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5.6. The modeling of the dynamic relationships and shocks impact for socio-economic sphere in Ukraine

During the transformation period a socio-economic systems and labor market in Ukraine are in a difficult situation, when a considerable part of working population is in search of jobs, which is more often a condition for survival and provision the basis of human existence. In the present conditions of macroeconomic instability of the economy and strengthening of social tension various forms of unemployment exist as well as its overall level increases. Support for employment is an important condition for the functioning and development of society, the preservation and enhancement of its human capital. Overcoming the crisis on the labor market will contribute to social security of an individual and society from various dangers and will have an influence on social security of the state. Elaboration of strategy of socio-economic development in Ukraine and creation of effective system of its regulation that are designed for the long term, require investigation of an internal contradictions in the labor sphere, determination of basic quantitative and qualitative parameters of the future labor force.

In terms of changing internal and external economic environment, globalization, structural transformations and macroeconomic disturbances it is very important to investigate the structural and cyclical factors and characterize shocks which lead to permanent changes in the Ukrainian socio-economic system. A number of scientists conducted researches of influence of different disturbances on the labor markets of different countries and their analysis was based on structural vector models of the labor market. Jacobson, Vredin and Warne (1997) for the first time investigated the sources of fluctuations on the labor market in the Scandinavian countries on the basis of structural VAR model with common trends and identified factors of hysteresis in unemployment and differences between labor markets of Denmark, Norway and Sweden. In the result of modeling was detected the presence of hysteresis in unemployment not only on the labor market of Denmark, which demonstrates European trends, but also for Sweden and Norway, which are characterized by traditionally low and stable unemployment rate. The authors substantiate the existence of three disturbances which have a permanent impact on unemployment, namely these are technological shocks, labor supply shocks and wage shocks. Saltari and Travaglini (2009) on the basis of analysis of three-dimensional structural VAR model for labor productivity, employment and aggregate demand claim that for explanation European economy dynamics in recent decades it has been necessary to take into account both technological shocks and non-technological shocks of labor supply, caused by institutional changes. The authors indicate that technological shocks are the cause of structural slowdown in productivity growth, but they can not explain the increase in employment. On the other hand, non-technological shocks cause dynamic changes in employment, but can not explain the slowdown in productivity. Partridge and Rickman (2009) analyze dynamics of Canadian provincial labor markets on the basis of structural vector autoregression with long-run restrictions. Researches investigate three components of market fluctuations connected with labor demand shocks (new jobs), labor supply shocks which arise as a result of migration (new people) and internal labor supply (original residents). Park (2012) investigates influence of two types of technological shocks (aggregate and sectoral) to sectoral employment in the US manufacturing. For identifying each shock separately was constructed two VAR

models: factor-augmented vector autoregression (FAVAR) for identifying the aggregate shocks and sectoral SVAR model for identifying sectoral shocks. Cravo (2011) study influence of economic activity fluctuations to employment on small and large businesses in different Brazilian sectors and regions, and show that behavior of the difference in employment growth rates between large and small firms is counter-cyclical.

The aim of our study is an empirical analysis and econometric modeling of the dynamic relation between labor productivity, number of employees, unemployment rate and real wages in Ukraine on the basis of structural vector error correction model. The conducted analysis will allow to characterize impact of technological shocks, labor demand shocks, labor supply shocks, wage shocks and to determine which of them have a long-term effect on the domestic labor market, and which have only a temporary impact.

Theoretical model include modeling of production function, labor demand equation, labor supply equation and wage setting relation (Jacobson et al., 1997). We will denote natural logarithms of variables by small letters as it is usual for empirical analysis. Let $rgdp = \log RGDP$, $empl = \log EMPL$, $lf = \log LF$, $wage = \log WAGE$ i $p = \log PRICE$ denote natural logarithms of real gross domestic product, number of employed in economics, labor force, average wage and price level respectively.

