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Hysteresis Effects on Unemployment Rates: A Comparative Study of the Baltic States Before and After EU Accession

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Abstract. *This study examines the hysteresis effects on unemployment rates in the Baltic countries using the RALS-LM unit root test method, based on monthly data from February 2000 to August 2024. It assesses the persistence of unemployment by gender, focusing on both female and male unemployment rates. Additionally, the study provides a detailed evaluation of the hysteresis effects observed on unemployment rates before and after the Baltic countries' accession to the European Union (EU). The findings show that the unemployment rates in these countries are highly sensitive to long-term structural changes. Structural breaks occurred mainly between 2001 and 2003 before EU accession, while the 2008–2009 Global Financial Crisis and the European Debt Crisis shifted these breaks to the 2007–2010 period. Significant structural changes in total unemployment were observed in Estonia and Lithuania after their EU accession. The results indicate hysteresis effects in Estonia and Latvia, whereas Lithuania shows varying patterns of unemployment persistence. This study highlights the importance of understanding the long-term effects of structural changes and external shocks on labor market dynamics in the Baltic countries.*

Keywords: *unemployment, hysteresis, Baltic countries, RALS-LM*

1. Introduction

Unemployment has become one of the most significant economic issues faced by many countries worldwide, particularly after the onset of the global financial crisis in the late 2000s. Following the 2008–2009 Global Financial Crisis, the unemployment issue deepened further in 2010 due to the impact of the European debt crisis. This situation has adversely affected labor markets in many economies, particularly in the Baltic

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countries, which are part of the transition economies. Despite experiencing significant economic growth following their accession to the European Union (EU) in 2004, these countries have faced persistent unemployment challenges, raising concerns regarding the nature of unemployment dynamics. The dynamic characteristics of the unemployment process are of significant importance to macroeconomic theory and policymakers, as unemployment constitutes one of the most critical issues on the policy agenda. In this context, the question of whether unemployment is cyclical or structural is one of the key issues that policymakers focus on. However, traditional theories on unemployment provide conflicting perspectives on the persistence of unemployment, leading to ongoing debates regarding the appropriate policy responses. Therefore, the persistent fluctuations in the unemployment rate have necessitated the determination of whether unemployment is temporary or permanent. While the short-term effects of economic shocks on unemployment can be addressed through expansionary fiscal or monetary policies, their long-term consequences require the implementation of structural reforms (Cuestas et al., 2011). In the case of cyclical unemployment, it is essential to support aggregate demand through expansionary fiscal or monetary policies (Cheng, 2022). However, in the case of structural unemployment, in-depth and targeted labor market reforms that eliminate barriers preventing the unemployed from accessing job opportunities must be implemented (IMF, 2014). Additionally, directing the unemployed towards education and skill development programs during periods of economic stagnation can contribute to the creation of a skilled workforce needed during the economic recovery process (Randveer & Staehr, 2021).

The literature includes a range of hypotheses that aim to explain the dynamics of unemployment. Friedman (1968) and Phelps (1968) argued that changes in the unemployment rate following an economic shock are temporary, with the unemployment rate tending to return to its natural level over time. This perspective suggests that unemployment follows a stationary process, forming the basis of the natural rate hypothesis. Blanchard and Summers (1986, 1987) argued that the equilibrium unemployment rate depends on past levels of actual unemployment, suggesting that high unemployment can raise the natural rate of unemployment. According to this perspective, the unemployment rate does not converge to its long-term equilibrium following a shock, implying that the unemployment series is non-stationary. This hypothesis, referred to as the hysteresis effect, suggests that adverse labor market shocks may lead to persistent effects due to labor market rigidity and other structural factors. In a similar vein, Pissarides (1992) argued that the loss of skills among the long-term unemployed, combined with temporary economic shocks, may result in a long-term rise in unemployment. On the other hand, Phelps (1994) examined the impact of structural factors on unemployment rates, suggesting that while some shocks may be temporary, others can have lasting effects on unemployment. Consequently, the unemployment rate is described as a stationary process around a limited number of permanent structural breaks (Gomes

& Silva, 2008). These theoretical discussions underline the importance of accurately identifying the nature of unemployment dynamics in the Baltic economies, particularly in light of the structural transformations they have undergone since their EU accession. These hypotheses are typically examined within an econometric framework based on unit root tests. This approach allows for testing whether unemployment rates revert to their long-term equilibrium following shocks. The natural rate hypothesis considers unemployment as an I(0) process, whereas the hysteresis hypothesis associates it with an I(1) process. Therefore, the rejection of the unit root hypothesis supports the natural rate hypothesis, while the detection of a unit root validates the hysteresis hypothesis. The structural hypothesis, on the other hand, associates unemployment with an I(0) process within the framework of structural breaks.

While the Baltic countries have shown a stable performance in terms of economic growth, global financial crises and structural transformations have significantly impacted unemployment rates, particularly in these small and open economies. As a result, after joining the EU, the Baltic countries experienced both economic and structural changes, offering an important case of unemployment hysteresis. However, the empirical evidence regarding the nature of unemployment in these countries remains inconclusive, as previous studies have yielded mixed results depending on the methodology and time period considered. Given this context, this study aims to address the following research questions: (i) Does unemployment in the Baltic countries exhibit hysteresis effects, or does it follow a mean-reverting process? (ii) How do structural changes, such as EU accession and economic crises, impact the persistence of unemployment in these countries? (iii) Are there significant differences in unemployment persistence across different demographic groups, such as male and female workers? To answer these questions, this study investigates the hysteresis effects on unemployment rates in Estonia, Latvia, and Lithuania using monthly data from the period 2000M02 to 2024M08. Existing literature typically examines these countries within the broader context of transition economies, but this study offers a more in-depth analysis by centering on the Baltic countries. By explicitly considering structural changes and disaggregating unemployment rates by gender, this study provides new insights into the heterogeneous impacts of unemployment persistence.

