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DYNAMIC ANALYSIS OF MACROECONOMIC FLUCTUATION SOURCES IN UKRAINE

Summary
The article presents an empirical research of the macroeconomic fluctuation dynamics in Ukraine. The investigation of behaviour of real gross domestic product and unemployment rate as well as the correlation relationship between them are conducted. We interpret fluctuations in real GDP and unemployment as due to two types of disturbances: disturbances that have a permanent effect on output and disturbances that do not. On the basis of developed structural autoregressive vector error correction model the impact of demand and supply shocks are investigated. Short-run and long-run reactions of variables on macroeconomic disturbances are obtained by impulse response analysis. Forecast error variance decomposition is analyzed. The investigation have showed that positive supply disturbances have a permanent impact on output and lead to increase its growth rate in the long term, besides this these disturbances statistically significantly reduce a cyclical unemployment.

Introduction

The current state of macroeconomic situation in Ukraine is characterized by considerable volatility that connected with transitional and crisis periods of economic development. In terms of changing internal and external economic environment, globalization, structural change and macroeconomic disturbances we observe institutional, economic, social and information asymmetries, with both positive and negative consequences. The existing significant disparity in the employment, wages and productivity, uneven income distribution, social vulnerability of the poor, increased unemployment and asymmetry process to adapt to volatile market conditions, identify urgent problems of the domestic economic situation.

In a globalizing world economy must be figured on that the formulation and implementation of economic policy are compounded by the impact of exogenous factors and shocks. The response to them because of the inertia of the labour market and unemployment hysteresis can be not only temporary but have long-term nature. The efficiency of solving social and economic problems require improved methods of modelling the transformation processes and to develop methodological bases assess the nature and impact of different types of disturbances economic environment in the short and long-term dynamics of changes in the components of industrial relations. In this regard, there are important structural dynamic analyses of economic and mathematical models that allow identifying the characteristics of the impact of macroeconomic shocks on macroeconomic indicators both in the short and in the long run.

In terms of macroeconomic fluctuations, it is important to explore the structural and cyclical factors unemployment and to characterize shocks that lead to permanent changes in the level of unemployment. Open question of current research is search for fluctuation sources and investigation of structural and cyclical factors that caused variations of aggregate output and unemployment. Scientists show that temporary disturbances lead to permanent changes in the level of unemployment. But they also justify that the only signs of hysteresis in unemployment, which are found in various countries, do not allow making an accurate conclusion and is difficult to distinguish cyclical and structural factors of unemployment and aggregate output fluctuations [C. Wyplosz, 1994].

Scientists base a modern analysis and investigation of macroeconomic fluctuations in the various countries on vector dynamic econometric models studying.

T. Jacobson, A. Vredin, A. Warne (1997) investigated first the sources of market fluctuations in the Nordic countries on the basis of structural vector autoregression model with common trends. They analyzed factors and differences in unemployment between the labour markets of Denmark, Norway and Sweden. The result of the simulation revealed the presence of hysteresis in unemployment not only for the labour market of Denmark, which shows European trends, but also for Sweden and Norway, which are characterized by traditionally low and stable unemployment. Authors justify the existence of three disturbances that have long-term effects on unemployment, namely technological shocks, labour supply shocks and equilibrium unemployment shocks (or wages shocks), while the impact of labour demand shocks have only a short-term effect.

The methodology of structural vector autoregression analysis used in their studies many scientists in the world. Among others J. García-Solanes, J. Rodríguez-López and J. Torres (2011) based on SVAR methodology have developed stochastic model for an open economy and have explored the dynamics of credit current account balance for G-7 countries. S. Leu (2011) has evaluated the neo-Keynesian SVAR model for the Australian economy. J. Jurgutyte (2006) based on structural analysis and decomposition shocks Blanchard-Quah has analyzed the benefits of the euro input and synchronization of business cycles between Lithuania and other EU countries.

Scientists study the reaction of macroeconomic variables to the three different types of disturbances, such as supply shocks, real demand shocks and nominal shocks. In particular F. Issaoui, T. Boufateh and G. El (2013) have examined the impact of oil prices shocks to added value in industry for a number of countries with different levels of economic development. H. Ghassan, M. Souissi and

M. Alaoui (2009) have analyzed the problem of identifying the impact of macroeconomic shocks on the economy of Morocco. N. Arfa (2012) has used structural vector autoregression model to determine the main sources of pulses and explain economic fluctuations in the economy of France. A. Afonso and R. Sousa (2011) have rated the Bayesian SVAR model to analyze the macroeconomic effects of fiscal policy and have explored the impact of disturbances in public spending to real GDP and public debt dynamics in Portugal. M. Partridge and D. Rickman (2009) have analyzed the dynamics of labour markets Canadian provinces based on structural vector autoregression model with restrictions on long-term effects. They have investigated three components market fluctuations related to shocks in labour demand (jobs), labour supply shocks arising from migration (new people) and domestic labour supply (indigenous people). T. Cravo (2011) studied the effect of fluctuations in economic activity and employment at large and small companies in various sectors and regions of Brazil. He shows that the behaviour difference between the growth rates of employment between large and small firms are countercyclical. K. Park (2012) examined the impact on industry employment in the US production of two types of shocks: aggregate and sectoral. For isolating the impact of each shock he built two independent VAR models: factor-augmented vector autoregression (FAVAR) model to identify aggregate shocks and industry SVAR model to identify sectoral disturbances.