Production function will be defined as relation between an output and employment

$$rgdp_t = \rho empl_t + \vartheta_t,$$

where ρ measures returns to scale. Variable ϑ_t determines stochastic technology trend that follows a random walk

$$\vartheta_t = \vartheta_{t-1} + \varepsilon_t^{technology},$$

where $\varepsilon_t^{technology}$ – is the pure technology shock. Labor demand equation describes dependence of employment on real wages $rwage_t = wage_t - p_t = \log (WAGE_t / PRICE_t)$ and output

$$empl_t = -\eta rwage_t + \lambda rgdp_t + \zeta_t,$$

where parameters η and λ measure elasticities of employment by real wage and output accordingly. The variable ζ_t determines random disturbances of labor demand which are described by autoregressive process

$$\zeta_t = \varphi \zeta_{t-1} + \varepsilon_t^{demand}.$$

If $|\varphi| < 1$, then labor demand trend is stationary and innovations of labor demand ε_t^{demand} have only temporary effects on employment. In particular, in a partial case $\varphi = 0$, labor demand shocks do not have a long-term impact on employment. The third component of the model characterizes labor supply equation and describes the relationship between labor force and real wages

$$lf_t = \pi rwage_t + \xi_t.$$

Exogenous labor supply trend ξ_t is described by a random walk process

$$\xi_t = \xi_{t-1} + \varepsilon_t^{supply},$$

where the parameter π measures the slope of the labor supply curve that is the elasticity of labor supply and ε_t^{supply} is a labor supply shock. In the particular case where π is equal to zero, we obtain exogenous labor force. The wage-setting relation takes the form

$$rwage_t = \delta (rgdp_t - empl_t) + \kappa empl_t - \gamma (lf_t - empl_t) + \zeta_t$$

and shows that real wages depend on labor productivity $prod_t = rgdp_t - empl_t$, employment $empl_t$ and unemployment rate, which is defined as $UR_t = lf_t - empl_t$. Wages trend ζ_t can be stationary or nonstationary, depending on the parameter ψ of autoregressive process

$$\zeta_t = \psi \zeta_{t-1} + \varepsilon_t^{rwage},$$

which characterizes its behavior. If $|\psi| < 1$, then the wage trend is stationary, otherwise the process of wage formation is described by a stochastic trend characterizing the accumulation of permanent random shocks with zero mean and constant variation.

Assume that all four pure shocks, namely technological shocks $\varepsilon_t^{technology}$, labor demand shocks ε_t^{demand} , labor supply shocks ε_t^{supply} and wages shocks ε_t^{rwage} are iid. Gaussian with zero mean, variances $\sigma_i^2 > 0$ for $i = technology, demand, supply, rwage$ and zero covariances.

For empirical analysis and modeling of Ukrainian labor market we will use quarterly data of the State Statistics Service of Ukraine for the period from 2002 to 2014. Labor productivity series will be defined by subtracting the logarithm of the number of employees EMPL from logarithm of real gross domestic product RGDP, that is $prod_t = \log PROD_t = \log (RGDP_t/EMPL_t) = \log RGDP_t - \log EMPL_t = rgdp_t - empl_t$. UR_t variable denotes the unemployment rate, which is defined by the International Labor Organization and $rwage_t = \log RWAGE_t = \log (WAGE_t/PRICE_t) = \log WAGE_t - \log PRICE_t = wage_t - p_t$ denotes

series of logarithms of real wages. For modeling we use series which previously were adjusted for seasonality (using method CensusX12) and determined shifts in average values at different time intervals.

Therefore we conduct modeling of time series vector

$$y_t = (prod_t \quad empl_t \quad UR_t \quad rwage_t)'$$

on basis of structural vector autoregressive model

$$y_t = A_1 * y_{t-1} + \dots + A_p * y_{t-p} + B \epsilon_t .$$

Selecting the lag length of a VAR specification is done on the basis of the Akaike information criterion (AIC), the Hannan-Quinn criterion (HQ) and the Schwarz criterion (SC), and also results of autocorrelation, nonnormality, and heteroskedasticity effects in the VAR residuals for various lags orders. Taking into account that when $p=4$, none of the diagnostic tests indicate signs of misspecification, we continue analysis using VAR (4) model.