The RALS-LM unit root test, based on the residuals-augmented least squares (RALS) method introduced by Meng et al. (2017), was used to examine the presence of hysteresis effects on unemployment rates. The main advantage of this test is its ability to account for non-normal error distributions, which are often overlooked in the literature, thereby enhancing test power and making the results more reliable. In other words, the RALS-LM test offers more sensitive and accurate results regarding the presence of a unit root by utilizing additional information in the error terms compared to traditional unit root tests. Given that the presence of non-normality is a common issue in macroeconomic data, applying this method provides a more robust assessment

of unemployment hysteresis. Studies in the literature that test the hysteresis effect on unemployment rates using the RALS-LM unit root test are limited (Krištić et al., 2019; Kızılkaya et al., 2024).

This study contributes to the empirical literature in several ways. Firstly, by investigating the effect of structural breaks on unemployment dynamics in the Baltic countries, this study offers a more comprehensive perspective on how economic integration and crises (e.g., economic shocks and the COVID-19 pandemic) have influenced labor market outcomes. Second, by employing the RALS-based unit root test, it introduces a more refined methodological approach to studying unemployment hysteresis, addressing gaps in previous empirical studies. Third, this study extends the analysis beyond aggregate unemployment rates by considering gender-based differences, offering a more comprehensive perspective on labor market dynamics. Moreover, by examining periods before and after the accession of theBaltic countries to the EU in May 2004, the study elucidates the long-term impacts of economic integration on unemployment dynamics and offers concrete insights for policymakers. Finally, it provides policy-relevant insights by identifying whether labor market interventions should focus on cyclical adjustments or structural reforms.

The structure of the paper is as follows: Section 2 provides information about the dynamics of unemployment in the Baltic countries. Section 3 presents a general review of the literature on unemployment hysteresis. Section 4 explains the methodology of the RALS-LM unit root test and also presents the data used in the study. Section 5 contains a comprehensive presentation of the estimation results. The findings and policy recommendations of the study are presented in detail in Section 6.

2. Unemployment Dynamics in the Baltic States

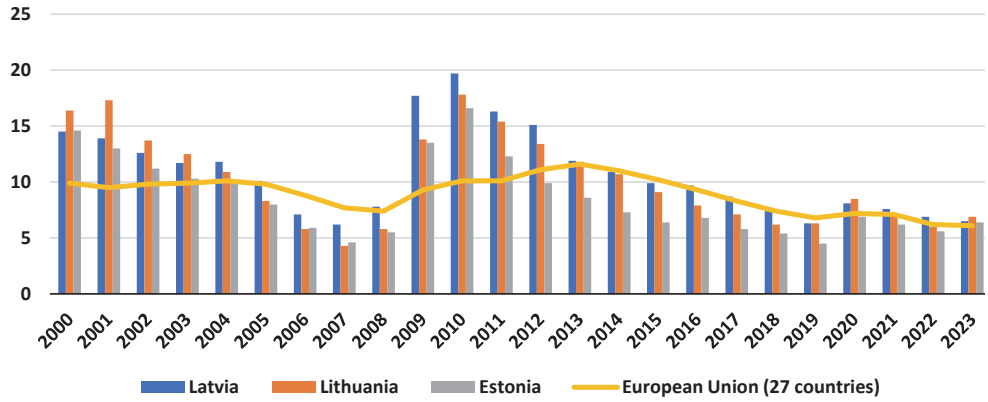
The Baltic countries faced significant economic and social challenges in the early 1990s, but after joining the EU, they entered a period of notable economic growth (Campos et al., 2019). This growth has generated supportive effects on social and economic development in the region, promoting modernization by increasing trade, capital, and labor mobility (Randveer & Staehr, 2021). However, EU membership has made the Baltic countries more sensitive to external economic developments, leading to the emergence of certain challenges. In these countries, issues such as poverty and unemployment have deepened and persisted over time. The primary reason for this is the relatively low wages in the Baltic countries compared to other EU nations, which has led to the migration of skilled labor abroad (Tsaurkubule, 2024). Galstyan et al. (2021) identified low income levels, low GDP per capita, and high unemployment rates as the main determinants of migration in the Baltic region. In the case of Lithuania, Kavalnis and Kasnauskiene (2022) highlighted that the primary determinants of migration are economic in nature. Moreover, Kasnauskiene and Kavalnis (2021) emphasized that increased migration is associated with higher real wage growth. Park (2015) stated that

not only economic factors but also political and social motivations, rooted in the sense of deprivation ingrained among the population, played a role in Lithuanians leaving their country.

Figure 1 illustrates the total unemployment rates in the Baltic countries and the European Union member states.

