

A. A. Khodzhaian¹,
orcid.org/0000-0002-3015-1016,
A. I. Ignatyuk¹,
orcid.org/0000-0002-9103-6943,
V. V. Korneev²,
orcid.org/0000-0003-0654-5311,
A. R. Khodzhaian²,
orcid.org/0000-0002-0940-2220

1 – Taras Shevchenko National University of Kyiv, Kyiv, Ukraine, e-mail: alina_khodzhaian@ukr.net
2 – State Research Institute of Informatization and Modeling of Economics, Kyiv, Ukraine

MODELING OF THE STRUCTURAL SHIFT IMPACT ON ECONOMIC DYNAMICS OF UKRAINE'S DEVELOPMENT

Purpose. To provide quantification of industry-specific structural shifts in the economy of Ukraine in the medium term perspective as a result of the structural policies application.

Methodology. The methodological basis of the study is economic and mathematical modelling using the computable general equilibrium model GTAP (Global Trade Analysis Project). Methods of analysis and synthesis were used in systematization and generalization of modelling results. The study on the theoretical basis of the GTAP model was carried out using the system method.

Findings. The influence of structural policy instruments of the state on the dynamics of economic development in Ukraine is analyzed using the applied general equilibrium model GTAP. The essence and peculiarities of functioning of computable general equilibrium models, scope of their application in the analysis of structural changes in the economy are revealed. Using the GTAP model, the macroeconomic and sector-structural effects of the implementation of a number of structural policy measures in Ukraine have been quantified, including: exemption from payment of import duties on innovative equipment for processing industry manufacturers; preferential insurance and export crediting through an export credit agency; foreign trade facilitation; exemption of industrial park residents from payment of some direct taxes and fees (VAT, land tax, infrastructure levy). Positive economic effect of the proposed measures in structural and macroeconomic dimensions is argued. The impact of domestic economy restructuring on the dynamics of socio-economic development and general welfare of the population is estimated.

Originality. A methodical approach to quantitative assessment of macroeconomic and sectoral-structural effects in the economy of Ukraine in the medium term using the applied model of general equilibrium GTAP is proposed. It is revealed that in the medium term, the aggregate effect of the structural policy measures is 11.4 % of GDP growth, both due to intensification of business activity as a whole and due to more efficient use of resources and factors of production in the more productive sectors of the national economy. Among the measures considered, the greatest structural effect is observed as a result of the development of a network of real-life industrial parks in Ukraine. At the same time, structural tariff policy has the lowest potential for economic growth, although it remains an important element in improving manufacturers' access to innovative equipment.

Practical value. The results obtained can be used as a scientific substantiation of reforms in the industrial and foreign trade policy of Ukraine, aimed at ensuring qualitative structural shifts in the domestic economy.

Keywords: *structural policy, structural shifts, computable general equilibrium model, Global Trade Analysis Project (GTAP), import duty, export credit agency, industrial park*

Introduction. The main objective of the structural state policy is the growth of real welfare and living standards by changing the ratio of shares of different economic sectors in social production. Undoubtedly, it can be accompanied by a set of other objectives: improvement of the economic safety and stability as for external shocks, decrease in the environmental pollution, growth of the international competitiveness level and so on. However, provision of the advancing dynamics of economic growth by attracting workforce and capital into more efficient producing operations is still the quintessence of state policy aimed at transformation of the national economic structure. Consequently, the following two issues are gaining their topicality: substantiation of the efficient cause and effect relationship between the implementation of the measures of state structural policy and changes in the ratio of economic

sectors, and changes in the industrial and sectorial proportions along with the acceleration of welfare growth dynamics.

It should be noted that possibilities to predict economic effects as a result of long-term structural transformations are still quite restricted due to certain objective reasons. The shifts experienced by the economic structure in the longer term are practically impossible to foresee owing to rapid development of innovations and permanent development of principally new technologies, which are able to change completely the processes in some industries (i. e. robotization of production that levels the established approaches to the specification of the employment structure) and to transform the value-added chains (i. e. transfer to other energy sources of other materials in traditional production, which restructures the established inter-industry relations).

Instead, medium-term nature of the structural changes meaning the transfer of production resources and factors between the industries as the reaction to the changing return

level (however, in terms of the non-available principle shifts in technological structures) is more substantiated to be analysed economically and mathematically, i.e. while using computable general equilibrium model (CGEM).

Literature review. Numerous important studies by different Ukrainian scientists deal with the analysis of structural shifts in the national economy, i.e. those by O. Pelekh [1], Yu. Kin-zarskyi [2], L. Simkiv and N. Melinyshyn [3], O. Pyrog [4], A. Kalinina [5], A. Ignatiuk and Yu. Petlenko [6]. The paper by I. Grishova, M. Kyzym, V. Khaustova, V. Korneieva, and G. Kramariova [7] highlights their effect on the economic stability and quality of social life in the context of the industrial sector of economy. At the same time, L. Duma [8], S. Kho-mykh [9], K. Gorditsa, T. Slyvka [10] studied model sectorial and structural changes in the national economy.

The publications study mostly those structural shifts which took place in the Ukrainian economy during the previous years. The scientific papers touching upon the problems of modelling of structural changes emphasize mostly the methodology of applying statistic methods and using the model of inter-industry equilibrium (the “costs output” tables). Along with that, use of the computable general equilibrium models to evaluate the prospective structural shifts in the national economic systems has not been introduced in the national scientific literature yet; that stipulates the necessity of carrying out the research in this area.

