Z-statistic is represented in Eq. (15):

$$Z_{LM,m} = \frac{\sqrt{N}(H_{LM,m} - \xi_m)}{\zeta_m} \Rightarrow N(0,1) \qquad (15)$$

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In Eq. (15), if the model includes only constant, the optimal numbers for the parameters will be $\xi = 1/6$ and $\zeta = 1/45$; however, if the other conditions are valid, they will be $\xi = 1/15$ and $\zeta = 1/6300$ (Hadri, 2000: 153-154).

Second, the IPS test relaxes the assumption of a common autocorrelation coefficient and thus instead allows each panel to have its own autocorrelation coefficient. In addition, IPS test leads to the allowance of heterogeneity among the panel units contrary to the other unit-root tests produced by such as Harris and Tzavalis (1999) and Levin et al. (2002). The first autoregressive process for y_{it} is produced as follows:

$$y_{it} = (1 - \phi_i)\mu_i + \phi_i y_{i,t-1} + \varepsilon_{it} \tag{16}$$

and

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \varepsilon_{it} \tag{17}$$

where the null hypothesis is that all panels have a unit-root ($H_0: \beta_i = 0$) and the alternative hypothesis is that the fraction of panels that are stationary is different than zero ($H_1: \beta_i < 0$). In that case, *t*-statistics for the IPS test is conducted as follows:

$$\tilde{t} - bar_{NT} = \frac{1}{N}\sum_{i=1}^{N} \tilde{t}_{iT} \tag{18}$$

Besides the estimated standardized $\tilde{t} - bar_{NT}$ statistics in Eq. (18), the W_{t-bar} statistics is also formulated in the following regression:

$$W_{t-bar} = \frac{\sqrt{N}\left\{t - bar_{NT} - \frac{1}{N}\sum_{i=1}^{N} E[t_{iT}(p_i, 0)|\beta_i = 0]\right\}}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} VAR[t_{iT}(p_i, 0)|\beta_i = 0]}} \overset{T,N}{\Longrightarrow} N(0,1) \tag{19}$$

Finally, the Fisher-type test proposed by Maddala and Wu (1999), and Choi (2001) uses Fisher's (1932) results which combine the *p*-values from univariate unit-root tests such as ADF and PP. The formula of the test to have asymptotic results is regressed in the following Eq. (20):

$$-2\sum_{i=1}^{N} \log(\pi_i) \to \chi^2_{2N} \tag{20}$$

where π_i denotes the *p*-value from univariate unit-root tests for the *i*-th cross-section *i*. In consideration of this asymptotic assumption, Choi (2001) also calculates the asymptotic results as follows:

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$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \phi^{-1}(\pi_i) \rightarrow N(0,1) \quad (21)$$

where ϕ^{-1} denotes the inverse of the standard normal cumulative distribution function. Each panel unit-root test statistics have standard normal limiting distributions.

3. Estimation Results

This section carries out different types of unit-root testing procedures to reveal whether the hysteresis in unemployment exists or not over the 19 Euro Area countries. While we apply univariate unit-tests to understand the hysteresis issue, we also compare both univariate and panel unit-root test outcomes as robustness checks, including structural breaks. To estimate our results, we use monthly series on seasonally adjusted unemployment rates from 19 Euro Area countries over the period 1983M1-2019M7. Since the number of observations is very high in total on a monthly basis, it provides an advantage for the long-run understanding of the effects of deviations on the relevance of unemployment hysteresis.

3.1 Univariate time-series unit-root tests results

Table 2 sets out three different widely-used unit-root tests on the monthly, seasonally-adjusted unemployment series of our set of Euro Area countries. First of all, the ADF test points to the case that the rejection of the unemployment hysteresis does not relevant for the Euro Area as a whole. However, in case of country-specific results, it shows that the same issue is rejected for Belgium, Finland, France, Latvia, Netherlands and Spain where the ADF results are statistically significant and thus lead to the fail of the relevance of unemployment hysteresis. Second, the PP test reveals that none of the unemployment series are stationary. Finally, KPSS test indicates that 13 unemployment series out of 19 countries are non-stationary. In addition to the single base analysis, we also check the stationary condition of all countries integrated with the Euro Area in which the unemployment series are non-stationary for all pure time-series unit-root tests.

