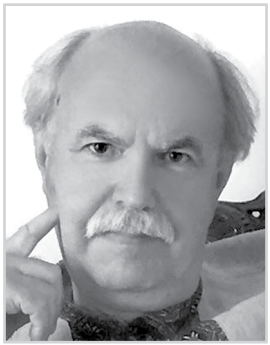
UDC 330.43 + 519.862

Marianna Oliskevych
D.Sc. (Economics), Associate Professor,
Professor of the Department of Mathematical Economics and Econometrics,
Ivan Franko National University
1 Universytetska Str., Lviv, 79000, Ukraine
olisk@ukr.net
ORCD ID: https://orcid.org/0000-0003-1264-1684

Viktor Tokarchuk
PhD (Mathematics and Physics),
Associate Professor of the Department of Finance,
National University of Kyiv-Mohyla Academy
10 Voloska Str., Kyiv, 04655, Ukraine
fivalet@gmail.com
ORCD ID: https://orcid.org/0000-0002-5138-4476



Dynamic modelling of nonlinearities in the behaviour of labour market indicators in Ukraine and Poland

Abstract. The paper studies asymmetries in cyclical behaviour of the Ukrainian and Polish labour markets, accompanied by significant nonlinear fluctuations in economic activity and the unemployment rate due to economic instability, dramatic internal disturbances of social environment and strong external shocks. We investigate the labour market in Ukraine in comparison with the labour market in Poland, the country closest to Ukraine. The conducted econometric analysis shows that after a significant economic downturn, the recovery of the labour market recovers at a slower pace than the overall economic activity. The developed Markov switching autoregressive model implies distinctive regimes of the behaviour of the unemployment rate over time, which is associated with declining and rising modes. The changes in jobless recovery depend on the current and previous changes in real gross domestic product, which has a significant impact on the unemployment rate in both regimes. The estimated transition probabilities related to being in either of the regimes implies that the Ukrainian labour market exhibits the greatest probability of remaining in the increasing unemployment regime, as well as a relatively high probability of transition from low to high unemployment. On the contrary, the Polish unemployment rate is characterised by a high probability of being in a regime with low and declining unemployment, as well as a low probability of moving into an unfavourable situation, which reflects stability of its labour market. The opposite features attributed to the Ukrainian labour market, on the one hand, and the Polish labour market, on the other hand, cause significant labour migration from Ukraine to Poland. The high uncertainty in Ukraine is a motive to seek jobs overseas, especially for the young generation. The results of the investigation confirm the urgency and importance of immediate positive shifts and development of the Ukrainian labour market in order to preserve human capital and, taking into account the negative demographic trends, ageing of the population and significant labour migration, to prevent potential depletion of the labour force.
Keywords: Labour Market; Unemployment; Nonlinear Econometric Modelling; Regime Switching; Poland; Ukraine
JEL Classification: C24; J64
DOI: https://doi.org/10.21003/ea.V169-07

Оліскевич М.
доктор економічних наук, доцент, професор кафедри математичної економіки та економетрії,
Львівський національний університет імені Івана Франка, Львів, Україна
Токарчук В.
кандидат фізико-математичних наук, доцент кафедри фінансів,
Національний університет «Києво-Могилянська Академія», Київ, Україна
Динамічне моделювання нелінійностей у поведінці індикаторів ринку праці в Україні та Польщі
Анотація. Статтю присвячено дослідженню асиметричностей і нелінійностей у циклічній поведінці макропоказників ринку праці України та Польщі. Розроблено Марківську авторегресійну модель переключення режимів, на підставі якої виявлено два різні режими поведінки часового ряду рівня безробіття, пов'язані з його зростанням і спадом. Обґрунтовано, що відновлення зайнятості залежить від поточних і попередніх змін реального валового внутрішнього продукту, що має значущий вплив на рівень безробіття в обох режимах. Результати економетричного оцінювання перехідних імовірностей засвідчили, що український ринок праці з найбільшою очікуваною ймовірністю перебуває в режимі зростання безробіття; відносно високою також є ймовірність переходу від низького до високого рівня безробіття. Проведено порівняння властивостей процесів на ринку праці України та її найближчого сусіда – Польщі. Виявлено та проаналізовано відмінності між ними.
Ключові слова: ринок праці; безробіття; нелінійна економетрична модель; переключання режимів; Польща; Україна.

