

EXTERNAL SECTOR OF UKRAINE: TENDENCIES, DETERMINANTS AND INTERDEPENDENCIES BETWEEN INDICATORS

The investigation implements a simultaneous econometric model of the external sector of the Ukrainian economy. The endogenous variables are: volume of direct foreign investments in Ukraine (FDI), gross foreign debt, export of goods and services and import of goods and services. The exogenous variables of the model are: volume of industrial production, expenditures from the state budget, gross domestic product (GDP), tax revenues, exchange rate of the national currency to the US dollar; the level of the shadow economy. All data are collected for Ukraine for the period 2002–2021 years.

Purpose of the investigation is to identify and interpret indicators that affect external sector of the Ukrainian economy, and identify interdependencies between indicators of the external sector with quantitative methods of analysis.

Method of simultaneous modeling was used, which makes it possible to investigate the interdependence between exogenous and endogenous variables.

The system of four equations was proposed that describes the dependence between indicators of the external sector and indicators of the economic sector of Ukraine. The model was checked for adequacy and an econometric analysis of quality was carried out.

Discovered that an increase in gross foreign debt has a negative impact on the volume of FDI and the increase in the export of goods and services contributes to the increase in the volume of FDI (the first equation).

The second equation proved that an increase in the volume of FDI may lead to an increase in the gross external debt and an increase in the import of goods and services can lead to a decrease in the gross external debt.

According to the third equation an increase in the volume of FDI in Ukraine and gross foreign debt can contribute to an increase in the export of goods and services.

The fourth equation confirmed that an increase in FDI can lead to a decrease in imports of goods and services and an increase in exports can lead to an increase in imports because more foreign currency will be available to buy imported goods and services.

Key words: model, export, import, direct foreign investments, gross foreign debt, external sector, indicators, economic development, simultaneous equations.

JEL Classification: C02, C3, F21, F47.

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Introduction. Exports and imports have a significant impact on the country's economy. Exports can contribute to GDP growth by creating jobs and increasing revenue from the sale of goods and services abroad. Imports can meet the needs of the population for goods and services that cannot be produced domestically, and can promote competition, which can lead to lower prices and higher quality of goods and services. Foreign direct investment (FDI) can also have a significant impact on a country's economy. FDI can contribute to GDP growth by creating jobs, introducing new technologies and promoting competition. FDI can also contribute to infrastructure development and higher living standards. However, exports, imports and FDI can also have a negative impact on a country's economy. For example, exporting can lead to job losses in industries that compete with imported goods and services. Imports can lead to a deficit in the trade balance and a decrease in the exchange rate of the national currency. FDI can lead to a loss of control over the national economy and an increase in income inequality. Gross

public debt can be caused by various factors such as war, economic crises and social programs. It is important that the national debt is not too high, as this can lead to financial instability. The state can reduce the public debt with the help of various measures, such as: increasing exports, decreasing imports, attracting foreign direct investments, increasing tax revenues, reducing government expenditures, etc. The relationship between exports, imports, foreign direct investment and gross public debt is complex and indirect. In general, it can be said that the growth of exports and foreign direct investment contributes to the reduction of public debt, while the growth of imports contributes to its increase. The impact of exports, imports and FDI on a country's economy depends on many factors, such as the structure of the economy, the country's level of development and international trade conditions. It is important to take into account all these factors when formulating policies that will contribute to the economic growth and development of the country. In order to identify and study the influences between exports, imports, direct foreign investments and the gross external debt of Ukraine, it is advisable to use econometric methods and models that make it possible to quantitatively assess the dependencies between these economic indicators, to identify direct and reverse influences based on a statistical sample. Another characteristic feature of dependencies between economic indicators is that these dependencies can be mutual. In this study, for example, it is difficult to clearly identify causal relationships between exports and imports, as exports affect imports and imports affect exports. To identify mutual dependencies between variables, it is advisable to use simultaneous econometric models. Therefore, a simultaneous approach was developed to study the mutual influence between export, import, FDI and the gross external debt of Ukraine. The independent variables are: the volume of industrial production, million hryvnias; expenditures from the state budget, UAH million; gross domestic product (GDP), UAH million; tax revenues, UAH million; the rate of the national currency against the US dollar and the level of the shadow economy, %. The model consists of four equations that describe both the interdependence between dependent variables and the influence of independent variables on them. Model parameters were estimated using the two-step least-squares method.