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Table 2. Univariate time-series unit-root tests: ignoring structural breaks

Country	*ADF*	*PP*	*KPSS*
Austria	-1.97	-2.36	0.78*
Belgium	-4.01*	-1.89	0.38***
Cyprus	-1.61	-1.02	1.31*
Estonia	-2.50	-1.68	0.51**
Finland	-3.69*	-1.73	0.31
France	-2.86***	-2.53	0.24
Germany	-0.70	-0.26	1.16*
Greece	-2.43	-0.93	1.34*
Ireland	-2.08	-0.89	0.93*
Italy	-2.20	-1.79	0.33
Latvia	-2.81***	-1.40	0.28
Lithuania	-2.52	-1.34	0.49**
Luxembourg	-0.71	-0.62	2.11*
Malta	0.21	-0.10	1.62*
Netherlands	-3.26**	-1.92	1.03*
Portugal	-1.79	-1.29	0.97*
Slovakia	-0.50	-0.09	1.29*
Slovenia	-1.45	-0.94	0.26
Spain	-2.59*	-1.48	0.30
Euro Area	*-2.10*	*-1.19*	*0.55***

Notes: *** p<0.01, ** p<0.05, * p<0.10. Lag selection is determined by the AIC.

One of the most significant mistakes of these unit-root tests is neglecting the structural breaks, whereas the given period possibly includes different dynamics for each country. For instance, many of these countries were confronted with a number of economic shocks, which led to a change in case of hysteresis in unemployment in line with occurring structural breaks. Therefore, in order to check the stationary positions of unemployment series in case of structural breaks, we consider two kinds of unit-root tests that allow for a single break in intercept and/or trend and consider the double mean shifts. While Table 3 provides the unit-root test results with structural breaks with a single break in intercept and/or trends developed by Zivot and Andrews (1992), Table 4 and Table 5 show the unit-root test results with double mean shifts, as proposed by Clemente et al. (1998).

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At first glance, the Zivot-Andrews unit-root test statistics seem to offer different results than the results provided in pure time-series unit-root tests. The non-stationary positions are more powerful than the initial results; however, besides Latvia, we see that unit-root statistics are also stationary for Estonia, Lithuania, Malta, and Slovakia in the presence of structural breaks. In other words, the null hypothesis is not rejected for almost all countries due to the fact that the min-*t* values are smaller than the critical values in levels. In that sense, the unit-root test results in first-differences of the series should be stationary. All these statistics imply that the hysteresis phenomenon is still relevant for many Euro Area countries in the presence of structural breaks.

Table 3. Zivot-Andrews unit-root test results: single structural break

Country	*Intercept*			*Trend*			*Both*		
	k	*min-t*	T_B	*k*	*min-t*	T_B	*k*	*min-t*	T_B
Austria	2	-2.83	2017M1	2	-2.77	2016M9	2	-2.98	2015M10
Belgium	4	-2.69	1992M9	4	-2.32	2015M4	4	-2.52	2012M6
Cyprus	1	-2.00	2016M11	1	-2.30	2014M10	1	-3.74	2011M8
Estonia	2	-5.40***	2008M7	2	-2.23	2010M4	2	-5.29**	2008M6
Finland	4	-4.38	1990M8	4	-4.09	1991M7	4	-4.36	1990M8
France	3	-3.68	1995M5	3	-2.40	2016M2	3	-3.69	1999M5
Germany	3	-3.93	2001M4	3	-3.91	2004M3	3	-4.37	2002M4
Greece	3	-3.20	2010M1	3	-1.67	2015M8	3	-3.04	2010M9
Ireland	4	-4.30	2010M3	4	-2.13	1998M1	4	-5.05*	2008M5
Italy	4	-3.21	2011M5	4	-1.96	2005M8	4	-2.96	2011M8
Latvia	4	-6.34***	2008M7	4	-2.63	2011M5	4	-6.43***	2008M7
Lithuania	4	-5.40**	2008M6	4	-2.22	2004M5	4	-5.44**	2008M6
Luxembourg	3	-4.01	2002M3	3	-2.99	1986M8	3	-3.75	2002M3
Malta	1	-4.85**	2016M2	1	-5.00***	2013M5	1	5.37**	2009M1
Netherlands	4	-3.86	2011M7	1	-3.21	1999M4	1	-4.11	2011M5
Portugal	4	2.35	2016M3	4	-2.27	2014M4	4	-2.89	2008M12
Slovakia	2	4.59*	2008M1	2	3.06	2013M10	2	-4.57	2009M1
Slovenia	3	2.96	2009M1	3	1.94	2014M10	3	-2.71	2009M1
Spain	2	-3.88	2007M11	2	-1.87	1998M12	2	-3.40	2008M4
Euro Area	*2*	*-3.18*	*2008M9*	*2*	*-2.61*	*2014M2*	*2*	*-3.58*	*2011M5*