The researchers note that study the impact of shocks of different types on the labour market is particularly relevant and important for understanding the dynamics of the labour market in developing countries, to develop national, sectoral and regional employment policies aimed at damping employment, especially in periods of economic recession.

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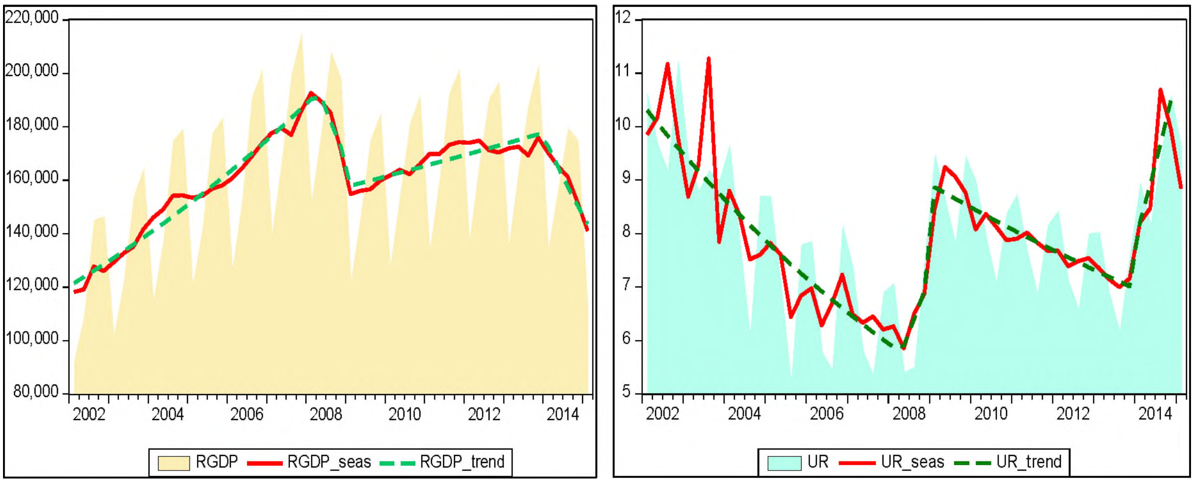
Part 1. Theoretical model and data analysis

The aim of our research is studying and building an econometric model of the dynamic relationship between real GDP growth and cyclical unemployment in Ukraine on the basis of structural vector cointegration model. This study will allow to generalize the Okun's law and to quantify the impact of different types of shocks. We consider two types of disturbances that affect to output and employment, namely aggregate supply shocks and aggregate demand shocks and investigate their temporary and long-term impact.

By exploring of movement the aggregate demand curve (AD) and long term (LRAS) and short term (SRAS) aggregate supply curve is found that the permanent positive demand shock which causes shift of AD curve to the right leads to constant rise in prices and to short-term increase in output, but in the long-term it returns slowly to the initial level [D. Romer (2011)]. Due to positive supply shock that moves to the right both the short and long-term aggregate supply curves, short-term equilibrium shifts along the aggregate demand curve to the point where there are a higher performance and a lower prices. In addition over time as a result of moving to the right LRAS we observe further growth in production and lower prices. Therefore, it can be argued that supply shocks have a permanent impact on output and prices, while positive demand shocks cause permanent price increase and only a temporary increase in output.

Various factors affect the movement of supply and demand curves. Usually AS curve reacts to structural changes in the economy, causing a shift of release conditions of full employment and may be caused by technological shocks or shocks factors. AD curve may move via two types of disturbances. The first group of factors relates to real demand shocks (changes in public or private spending, changes in taxes, welfare or expected future production), another group of factors caused by monetary policy or shocks in the currency markets (changes in the supply of nominal money supply, nominal interest rate, inflation expectations, etc.) [A. Abel and B. Bernanke (2005), p. 337–338].

Full employment of the working age population in Ukraine prevent instability of the labour market that is caused by structural changes and instability of the national economy as well as typical seasonal fluctuations in unemployment that are caused by seasonal fluctuations in the output of industries. Fig. 1 plots the behaviour of Ukraine's real GDP and unemployment rate defined by ILO during the 2002–2015 years, and the dynamics of their seasonally adjusted (using multiplier method Census X12) values.