Figure 1

Evolution of Total Unemployment during the Period 2000–2023



Source: EUROSTAT

When examining the development of the labor force, it is evident that the Baltic countries faced significant unemployment issues before their EU membership, but experienced a notable decline in unemployment rates following their accession. The unemployment increase that started in the Baltic countries as a result of the 2008–2009 global financial crisis deepened further with the 2010 European debt crisis, transforming into a long-term problem. During this period, the economic crisis adversely affected the development of the countries (Verkulevičiūtė-Kriukienė, 2015). As a result, the Baltic states faced a slowdown in GDP growth, rising unemployment rates, and job losses (Aidukaite, 2013, 2019). For example, the unemployment rates in Estonia and Lithuania reached 16.6% and 17.8%, respectively, in 2010, while Latvia's unemployment rate surged to approximately 19.7%, marking an exceptionally high level.[1] During this period, the Baltic states implemented various institutional and structural reforms to address the rising unemployment. Estonia, through its Labor Law reform enacted in 2009, liberalized the use of fixed-term contracts, thereby increasing labor market flexibility and making layoffs and the employment of temporary workers easier (Masso & Krillo, 2011). In addition, Latvia and Lithuania expanded active labor market policies

[1] For a more detailed assessment of the rise in unemployment rates in the Baltic countries, see Verkulevičiūtė-Kriukienė (2015).

supported by EU funds, such as training (29.8% and 42.5%, respectively), employment incentives (39.7% and 45.4%, respectively), and direct job creation (28.4% and 10.1%, respectively), launching publicly subsidized temporary employment programs (Kuddo, 2009). As a result, the continuation of economic downturn and the widespread occurrence of bankruptcies led to a significant increase in the number of individuals unable to find employment (Moskvina & Okunevičiūtė-Neverauskienė, 2011). In the post-crisis period, while the share of social security expenditures on GDP and total public spending steadily increased in Latvia, a significant decline was observed in Estonia (29.1%) and a more limited decrease in Lithuania (Prasad & Gerecke, 2010). On the other hand, in terms of the share of total public spending allocated to unemployment, Latvia ranked first with a rate exceeding 4%, followed by Estonia with slightly above 3%, while Lithuania ranked last with a share falling below 3% (Aidukaite, 2019). Although economic growth regained momentum as of 2013, outward migration flows in the Baltic countries remained well above pre-crisis levels. This trend has been associated with factors such as the wide income gap between the Baltic countries and other European countries, non-economic push factors, network effects, inadequate social protection systems, and limited labor demand in the home countries (Hazans, 2016).

The COVID-19 pandemic, which emerged in 2020, had adverse effects on labor market trends in the Baltic countries, as it did globally. These negative shocks affected industries in different ways; while some sectors were able to maintain employment and production by shifting to remote work models, others were forced to reduce production capacity, leading to job losses (Baqaee & Farhi, 2021). Indeed, Baert (2021) notes that unemployment rates in the Baltic countries rose sharply during this period. Notably, during the peak of the pandemic, Lithuania recorded the highest unemployment rate, reaching 8.5% (Bilczak, 2022). As a result, the impact of these crises has been more pronounced on vulnerable groups, making them increasingly vulnerable to future crises (Okunevičiūtė-Neverauskienė et al., 2021).

3. Literature Review

Although the phenomenon of unemployment hysteresis has been extensively examined in the literature, methodological differences and the adoption of new techniques have prevented the empirical findings from reaching a definitive conclusion. The literature includes studies that examine unemployment hysteresis through fractional integration methods (Gil-Alana & Henry, 2003; Caporale & Gil-Alana, 2007, 2008; Figueiredo, 2010; Cuestas et al., 2011; Shalari et al., 2015; Trejo & Gil-Alana, 2021; Caporale et al., 2022; Cuestas & Gil-Alana, 2024), in addition to those utilizing a range of unit root tests. Unit root tests analyze the long-term impacts of shocks in a given series. In previous works, the hysteresis effect has commonly been tested using traditional unit root tests, such as the Augmented Dickey-Fuller (ADF, 1979) and Phillips-Perron (PP, 1988) tests (Brunello, 1990; Cross et al., 1990; Neudorfer et al., 1990; Mitchell,

1993; Jaeger & Parkinson, 1994; Røed, 1996; Groenewold & Hagger, 1998). However, traditional approaches have been criticized due to the issues encountered in testing for unit roots. For instance, Arestis and Mariscal (1999) emphasized that unit root tests that do not account for structural breaks could be misleading, causing shocks to appear excessively persistent. Mednik et al. (2008) suggested that traditional unit root tests exhibit low power in the presence of structural breaks. Additionally, researchers have noted that the presence of structural breaks may lead to a misinterpretation of the unit root hypothesis. Cuestas et al. (2011) argued that traditional unit root tests may fail to reject the null hypothesis when structural breaks exist in deterministic components. In this regard, the literature includes unit root tests that account for structural breaks (Lee & Chang, 2008; Mednik et al., 2008; Cuestas & Gil-Alana, 2011; Mladenovic & Anic, 2016; Krištić et al., 2019; Çağlayan Akay et al., 2020; Özdemir, 2020; Kızılkaya et al., 2024; Nnyanzi et al., 2024; Congregado et al., 2025), as well as studies testing hysteresis effects through the Fourier function, regardless of the number or location of structural breaks (Bolat et al., 2014; Furuoka, 2015; Dursun, 2017; Xie et al., 2018; Sigeze et al., 2019; Yaya et al., 2019; Çağlayan Akay et al., 2020; Mike & Alper, 2020; Çat & Kırca, 2024; Kızılkaya et al., 2024; Balcı, 2025). Several studies on unemployment hysteresis in Estonia, Latvia, and Lithuania, have identified hysteresis effects (Gözgör, 2013; Marques et al., 2017 (only for Estonia); Mike & Alper, 2020; Konat & Coşkun, 2022 (only for Estonia)), while other works have reported mixed empirical results (León-Ledesma & McAdam, 2004; Camarero et al., 2005, 2008; Cuestas & Gil-Alana, 2011; Cuestas & Ordóñez, 2011; Cuestas et al., 2011; Bolat et al., 2014; Marjanović & Mihajlović, 2014; Mladenovic & Anic, 2016; Akdoğan, 2017; Dursun, 2017; Krištić et al., 2019; Sigeze et al., 2019; Bella et al., 2020; Çağlayan Akay et al., 2020; Özdemir, 2020; Collins, 2021; Cheng, 2022; Çorakçı et al., 2022; Kızılkaya et al., 2024). In addition to these studies, Furuoka (2015) demonstrated that unemployment rates in five regions of Estonia follow a stationary process. According to Xie et al. (2018), the hysteresis effect is not valid for Lithuania and Latvia.