Literature review. The external sector modeling is the process of developing and using mathematical models to analyze the interactions between a country's economy and the global economy. As it is known external sector impacts on different aspects of economics. Acharya V. V. investigated dependence between external sector and macroprudential policies for India (Achatya, 2023). Sahoo, M. and coauthors (also for India) proved with the econometric methods that oil imports significantly improve the balance of the country, which is important for the sustainability of the external sector (Sahoo, 2022). Badejo, B. A. and coauthors in the contrary investigated impact of non-oil export commodities on the external sector of Nigeria and proved significant and positive dependence in the short-run horizons, but not in the long-run, they used Vector Error Correction Model (VECM) (Badejo, 2018). Emter L. and McQuade P. claim that China's capital flows and exchange rate have become more volatile in recent years, due to a number of factors, including the trade war with the United States, the liberalization of financial markets, and domestic financial market vulnerabilities; this volatility could have significant implications for the Chinese economy and the global financial system (Emter, 2018). Ruiz Estrada M. A. investigated external sector in COVID-19 conditions in China (Ruiz Estrada, 2020), Aragie E. and coauthors in Ethiopia in short-term (Aragie, 2020) Vdovyn M. and Zomchak L. in pre-pandemic period, Covid-19 and war in Ukraine (Vdovyn, 2022). Ruiz Estrada M. A. with coauthors proposed the ESVM-index (λ) as a new indicator to evaluate the external sector behavior of a country or region, which is not a forecasting model, but rather a tool for policy-makers and researchers to study the past and present economic situation in any country's external sector performance (Ruiz Estrada, 2018). Arturo, M. and coauthor introduced a new index called the External Sector Development Index (SXi) to measure the external sector of a country and applied the SXi to the Chinese and ASEAN economies (Arturo, 2011).

One of the most popular types of models for external sector are autoregressive. For example, Onwioduokit E. A. and Effiong O. E. used vector autoregressive model for investigation the impact of external sector liberalization on output growth in Nigeria from 1981 to 2019 (Onwioduokit, 2021). Korgbeelo C. used autoregressive lag-distributed model for investigation the impact of the IMF stabilization program on the development of Nigeria's external sector (Korgbeelo, 2023). The same method used Kaur M. and Kulaar N. for external sector of India investigation (Kaur M., 2023). Zomchak L. and Starchevska I. used logistic regression analysis for economy of Ukraine (Zomchak, 2022). The findings of the study (Onyimadu, 2019) with structural equations model show that oil price shocks do have significant impacts

on the components of Nigeria's external sector. The paper (Sobański, 2019) discusses the concept of «dark matter» in the context of the US external sector, where dark matter is defined as the difference between the official net international investment position (IIP) and the actual net IIP, which is estimated based on prevailing income differentials. The paper by Sahoo M. and coauthors (Sahoo, 2022) examines the dynamic relationship between fiscal balance and current account balance in India, and tests the twin deficit hypothesis, the paper finds that there is evidence to support the twin deficit hypothesis in India. The paper by Vdovyn M. and coauthors (Vdovyn, 2022) explains the game theory methods use in economic systems modeling. The paper (Petraikos, 2022) examines the political budget cycles in Greece and their impact on the country's public debt and economic growth with five econometric models and finds that political budget cycles have been a persistent problem in Greece since 1974.

Simultaneous model of external sector of Ukraine. To carry out an econometric analysis of the relationship between foreign trade and investment, data were collected from the official page of the State Statistics Service of Ukraine for 2002–2021 (State Statistics Service of Ukraine, 2022) according to the following indicators:

Endogenous variables:

– y_1 – volume of direct foreign investments in Ukraine, million dollars USA – this indicator indicates the amount of foreign investments that are coming to Ukraine. The higher this indicator, the greater the interest in investing in Ukraine and the greater the need for infrastructure and business development in the country;

– y_2 – gross foreign debt, million dollars USA. This is an indicator that indicates the total amount of the country's debt to foreign creditors. The higher this indicator, the more difficult it is to repay the debt to foreign creditors, which can lead to a decrease in confidence in the country's economy;

– y_3 – export of goods and services, million dollars USA – this indicator indicates the volume of goods and services exported from the country. The higher this indicator, the more opportunities for attracting foreign investment into the country's economy;

– y_4 – import of goods and services, million dollars USA – this indicator indicates the volume of goods and services imported into the country. The higher this indicator, the greater the dependence on the foreign economic environment, which can lead to a decrease in the stability of the country's economy.