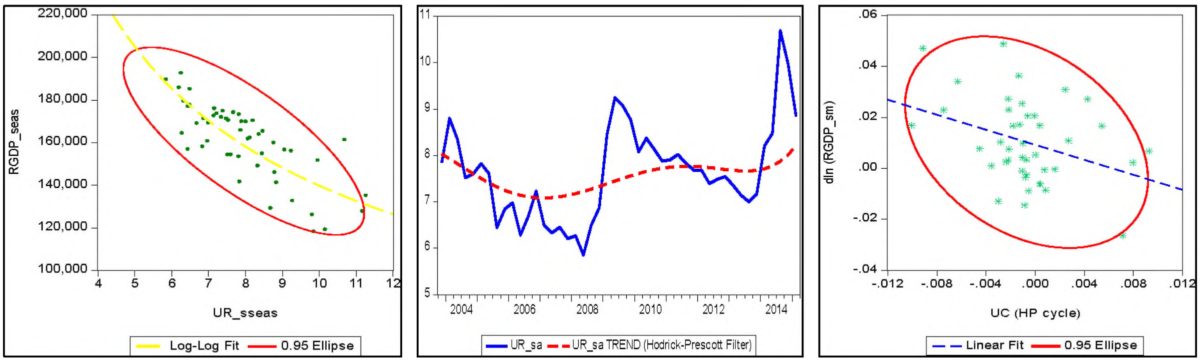
(a) (b)

Fig. 1. Dynamic of (a) real GDP; (b) unemployment rate in Ukraine during 2002-2015

Source: data of the State Statistics Service of Ukraine, evaluation of the authors

The results of the econometric estimation for trend component behaviour of real GDP (series $RGDP_t$) and unemployment rate (series UR_t) based on log-linear models indicated the shifts in the specifications and determined statistically significant changes in their slopes. External disturbances negative economic environment is one of the reasons for the decline of domestic production, increase public debt, significant outflow of deposits, decline in construction and reduced exports.

The modelling showed that as a result of adverse macroeconomic shocks caused by the global economic crisis at the end of 2008, the level of real output got a significant negative shift also its growth rate reduced statistically significantly. In 2008 growth rate RGDP was 1.8% in the quarter, after 2009 this had fallen to 0.8%. In recent years, an economic and political situation in Ukraine complicated significantly. In 2014 the level of real GDP that characterizes the final result of production activity decreased significantly. According to Okun's law reducing GDP leads to an increase in the number of unemployed. Therefore, along with a reduction in real output, we observed the increased unemployment (Fig. 1(b)), which in late 2008 abruptly increased from 5.4 to 9.3 percent, and in 2014 from 7.6 to 10.6%. But the slope of UR series trend line did not experience statistically significant changes. Reducing of unemployment rate was with score -0.0234 till 2008 and –0.0103 from 2009 till the end of 2013. Statistical analysis showed a strong inverse relationship between unemployment and dynamic behaviour of real output (Fig. 2(a)), the correlation coefficient between these indicators is -0.62.



(a) (b) (c)

Fig. 2. (a) Correlation between real GDP and unemployment rate; (b) dynamics of natural unemployment rate; (c) correlation between *RGDP* growth and cyclical unemployment *UC*

Source: data of the State Statistics Service of Ukraine, evaluation of the authors

Jobless of labour force is observed because of frictional, structural and cyclical unemployment, which are caused by three main reasons for unemployment: job search, inflexibility of wages, insufficient aggregate demand. A structural unemployment is associated with technological changes in production, loss of need in some professions. A frictional unemployment is associated with the dynamics of a new job search people who are (mostly) retired voluntarily, completed higher education or lost seasonal work (especially in rural areas). Both of them determine the natural rate of unemployment that characterizes the labour market with full employment when jobs correspond to the number of people looking for work.

The dynamic of unemployment natural rate we defined by applying the Hodrick–Prescott filter to seasonal adjusted UR series (Fig. 2(b)). Deviations from the natural trajectory determine the dynamics of cyclical unemployment that caused by irregular and usually unpredictable economic fluctuations related to the uneven level of business activity in different periods. Business cycles that may have a different duration are accompanied by fluctuations in output and employment. They occur as a result of the impact of demand shocks and because of the impact of supply shocks. During of recession that could be particularly due to falling of goods and services demand the cyclical unemployment increase.

The relationship between real GDP growth and the cyclical unemployment rate was evaluated by A. Okun for the first time quantitatively. He found that in the early years of the 60th in USA increasing of deviation in actual unemployment rate from it natural rate of 1% led to output gap of 2.5% [A. Abel and B. Bernanke (2005)]. GDP gap characterizes the economic costs of unemployment and measures the amount of goods and services that society lost due to the fact that some of its resources was not used. Econometric analysis for Ukraine also shows the inverse relationship between cyclical unemployment and GDP growth (Fig. 3(c)). Estimated Okun's coefficient is equal approximately to 1.5%.

We will generalize the Okun’s model and will construct a dynamic vector model that describes the relationship between real GDP growth and cyclical unemployment that is denoted UC, but also allows to consider and quantitatively describe the impact of aggregate supply shocks and aggregate demand shocks. We assume that demand shocks have no permanent impact effect on unemployment and aggregate output, but supply shocks can have long term effects on output.