The results in the literature vary based on the methods used to examine the presence of the hysteresis effect. For example, when traditional unit root tests are applied in a specific country, hysteresis effects are detected, while unit root tests that account for structural breaks show no hysteresis effects. Therefore, the empirical evidence on unemployment hysteresis in the Baltic countries remains inconclusive and is sensitive to methodological choices. Although previous studies have investigated hysteresis in Estonia, Latvia, and Lithuania individually or collectively, no consensus has been reached, particularly regarding the role of structural breaks and nonlinear dynamics. Moreover, the application of more recent and robust methodologies, such as the RALS-LM unit root test (Hepsağ, 2022), which is more powerful in the presence of non-normal errors and conditional heteroskedasticity, has been limited in the context of these countries. This gap in the literature calls for further research employing advanced econometric approaches to re-examine the persistence of unemployment rates in the Baltic region.

In this context, considering the variety of methods used to examine hysteresis effects, the RALS-LM unit root test has been applied in this study.

4. Methodology

4.1 Data

This study examines the effects of the hysteresis hypothesis in the Baltic countries using monthly data from February 2000 to June 2024.[2] Additionally, the research compares the periods before (February 2000–April 2004) and after (May 2004–June 2024) European Union accession to analyze the hysteresis effect on unemployment rates in the Baltic countries. As part of the examination of the hysteresis effect, the unemployment rates for females (U_F), males (U_M), and the total population (U_T) in the age group 15 to 74 are analyzed. The study utilizes a dataset obtained from the European Union Statistics Office (EUROSTAT).

Table 1 provides the descriptive statistics related to the variables. According to this, Latvia has the highest average unemployment rate, while Estonia has the lowest unemployment rate. Furthermore, it can be observed that in all three countries, the unemployment rates for females are overall lower than those for males. The pattern of unemployment rates in the Baltic countries is shown in Figure 2.

Table 1

Descriptive Statistics

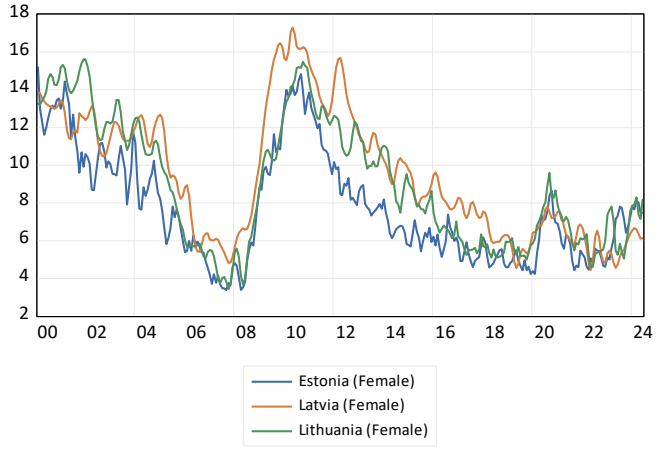
	Estonia			**Latvia**			**Lithuania**		
	U_T	U_F	U_M	U_T	U_F	U_M	U_T	U_F	U_M
Mean	8.521	7.740	9.282	10.598	9.538	11.656	10.066	8.972	11.166
Median	7.436	7.145	7.677	9.878	8.993	10.785	8.923	8.193	9.766
Maximum	19.547	15.187	25.407	21.429	17.295	27.122	19.074	15.615	23.669
Minimum	3.934	3.388	3.501	5.094	4.455	5.349	3.655	3.441	3.635
Std. Dev.	3.453	2.876	4.213	3.823	3.369	4.468	4.102	3.350	5.014
Skewness	0.895	0.690	1.189	0.800	0.381	1.180	0.524	0.349	0.678
Kurtosis	3.112	2.513	4.381	2.935	2.013	4.074	2.114	1.845	2.409
J-B*	39.304	26.146	92.286	31.330	18.959	82.097	23.011	22.222	26.746

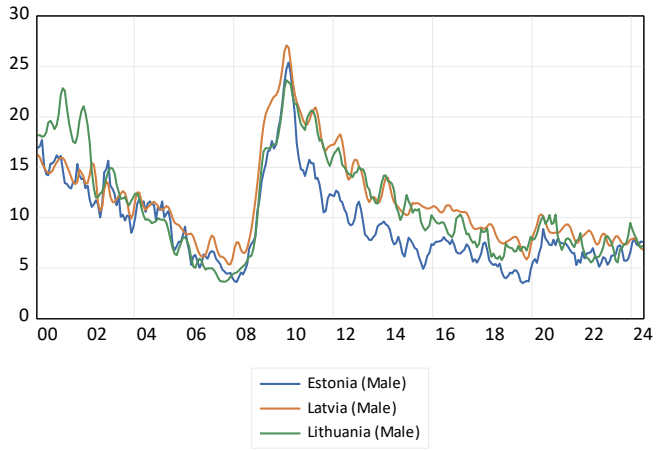
Note. * The p-values of the Jarque-Bera test statistics indicate that all series exhibit non-normal distributions.