Purpose. The objective of the paper is to estimate quantitatively the sectorial and structural medium-term shifts in the economy of Ukrainian as a result of the implementation of certain measures of the state structural policy.

Results. The computable general equilibrium models are the system of equilibrium equations to describe (according to the basic theories of micro- and macroeconomy) the behaviour of the main economic agents (households, government, enterprises of different industries specializing in goods, operations and services) in both internal and external markets. In

particular, representative consumers (households) optimize the use of labour and consumption; representative economic agents optimize the income and expenditure. Industrial sector involves also production functions, technological restrictions and others. The CGEM databases are structured in the form of a table representing the turnover of costs and revenues in the economy through transactions between the main economic agents (households, manufacturers, government) and areas of economic relations (production, consumption, taxation, labour remuneration, saving, investment, trade) [11].

From the viewpoint of the analysis of structural shifts, tables of inter-industry “costs-output” balance, representing the ratio between the production output in terms of economic sectors and total need of other sectors in the products, are an important element of the CGEM databases. The system of goods and services production is formed so that each sector will produce certain products, whose share will be consumed by both the same and some other sector; the rest of the products will be taken beyond the system as the end products meeting the demands of households and government. The indicated characteristics help CGEM cover all the essential structural relations within the national economy.

However, the CGEM databases are not just the “costs-out-put” tables, they cover both much greater amount of statistic data (concerning the market of production factors, taxes, investments, savings, amortization expenses, government costs) and specially calculated and calibrated parameters of elasticity, which include specifics of the reaction of economic agents to the effect of various external factors according to the leading economic theories. That makes it possible to expand the sphere of analysis considerably and provide the comprehensive analysis of the consequences of structural changes in the national economy.

Consider the sequence and principle for mathematical calculations in CGEM to determine the quantitative effects of influence on the economy (Figure).

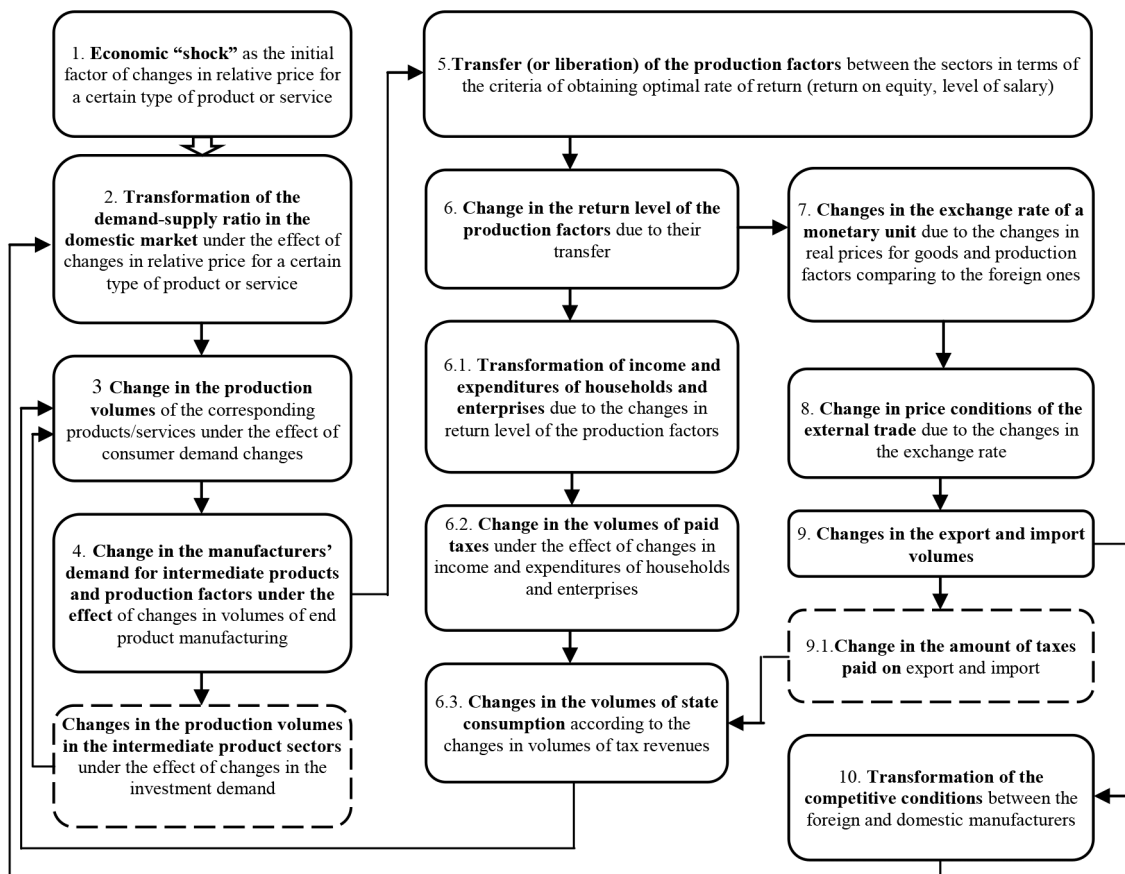


Fig. Basic scheme to calculate economic effect in the computable general equilibrium models [on the basis of the GTAP Model analysis]

The Figure represents the algorithm of mathematical calculations, in terms of which CGEM estimates the effect of regulatory measures at the sectorial and macroeconomic level. As it is seen, the model databases make it possible to cover shifts within the whole real economic sector of the country under consideration and its external trade partners. Quantitative estimation of the changes is provided by the corresponding elasticity indices, i. e. at calculation stage 2 – elasticity of demand in terms of price; at calculation stage 4 – elasticity of demand for the production factors and intermediate products; at calculation stage 5 – elasticity of mobility of the production factors. Influence of the changes in household and government incomes on the consumer demand is estimated through the elasticity of demand in terms of income. At the stage of changes in exchange ratio, changes in the external trade volumes are defined through the cross elasticity of demand between the goods-analogues of domestic and foreign production as well as through elasticity of access to foreign markets.