Олискевич М.
доктор экономических наук, доцент,профессор кафедры математической экономики и эконометрики,
Львовский национальный университет имени Ивана Франко, Львов, Украина
Токарчук В.
кандидат физико-математических наук, доцент кафедры финансов,
Национальный университет «Киево-Могилянская Академия», Киев, Украина
Динамическое моделирование нелинейностей в поведении индикаторов рынка труда в Украине и Польше
Аннотация. Статья посвящена исследованию асимметричности и нелинейности в циклическом поведении макропоказателей рынка труда Украины. Разработано Марковскую авторегрессионную модель переключения режимов, на основании которой выявлено два разных режима поведения временного ряда уровня безработицы, связанные с его ростом и падением. Обосновано, что восстановление занятости зависит от текущих и предыдущих изменений реального валового внутреннего продукта, имеющего значимое влияние на уровень безработицы в обоих режимах. Результаты эконометрического оценивания переходных вероятностей показали, что украинский рынок труда с наибольшей ожидаемой вероятностью находится в режиме роста безработицы; относительно высокой также является вероятность перехода от низкого к высокому уровню безработицы. Проведено сравнение свойств процессов на рынке труда Украины и ее ближайшего соседа – Польши. Выявлены и проанализированы различия между ними.
Ключевые слова: рынок труда; безработица; нелинейная эконометрическая модель; переключение режимов; Польша; Украина.

1. Introduction

The instability of modern economic structures and the unevenness of external and internal economic shocks are accompanied by significant asymmetric cyclical fluctuations in the economic activity and employment in Ukraine, which has led lead to significant disturbances in the economic and social environment of the country [1-2]. In this regard, the implementing effectiveness of the market transformation regulatory measures in the Ukrainian economy, aimed at ensuring its socio-economic development, competitiveness and improvement of human capital [3] requires an in-depth theoretical and empirical investigation of the functioning peculiarities of the labour market, as well as modelling the dynamics of its main indicators [4].

The analysis and forecasting of changes in unemployment, employment and income trends at different phases of the economic cycle, as well as the evaluation of the main factors of unemployment in the long run is an important direction of modern macroeconomic studies. One of the issues, which is being actively studied by scientists, is the questions about how unemployment reflects the imperfection of the market and what are the causes and consequences of this.

An important trend in modern research also concerns the cyclicality of short-term behaviour of the main labour market indicators [5]. In particular, theoretical and empirical scientific results have revealed that the unemployment rate show asymmetric lags in their cyclical behaviour during business cycles, and after a significant economic downturn, the recovery of the labour market recovers at a slower pace than the overall economic activity [6-7]. However, these studies have not been sufficiently reflected in the works by Ukrainian scholars yet. At the same time, the results of scientific research have indicated that the statistical observations on labour market indicators for different countries reveal various properties, which necessitates the search for non-traditional approaches to their empirical analysis and modelling.

2. Brief Literature Review

To model nonlinear economic processes, scientists use econometric time series models, in particular nonlinear smooth transition models, threshold autoregressive models and, in the cases where the dynamics of the economic variable demonstrates different behaviour modes which change each other, regime switching models. A model with Markov switching was first developed by J. Hamilton (1989) who conducted the modelling of asymmetry in the dynamics of economic activity during contractionary and expansionary states of the economy and estimated the probabilities of being in each of these states [8].

Now the Markov switching model is widely used to model various economic processes. P. Deschamps (2008) estimated both the logistic smooth transition model and the Markov switching autoregressive model. He applied them to study the behaviour of unemployment in the United States and justified the adequacy of switching modelling with constraining the first autoregressive coefficient to differ across regimes [9].