Interpretation of disturbances that have a permanent effect as supply shocks and disturbances with a temporary effect as demand shocks is motivated by traditional Keynesian view of the fluctuations and labour market model that is developed by S. Fischer (1977)

$$y(t) = m(t) - p(t) + \alpha\,\theta(t), \tag{1}$$

$$y(t) = l(t) + \theta(t), \tag{2}$$

$$p(t) = w(t) - \theta(t), \tag{3}$$

$$w(t) = \mathrm{E}_{t-1}\,[\,w \mid l(t) = l^0\,]. \tag{4}$$

The variables $y = \log Y$, $l = \log L$ and $\theta = \log \Theta$ denote natural logarithms of output Y, employment L and productivity Θ respectively. Full-time employment is determined by the value l^0=log L^0, and p=log P, w=log W i m=log M are logarithms of price level, nominal wages and money supply

Equation (1) determines the aggregate demand as a function of real money balances and productivity. Production function that is given by (2) connects output, employment and productivity and assumes constant returns to scale. Equation (3) determines the behaviour of prices depending on nominal wages and productivity. Equation (4) describes the process of wage formation. In particular, it is assumed that wages are determined in the previous period and it is based on the expectation of full employment. Note that under this model productivity have a directly affect to aggregate demand that in particular can be explained by changes in investment demand (in this case $\alpha > 0$).

Model (1)–(4) is completed by stochastic equations that describe the dynamics of money supply and productivity

$$m(t) = m(t-1) + e^d(t), \tag{5}$$

$$\theta(t) = \theta(t-1) + e^s(t), \tag{6}$$

where $e^d(t)$ i $e^s(t)$ – aggregate demand shocks and aggregate supply shocks serially uncorrelated and orthogonal. Defining the unemployment rate as $u(t)=l^0 - l(t)$ and solving the model regarding $u(t)$ and output $y(t)$, we obtain

$$\Delta y(t) = e^d(t) - e^d(t\text{-}1) + \alpha\,(e^s(t) - e^s(t\text{-}1)) + e^s(t),$$

$$u(t) = -\,e^d(t) - \alpha\, e^s(t).$$

Therefore the model (1)–(6) shows that the effects of demand shocks to output and unemployment are short term in nature and disappear with time. In the long term only supply shocks, which are caused by disturbances in productivity affect to output.

The methodology of model constructing is based on dynamic vector autoregression model for $x_t = (Q_t, UC_t)'$, where $Q_t = \log RGDP\_sm_t$ denotes the natural logarithm of seasonal and shift adjusted series of real GDP level; UC_t – cyclical unemployment rate that we measure as deviation of seasonal adjusted series of unemployment (according to the ILO) from nonlinear trend line that was defined by Hodrick–Prescott filter; series $\Delta\log RGDP\_sm_t$ measures the rate of real GDP growth.

Stochastic factors influence in the model definite a structural supply shocks and demand shocks respectively. They are denoted as η^d and η^s. We assume that demand shocks have no long-run impact on output. Then innovations of the two-dimensional Wald decomposition for output growth rate and unemployment are determined as linear combinations of disturbances that are the basis of supply and demand shocks. The idea of such a modelling was suggested by O. Blanchard and D. Quah (1989).

If the vector $\boldsymbol{x}_t$ is determined by stationary process

$$x_t = A(0)\,\eta_t + A(1)\,\eta_{t\text{-}1} + \ldots = \sum_{j=0}^{\infty} A(j)\,\eta_{t\text{-}j}\,,\ \mathrm{Var}\,[\eta] = I, \tag{7}$$

where $A(j)$ – sequence of matrices such that their sum of (1,1) elements is zero $\sum_{j=0}^{\infty} a_{11}(j) = 0$, then equation (7) defines the dynamics of Q_t and UC_t as distributive process with distributed lags of two disturbances η^d and η^s. Contemporaneous effects $\eta = (\eta^d, \eta^s)$ to x are determined by matrix $A(0)$. Further lagged effects are defined by $A(j), j\geq 1$. Restrictions $\sum_{j=0}^{\infty} a_{11}(j) = 0$ means that η^d has no effect on the Q level. If x is stationary, there is a moving average representation [W. Enders (2010), p. 297]

$$x_t = v_t + C(1)\,v_{t\text{-}1} + \ldots = \sum_{j=0}^{\infty} C(j)\,v_{t\text{-}j},\ \mathrm{Var}\,[v] = \Xi. \tag{8}$$

Comparing equation (7) and (8) we see that innovation vector v and the vector of initial disturbances v are related by $v = A(0)\eta$, where $A(j) = C(j)A(0)$ for all j. After estimating of $A(0)$ we can determine η using the estimated v and estimate $A(j)$ on the basis of estimates $C(j)$. From (7) and (8) follows that $A(0)$ satisfies the condition

$A(0)A'(0) = \Xi$ and that the upper-left element in $A(j)$ is zero. The first condition for known Ξ imposes three restrictions on the four elements of $A(0)$. Besides having C(j) we can impose the fourth restriction. First we build the matrix $A(0)$ and use it for $A(j) = C(j)\ A(0)$, $j = 0,1,2, ...$, and $\eta_t = A(0)^{-1}\ v_t$. Therefore, the model describes the dynamics of output and unemployment rate as a function of current and past disturbances of supply and demand.