Structural vector autoregressive model makes it possible to analyze the impact of structural shocks, based on the research of stochastic trends and allows to differentiating and isolating the impact of shocks with permanent effect and shocks with temporary effect. The theoretical model, which is a basis for empirical research, provides the possibility of existence of one or two temporary shocks that are related to labor demand shocks and wages shocks, and accordingly at least two and no more than four common trends. Research of common stochastic trends presence is based on cointegration analysis of variables. In particular, if there is one cointegration relation ($r=1$) between variables of four dimensional VAR model of the labor market ($n=4$), then dynamics of productivity, employment, unemployment rate and real wages are defined by $k=n-r=3$ shocks that have a permanent effect, and if was substantiated the existence of two cointegration relations, we get only two common trends.

Taking into account detected the same order of integration and trend properties of time series $prod_t$, $empl_t$, UR_t and $rwage_t$ we explore the existence of possible cointegration relationships between them. To check the cointegration we use the VAR(4) specification and investigate the cointegration relationship with various deterministic terms. According to the Johansen methodology testing of cointegrating rank we perform using a likelihood ratio test, namely the maximum eigenvalue statistics and trace test.

The results of conducted tests show that when testing the existence of cointegration relations that include determined shift and do not include the trend, the choice is not justified. In the case of inclusion of linear trend in the cointegration relation both statistics of maximum eigenvalue and trace statistics indicate the existence and correctness of one cointegration long-term equilibrium relationship usage in the estimation of error correction model.

Developed SVEC model allows to analysing the dynamic effects of structural shocks influence on output level and unemployment. Impulse analysis of VEC model

$$\Delta y_t = \alpha \beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \dots + \Gamma_p \Delta y_{t-p+1} + u_t$$

is carried out on the basis of moving average representation (Lutkepohl, Breitung and Bruggemann, 2004, p. 168)

$$\Delta y_t = \Psi u_t + \sum_{i=1}^t \Phi(L) u_t + y_0,$$

where Ψ – is a long-run impact matrix, and $\Phi(L)$ – is an infinite-order polynomial in the lag operator with coefficient matrices Φ_j , that go to zero as $j \rightarrow \infty$ and contain transitory effects. The term y_0 contains all initial values.

To identify shocks in the model of Ukrainian labor market we will use restrictions on the long-run impact matrix according to the ideas of Blanchard and Quah (1989). As the estimated cointegration relation is consistent with the wage-setting relation, its stationary detects that wage shocks have no long-term impact on the variables included in y_t . Such conclusions correspond to zero last column of long-run effects matrix $\Omega = \Psi B$. Also assume a constant effect of scale and that supply shocks have no long-run impact on real wages.

Using the obtained estimations we calculate impulse response functions for labor market indicators to structural shocks that provide more informative picture of dynamic effects of macroeconomic shocks on the domestic labor market. Graphic representation for impulse response functions values of developed SVEC model together with 95% and 90% confidence intervals are shown in Fig. 1-3. Confidence intervals are determined on the basis of Hall's bootstrap percentile intervals (Lutkepohl, Kratzig, 2004, p. 177).

Results of modeling show that the technological shock has a significant long-term dynamic influence for all variables. Variables of productivity,

employment and real wages react to shock contemporaneously, only unemployment rate shows delay in one period.

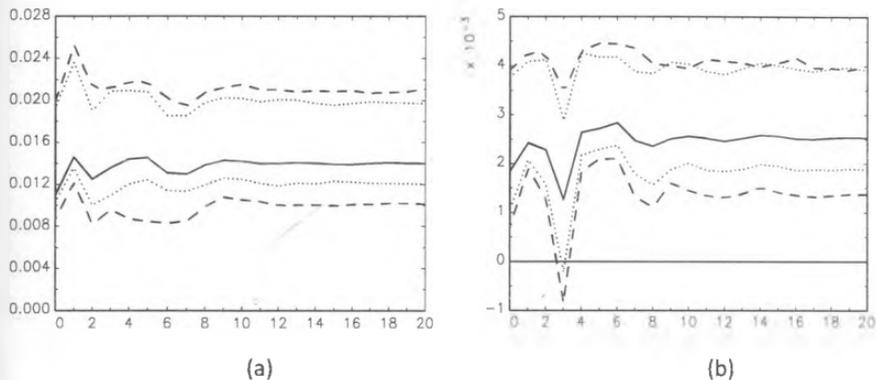


Fig. 1. Impulse response functions to technological shock for (a) productivity; (b) employment.