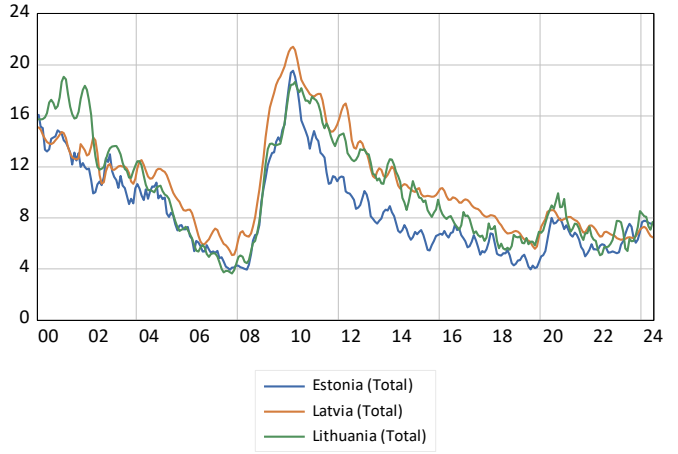
[2] Although the datasets for Lithuania and Latvia extend back to 1998, the dataset for Estonia starts from 2000. To ensure comparability, the data for all three countries have been analyzed from 2000 onwards, as indicated by the EUROSTAT data.

Figure 2

Progression of Unemployment Rates in the Baltic Countries







4.2 Estimation Technique

This study assumes that changes in unemployment rates in the Baltic countries have been shaped by significant economic and political events, such as accession to the European Union. Indeed, EU membership can influence economic integration processes, trade and labor market dynamics, as well as shape labor mobility. Therefore, understanding the differences observed in unemployment rates before and after the accession process will allow for a more in-depth analysis of the economic structure. In order to evaluate the hysteresis effect on unemployment in the Baltic countries pre- and post-EU accession, this study incorporates the LM unit root test formulated by Lee and Strazicich (2003, 2004) and the RALS-LM methodology proposed by Meng et al. (2017) while taking into account the existing structural breaks. The reason for utilizing the RALS-LM unit root test in this study is to identify endogenous structural breaks in time series as well as trend changes, thereby enhancing the test power by incorporating additional information about errors in cases where they do not exhibit a normal distribution (Meng et al., 2017; Payne et al., 2017).

The RALS LM unit root test, which accounts for structural breaks, follows a two-stage estimation process. In the first stage, the LM test regression developed by Lee and Strazicich (2003, 2004) is estimated using the least squares method. Subsequently, the residual series from this regression is obtained. In the second stage, the RALS-LM test regression is obtained by including the variables extended with residuals in the LM test regression (Hepsağ, 2022).

First, the regression representation of the LM unit root test is given in Equation 1.

$$\Delta y_t = \delta' \Delta Z_t + \varphi \check{S}_{t-1} + \sum_{j=1}^{k} d_j \, \Delta \check{S}_{t-j} + u_t \qquad (1)$$

where y_t represents the unemployment rate series, while Z_t represents a vector of exogenous variables that includes the constant term, trend, and structural break effects. $\check{S}$ corresponds to the y_t series de-trended by the LM method, which is calculated as follows:

$$\check{S} = y_t - \check{\psi}_x - Z_t \check{\delta} \qquad (2)$$

where $\check{\psi}_x = y_1 - Z_1 \check{\delta}$. Next, the LM unit root test statistic, associated with the t-statistic for the $\phi = 0$ hypothesis, is extracted from regression Equation (1). To implement the LM unit root test with two breaks in level and break, Z_t can be represented as $Z_t = [1, t, D_{1t}, D_{2t}, DT^*_{1t}, DT^*_{2t}]'$, where $D_{jt} = 1$ and $DT^*_{jt} = t - TB_j$ for $t \geq TB_j + 1$, $j = 1, 2$, and zero otherwise, within the framework of Equation (1). In cases where trend breaks are present, the LM unit root test depends on the λ_i^* parameter, which indicates the proportion of sub-samples in each regime; thus, it is related to $\lambda_1^* = T_{B1}/T$ and $\lambda_2^* = (T_{B2} - T_{B1})/T$. Then the transformation pertaining to this parameter is presented as follows:

$$\tilde{S}_t^* = \begin{cases} \left(\frac{1}{\lambda_1}\right)^* \check{S}_t \; for \; t \leq T_{B1} \\ \left(\frac{1}{\lambda_2}\right)^* \check{S}_t \; for \; T_{B1} < t \leq T_{B2} \\ \qquad or \\ \left(\frac{1}{1-\lambda_2}\right)^* \check{S}_t \; for \; T_{B2} < t \leq T \end{cases}$$

where, $\check{S}_t$ indicates the untransformed series, while $\tilde{S}_t^*$ represents the transformed series. In Equation 1, if parameter $\check{S}_{t-1}$ is substituted with parameter $\tilde{S}_{t-1}^*$, we derive the following equation.