Notes: In all models, the trim value is accepted as 0.05. Lag length is determined by Akaike-Schwarz information criteria (AIC). min-t is the minimum t-statistic measured. The critical values of t-statistics are as follows: intercept: -5.34 (1%), -4.80 (5%), -4.58 (%10); trend: -4.93 (1%), -4.42 (5%), -4.11 (10%); both: -5.57 (1%), -5.08 (5%), -4.82 (10%).

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Moreover, Table 4 and Table 5 present the extended results of the Zivot-Andrews method by way of allowing for double mean shifts of the series in the case of AO and IO models proposed by Clemente et al. (1998), respectively. First, the results from the additive model show that break date is not limited to any year. For each country, the break date differs subject to other determinants influencing by the changes in socio-economic and political issues and therefore all of the factors affecting the unemployment rate lead to the validity of the hysteresis phenomenon.

Table 4. Additive outlier model results: double mean shifts

Country	*T_{B1}, T_{B2}*	*min-t*	*du_1*	*t-stat (du_1)*	*du_2*	*t-stat (du_2)*
Austria	2003M7, 2013M3	-2.68	0.63	10.11	0.44	6.53
Belgium	1993M11, 2000M4	-2.81	1.19	7.91	-1.58	12.28
Cyprus	2012M6, 2017M10	-4.71	9.13	34.75	-5.98	-13.52
Estonia	2009M8, 2011M9	-2.90	5.69	9.41	-7.98	-12.94
Finland	1992M8, 1998M3	-4.60	9.56	33.41	-6.32	-29.15
France	1993M12, 2000M11	-3.75	1.68	16.13	-1.38	-14.51
Germany	2011M7, 2016M12	-2.82	-3.45	-20.78	-1.46	-5.62
Greece	2012M1, 2016M1	-4.18	15.09	39.36	-5.08	-10.22
Ireland	1999M9, 2010M2	-3.83	-7.92	-22.03	5.10	12.45
Italy	2002M2, 2011M8	-3.09	-1.99	-16.29	3.72	25.07
Latvia	2009M9, 2013M7	-2.97	4.92	10.34	-7.17	-13.61
Lithuania	2006M7, 2009M12	-3.09	-5.26	-7.64	3.12	4.60
Luxembourg	2003M11, 2013M7	-3.70	2.29	40.22	1.13	14.83
Malta	2006M12, 2016M4	-4.93	-0.93	-12.72	-2.27	-24.04
Netherlands	1999M1, 2013M10	-3.14	-2.45	-19.29	0.89	5.14
Portugal	2013M2, 2014M10	-3.28	7.15	12.34	-5.59	-8.52
Slovakia	2007M4, 2017M4	-3.35	-4.45	-15.61	-5.58	-12.08
Slovenia	2011M12, 2017M6	-4.23	2.45	17.65	-3.76	-16.46
Spain	2000M6, 2009M6	-3.51	-7.31	-20.45	9.98	25.91
Euro Area	*2010M7, 2017M7*	*-3.09*	*1.99*	*17.88*	*-2.45*	*-11.44*

Notes: The 1% (***), 5% (**), and 10% (*) critical values of t-statistics with two breaks are -5.96, -5.49 and -5.24, respectively. T_B denotes the estimated breakpoints. The coefficients (du_i) are also reported in the table.

Second, the results for the innovative outlier model, which implies that the unemployment series have gradual changes, show that the inner dynamics of sample countries are substantially (only exception is

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Finland) affected by different factors emerging in societal norm. Therefore, there is no change occurring in the non-stationary characteristics of the unemployment rate.