T. Bayat, S. Kayhan and A. Kocyigit (2013) applied a linear unit root test and found that the unemployment rate in Turkey was not stationary in the time series, while the initial differences in the data relating to the time series were stationary[10]. They developed the Markov switching model and showed that the unemployment rate in Turkey behaved asymmetrically and the structure of unemployment was nonlinear.

N. Gaston and G. Rajaguru (2015) investigated the unemployment rate, the labour force participation rate (LFPR) and the employment rate in Australia during the period from 1978 to 2012. They estimated the Markov-switching structural vector autoregression (SVAR) in order to examine the relationship between unemployment, labour force participation and productivity in the Australian labour market [11]. The research revealed the existence of different regimes in the functioning of the labour market, including the regime with low unemployment and the low Labour Force Participation Rate (LFPR), the long period of relative stability and the short period of high unemployment and a low coefficient of labour force participation.

O. Shalari, E. Laho and A. Gumeni (2015) identified the asymmetry and the long-run memory of the unemployment rate in Albania and confirmed the unemployment nonlinearity that caused the low explanatory and poor quality predictions of linear economic models. They developed a regime-switching model which was expanded by including a variable which characterised the current depth of the recession and allowed to describe asymmetry and nonlinearity. They showed that shocks had a greater impact on the unemployment in Albania than positive disturbances [12].

Unemployment rates in different countries show nonlinear and asymmetric behaviour because of unemployment hysteresis, lag recovery and regimes that do not coincide with the official ups and downs of a business cycle. Scientists have discovered various reasons for jobless recoveries. K. Koenders and R. Rogerson (2005) accentuate the importance of the correction of inefficient allocation of labour that emerges during long expansions [13]. S. Schreft and A. Singh (2003) emphasise that we needed more flexibility in using the existing labour force [14]. D. Andolfatto and D. MacDonald (2004) investigated the effect of technology diffusion that created more incentives to invest in job search or human capital development [15]. S. Klinger and E. Weber (2016) developed a new approach that took into account the Markov-switching unobserved components to study the hysteresis of unemployment and showed the asymmetry of unemployment in Germany in relation to the business cycle [16].

3. The purpose of the article is to investigate the Ukrainian unemployment rate nonlinear dynamics by using a flexible econometric Markov switching approach and compare it with the unemployment rate in Poland, as well as to research different behaviour regimes and evaluation their transition probabilities.

Figure 1(a) presents plots of a seasonally adjusted unemployment rate series for Ukraine and other East European countries for comparison. The dynamics of the Ukrainian unemployment rate shows a distinctive behaviour pattern comparing with European countries. Particularly, it developed in opposite direction, if compared to that of Poland, Ukraine's closest neighbour. The correlation between the seasonal adjusted series of Ukrainian and Polish unemployment rates is estimated at 0.6 and is significantly negative at the 0.99 level. In the period between 2000 and 2008, when the Polish labour market showed a high level of jobless, Ukraine demonstrated moderate unemployment. However, over the last four years, we have observed the recovery of the Polish employment rate and a substantive increase in the Ukrainian unemployment rate.

Figure 1(b) displays the distribution density of the Ukrainian unemployment rate (in bold) together with a normal distribution having the same mean and variance. The distribution of the unemployment rate (UR) series is not normal. The shape of distribution plot (Figure 1(b)) suggests two separate modes: one for the upper part of the distribution, encompassing most of the observations, and the second for the lower part covering high values of the UR. Such an observation implies that a switching approach is an appropriate model for unemployment rate, which allows us to use a mixture of normal distributions (Brooks, 2008), where the weights attached to each distribution sum and where movements between modes are governed by a Markov process [17].