Common dynamic modelling of real output and unemployment we begin with estimation and investigating of vector autoregression model in the general form [H. Lutkepohl and M. Kratzig (2004), p. 88]:

$$x_t = A_1\, x_{t-1} + \ldots + A_p\, x_{t-p} + \varepsilon_t\ , \qquad (9)$$

where $x_t = (y_{1t}, ..., y_{Kt})'$ is $(K\times 1)$ – vector of endogenous variables, A_j $(j=1,\ldots,p)$ – $(K\times K)$-matrices.

However using VAR specification (9) suggests that the roots of the characteristic equation $|\, I_n - A_1 z - A_2 z^2 - \ldots - A_p z^p\,| = 0$ lie outside the unit circle and correspond to the case of stationary variables. If series are non-stationary, it is necessary to use a VAR model for the first differences. If series are cointegrated, it is correctly to use a vector error correction model.

Part 2. Econometric modelling and empirical results

The investigation results of stationarity for *RGDP* and *UC* series in level and also their deviations from trend lines shown in Table 1. The conclusions of augmented Dickey-Fuller test confirm the presence of a unit root in levels and stationarity of their first differences series.

Table 1

Results of augmented Dickey-Fuller unit root test

Variable	Deterministic terms	*ADF*-statistic	Variable	Deterministic terms	*ADF*-statistic
log *RGDP_sm*	Const, Trend, Shift	-0,3209	Δlog *RGDP_sm*	Const, Shift	-6,129**
UR_sm	Const, Trend, Shift	-3,7229	Δ *UR_sm*	Const, Shift	-9,590**
e_RGDP	Const	-3,3219	Δ *e_RGDP*	–	-8,492**
UC	Const	-2,4105	Δ *UC*	–	-6,016**

Note: ** denotes statistically significant on the level 5%.
Source: evaluation of the authors

Testing of causality and its direction we do using Granger causality procedures [C. Brooks (2008), p. 298]. Using the Lagrange multipliers test we have found that changes in real GDP cause changes in unemployment rate in these periods, while the opposite effect have not showed statistical significance (Table 2). The results of the

Ingle-Granger test have indicated the presence of cointegration relationships between the variables (Table 2).

Table 2

Results of causality and cointegration tests

Pairwise Granger Causality Tests				
Null Hypothesis:			*F*-Statistic	*p*-value
UC does not Granger Cause log *RGDP*			0,0201	0,9801
log *RGDP_sm* does not Granger Cause *UC*			5,8568	0,0057
Engle-Granger Cointegration Tests				
Dependent Variable	tau-Statistic	*p*-value	*z*-Statistic	*p*-value
log *RGDP*	-4,8436	0,0014	-31,4877	0,0009
UC	-5,2849	0,0004	-35,8003	0,0002

Source: evaluation of the authors

Since our series are cointegrated the correct model to describe their behaviour can be a structural vector error correction model that in general takes the form [H. Lutkepohl and M. Kratzig (2004), p. 162].

$$B\,\Delta x_t = \Pi\, x_{t-1} + \Gamma_1\,\Delta x_{t-1} + \ldots + \Gamma_{p-1}\,\Delta x_{t-p+1} + R\,\eta_t\,, \tag{10}$$

where $\Delta x_t = x_t - x_{t-1}$, matrix $\Pi = -(I - \sum_{j=1}^{p} A_j)$ – describe long-term effects; $\Gamma_k = -\sum_{j=k+1}^{p} A_j$, $(k = 1,\ldots,p-1)$. Reduced form of model (10) is

$$\Delta x_t = \Pi^*\, x_{t-1} + \Gamma^*_1\,\Delta x_{t-1} + \ldots + \Gamma^*_{p-1}\,\Delta x_{t-p+1} + \varepsilon_t\,, \tag{11}$$

where $\Pi^* = B^{-1}\Pi$, $\Gamma^*_k = B^{-1}\Gamma_k$. Innovation of reduced form ε_t and structural shocks η_t are related by [J. Breitung (2001)]

$$\varepsilon_t = B^{-1} R\,\eta_t\,. \tag{12}$$

Matrices B i R are non-singular. Vector of disturbances $u_t = R\,\eta_t$ is described by white noise process with zero mean and covariance matrix $E[u_t\, u_t'] = \Omega$.