Table 5. Innovative outlier model results: double mean shifts

Country	T_{B1}, T_{B2}	*min-t*	du_1	*t-stat* (du_1)	du_2	*t-stat* (du_2)
Austria	2002M4, 2011M7	-3.14	0.03	1.29	0.02	1.17
Belgium	1992M7, 1999M4	-3.14	0.07	2.89	-0.06	2.81
Cyprus	2010M11, 2017M1	-4.17	0.36	4.36	-0.33	-4.86
Estonia	2008M9, 2010M12	-3.86	0.46	4.15	-0.55	-4.57
Finland	1990M11, 1996M8	-6.19***	0.29	5.95	-0.18	-6.54
France	1999M3, 2008M8	-4.58	-0.04	-4.26	0.03	3.51
Germany	2002M2, 2005M7	-3.74	0.03	2.51	-0.07	-4.46
Greece	2009M11, 2016M11	-4.43	0.35	4.89	-0.26	-4.51
Ireland	1993M11, 2008M1	-2.84	-0.06	-2.99	0.04	2.32
Italy	2000M1, 2011M3	-4.17	-0.08	-3.76	0.13	4.17
Latvia	2008M5, 2012M3	-3.91	0.22	4.45	-0.26	-4.85
Lithuania	2010M9, 2008M2	-3.04	-0.15	-3.14	0.08	2.57
Luxembourg	2002M1, 2012M7	-4.58	0.08	4.89	0.04	2.34
Malta	2007M1, 2015M12	-4.45	-0.10	-3.31	-0.23	-4.09
Netherlands	1995M11, 2008M12	-3.13	-0.02	-2.48	0.01	1.49
Portugal	2008M10, 2014M12	-3.21	0.10	3.54	-0.14	-4.71
Slovakia	2004M3, 2015M1	-3.97	-0.12	-3.92	-0.11	-3.29
Slovenia	2008M11, 2016M10	-4.35	0.09	3.96	-0.16	-4.69
Spain	1998M5, 2008M2	-3.72	-0.07	-2.94	0.09	3.33
Euro Area	*2008M9, 2015M5*	*-3.87*	*0.05*	*3.62*	*-0.06*	*-3.75*

Notes: The 1% (***), 5% (**), and 10% (*) critical values of t-statistics with two breaks are -5.96, -5.49 and -5.24, respectively. T_B denotes the estimated breakpoints. The coefficients (du_i) are also reported in the table.

3.2 Panel unit-root tests results

While the univariate unit-root test results indicated that the hysteresis phenomenon is statistically prevailing and still powerful in the socio-economic structure, we also test it by using a panel data approach through the incorporation of country-specific effects. In Table 6, we test three panel unit-root tests. Each of them allows for different options for time trends and cross-sectional dependence.

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First, we embark upon the results of the IPS panel unit-root test at level, which clearly shows that the null hypothesis of a panel unit-root in the level of the unemployment series cannot be rejected at lag length chosen by AIC. Therefore, we can conclude that the unemployment series are non-stationary in with and without time trend specifications at level in case of using the IPS test which can also allow for heterogeneous panel to test whether the unemployment series contain unit-root. The results of the first panel unit-root test of IPS support the hysteresis hypothesis in unemployment rates for 19 Euro Area countries.

The second test is the panel Fisher-PP test defined by Choi (2001), which allows for univariate unit-root processes so that ρ_i may vary across cross-sections. The rationale to apply the panel Fisher-PP test is to derive a panel-specific result for the validity by way of combining the univariate unit-root tests. The estimated panel Fisher-PP test strongly and statistically rejects a unit-root in the unemployment rate for the 19 Euro Area countries. Therefore, the results based on the Fisher-PP test bring no support for the stationary of the series even at 10% significance level and individual effects.

Lastly, the Hadri-LM panel unit-root test is applied to check that the series are stationary or not. The test of Hadri (2000) strongly rejects the null hypothesis of stationary for both homogeneous and heterogeneous cases supporting the hysteresis hypothesis for unemployment rates even in the case of allowing for cross-sectional dependence and time trend.