Thus, a principle of modelling of structural shifts in CGEM may be represented as the sequence of a series of economic phenomena in response to the regulatory interference of the government or influence of other exogenous factors on the initial equilibrium in the economic system. Consider the sequence given in Figure in terms of the selective reduction of a taxation rate:

1) influence of the external factor favours a decrease in price for goods or services of certain economic sectors relative to other industries;

2) reduction of relative prices results in the increased demand for goods of the corresponding sectors on the parts of households, government, and enterprises of other industries;

3) in response to the increasing demand, companies ramp up the production involving additional capital and workforce (i.e. attracting the unemployed from other sectors) and increasing demand for raw material and intermediate products of the industries being a part of the value-added chain;

4) revenues of the owners of the involved capital and workforce grow, favouring the increase in total demand in the economy for all the domestic and foreign goods;

5) at the same time, the sectors, which lose a competition for the production factors to the sectors being in the privileged position owing to the taxation incentives, may experience stagnation;

6) changes in the volumes of production, trading, labour, and capital influence the overall tax revenues, which change the government demand in the public procurement market;

7) possible changes in the external trade conditions may result in the changes in the exchange rate of the national currency being the macroeconomic shock, which will cause end-to-end shifts in paying capacity and structure of demand and supply.

The outlined sequence of structural transformation of economic system lasts in the CGEM calculations up to the moment when new balanced state of demand and supply in all markets (intermediate products, goods and services of final consumption, production factors) is reached in all the economic sectors in terms of new level of prices.

We consider that the GTAP (Global Trade Analysis Project) model is expedient to be selected among the ones used in the CGEM practice as the database and mathematical toolset applied by that model make it possible to determine quantitatively the economic effect of the selective and functional measures of structural policy for medium-term perspective. The GTAP advantage is in the automation of calculations by using *Run GTAP* software. It helps to perform operational analysis of the effect of regulatory measures on the key socioeconomic and sectorial-structural indices – GDP, welfare, output, external trade, unemployment, salary, taxable income and so on. In this context, there is a possibility to single out and estimate the values of influence of a certain factor on the economic growth dynamics. That allows forming the scientifically sub-

stantiated statements on the available cause and effect relationships between the implementation of certain measures and growth of the national welfare.

While using the GTAP model, we estimate quantitatively the macroeconomic and sectorial-structural effects in Ukraine as a result of implementation of certain measures of the state structural policy, i. e.:

- exemption of the processing industry enterprises from import duties on the innovative equipment and facilities;

- provision of preferential insurance and loans of export supply through the export-credit agency;

- simplification of the external trade procedures;

- exemption of the residents of industrial parks from some direct taxes and duties (VAT, land tax, infrastructure fee).

Each of the indicated measures gives the possibility for quantitative determination of the effect of regulatory interference of a state on the changes in market value of products, which is the basis for economic and mathematical modelling in CGEM.

Let us substantiate the approaches to the modelling of each of the mentioned areas of the implementation of Ukrainian re-structuring policy involving the GTAP model. The methodological approach to the evaluation of the effect of changes in import duty rates on the dynamics of external trade and macroeconomic indicators is based on the influence of that measure (tms) on the internal prices of the corresponding products (pms) determined by the formula

$$pms(i, r, s) = tm(i, s) + tms(i, r, s) + pcif(i, r, s),$$

where $pms(i, r, s)$ is change in the price of product i imported from country r in the domestic market of country/region s ; $tm(i, s)$ is change in the import duty for product i in country s ; $tms(i, r, s)$ is change in import duty for product i , originating from country r , in country/regions s ; $pcif(i, r, s)$ is price of import of product i from country r to country/regions s under CIF terms.

Thus, calculation of the effect as a result of changes in import duty in GTAP is based on determining the relative value of deviation of prices for the imported products, which further influences the macroeconomic balance due to the factor of national or regional demand for those products through the use of Armington coefficient of cross elasticity between the imported products originating from different countries [13]. The corresponding calculations are carried out according to the formula

$$qxs(i, r, s) = -ams(i, r, s) + qim(i, s) - ESUBM(i) \cdot [pms(i, r, s) - ams(i, r, s) - pim(i, s)],$$

where $qxs(i, r, s)$ is change in cost volumes of product supply i from country r to country/region s ; $ams(i, r, s)$ is the coefficient of technological variable of product i imported from country r to country/region s ; $qim(i, s)$ is change in cost volumes of total import of product i to country s ; $ESUBM(i)$ is Armington coefficient of elasticity for product i ; $pim(i, s)$ is change in the market price for the import of product i to country s .

Evaluation of the economic effect due to state support of export in the GTAP model is represented through the influence of the corresponding subsidies (txs) on the export price of the corresponding product (pfob) represented in the formula

$$pfob(i, r, s) = pm(i, r) - tx(i, r) - txs(i, r, s),$$

where $pfob(i, r, s)$ is change in the export of product i supplied from country r to country s ; $pm(i, r)$ is market price of product i in country r ; $tx(i, r)$ is subsidy for the export of product i from country r ; $txs(i, r, s)$ is subsidy for the export of product i supplied from country r to country s .