4. Methodology

Since the Ukrainian labour market indicators revealed the asymmetries in their dynamics [18], we investigate the unemployment rate series as the random variable y_t which is described by the process depending on the values of the unobserved discrete variable s_t. Suppose that M different regimes exist. The economy is in a state or regime r in the period t, when $s_t = r$ for $r = 1, \ldots, M$. The switching model

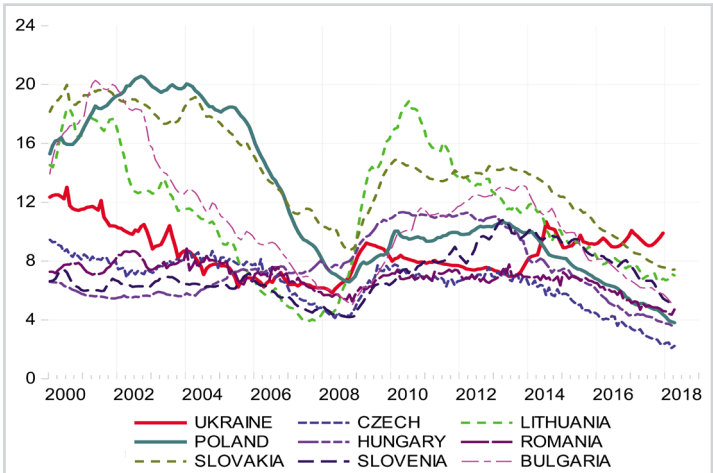


Fig. 1(a): **Dynamics of unemployment rate in Ukraine and East European countries during 2000-2016**

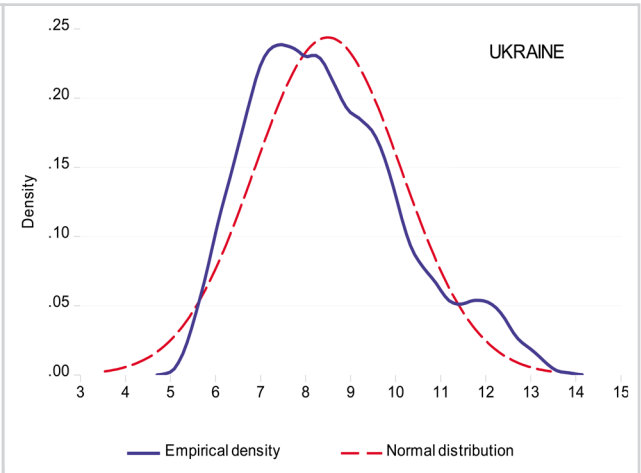


Fig. 1(b): **Plot of the Ukrainian unemployment probability density in comparison with normal distribution**

Source: Compiled and calculated by the authors based on data from Eurostat and the State Statistics Service of Ukraine

applies a combining of different regression models, which are related to each regime, respectively. Taking into account the explanatory regressors, the conditional mean y_t in the regime r is described by the linear specification [17] which takes the form of:

$$\mu_t(r) = X_t\beta_r + Z_t\gamma\,, \tag{1}$$

where β_r and γ are the vectors of unknown parameters. The parameters β_m are the coefficients for the regressors X_t and depend on the regime, γ are the coefficients for the regressors Z_t, which are the regime invariant. The errors have normal distribution with the variance that may depend on the regime. We consider the model as follows:

$$y_t = \mu_t(r) + \sigma(r)\,u_t\,, \tag{2}$$

where the error u_t is a standard normally distributed for each state $s_t = r$ and the standard deviation σ may depend on the regime $\sigma(r) = \sigma_r$.

The switching model can also contain lag values of the endogenous variable and exogenous variables of different types. The general form of the model with p lags of endogenous variable and the random state variable s_t, which takes the value r, is [19]:

$$\mu_t(r) = X_t\beta_r + Z_t\gamma + \sum_{j=1}^{p}\varphi_{jr}\,y_{t-j}\,. \tag{3}$$

The coefficients for lags of the endogenous variable can be regime varying or regime invariant. Therefore, they may depend on the mode or be invariant with respect to changes in the regime behaviour of the variable.

Under the Markov switching approach, the set of possible occurrences is split into M states, denoted s_r ($r = 1, \ldots, M$), corresponding to the r regime. Therefore, it is assumed that the unemployment rate UR_t switches the regime according to some unobserved variable s_t which takes integer values. We assume that $r = 1$ or 2 if $s_t = 1$ the process is in the regime 1 at time t; and if $s_t = 2$, the process is in the regime 2 at time t. Movements of the state variable between the regimes are governed by a Markov process. This Markov property can be expressed as follows [17]:

$$\text{Prob}[a < y_t \le b \mid y_1, y_2, \ldots, y_{t-1}] = \text{Prob}[a < y_t \le b \mid y_{t-1}]\,. \tag{4}$$

The equation (4) states that the probability distribution of the state at the current time t depends only on the state at the previous time t-1 and does not depend on the states that were passed through at the times t-2, t-3, . . . Hence, Markov processes are not path-dependent. The model is flexible and can capture the changes in the variance between state processes as well as changes in the mean.