$$\Delta y_t = \delta' \Delta Z_t + \varphi \check{S}_{t-1} + \sum_{j=1}^{k} d_j \, \Delta \check{S}_{t-j} + u_t \tag{3}$$

The LM unit root test statistic specified in Equation 3 can be expressed as τ^*_{LM}. Following this, the RALS-LM test statistic may be obtained using the regression shown below.

$$\Delta y_t = \delta' \Delta Z_t + \varphi \check{S}_{t-1}^* + \sum_{j=1}^{k} d_j \, \Delta \check{S}_{t-j} + \widehat{w}_t \gamma + u_t \tag{4}$$

where $\widehat{w}_t$ represents the augmented term that utilizes the second and third moments of the residuals from the regression in Equation (3) to capture the moment conditions with $\widehat{m}_j = T^{-1} \sum_{t=1}^{T} \hat{e}_t^j$ and $\widehat{w}_t = [\hat{e}_t^2 - \widehat{m}_2, \hat{e}_t^3 - \widehat{m}_3 - 3\widehat{m}_2 \hat{e}_t]'$. In the presence of non-normal errors, the term $\widehat{w}_t$ enhances asymptotic efficiency, thereby increasing the power of the test. The corresponding t-statistic for is represented $\varphi = 0$ as $\check{\tau}^*_{RALS-LM}$. Hence, the asymptotic distribution of $\check{\tau}^*_{RALS-LM}$ can be described by $\rho\tau^*_{LM} + \sqrt{1-\rho^2}Z$. In this case, ρ reflects the correlation between the error terms of both Equation (1) and Equation (4). If the calculated $\check{\tau}^*_{RALS-LM}$ test statistic is less than the critical value established by the ρ_2 value, the null hypothesis cannot be rejected; if it is greater, the null hypothesis is rejected, and the time series is considered stationary.

5. Empirical Results

This section compares the findings of the total unemployment rate as well as male and female unemployment rates before and after EU membership, using the RALS-LM unit root test to test unemployment hysteresis in the Baltic countries.

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Table 2

Results of RALS-LM Unit Root Tests with One Structural Break (in the Constant Term and Deterministic Trend)

Countries	Pre-EU Accession				Post-EU Accession			
	τ_{LM}	$\tau_{RALS-LM}$	ρ_2	Break	τ_{LM}	$\tau_{RALS-LM}$	ρ_2	Break
Estonia								
U_T	**-4.8281*** [15]	**-3.7238*** [13]	0.671	2002:07	-3.9292 [12]	-3.4791 [16]	0.903	2008:01
U_F	**-7.9426*** [2]	**-4.6703*** [10]	0.678	2002:04	-3.5433 [17]	**-4.1761*** [17]	0.895	2020:08
U_M	**-5.1082*** [15]	-2.5255 [15]	0.917	2002:07	-4.0272 [13]	**-3.7811*** [16]	0.917	2020:05
Latvia								
U_T	**-5.3973*** [1]	-2.6474 [13]	0.322	2003:09	**-4.5296*** [11]	-3.0415 [10]	0.897	2007:10
U_F	**-5.3140*** [16]	**-4.2928*** [1]	0.544	2003:10	-3.7235 [17]	-2.9978 [14]	0.992	2007:01
U_M	**-8.1816*** [1]	**-5.0574*** [9]	0.533	2002:02	-3.7216 [16]	-2.0735 [16]	0.875	2012:03
Lithuania								
U_T	**-12.2367*** [17]	**-10.5848*** [17]	0.863	2002:02	**-4.4056*** [12]	-3.3067 [17]	0.983	2020:08
U_F	**-5.8005*** [17]	**-8.8307*** [17]	0.329	2002:02	-3.1838 [15]	**-4.1701*** [15]	0.921	2020:08
U_M	**-8.4019*** [17]	**-7.7425*** [17]	0.792	2001:11	-4.1629 [13]	-2.9438 [17]	0.915	2020:08

Note. * indicates statistical significance at the 5% level. The values in parentheses represent the lag length.

Table 3

Results of RALS-LM Unit Root Tests with Two Structural Breaks (in the Constant Term and Deterministic Trend)

Countries	Pre-EU Accession					Post-EU Accession				
	τ_{LM}	$\tau_{RALS-LM}$	ρ_2	Break 1	Break 2	τ_{LM}	$\tau_{RALS-LM}$	ρ_2	Break 1	Break 2
Estonia										
U_T	**-7.2262*** [11]	-1.6288 [17]	0.630	2003:03	2003:06	-5.7812 [17]	-2.7661 [17]	0.975	2008:04	2010:02
U_F	**-9.0448*** [13]	-0.7482 [16]	0.958	2002:06	2003:06	-5.2178 [17]	-3.6993 [8]	0.980	2008:05	2010:02
U_M	**-6.5634*** [5]	-3.6979 [16]	0.633	2002:07	2002:11	**-6.0983*** [13]	-3.5750 [13]	0.942	2010:03	2010:11
Latvia										
U_T	-5.6319 [1]	**-6.9543*** [1]	0.720	2002:05	2002:09	**-7.0788*** [12]	-2.5063 [10]	0.914	2008:06	2009:07
U_F	**-7.5787*** [16]	**-9.2279*** [15]	0.868	2001:08	2002:05	-5.7807 [17]	-2.1716 [14]	0.975	2007:10	2010:04
U_M	**-8.5943*** [1]	**-8.9898*** [1]	0.749	2002:05	2002:09	**-7.7066*** [14]	-3.0959 [16]	0.878	2008:08	2009:04
Lithuania										
U_T	**-11.5639*** [17]	-4.2415 [2]	0.999	2002:01	2002:07	-5.4837 [15]	-2.3074 [13]	0.952	2007:09	2010:07
U_F	**-7.4691*** [1]	**-7.752*** [16]	0.446	2002:02	2002:07	-4.1752 [15]	-2.8951 [15]	0.866	2007:10	2010:10
U_M	**-14.2961*** [17]	-1.8356 [17]	0.797	2002:09	2003:06	**-6.3020*** [12]	-3.0633 [13]	0.905	2008:10	2009:03

Note. * indicates statistical significance at the 5% level. The values in parentheses represent the lag length.