As it is seen, calculation of the effect as a result of export subsidy giving in GTAB is based on the calculation of relative deviation of price for the exported product/service, which fur-

ther influences positively the trade terms, increasing the price competitiveness of manufacturers in the external market.

The GTAP-based calculation of the effect from the simplified procedures of external trade is carried out by introducing a specialized technological variable into a system of the model equations. In percentage points, the variable represents certain change in the level of transaction costs in the external trade, i.e. the ones taking place while undergoing customs formalities. Structural elements of that variable are defined according to the formula

$$atmfsd(i, r, s) = atf(i) + ats(r) + atd(s) + atall(i, r, s),$$

where $atmfsd(i, r, s)$ is the total coefficient of a technological variable; $atf(i)$ is worldwide change in a share of transaction costs in the product value; $ats(r)$ is change in a share of transaction costs in the value of product export in terms of all the nomenclature from country r to the rest of the world countries/regions; $atd(s)$ is change in a share of transaction costs in the value of product import in terms of all the nomenclature from country s to the rest of the world countries/regions; $atall(i, r, s)$ is change in a share of transaction costs while delivering product i from country r to country/region s .

Next step of the automated modelling of the overhead costs dynamics is the use of the obtained generalizing coefficient of a technological variable to calculate the index of international transportation costs using the formula

$$ptrans(i, r, s) = \text{sum}(m, MAGR_COMM, VTFSD_MSH(m, i, r, s) \cdot [pt(m) - atmfsd(m, i, r, s)]),$$

where $ptrans(i, r, s)$ is the index of international transportation of product i from country r to country/region s ; $VTFSD_MSH(m, i, r, s)$ is share of the costs for transportation services m in the transportation price of imported product i from country r to country/region s ; $pt(m)$ is change in the cost of international transportations in terms of service m .

The obtained value of the international transportation index is used to estimate its effect on the import price ($Pcif$) involving the identical equation, combining export and import prices according to the formula

$$pcif(i, r, s) = FOBSHR(i, r, s) \cdot pfob(i, r, s) + TRNSHR(i, r, s) \cdot ptrans(i, r, s),$$

where $FOBSHR(i, r, s)$ is share of the export price in the final price of product i imported from country r to country/region s ; $TRNSHR(i, r, s)$ is a share of transportation costs in the final price of product i imported from country r to country/region s .

Finally, corresponding change in the import price is expressed in the changes in import cost volumes ($viwCIF$) of the corresponding products, being calculated in terms of GTAP according to the following formula

$$VIW(i, s) \cdot viwCIF(i, s) = \text{sum}(r, REG, VIWS(i, r, s) \cdot [pcif(i, r, s) + qxs(i, r, s)]),$$

where $VIW(i, s)$ is import cost volumes of product i to country s ; $viwCIF(i, s)$ is change in a share in the import of product i to country s .

As for the influence of direct taxes on the economic dynamics, methodological expression of that mechanism in the GTAP model is quite simple. The taxes form the difference between the product cost before and after taxation, being determined by the formula

$$ps(i, r) = to(i, r) + pm(i, r),$$

where $to(i, r)$ is direct tax for the manufacturing of product i in country r ; $ps(i, r)$ is price of the supply of product i in country r (product price after taxation).

However, specific feature of the model is in the consideration of the influence of direct taxes on the growing price of intermediate products throughout the value-added chain; that

helps to trace the cumulative effect of taxation on the price of final products and identify the changing demand for the intermediate products in the inter-industry relations. In terms of GTAP, an identical equation, determining the points of direct taxes in that effect, is as follows

$$qf(i, j, r) = qo(j, r) - af(i, j, r) - ao(j, r) - ESUBT(j) \cdot [pf(i, j, r) - af(i, j, r) - ps(i, j, r) - ao(j, r)],$$

where $qf(i, j, r)$ is change in the demand for product i from sector j in country r ; $qo(j, r)$ is change in production output in sector j in country r ; $af(i, j, r)$ is influence of technological changes on the demand for product i from sector j in country r ; $ao(j, r)$ is influence of technological changes on the production output in sector j in country r ; $ESUBT(j)$ is the coefficient of elasticity of the replacement of one intermediate product by the other in sector j ; $pf(i, j, r)$ is change in the prime cost of intermediate product i to meet the demand of sector j in country r ; $ps(i, j, r)$ is change in the supply price of intermediate product i to meet the demand of sector j in country r .

The initial data to calculate the effect from the reduced import duties on the equipment involving the mentioned methodology were taken immediately from the databases of the GTAP model. Potential volumes of export subsidizing in the form of preferential insurance and loans through the ECA are defined basing on the data of the comparative characteristics of the credit servicing programmes for EEA in Ukraine and other world countries performed by national scientist V. P. Voitseshyn [14]. Prospects of the reduction of operational costs in the external trade with the help of a mechanism of simplification of its procedures have been determined basing on the estimates by O. S. Rubtsova [15] concerning the burden of the corresponding costs for Ukrainian exporters. Volumes of tax incentives are defined on the basis of statements of the draft Law "On introducing changes to division XX "Transient statements" of the Tax Code of Ukraine concerning the development of national production by stimulating the investment attraction in a real sector of economy through the industrial parks" No. 2554a-d [16].