The unobserved state variable s_t is described according to a first order Markov process:

$$\text{Prob}[\,s_t = 1 \mid s_{t-1} = 1\,] = p_{11}\,, \quad \text{Prob}[\,s_t = 2 \mid s_{t-1} = 1\,] = p_{12} = 1 - p_{11}\,, \tag{5}$$

$$\text{Prob}[\,s_t = 2 \mid s_{t-1} = 2\,] = p_{22}\,, \quad \text{Prob}[\,s_t = 1 \mid s_{t-1} = 2\,] = p_{21} = 1 - p_{22}\,, \tag{6}$$

where $p11$ denotes the probability of being in the regime one, given that the system was in the regime one during the previous period; and $p22$ is the probability of being in the regime two, given that the system was in the regime two during the previous period, respectively. Thus, $p12 = 1 - p11$ defines the probability that y_t changes from state 1 in the period t-1 to state 2 in the period t, and $p21 = 1 - p22$ defines the probability of a shift from state 2 to state 1 between the times t-1 and t.

In case of Markov's switching, the model (2)-(3) is a Markov switching dynamic regression (MSDR) model. When the coefficients for lags are regime invariant, the model can be considered as a variant of the Markov switching intercept (MSI) specification.

5. Econometric results

We have developed a Markov switching autoregressive model of unemployment rate with an exogenous variable of real gross domestic product:

$$\Delta\,UR_t = \mu_t(r) + \sigma(r)\,u_t\,, \tag{7}$$

$$\begin{aligned}\mu_t(r) = {} & c_r + \varphi_{1r}\,\Delta\,UR_{t-1} + \varphi_{2r}\,\Delta\,UR_{t-2} + \beta_{1r}\,\Delta\log RGDP_t + \\ & + \varphi_3\,\Delta\,UR_{t-3} + \varphi_4\,\Delta\,UR_{t-4} + \gamma_1\,\Delta\log RGDP_{t-1} + \\ & + \gamma_2\,\Delta\log RGDP_{t-2} + \gamma_3\,\Delta\log RGDP_{t-3} + \gamma_4\,\Delta\log RGDP_{t-4}\,,\end{aligned} \tag{8}$$

where UR_t is the seasonally adjusted unemployment rate in Ukraine, ΔUR_t is its first differences, $RGDP_t$ is real GDP in Ukraine, $\Delta\log RGDP_t$ is the first differences of its natural logarithms that defines the growth rate of $RGDP$. To estimate the probabilities, we applied the following logistic model:

$$p_{11}(t,\delta) = \exp(\delta_{11} + \delta_{12}UR_{t-1})/(1 + \exp(\delta_{11} + \delta_{12}UR_{t-1}))\,, \tag{9}$$

$$p_{22}(t,\delta) = \exp(\delta_{21} + \delta_{22}UR_{t-1})/(1 + \exp(\delta_{21} + \delta_{22}UR_{t-1}))\,, \tag{10}$$

where $\delta = (\delta_{11}, \delta_{12}, \delta_{21}, \delta_{22})$ are unknown parameters of transition probabilities specification.

The nonlinear switching model (7)-(10) was estimated by the method of maximum likelihood estimation. We used,

which were published in statistical reports by the State Statistics Service of data relating to the 2002-2017 period Ukraine and EUROSTAT for model construction and estimation. The results are presented in Table 1 which contains the parameter estimates along with their standard errors, z-statistics and corresponding p-values for testing statistical significance of each factor.