We estimate the parameters of SVEC model (11)–(12) for series of real GDP and unemployment in Ukraine. The necessary calculations have performed in a specialized econometric package JMulti. The simulation results that have obtained on the basis of maximum likelihood the method is given in Table 3. Note that the constructed model is combined the estimation of long-term relationships between variables and the description of dynamics of their short-term behaviour. In this model, the real GDP growth rate and changes in cyclical unemployment are connected by system of equations for their previous values and previous deviations from long-term equilibrium cointegrating relationships. Estimated coefficient of adaptability rates define the convergence to long-term trajectories and their negative signs indicate that the variables tend to break the gap between them and tend to decrease if there is a positive deviation from equilibrium.

Selection number of lags that are included in the model is based on the sequence of modified likelihood ratio statistic (LR), the final prediction error (FPE), multidimensional Akaike Information Criterion and Schwarz Criterion [C. Brooks (2008), p. 233].

Table 3

Results of estimation VEC model (11)–(12)

Variable	Equation for $\Delta\log RGDP\_sm$		Equation for ΔUC	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Coefficients of short-run effect				
Const	0,137	2,545**	–0,078	–5,922**
$\Delta\log RGDP(t\text{-}1)$	0,114	0,704	0,114	0,558
$\Delta UC(t\text{-}1)$	–0,056	–0,134	0,022	–4,071**
$\Delta\log RGDP(t\text{-}2)$	0,065	0,399	0,065	-0,221
$\Delta UC(t\text{-}2)$	0,488	1,331	–0,009	–2,882**
Adjustment speed coefficients				
$E\_long(t\text{-}1)$	–0,471	–5,851**	–0,186	–2,547**
Coefficients of cointegrating long run relationship				
UC	log *RGDP*		*Trend*	
Coefficient	Coefficient	*t*-statistic	Coefficient	*t*-statistic
1,00	–0,021	4,476**	0,001	3,102**

Source: evaluation of the authors

The main elements in the SVEC model are structural shocks η^s_t and η^d_t. Since they are not predicted using past performance that generates by vector time series x_t and cannot be directly observed, it requires certain assumptions to their identification. In order to determine the parameters of the structural form for the matrices of parameters B, R, A_1, …, A_p, Ω we have to impose restrictions that are usually based on the findings of economic theory and contain conditions of non-correlation of structural disturbances, normalized variances of shocks, restrictions on contemporaneous and long-term effects. In particular to identify the full model should impose $K^2+K(K-1)/2$ restrictions [H. Lutkepohl and M.Kratzig (2004)].

Imposing restrictions $B=I$, we obtain the so-called C-model. As we have $K = 2$ variables to identify structural shocks $\eta_t = (\eta^s_t, \eta^d_t)$ from the residuals VEC model we must specify $K(K-1)/2=1$ restrictions else. Due to a preliminary analysis of supply and demand shocks impact to output and unemployment we introduce a restriction that demand shocks have no long-term impact to output. This condition can be realized by imposing limits on zero (1.2) – element of long-run impact matrix Ψ. Then the structural parameters can be estimated using the LV-representation (latent variable) [J. Breitung (2001)]

$$\Delta \tilde{x}_t = R\,\xi^u_t\,, \tag{13}$$

$$\tilde{x}_{t-1} = -\,\Psi\,\xi^v_t\,, \tag{14}$$

$$\xi^u_t + \xi^v_t = \eta_t\,, \tag{15}$$

where (1.2) – element of matrix Ψ is equal zero. As a result of the evaluation system (13)–(15) we have obtained the following results:

$$\hat{\boldsymbol{\Omega}} = \begin{pmatrix} 0{,}0191 & -0{,}0008 \\ -0{,}0008 & 0{,}0011 \end{pmatrix}, \quad \hat{\boldsymbol{R}} = \begin{pmatrix} 0{,}0127 & -0{,}0056 \\ 0{,}0008 & 0{,}0033 \end{pmatrix}, \quad \hat{\boldsymbol{\Psi}} = \begin{pmatrix} 0{,}0166 & 0{,}0000 \\ 0{,}0003 & 0{,}0001 \end{pmatrix},$$

$$st.er.(\boldsymbol{R}) = \begin{pmatrix} 0{,}0029 & 0{,}0020 \\ 0{,}0007 & 0{,}0006 \end{pmatrix}, \quad t-stat.(\boldsymbol{R}) = \begin{pmatrix} 4{,}4172^{**} & -2{,}7816^{**} \\ 1{,}1094 & 5{,}4783^{**} \end{pmatrix},$$

$$st.er.(\boldsymbol{\Psi}) = \begin{pmatrix} 0{,}0045 & 0{,}0000 \\ 0{,}0001 & 0{,}0000 \end{pmatrix}, \quad t-stat.(\boldsymbol{\Psi}) = \begin{pmatrix} 3{,}6668^{**} & 0{,}0000 \\ 3{,}3457^{**} & 1{,}0151 \end{pmatrix}.$$

Analyzing the t-statistic of structural parameters, we have found that supply shocks have no significant immediate impact on the unemployment rate.