Exogenous variables:

– x_1 – volume of industrial production, UAH million. This indicator indicates the volume of production of industrial products in the country. The higher this indicator, the more opportunities there are for the development of exports and the attraction of foreign investments in the country's economy;

– x_2 – expenditures from the state budget, UAH million. An indicator that indicates the level of state investment in the country's economy. The higher this indicator, the more opportunities there are for the development of the country's economy and the attraction of foreign investments;

– x_3 – gross domestic product (GDP), UAH million. This indicator indicates the volume of all goods and services produced in the country. This is a key indicator that reflects the country's economic development. The higher this indicator, the more opportunities for attracting foreign investment into the country's economy;

– x_4 – tax revenues, UAH million. This indicator indicates the amount of taxes collected by the state from enterprises and citizens. This indicator can indicate the level of economic activity in the country, as well as the effectiveness of fiscal policy;

– x_5 – exchange rate of the national currency to the US dollar – this indicator indicates the exchange rate of the national currency of the country to the US dollar. This can affect the export and import of goods and services, as well as the attractiveness of foreign investments;

– x_6 – the level of the shadow economy, % – an indicator that indicates the amount of economic activity that is unofficially registered in the country's economy. The higher this indicator, the more difficult it is to control the country's economy, which can affect the attractiveness of foreign investments.

These indicators can be grouped into 4 groups:

1. Indicators of foreign trade:

– y_3 – export of goods and services, million dollars USA;

– y_4 – import of goods and services, million dollars USA;

2. Indicators of foreign investments:

– y_1 – volume of direct foreign investments in Ukraine, million dollars USA;

3. Indicators of the country's financial condition:

- y_2 – gross foreign debt, million dollars USA;
- x_6 – level of the shadow economy, %;

4. Indicators of economic development of the country:

- x_1 – volume of industrial production, UAH million;
- x_2 – expenditures from the state budget, UAH million;
- x_3 – gross domestic product (GDP), UAH million;
- x_4 – tax revenues, UAH million;
- x_5 – exchange rate of the national currency to the US dollar.

That is, for the analysis of foreign trade, such indicators as export (y_3) and import (y_4) of goods and services can be used. These indicators indicate the level of the country's foreign trade and its ability to compete on the international market. With the help of these indicators, it is possible to assess the country's foreign trade balance and its dependence on imports.

Regarding investments, indicators such as the volume of foreign direct investment (y_1) and gross external debt (y_2) can be used for their analysis. These indicators indicate the level of foreign investment in the country and its ability to attract investment from abroad. In addition, the amount of direct investment can indicate the level of confidence in the country and its economic stability, and the gross external debt can indicate the level of the country's debt burden.

Domestic indicators, such as the volume of industrial production (x_1), state budget expenditures (x_2), gross domestic product (x_3), tax revenues (x_4), the exchange rate of the national currency to the US dollar (x_5) and the level of the shadow economy (x_6), can indicate the general level of economic development of the country. The volume of industrial production can indicate the level of production and industrial development of the country, and expenditures from the state budget and tax revenues can indicate the effectiveness of public administration and fiscal policy. Gross domestic product is one of the main indicators of the country's economic development and can indicate the general standard of living of the population. The exchange rate of the national currency against the US dollar can indicate the level of international competitiveness of the country and the state of its foreign trade. The level of the shadow economy may indicate the level of corruption and illegal capital outflow in the country.

The simultaneous model of the relationship between foreign trade and investment consists of four equations.

The first equation:

$$y_1 = a_{10} + a_{14}x_4 + a_{15}x_5 + \beta_{12}y_2 + \beta_{13}y_3 + \beta_{14}y_4 + \varepsilon_1,$$

where a and β – parameters of the equation, y_1 – volume of direct foreign investments in Ukraine, x_4 – tax revenues, x_5 – exchange rate of the national currency to the US dollar, y_3 – export of goods and services, y_4 – import of goods and services, ε – error term.