We obtained distinct estimates of the intercept, two autoregressive coefficients for lags of UR and coefficients for $\Delta \log RGDP$ in each regime. In the bottom section of Table 1, we gave the results for the regime invariant coefficients by the third and fourth lag of UR and the lag from 1 to 4 for $RGDP$. The evaluation revealed significant differences between the regimes. Actually, the first regime was associated with a decline in the unemployment rate, while the second one explained its increase. The values of z-statistics imply that the current value of real GDP has a significant impact on unemployment behaviour as well as its previous values.

To diagnose the adequacy of the evaluated model, we applied an autocorrelation test for different lags orders, a heteroscedasticity test of ARCH effects and a test of normal distribution by means of Jarque-Bera statistics. We used Akaike information criteria to compare different model specifications. The results of the tests, given in Table 2, demonstrated the normal distribution of residuals, the absence of conditional heteroscedasticity and no autocorrelation of the residuals. Thus, the results of the statistical tests show the correctness of the conducted modelling and the adequacy of the Markov switching nonlinear logistic model in describing dynamic changes in the behaviour of the labour market indicators in Ukraine.

Table 3 represents the estimation settings of the logistic coefficients for the regime probabilities. Since the model allows for the Markov switching, the probabilities of being in regime 1 and regime 2 depend on the origin state. We used the lag of unemployment level as an indicator variable in our probability equation (9)-(10) so that the previous values of unemployment corresponded to the values influencing the transitions for t-1 to t. The signs of the estimated coefficient (δ12 and δ22) show that a higher level of past unemployment causes a decrease in the probability of remaining in the declining regime; if otherwise, it leads an increase in probability of being in rising regime.

The estimated transition probabilities for Ukraine imply a higher probability of remaining in the origin regime, in comparison with transition from one state to another. Simultaneously, we observe a greater probability (0.81) of being in regime 2, which is associated with the growth of unemployment, and only 0.57 for the declining regime. Therefore, the average expected probability of transition from the low unemployment regime to the high regime (0.43) is relatively high. The corresponding expected durations in the regime are roughly 2.3 and 5.3 quarters, respectively.

For Poland, we have received distinctive results (Table 3). The probability of being in the regime with increasing unemployment and the probability of transition from a high level to the declining regime are similar. It means that Polish unemployment does not tend to a high value of the unemployment rate. Also, we observe a greater probability of remaining in the decreasing unemployment regime (0.82) and a longer duration of the favourable mode for labour market in Poland.

Tab. 1: **Estimation results of the Markov switching autoregressive model for the Ukrainian unemployment rate data relating to the 2002-2017 period**

Variable	Coefficient	Standard error	*z*-Statistic	*p* - value
Regime 1				
C	-0.001	0.000	-37.385	0.000
Δ *UR* (-1)	0.009	0.009	0.963	0.335
Δ *UR* (-2)	0.279	0.006	44.056	0.000
Δlog *RGDP*	-0.014	0.001	-16.767	0.000
Regime 2				
C	0.002	0.002	0.928	0.354
Δ *UR* (-1)	0.369	0.293	1.258	0.208
Δ *UR* (-2)	-0.093	0.313	-0.297	0.767
Δlog *RGDP*	-0.125	0.103	-1.221	0.222
Regime Invariant Estimates				
Δlog *RGDP* (-1)	-0.015	0.002	-8.899	0.000
Δlog *RGDP* (-2)	-0.034	0.001	-46.409	0.000
Δlog *RGDP* (-3)	0.004	0.001	5.969	0.000
Δlog *RGDP* (-4)	-0.010	0.001	-16.597	0.000
Δ *UR* (-3)	-0.495	0.004	-137.461	0.000
Δ *UR* (-4)	0.286	0.007	42.737	0.000

Source: Compiled and calculated by the authors

Tab. 2: **Model Diagnostic Statistics**

Autocorrelation Test				**Heteroscedasticity Test**			
LM(1)	p-value	LM(4)	p-value	ARCH(1)	p-value	ARCH(4)	p-value
0.3943	0.530	3.7425	0.442	0.5286	0.467	2.0641	0.724
Log-likelihood	**Information Criteria**		**Residual Normality Distribution Test**				
log (L)	AIC		Skewness	Kurtosis	Jarque-Bera statistics		*p* - value
192.1310	-8.0060		0.5518	3.5327	2.6909		0.2604