The results of economic and mathematical analysis of the prospects of structural shifts in the Ukrainian economy demonstrate high efficiency of the measures proposed in the dissertation research both in the context of restructuring and from the viewpoint of acceleration of the economic growth dynamics (Table 1).

Granting a remission of import duties on the innovative equipment will help to accelerate the dynamics of national GDP by 1.24 %. The product index of processing industry will increase by 1.84 % mostly as a result of growing output of the national production means. Growth rates of agricultural goods production will decelerate by 0.61 %; first of all, that concerns crops (-1.37 %) and vegetable oils (-2.81 %). Despite the fact that the budget receives less than it is due from the import duties, total increment of tax revenues owing to the business activity is 2.22 %. Actual earnings will increase by 0.82 %; return on capital will grow by 2.91 %. Creation of new jobs will allow increasing the number of employed people by 1.29 %.

Valid start of the mechanism of preferential insurance and loads for import through ECA (according to the selective principles envisaged by a specialized law) will favour the increase in GDP in Ukraine by additional 2.4 % in terms of growing export revenues (6.9 %). Accelerated rates will be observed for the development of processing industry (3.68 %) against the background of decelerating dynamics of progress in agricultural (-1.33 %) and raw material (-2.19 %) sectors. Owing to the selective nature of the export support, growth in the processing sector will be unequal, i.e. ferrous metal production will fall by 5.2 % and production of ferrous-metal products will decrease by 7.1 %. Light industry (-2.4 %) and wood-working industry (-2.1 %) will also experience reduction of the production output. Certain increase will be observed first

Results of economic and mathematical modelling of certain measures of state policy concerning restructuring of the national economy of Ukraine, % (calculated involving the GTAP model basing on the GTAP data v. 9.1 database)

Parameters	Measure of structural policy				
	Granting a remission of import duties on innovative equipment	Preferential export loans through ECA	Simplification of the external trade procedures	Giving tax incentives for the IP residents	The measures, total
Real GDP	1.24	2.40	3.70	4.08	11.42
Index of agricultural products	-0.61	-1.33	0.86	-3.38	-4.46
Index of mining industry products	-0.71	-2.19	0.75	-1.67	-3.82
Index of processing industry products	1.84	3.68	8.68	16.85	31.05
Service sector	2.38	3.99	2.63	2.85	11.85
Export	-3.40	6.90	6.58	16.22	26.30
Import	3.30	3.03	8.75	12.31	27.39
Tax revenues	2.22	4.67	3.74	-6.71	3.92
Employment	1.29	2.37	2.58	3.76	10.00
Actual earnings	0.82	1.70	0.41	1.33	4.26
Rent from capital	2.91	5.67	4.63	9.94	23.15
Welfare	3.21	6.13	7.58	6.36	23.28

of all in the production of machines and equipment (5.9 %), transport means (5.43 %), and electric facilities (5.01 %). General growth of production and welfare will favour the development of service sector by almost 4 %. It should be noted that it is activation of export-oriented production with the help of ECA that has the highest potential for the growth of actual earnings among the rest of the analysed measures (1.7 %).

Simplification of the external trade procedures will help accelerate the national GDP growth by 3.7 % and national welfare by 7.58 % (mostly, at the expense of the improved trade terms). Relying on the fact that this is the only factor of functional nature among the analysed ones, its positive effect will be observed in the economic sectors; though, the effect will be nonuniform. Agriculture (0.86 %) and mining industry (0.75 %) will grow more slowly than the processing industries (8.68 %) and service sector (2.63 %). It should be emphasized that the rates of export growth (6.58 %) will be lower than the import ones (8.75 %). Since functional measures (like simplification of trade procedures) act in both directions of trade flow, one may conclude that their use in terms of high import dependence will complicate Ukrainian pay-balance problems.

The highest potential of economic growth is traced in the modelling results of the scenario of tax incentives granting for the industrial park residents. Development of full-scale economic activity in terms of the operating and newly established industrial parks of Ukraine under conditions of the expanding packet of tax incentives for companies-residents will provide GDP growth by 4.08 %. Inflow of investment, capital, and workforce into the processing enterprises of the parks will make it possible to accelerate the dynamics of corresponding production by 16.85 %. There will be partial transfer of the resources into high-productive industries from agricultural and mining sectors, whose growing rates will decelerate by 3.38 % and 1.67 % respectively. The highest effect of tax incentives will be observed in the production of electric facilities (growth by 83.0 %), machines and equipment (82.4 %), transport means (60.9 %), and chemical products (46.2 %).

Total effect of the four analysed measures will provide additional 11.4 % of national GDP. It should be stressed that it is the medium-term effect, which will manifest itself gradually along with the attraction of investments, inter-industry transfer of production factors, and development of the corresponding structural shifts. Thus, the modelling results should be considered as the cumulative effect within the period up to

10 years, i.e. on average, GDP dynamics of Ukraine will accelerate by 1.14 % per year. Processing industry will rise by almost a third (31.05 %); external trade will increase by a quarter (export – by 26.3 %, import – by 27.4 %). Tax revenues will grow only by 3.92 % due to their considerably less receipt as a result of tax incentives for industrial parks (-6.71 %). The total number of the employed people will increase by 10.0 %, which will help to overcome the unemployment completely in view of current situation in the Ukrainian labour market. Undoubtedly, the result is too optimistic and overestimated as the modelling does not take into consideration rapid robotization at modern and competitive industrial production operations. It also means possibility of endless replenishment of the workforce in the country at the expense of labour immigrants (that somehow also causes underestimation of the expected level of salary growth).