All in all, based on the above panel unit-root tests, the empirical results indicate that the hysteresis hypothesis is valid for the 19 Euro Area countries and thereby are complemented the arguments provided by Blanchard and Summers (1986). In other words, the empirical results of given tests point to the fact that the shocks have a permanent effect on unemployment rates. All estimated results reject the other views of unemployment such as structuralist and/or NAIRU, implying that the economic hysteresis strictly depends on the existence of *path-dependence* of steady-state equilibrium unemployment since most of them neglect to cover the country-specific and time-variant effects of the shocks in unemployment rates, especially in the Euro Area. Therefore, contrary to cyclical determinants, the structural and country-specific factors should be taken into account to characterize the deviations in unemployment rates and thereby the economic performance in the Euro Area.

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Table 6. Panel unit-root test results

Panel Tests	*Test Statistic (p-value)*
Im-Pesaran-Shin (IPS) Test	1.0585 (0.8551) Panel means included No time trend
	2.4083 (0.9920) Panel means included Time trend included
Fisher-PP Test	Inverse χ^2 (p) = 0.0061 (0.9970) Inverse normal (z) = 2.7449 (0.9970) Inverse logit (L*) = 3.4169 (0.9962) Modified inverse χ^2 (P_m) = -0.9970 (0.8406)
Hadri-LM Test	43.9490 (0.0000) Allow for cross-sectional dependence No time trend
	4.5618 (0.0000) Allow for cross-sectional dependence Time trend included

Notes: Lag specification is chosen by Akaike Information Criteria (AIC) in the IPS panel unit-root test. The lagged differences are determined by two in Fisher-type test and the Phillips-Perron unit-root tests conducting on each panel which includes both panel means and time trend. While the null hypotheses for IPS and Fisher-type unit-root tests imply that all panels contain unit-roots, the reverse case is prevailing for Hadri-LM test in which all panels are stationary for the null hypothesis.

4. Concluding Remarks

This paper investigates the hysteresis hypothesis for 19 Euro Area countries through the use of both univariate and panel unit-root tests, taking into account the possible structural breaks. In consideration of the existing literature, the stationary conditions of the unemployment rates provide challenging and complicated results for many sample countries, which imply that the hysteresis hypothesis can be affected by different sources. In particular, we divide the testing procedure into two parts as univariate and panel to show that both empirical results can complement each other due to some common factors such as the labor market rigidities and thus the demand management policies, which might be prepared to solve *path-dependent* long-run unemployment. However, the theoretical differences in the literature lead to the emergence of idiosyncratic arguments for understanding the long-run correlation between unemployment dynamics and the behavior of business cycles. While the natural rate of unemployment hypothesis states

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that shocks may generate cyclical movements in the unemployment rate but tends to revert to its equilibrium in the long-run depending on mean-reverting process, the structuralist view argues that the shocks have not permanent effects on unemployment even though they are highly persistent to resolve over time, which are subjected to the changes in structural factors and institutional environment. Furthermore, the persistence view implies that there are a near unit-root process and long-lasting effects on unemployment caused by the economic downturns. There should be a sufficient period of time to re-establish the equilibrium and thus the series have a constant long memory process.

Regarding these conflicting arguments, the question on the validity of the hysteresis hypothesis still remains in force and the given results provided for the stationary process of unemployment series are ambiguous to make further discussions. In case of testing the significance of hysteresis hypothesis, on the one hand, we deal with univariate unit-root tests without and with structural breaks, which are ADF, PP, KPSS for the first part, and are Zivot and Andrews (1992) and Clemente et al. (1998) for the second part. On the other hand, we use panel unit-root tests, which are IPS, Fisher-PP, and Hadri-LM to test for unemployment hysteresis in 19 Euro Area countries against the alternative of other views. The results indicate that the hysteresis in unemployment hypothesis is accepted within the context of both univariate and panel unit-root tests for the given countries and thereby confirms the view described by Blanchard and Summers (1986). In other words, all of the results providing by different unit-root tests strengthen the hysteresis hypothesis, implying that potential shocks and economic downturns have highly persistent and also permanent effects on unemployment. Therefore, any kind of interruption in the process of economic functioning can lead to the deviations of unemployment rate from the equilibrium, which point out significant heterogeneity in unemployment dynamics over 19 Euro Area countries due to the fact that there is a large difference in labor market institutions. Accordingly, the lack of structural reforms may intensify the problems not only in the current level of unemployment but also the loss of the influences on wage-settings and union behaviors each of which can be considered as the major factors for highly persistent unemployment rates in the Euro Area.

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