Source: Compiled and calculated by the authors

Tab. 3: **Estimated transition probabilities and expected durations**

Country	δ_{11}	δ_{12}	δ_{21}	δ_{22}
Ukraine	0.2820	-0.0004	-2.6858	0.1616
	(9.0485)	(1.1170)	(4.2146)	(0.5494)
Poland	-0.5465	-0.1442	-1.9204	0.1939
	(1.3333)	(0.1835)	(2.1549)	(0.2969)
	p_{11}	p_{12}	p_{21}	p_{22}
Ukraine	0.5692	0.4308	0.1903	0.8097
	(0.0001)	(0.0001)	(0.0274)	(0.0274)
Poland	0.8236	0.1764	0.6199	0.3801
	(0.0524)	(0.0524)	(0.1259)	(0.1259)
	$duration_1$		$duration_2$	
Ukraine	2.3212		5.3501	
	(0.0006)		(0.6948)	
Poland	6.3291		1.6932	
	(2.2954)		(0.4042)	

Note: Standard deviations are given in parentheses ().

Source: Compiled and calculated by the authors

6. Conclusions

The instability, dramatic internal disturbances of economic and social environment, and strong external shocks cause the negative processes in the Ukrainian labour market, which are accompanied by significant nonlinear cyclical fluctuations in both the economic activity and the unemployment rate. On the contrary, the Polish labour market demonstrates positive tendencies and recovery.

The conducted econometric analysis reveals that the unemployment rate dynamics is characterised by asymmetric lags in its cyclical behaviour during the periods of economic growth and recession. After a significant economic downturn, the recovery of the Ukrainian labour market occurs at a slower pace than the recovery of the overall economic and business activity and much slower than in Poland, Ukraine's neighbour.

The developed Markov switching autoregressive model implies different regimes of the unemployment rate behaviour over time, which have been associated with the declining and rising modes. Changes in jobless recovery depend on the current and previous changes in real gross domestic product, which have a significant impact on the unemployment rate in both regimes. The estimated regime transition probabilities in terms of being in either of the regimes implies that the Ukrainian labour market shows a greater probability of remaining in the increasing unemployment regime as well as a relatively high probability of transition from low to high unemployment.

On the contrary, the Polish unemployment rate is characterised by a high probability of being in a regime with low and declining unemployment, as well as a low probability of moving into an unfavourable situation, which reflects stability of its labour market. The opposite features attributed to the Ukrainian labour market, on the one hand, and the Polish labour market, on the other hand, cause significant labour migration from Ukraine to Poland. The high uncertainty in Ukraine is a motive to seek jobs overseas, especially for the young generation.

The results of the investigation confirm the urgency and importance of immediate positive shifts and development of the Ukrainian labour market in order to preserve human capital and, taking into account the negative demographic trends, ageing of the population and significant labour migration, to prevent potential depletion of the labour force.