Table 4

Results of diagnostic for VEC model

Univariate statistics				
ARCH-LM test (16 lags)				
Equation	χ^2 – statistic	*p* – value	*F* – statistic	*p* – value
$\Delta \log RGDP$	8,5462	0,9309	0,7957	0,6697
$\Delta\ UC$	10,8693	0,8175	1,1673	0,4209
Non-normality Test				
Equation	Skewness	Kurtosis	Jarque–Bera statistic	*p* – value
$\Delta \log RGDP$	0,6609	4,2736	5,8964	0,0524
$\Delta\ UC$	0,8408	3,7199	5,8557	0,0535

Multivariate statistics					
VARCH-LM Test Statistic		PORTMANTEAU Test (16 lags) (H_0: $R_h=(r_1,...,r_h)=0$)		*LM-TYPE* Test for Autocorrelation (5 lags)	
χ^2 – statistic	*p* – value	Test statistic	*p* – value	*LM* – statistic	*p* – value
44,2514	0,5036	37,4314	0,9581	17,2624	0,6359
Multiple Skewness Test		Multiple Kurtosis Test		Doornik-Hansen Statistic	
χ^2 [2] – statistic	*p* – value	χ^2 [2] – statistic	*p* – value	χ^2[4] – statistic	*p* – value
6,7966	0,0334	3,5158	0,1724	10,3124	0,3551

Source: evaluation of the authors

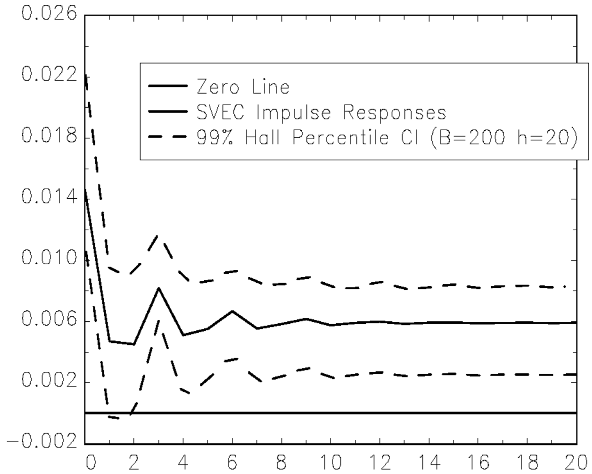
Diagnosis of structural vector error correction model was performed on the basis of residuals testing. Autocorrelation test results for residual vector of developed SVAR model, test the null hypothesis of no ARCH effects in residuals and testing of normality of their distribution based on the Jarque–Bera statistic are given in Table 4. The results of the testing have indicated non-autocorrelations of residuals, normality of distribution, rejecting of conditional heteroscedasticity and therefore the adequacy of our modelling.

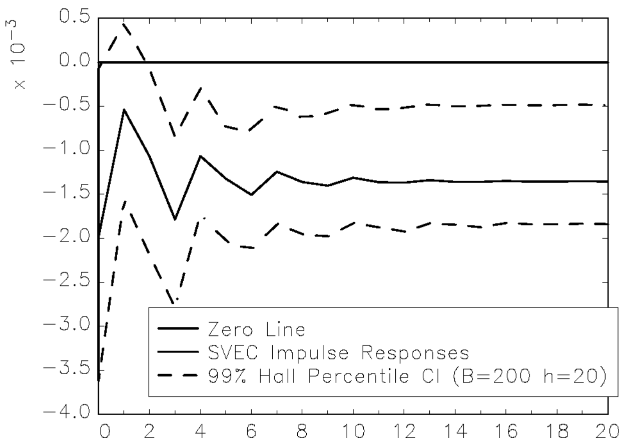
SVEC model developed allows analyzing the dynamic effects of structural shocks on output levels and unemployment. Pulse SVAR model analysis is carried out on the basis of the image moving average. Developed SVEC model allows analyzing the dynamic effects of structural shocks on output levels and unemployment. Impulse response analysis is carried out on the basis of the moving average representation [W. Enders (2008), p. 297–299]

$$x_t = \Phi_0 \varepsilon_t + \Phi_1 \varepsilon_{t-1} + \Phi_2 \varepsilon_{t-2} + \ldots = \Phi(L)\,\varepsilon_t =$$
$$= \Phi_0 B^{-1} R\,\eta_t + \Phi_1 B^{-1} R\,\eta_{t-1} + \Phi_2 B^{-1} R\,\eta_{t-2} + \ldots = \Psi(L)\,\eta_t\,, \qquad (16)$$

where $\Phi(L)=A(L)^{-1}=(1-A_1L-A_2L^2-\ldots-A_pL^p)^{-1}$; $\Psi(L)=\Psi_0+\Psi_1L+\Psi_2L^2+\ldots=A(L)^{-1}B^{-1}R$; a L – lag operator. The element (i, j) of matrix Ψ_h measures the effect of the j-th shock on the i-th variable through h periods and determines the value of impulse response function. Long-run effects are described by matrix $\Psi=\Psi(1)=(1-A_1-A_2-\ldots-A_p)^{-1}\cdot B^{-1}R$. Note that impulse response function for SVEC model depend on not only short-term effects matrices and structural parameters matrices, but also on estimated adjustment coefficients and parameters of cointegrating relationship (Table 3).