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Table 4

Results of RALS-LM Unit Root Tests with One and Two Structural Breaks (in the Constant Term and Deterministic Trend)

Countries	Both Pre- and Post-EU Accession								
	τ_{LM}	$\tau_{RALS-LM}$	ρ_2	Breaks	τ_{LM}	$\tau_{RALS-LM}$	ρ_2	Break 1	Break 2
Estonia									
U_T	-3.9618 [13]	-3.3662 [16]	0.960	2008:04	**-6.1972*** [17]	-3.5168 [17]	0.991	2008:04	2010:03
U_F	-3.7754 [17]	**-5.4090*** [17]	0.946	2002:07	**-5.4688*** [17]	-3.6055 [17]	0.977	2008:03	2010:05
U_M	-3.8147 [13]	**-4.6583*** [16]	0.889	2002:11	**-6.7254*** [15]	-3.6466 [15]	0.950	2008:05	2010:05
Latvia									
U_T	-3.4622 [10]	-2.5178 [17]	0.726	2007:10	**-7.5473*** [14]	-3.0198 [14]	0.725	2008:06	2009:07
U_F	-3.5082 [15]	-2.4503 [10]	0.822	2007:10	**-5.8136*** [15]	-2.5161 [5]	0.837	2008:06	2009:10
U_M	-3.6232 [16]	-2.7429 [16]	0.825	2007:10	**-7.8572*** [14]	-3.4525 [16]	0.793	2008:08	2009:04
Lithuania									
U_T	-3.8558 [15]	**-3.6209*** [15]	0.916	2008:04	**-5.3755*** [15]	-1.9468 [15]	0.950	2008:04	2010:01
U_F	-3.3456 [15]	**-4.6688*** [15]	0.917	2020:08	-4.1830 [15]	-2.1963 [15]	0.897	2008:04	2010:07
U_M	-4.0214 [15]	**-3.8641*** [15]	0.890	2008:01	**-5.9910*** [15]	**-4.1017*** [15]	0.889	2008:10	2009:03

Note. * indicates statistical significance at the 5% level. The values in parentheses represent the lag length.

The results of the unit root tests with one structural break, including the LM and RALS-LM tests, are presented in Table 2. According to the results of the LM unit root tests with one structural break, unemployment rates in the relevant countries were found to be stationary during the pre-EU period. The findings obtained support the results of León-Ledesma and McAdam (2004) for Lithuania, but are inconsistent with their findings for Estonia and Latvia. According to the results of the RALS-LM unit root test, in the pre-EU period, the female unemployment rate showed stationarity in all three countries, while the male unemployment rate exhibited a tendency towards stationarity in the other two countries, except for Estonia. Additionally, stationarity was observed in the total unemployment rate in the two countries, except for Latvia. Given the findings of stationarity, the validity of the structural hypothesis has been confirmed at the country and gender-specific levels in the pre-EU period. The relatively higher degree of persistence in female unemployment rates can be attributed to the fact that women, along with young people and low-skilled workers, are among the groups that are partially excluded from regulated labor markets. In this context, labor market liberalization and the promotion of flexible employment have been presented as an inclusive strategy aimed at enhancing women's integration into the labor market (Rubery, 2015). The findings from the LM unit root tests indicate that, in the post-EU period, only the total unemployment rates in Latvia and Lithuania are stationary. The findings from the RALS-LM unit root test indicate that the hysteresis hypothesis is valid in Latvia, while in Lithuania, it holds for total and male unemployment rates, and in Estonia, it is only valid for the total unemployment rate. In this context, it should be taken into account that EU accession led to structural reforms and institutional changes that affected male and female workers in different ways. The liberalization of the labor market and the restructuring of male-dominated sectors (such as manufacturing and construction) following EU membership disproportionately impacted male unemployment, whereas the relative expansion of the female-dominated services sector may have limited the hysteresis effect among women (Rubery, 2015). This suggests that gender-based unemployment disparities stem not only from macroeconomic shocks but also from sectoral transformations and labor market reforms.

Table 3 presents the results of the LM and RALS-LM unit root tests with two structural breaks. According to the results of the LM unit root tests with two structural breaks, unemployment rates in the relevant countries, except for Latvia's total unemployment rate, were found to be stationary in the pre-EU accession period. The research findings are consistent with the results obtained by Camarero et al. (2005) for the relevant countries. According to the results of the RALS-LM unit root test, while the hysteresis hypothesis is valid in Estonia, the validity of the structural hypothesis is observed in Latvia. For both total and male unemployment rates, the hysteresis hypothesis is found to be valid in Lithuania, while the structural hypothesis holds for the female unemployment rate. For instance, the validity of the structural hypothesis for female unemployment rates in Lithuania may be explained by the concentration of women's employ-

ment in less volatile sectors (such as services), while the presence of a hysteresis effect in male unemployment rates could stem from men's dependence on more vulnerable sectors (such as industry and construction) (Motiejūnaitė, 2010). The results from the LM unit root tests show that, in the post-EU accession period, the male unemployment rates in the examined countries are stationary. The study also found that, except for the total unemployment rate in Latvia, unemployment rates in other countries are not stationary. Nevertheless, these results are in conflict with those of Mladenovic and Anic (2016) for Latvia and Estonia. At the same time, these findings do not align with those obtained by Kızılkaya et al. (2024) for Latvia. The results of the RALS-LM unit root test indicate that the hysteresis hypothesis holds for all countries. The obtained results support the findings presented by Kızılkaya et al. (2024) for Latvia and Lithuania. According to the researchers, the structural hypothesis is valid for Estonia.