References

1. Guryanova, L., Klebanova, T., Sergienko, E., & Goncharenko, G. (2012). The Model of the Analysis of Asymmetry of Social and Economic Development of Regions. *Problemy ekonomiky (Problems of Economics), 2,* 27-33 (in Russ.).
2. Kharlamova, G., & Vertelieva, O. (2013), The International Competitiveness of Countries: Economic-Mathematical Approach. *Economics & Sociology, 6*(2), 39-52. doi: https://doi.org/10.14254/2071-789X.2013/6-2/4
3. Taner, M., Bulent, S., & Hakan, M. (2011). An Alternative Human Development Index Considering Unemployment. *South East European Journal of Economics and Business, 6*(1), 45-60. doi: https://doi.org/10.2478/v10033-011-0005-z
4. Lukianenko, I. (2010). Features of constructing a dynamic stochastic model of general equilibrium for the analysis of the Ukrainian economy. *Ekonomichna Kibernetyka (Economic cybernetics), 4-6,* 64-66 (in Ukr.).
5. Daradkeh, J., Guryanova, L., Klebanova, T., & Kavun, S. (2012). Forecasting the Cyclical Dynamics of the Development Territories: Conceptual Approaches, Models, Experiments. *European Journal of Scientific Research, 74*(1), 5-20. Retrieved from https://www.researchgate.net/profile/Sergii_Kavun/publication/273001884_Forecasting_the_cyclical_dynamics_of_the_development_territories_Conceptual_approaches_models_experiments/links/54f4c4180cf2eed5d7357142.pdf
6. Oliskevych, M. (2015). Hysteresis, Structural Shocks and Common Trends in Labor Market: Consequence for Ukraine. *Economic Studies, 4,* 120-137. Retrieved from https://www.ceeol.com/search/article-detail?id=287986
7. Lukianenko, I., & Oliskevych, M. (2015). The Effects of Shocks on the Labor Market: SVEC Modeling. *Procedia Economics and Finance, 27,* 311-322. doi: https://doi.org/10.1016/S2212-5671(15)01002-3
8. Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica, 57*(2), 357-384. doi: https://doi.org/10.2307/1912559
9. Deschamps, P. J. (2008). Comparing smooth transition and Markov switching autoregressive models of US unemployment. *Journal of Applied Econometrics, 23*(4), 435-462. doi: https://doi.org/10.1002/jae.1014
10.Bayat, T., Kayhan, S., & Kocyigit, A. (2013). Asymmetric Behavior of Unemployment Analysis with Regime Switching Models in Turkey. *Business and Economics Research Journal, 4*(2), 1-79. Retrieved from http://www.berjournal.com/asymmetric-behavior-of-unemployment-analysis-with-regime-switching-models-in-turkey
11. Gaston, N., & Rajaguru, G. (2015). A Markov-switching structural vector autoregressive model of boom and bust in the Australian labour market. *Empirical Economics, 49*(4), 1271-1299. doi: https://doi.org/10.1007/s00181-015-0920-4
12. Shalari, O., Laho, E., & Gumeni, A. (2015). The asymmetry and fractional integration of the unemployment rate in Albania. *International Journal of Economic Policy in Emerging Economics, 8*(3), 229-244. doi: https://doi.org/10.1504/IJEPEE.2015.072344
13. Koenders, K., & Rogerson, R. (2005). Organization dynamics over the business cycle: A view on jobless recoveries. *Federal Reserve Bank of St. Louis Review, 87*(4), 555-579. doi: https://doi.org/10.20955/r.87.555-580
14. Schreft, S. L., & Singh, A. (2003). A closer look at jobless recoveries. *Economic Review, Federal Reserve Bank of Kansas City, QII,* 45-73. Retrieved from https://www.kansascityfed.org/Publicat/econrev/Pdf/2q03schr.pdf
15. Andolfatto, D., & MacDonald, G. M. (2004). Jobless recoveries. *Macroeconomics, 0412014,* EconWPA. Retrieved from http://econwpa.repec.org/eps/mac/papers/0412/0412014.pdf
16. Klinger, S., & Weber, E. (2016). Detecting unemployment hysteresis. A simultaneous unobserved components model with Markov switching, *Economics Letters, 144*(C), 115-118. doi: https://doi.org/10.1016/j.econlet.2016.04.027
17. Brooks, C. (2008). *Introductory Econometrics for Finance* (2nd ed.). New York: Cambridge University Press. doi: https://doi.org/10.1017/CBO9780511841644
18. Oliskevych, M. (2015). Processes Dynamics Asymmetry at Labour Market: Nonlinear econometric Analysis. *Actualni problemy ekonomiky (Actual problems of economics), 164*(2), 427-436 (in Ukr.).
19. Schwartz, J. (2012). Labor market dynamics over the business cycle evidence from Markov switching models. *Empirical Economics, 43*(1), 271-289. doi: https://doi.org/10.1007/s00181-011-0486-8
20. Misra, R. (2015). Impact of Demographic Dividend on Economic Growth. *International Studies, 52*(1-4), 99-117. doi: https://doi.org/10.1177/0020881717714685

Received 18.04.2017