Next, focus on the indices of the social welfare growth according to the modelling results. Generally, calculations of welfare changes in GTAP (as in the majority of other CGEMs) are performed on the basis of a principle that the highest prosperity level meets greater volumes of consumption. In other words, real consumption (RC) reflects the welfare degree in the form of difference between the cost of new basket (Q^2) and the initial basket (Q^1) of goods and services in the initial and new state of market equilibrium respectively. Both baskets are estimated in terms of one and the same consumer prices (P^1) for each product i

$$RCwelfare = \sum_i (P_i^1 Q_i^2) - \sum_i (P_i^1 Q_i^1). \quad (1)$$

The difference of cost between the baskets is equivalent to the additional income that a consumer would require to afford a better basket (Q^2) in basic prices.

The automated modelling system GTAP allows resolving the obtained welfare effect in terms of a set of sources of its formation (Table 2).

According to the data from Table 2, main source for the social welfare (consumption) growth as a result of the implementation of the analysed measures of structural policy will be the growth of profitability of production factors, i.e. the household profitability (almost USD 11.5 of 19.8 billion). About 5.3 billion of the welfare growth will be provided by more efficient use of resources due to their attraction in more productive economic industries. In this case, technological

Growth of welfare as a result of implementation of certain state-policy measures aimed at the restructuring of Ukrainian economy, USD million (calculated involving the GTAP model basing on the GTAP data v. 9.1 database)

Measures of the structural policy	Factors of the welfare formation					
	Redistribution of resources	Growth of profitability of the production factors	Technological development	Changes in the external trade terms	Investments and savings	Total
Exemption from the import duties on equipment	896.8	1139.8	0.0	645.4	51.5	2733.5
Preferential loans for export (ECA)	1730.6	2199.2	0.0	1006.1	290.6	5226.6
Simplification of trade procedures	1512.6	2694.0	1861.5	387.9	2.9	6458.7
Tax incentives for the IP residents	1189.6	5440.8	0.0	-1434.4	224.6	5420.6
The measures, total	5329.6	11 473.8	1861.5	605.0	569.6	19 839.4

development is purely conventional. Actually, 1.86 billion in terms of the corresponding area will be provided as a result of additional increment of goods turnover owing to the freedom from a burden of overhead costs during EEA. Total effect of changes in the external economic activity conditions will be only USD 605 million due to the negative effect in terms of that factor because of tax incentives for IP residents (-1434.4 million). However, the least contribution in the social welfare is observed in the sphere of savings for investment in the industrial market (USD 569.6 million) that is related to the underdevelopment of the national stock market in particular and the financial sector in general. Lack of access of national households and enterprises to the financial tools of investment in proper production restricts considerably the prospects of the welfare growth in Ukraine.

Finally, we consider that it is expedient to warn about the results of economic and mathematical modeling. First, implementation of the analysed measures does not guarantee itself the reaching of sectorial and macroeconomic effect represented in Table 2 since the GTAP model means that there are no limitations in the motions of production factors. Thus, there are no limitations related to the unfavourable investment climate and imperfect institutional medium. It is obvious that reaching of the calculated indices of economic development requires that the considered measures of structural policy will be accompanied necessarily by the measures for strengthening of those fundamental factors of stable economic system construction. Some of the factors, i.e. the ones favouring free goods and resources flow and dealing with the regulation of trade arguments as the determining components of the toolset to prevent trade conflicts in terms of the WTO, are emphasized by national scientists (N. G. Kaliuzhna, A. O. Khodzhaian, and P. G. Nebotova, 2020).

Second, GTAP belongs to static CGEMs, i.e. it provides the comparison of national economy before and after the implementation of state-policy measures when regulatory tools launch the processes of transfer of production resources in more or less efficient way. Static models may tell the story about the final winners and about those who have lost because of external interference into the economic system. Nevertheless, their disadvantages are as follows: they do not describe the very process of changes of a transitive period, which may include the periods of activation of friction unemployment and have high social price irrespective of the scales of the expected benefits in the state of new equilibrium. State restructuring programme should take into account the potential economic complications at the initial stages of structural changes (in particular, so-called "artistic destruction") and foresee the measures for their mitigation.

Conclusions. The computable general equilibrium model GTAP is a modern tool to analyse and predict economic development of countries at macro- and meso-levels. Use of global database of the "costs-output" tables and specially developed software helps to perform promptly a complex analysis

of the economic policy effect. The GTAP-based research results answer the questions: what we will have in terms of the preset effect of the current market equilibrium. The GTAP advantages include the possibility to single out and estimate the influence of a specific factor on the changes in market equilibrium. That allows forming substantiated argumentation concerning the available cause and effect relationships between the economic phenomena.

Use of the computable general equilibrium model GTAP has made it possible to give quantitative evaluation of the prospects of implementation of certain tools of state regulation of structural and sectorial transformations taking into account current state of the Ukrainian national economy and specific features of the organizational implementation of the corresponding measures. Economic and mathematical analysis has proved the considerable potential of certain measures of structural policy to provide positive shifts in the industrial and sectorial proportions of the Ukrainian economy in favour of high-productive enterprises of processing industry as well as general growth of social welfare and favourable medium-term socio-economic dynamics. Total effect of such measures of structural policy as the abolishment of import duties on the innovative equipment, preferential insurance and loans of non-raw material export, reduced burden of overhead costs in trade owing to simplification of their procedures as well as widening of the range of tax incentives for the industrial-park residents accounts for additional 1.14 % of real Ukrainian GDP growth per year. General potential of those measures results in the increase in domestic processing industry by 31.1 %, external trade – by 26.9 %, social welfare (expressed in the consumption volume) – by 23.3 % of the budget revenues (despite a wide range of tax incentives and preferences for business) – by 3.9 %. That indicates the available considerable reserve in Ukraine to provide the faster economic growth by optimizing a sectorial structure of the national economy.