Finally, Table 4 presents the test results for the analysis of both periods combined. According to the results of the LM unit root tests with one structural break, it has been determined that the unemployment rate series in the examined countries are non-stationary. The findings are consistent with those of Özdemir (2020) and Akdoğan (2017) for Estonia and Latvia, and Marques et al. (2017) for Estonia. On the other hand, the findings of this study contradict the results obtained by Bella et al. (2020) for Estonia and Latvia, and Çağlayan Akay et al. (2020). When examining the results of the RALS-LM unit root test, it was found that the hysteresis hypothesis holds for Estonia (only for the total unemployment rate) and Latvia, while the structural hypothesis holds for Estonia (for both female and male unemployment rates) and Lithuania. According to the results of the LM unit root tests with two structural breaks, it was found that unemployment rates in the examined countries are stationary, except for the female unemployment rate in Lithuania. The results of this study show similarities to the findings of Akdoğan (2017). On the other hand, the findings obtained for Estonia and Latvia, excluding Lithuania, contradict the results presented in the studies by Cuestas and Gil-Alana (2011) and Cuestas et al. (2011). Similarly, the findings obtained in the study by Krištić et al. (2019) are inconsistent with the results of this research. According to the RALS-LM unit root test findings, the hysteresis hypothesis is valid for the countries under consideration, with the exception of the male unemployment rate in Lithuania. On the other hand, the findings for Estonia and Lithuania, except for Latvia, contradict the results presented by Krištić et al. (2019). Taken together, these findings highlight the importance of examining unemployment hysteresis and structural dynamics in the context of institutional and sectoral transformations that may have differently affected male and female labor market outcomes before and after these countries' accession to the EU.

6. Conclusion

This study evaluates the hysteresis effects of unemployment rates in Estonia, Latvia, and Lithuania using the RALS-LM unit root test method, with monthly data from the period 2000M02–2024M08. The findings reveal the sensitivity of female, male, and total unemployment rates in the Baltic countries to long-term structural changes. The results of the RALS-LM unit root test which considers a single structural break reveal that structural breaks frequently occurred between 2001 and 2003 in the pre-EU accession period. In contrast, in the post-EU accession period, structural breaks appear to be concentrated between 2007 and 2010, coinciding with the impacts of the 2008–2009 Global Financial Crisis and the European Debt Crisis on labor markets. After EU accession, significant structural changes in the total unemployment rates have been observed, particularly for Estonia and Lithuania.

The test results incorporating two structural breaks reveal that unemployment rates in the Baltic countries have shown sensitivity to shocks over time, leading to significant changes in long-term labor market dynamics. In particular, it is observed that male and female unemployment rates respond differently to structural breaks. This situation suggests that gender disparities in the labor market need to be examined in more detail, particularly in terms of sensitivity to crises. In Lithuania, it has been found that female unemployment exhibited a less stable structure before and after EU membership and was more sensitive to changes in the labor market. On the other hand, in Estonia and Latvia, male unemployment has been found to respond more strongly to economic shocks.

The findings suggest that the hysteresis hypothesis holds true, particularly in Estonia and Latvia, while exhibiting periodical variations in Lithuania. Moreover, the economic downturn caused by the COVID-19 pandemic has further worsened unemployment rates, contributing to the persistence of unemployment in these countries. In this context, the implementation of active labor market policies is of great importance in preventing unemployment rates from remaining elevated in the post-crisis and/or post-pandemic period. Structural reforms that enhance labor market flexibility, along with the implementation of training and skill development programs, will significantly contribute to reducing the effects of unemployment hysteresis. In addition, policies aimed at addressing gender inequalities in the labor market, such as targeted employment initiatives in sectors where women are underrepresented, will help mitigate the long-term unemployment effects among women.

In conclusion, it has been determined that the labor markets of the Baltic countries faced different structural challenges before and after EU accession, with varying responses to these challenges. The results suggest that Estonia, likely due to its more diversified economy and labor market policies, has a stronger capacity to cope with economic shocks. In contrast, Latvia and Lithuania appear to be more vulnerable to such shocks, indicating the need for more comprehensive and targeted interventions.

Therefore, policymakers in Latvia and Lithuania could benefit from sector-specific employment policies and the reinforcement of social safety nets to improve labor market resilience.

In light of these findings, this study provides a significant contribution to understanding the long-term effects of the EU accession process and economic shocks on unemployment in the Baltic countries. However, the fact that migration dynamics and the impact of the COVID-19 pandemic on unemployment were not directly addressed within the scope of this study can be considered one of its main limitations. Future research could examine the roles of specific industries and sectors in shaping labor market dynamics. In particular, more detailed policy recommendations could be developed for each country in the context of migration and post-pandemic and post-crisis labor market recovery.

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