Plots of impulse response functions for developed SVEC model for real GDP and unemployment rate is given in Fig. 3, 4. Confidence intervals obtained from Hall's bootstrap method [H. Lutkepohl and M. Kratzig (2004), p. 177–178].

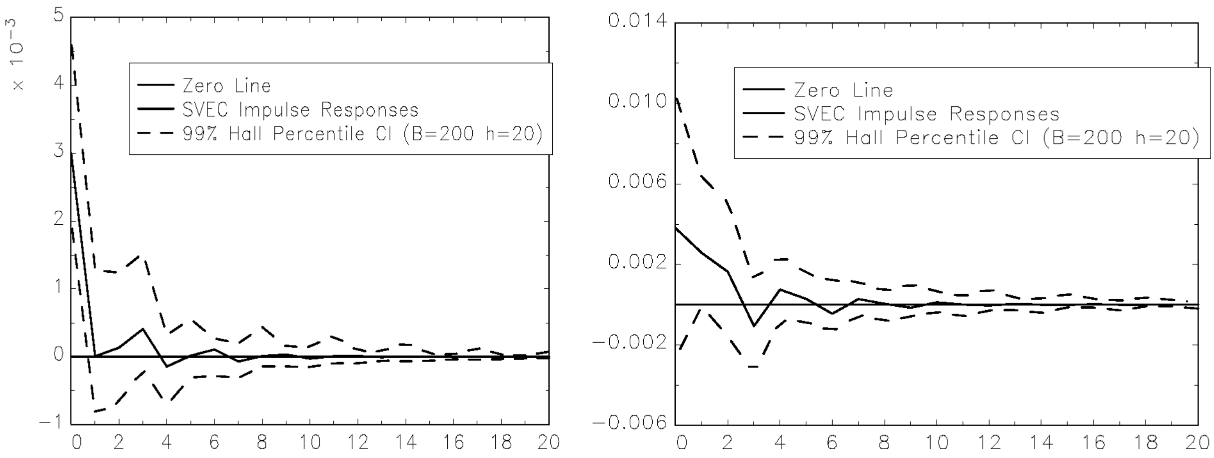




(a) *(b)*

Fig. 3. Dynamic effect of supply disturbances η^s :
(*a*) to output; (b) to unemployment

Source: evaluation of the authors



(a) *(b)*

Fig. 4. Dynamic effect of demand η^d: (*a*) to output; (b) to unemployment

Source: evaluation of the authors

By the analysis of impulse response functions [W. Enders (2010), p. 305–306] we have found that positive supply disturbances have stable effect on output, lead to an increase in its growth rate in the long run and statistically significant reduce cyclical unemployment (Fig. 3). Evaluated confidence intervals reveal that the reaction of variables on the supply shock is not instantaneous and in the first year after the shock its effect on unemployment is not significant. Reactions of variables on demand disturbances are given in Fig. 4. The modelling shows that these shocks have only a minor short-run impact and their effect disappears completely within two years after the shock occurred. After an initial increase the output level returns to its original level.

Table 5

Forecast error variance decomposition of output and unemployment associated with supply disturbances

Forecast horizon	Real GDP	Unemployment rate
1	0,84	0,30
2	0,89	0,32
3	0,93	0,37
4	0,94	0,48
8	0,97	0,62
12	0,98	0,71
20	0,99	0,80

Source: evaluation of the authors

Table 5 represents the forecast error variance decomposition of output and unemployment associated with supply shocks. Shares of variance associated with demand shocks can be obtained by subtracting these values from unit respectively.

The simulation results show that supply shocks are the determining factor in the changes in real GDP in Ukraine both in the short and in the long term. Variation in the level of unemployment in the short term caused mainly demand shocks, while in the long term it is became more tangible impact of supply shocks.

Conclusions

The effectiveness of social-economic regulation mechanisms requires a deepening of economic analysis of the macroeconomic fluctuation sources using modern flexible econometric tools. The modelling have to include an investigation of specific features of economic processes that are characterized an unstable economic development of our country. As a result of empirical research we have improved the Okun's model and have developed the structural vector autoregression error correction model. The constructed model describes the dynamic relationship between real GDP growth and cyclical unemployment in Ukraine. The model gives the possibility to take into account long-term relationship between the variables as well as measure short-run effects and the speed of adjustment to equilibrium trajectories. The analysis of the impact of structural disturbances we have based on the Blanchard-Quah decomposition. The investigation have showed that positive supply disturbances have a permanent impact on output and lead to increase its growth rate in the long term. Besides this, these disturbances statistically significantly reduce a cyclical unemployment. Demand shocks have only a temporary short-run impact on both indicators that quickly disappears. The analysis makes it possible to deepen the study of characteristics of macroeconomic fluctuation that are inherent in Ukraine and is the basis for the construction of complex structural dynamic macroeconomic model.

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