References.

1. Pelekh, O. B. (2018). Structural shifts and transformations as processes and results of structural changes in the economy. *Biznes Inform*, 3, 8-14.
2. Kindzerskyi, Yu. V. (2018). Neo-industrial renaissance of Ukraine: vectors and mechanisms of policy in the context of European integration. *Materialy Vseukrayinskoi naukovo-praktychnoyi konferentsiyi "Ekonomichna stratehiia ta polityka realizatsii yevropeiskoho vektoru rozvytku Ukrainy: kontseptualni zasady, vyklyky ta protyrichchia*, 94-97.
3. Simkiv, L. E., & Melinyshyn, N. T. (2018). Features of structural changes in the economy of Ukraine. *Naukovyi Visnyk Uzhhorodskoho Natsionalnoho Universytetu. Seriya: Mizhnarodni ekonomichni vidnosyny ta svitove hospodarstvo*, 19(3), 44-48.
4. Pyroh, O. V. (2017). Structural changes in the economic development of the national economy of Ukraine: sectoral view. *Molodyvchenyi*, 4, 729-735.

5. Kalinina, A.H. (2016). Assessment of structural changes in the economy of Ukrainian. *Visnyk Pryazovskoho Derzhavnogo Tekhnichnoho Universytetu. Seriya: Ekonomichni nauky*, 31(1), 184-188.
6. Ignatyuk, A., Petlenko, Y., Shevtsiv, L., Zaitsev, O., Klymash, N., & Dukhovska, L. (2020). Model of the dynamics of the company's value taking into account the ownership structure. *International Journal of Management*, 11(6), 323-333. <https://doi.org/10.34218/IJM.11.6.2020.028>.
7. Gryshova, I., Kyzym, M., Khaustova, V., Korneev, V., & Kramarev, H. (2020). Assessment of the Industrial Structure and Its Influence on Sustainable Economic Development and Quality of Life of the Population of Different World Countries. *Sustainability*, 12(5), 2072.
8. Duma, L. V. (2018). Modeling of sectoral structural changes in the region's economy. *Biznes Inform*, 12, 126-136.
9. Khomych, S.V. (2014). Modeling restructuring mixed economy based on dynamic model "input-output" with intellectual capital. *Investytsii: praktyka ta dosvid*, 18, 46-50.
10. Gorditsa, K.A., & Slyvka, T.O. (2020). Structural transformations in Ukraine in the context of the development of international economic relations: a historical dimension. *Ekonomika Ukrainy*, 2, 80-96.
11. Ivanov, E.I. (2019). Computable general equilibrium model GTAP as a tool for international trade policy analysis. *Naukovyi Visnyk Uzhhorodskoho Natsionalnoho Universytetu. Seriya: Mizhnarodni ekonomichni vidnosyny ta svitove hospodarstvo*, 24(2), 26-32.
12. Burfisher, M. E. (2016). *Introduction to computable general equilibrium models*. Center for Global Trade Analysis, Purdue University. NewYork: Cambridge University Press.
13. Dixon, P., Jerie, M., & Rimmer, M. (2016). Modern Trade Theory for CGE Modelling: The Armington, Krugman and Melitz Models. *Journal of Global Economic Analysis*, 1(1), 1-110.
14. Voitseshyn, V.P. (2019). Export crediting as a means of its functioning. *Vcheni zapysky Tavriiskoho Natsionalnoho Universytetu imeni V. I. Vernadskoho. Seriya: Ekonomika i upravlinnia*, 30(5), 105-109. <https://doi.org/10.32838/2523-4803/69-5-19>.
15. Rubtsova, O.S. (2020). Transaction costs of construction companies in foreign economic activity. *Shliakhy pidvyshchennia efektyvnosti budivnytstva v umovakh formuvannia rynkovykh vidnosyn*, 44, 67-72.
16. *Verkhovna Rada of Ukraine* (n.d.). Retrieved from http://w1.c1.rada.gov.ua/pls/zweb2/webproc4_2?id=&pf3516=2554%E0%E4&sk1=9.

Моделювання впливу структурних зрушень на економічну динаміку розвитку України

А. О. Ходжаян¹, А. І. Ігнатюк¹, В. В. Корнеєв²,
А. Р. Ходжаян²

1 – Київський національний університет імені Тараса Шевченка, м. Київ, Україна, e-mail: alina_khodzhaiyan@ukr.net

2 – Державний науково-дослідний інститут інформатизації та моделювання економіки, м. Київ, Україна

Мета. Кількісна оцінка макроекономічних і галузевих структурних ефектів в економіці України у середньостроковому періоді в результаті застосування заходів структурної політики держави.

Методика. Методологічною основою дослідження послугували методи економіко-математичного моделювання з використанням прикладної моделі загальної рівноваги Global Trade Analysis Project (GTAP). При систематизації та узагальненні результатів моделювання використані методи аналізу й синтезу. Опрацювання теоретичної бази моделі GTAP здійснено за допомогою системного методу.