Source: evaluation of the authors.

Should be noted that a short-term adaptation to new long-run equilibrium levels is enough fast for all indicators. Within four quarters all variables reach a new level, and then within one year show some fluctuation, and after 8 quarters they are fully stabilized at a new equilibrium level.

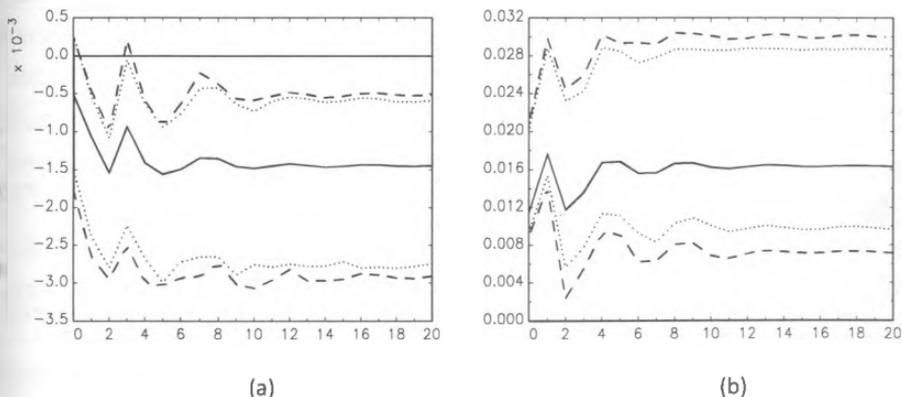


Fig. 2. Impulse response functions to technological shock for (a) unemployment rate; (b) real wages.

Source: evaluation of the authors.

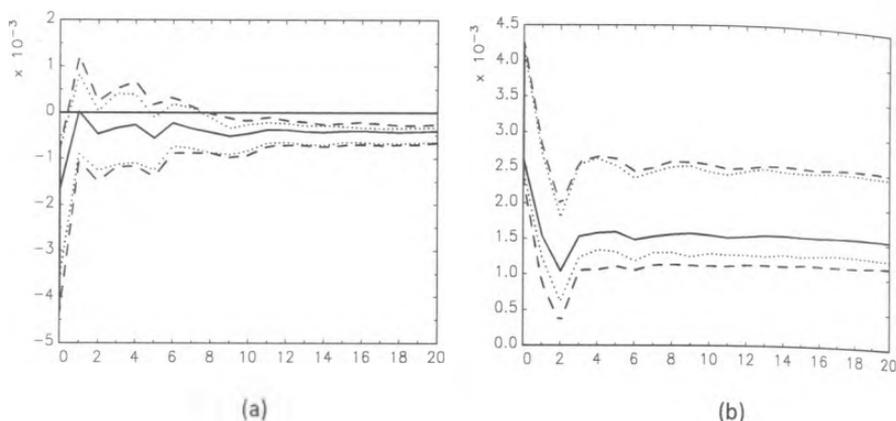


Fig. 3. Impulse response functions to labor supply shock of
(a) employment; (b) unemployment rate.

Source: evaluation of the authors.

The positive labor supply shock immediately leads to higher unemployment, which is two quarters is slightly reduced, but after a year it is stabilized at a new long-term level which is exceeding the initial. We also note that the number of employees on contrary slowly adapt to his new equilibrium level. Calculated confidence intervals detect that the response of employment to supply shock is not contemporaneous and significant negative changes in the number of employees caused by a positive labor supply shock will be seen only after approximately 2.5 years.

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