Результати. Досліджено вплив заходів структурної політики держави на економічну динаміку в Україні з використанням прикладної моделі загальної рівноваги GTAP. Визначена сутність і особливості функціонування прикладних моделей загальної рівноваги, сфера їх застосування при аналізі структурних зрушень в економіці країни. З використанням моделі GTAP надана кількісна оцінка макроекономічним і галузевим структурним ефектам в Україні в результаті реалізації низки заходів структурної політики держави, серед яких: звільнення виробників переробної промисловості від сплати ввізних мит на інноваційне обладнання та устаткування; забезпечення пільгового страхування та кредитування експортних поставок через експортно-кредитне агентство; спрощення процедур зовнішньої торгівлі; звільнення резидентів індустріальних парків від сплати деяких прямих податків і зборів (ПДВ, земельний податок, інфраструктурний збір). Обґрунтовано позитивний економічний ефект запропонованих заходів у структурному й макроекономічному вимірах. Дана оцінка впливу структурної перебудови вітчизняного господарства на динаміку показників соціально-економічного розвитку й загального добробуту населення.

Наукова новизна. Запропоновано методичний підхід до кількісного оцінювання макроекономічних і галузевих структурних ефектів в економіці України в середньостроковому періоді з використанням прикладної моделі загальної рівноваги GTAP. Виявлено, що в середньостроковому періоді сукупний ефект від розглянутих заходів структурної перебудови становить 11,4 % зростання ВВП як за рахунок активізації ділової активності в цілому, так і завдяки ефективнішому використанню ресурсів і факторів виробництва в більш високопродуктивних галузях національної економіки. Серед розглянутих заходів найбільший структурний ефект спостерігається в результаті розбудови мережі реально діючих індустріальних парків в Україні. Водночас структурна політика в митно-тарифній сфері має найнижчий потенціал економічного зростання, хоча залишається важливим елементом у покращенні доступу виробників до інноваційного обладнання.

Практична значимість. Одержані результати можуть бути використані в якості наукового обґрунтування реформ у промисловій і зовнішньоторговельній політиці України, покликаних забезпечити якісні структурні зрушення у вітчизняній економіці.

Ключові слова: структурна політика, структурні зрушення, прикладна модель загальної рівноваги Global Trade Analysis Project (GTAP), ввізне мито, експортно-кредитне агентство, індустріальний парк

Моделирование влияния структурных изменений на экономическую динамику развития Украины

А. А. Ходжаян¹, А. И. Игнатюк¹, В. В. Корнеев²,
А. Р. Ходжаян²

1 – Киевский национальный университет имени Тараса Шевченко, г. Киев, Украина, e-mail: alina_khodzhaiyan@ukr.net

2 – Государственный научно-исследовательский институт информатизации и моделирования экономики, г. Киев, Украина

Цель. Представить количественную оценку отраслевых структурных сдвигов в экономике Украины в среднесрочной перспективе в результате применения мер структурной политики государства.

Методика. Методологической основой исследования служат методы экономико-математического моделиро-

вания с использованием прикладной модели общего равновесия Global Trade Analysis Project (GTAP). При систематизации и обобщении результатов моделирования использованы методы анализа и синтеза. Разработка теоретической базы модели GTAP осуществлена с использованием системного метода.

Результаты. Исследовано влияние инструментов структурной политики государства на динамику экономического развития в Украине с использованием прикладной модели общего равновесия GTAP. Определена сущность и особенности функционирования прикладных моделей общего равновесия, сфера их применения при анализе структурных изменений в экономике страны. С использованием модели GTAP дана количественная оценка макроэкономическим и отраслевым структурным эффектам в Украине в результате реализации ряда мероприятий структурной политики государства, среди которых: освобождение производителей перерабатывающей промышленности от уплаты ввозных пошлин на инновационное оборудование; обеспечение льготного страхования и кредитования экспортных поставок через экспортно-кредитное агентство; упрощение процедур внешней торговли; освобождение резидентов индустриальных парков от уплаты некоторых прямых налогов и сборов (НДС, земельный налог, инфраструктурный сбор). Обоснован положительный экономический эффект предложенных мер в структурном и макроэкономическом измерениях. Дана оценка влияния структурной перестройки отечественного хозяйства на динамику показателей социально-экономического развития и общего благосостояния населения.

Научная новизна. Предложен методический подход к количественной оценке макроэкономических и отраслевых структурных эффектов в экономике Украины в среднесрочной перспективе с использованием прикладной модели общего равновесия GTAP. Выявлено, что в среднесрочной перспективе совокупный эффект от рассмотренных мер структурной перестройки составляет 11,4% роста ВВП как за счет активизации деловой активности в целом, так и благодаря более эффективному использованию ресурсов и факторов производства в более высокопроизводительных отраслях национальной экономики. Среди рассматриваемых мер наибольший структурный эффект наблюдается в результате развития сети реально действующих индустриальных парков в Украине. В то же время структурная политика в таможенно-тарифной сфере имеет низкий потенциал экономического роста, хотя остается важным элементом в улучшении доступа производителей к инновационному оборудованию.

Практическая значимость. Полученные результаты могут быть использованы в качестве научного обоснования реформ в промышленной и внешнеторговой политике Украины, призванных обеспечить качественные структурные сдвиги в отечественной экономике.

Ключевые слова: *структурная политика, структурные изменения, прикладная модель общего равновесия, Global Trade Analysis Project (GTAP), ввозная пошлина, экспортно-кредитное агентство, индустриальный парк*

Recommended for publication by H. S. Lopushniak, Doctor of Economic Sciences. The manuscript was submitted 24.06.20.