This equation describes the dependence of the amount of direct foreign investment in Ukraine (y_1) on various economic indicators, such as gross foreign debt (y_2), export of goods and services (y_3), import of goods and services (y_4), volume of industrial production (x_1), state budget expenditures (x_2), gross domestic product (GDP) (x_3), tax revenues (x_4), the exchange rate of the national currency to the US dollar (x_5), and the level of the shadow economy (x_6).

The second equation:

$$y_2 = a_{20} + a_{23}x_3 + a_{25}x_5 + a_{26}x_6 + \beta_{21}y_1 + \beta_{24}y_4 + \varepsilon_2,$$

where a and β – parameters of the equation, y_2 – gross foreign debt, x_3 – gross domestic product, x_5 – exchange rate of the national currency to the US dollar, x_6 – level of the shadow economy, y_1 – volume of direct foreign investments in Ukraine, y_4 – import of goods and services, ε – error term.

This equation shows that the foreign debt of Ukraine depends on domestic production, the exchange rate of the national currency, the level of the shadow economy, the volume of foreign direct investment in Ukraine, and the import of goods and services.

The third equation:

$$y_3 = a_{30} + a_{21}x_1 + a_{32}x_2 + a_{34}x_4 + \beta_{34}y_4 + \varepsilon_3,$$

where a and β – parameters of the equation, y_3 – export of goods and services, x_1 – volume of industrial

production, x_2 – expenditures from the state budget, x_4 – tax revenues, y_4 – import of goods and services, ε – error term.

This equation shows that the export of goods and services depends on the volume of industrial production, expenditures from the state budget, tax revenues and gross domestic product.

The fourth equation:

$$y_4 = a_{40} + a_{43}x_3 + a_{44}x_4 + a_{45}x_5 + \beta_{41}y_1 + \beta_{43}y_3 + \varepsilon_4,$$

where a and β – parameters of the equation, y_4 – import of goods and services, x_3 – gross domestic product, x_4 – tax revenues, y_1 – volume of direct foreign investments in Ukraine, y_3 – export of goods and services, ε – error term.

This equation describes the relationship between imports of goods and services and other variables:

– The amount of foreign direct investment in Ukraine (y_1): The more foreign investment, the more economic activity usually increases, which can lead to an increase in the import of goods and services.

– Export of goods and services (y_3): If there is a high amount of export of goods and services in Ukraine, then, usually, the import of goods and services decreases.

– Volume of gross domestic product (x_3): The greater the GDP in Ukraine, the more the population can afford to buy more foreign goods and services.

– Exchange rate of the national currency to the US dollar (x_5): If the national currency appreciates against the US dollar, this usually lowers the price of imported goods and services and increases the amount of imports.

Next, we will check the model for identity using the order condition.

Let m be the number of endogenous variables in the model (6 in our model);

m_i is the number of endogenous variables in the i -th equation of the model;

k is the number of exogenous variables in the model (4 in our model);

k_i is the number of exogenous variables in the i -th equation of the model.

We apply the rule: $k - k_i \geq m_i - 1$.

1) $6 - 2 > 3 - 1$ – overidentified;

2) $6 - 3 > 3 - 1$ – overidentified;

3) $6 - 3 > 2 - 1$ – overidentified;

4) $6 - 3 > 3 - 1$ – overidentified.

From the obtained results, we see that under the condition of order, all equations are overidentified, and therefore the entire model is also overidentified. To determine and estimate the parameters of the simultaneous model, we will use the two-step method of least squares. Let's write the model in an abbreviated form in a collapsed form. In this notation, the endogenous variables of the model depend on all the exogenous variables. Abbreviated form (collapsed expression):

$$y_1 = \pi_{10} + \pi_{11}x_1 + \pi_{12}x_2 + \pi_{13}x_3 + \pi_{14}x_4 + \pi_{15}x_5 + \pi_{16}x_6$$

$$y_2 = \pi_{20} + \pi_{21}x_1 + \pi_{22}x_2 + \pi_{23}x_3 + \pi_{24}x_4 + \pi_{25}x_5 + \pi_{26}x_6$$

$$y_3 = \pi_{30} + \pi_{31}x_1 + \pi_{32}x_2 + \pi_{33}x_3 + \pi_{34}x_4 + \pi_{35}x_5 + \pi_{36}x_6$$

$$y_4 = \pi_{40} + \pi_{41}x_1 + \pi_{42}x_2 + \pi_{43}x_3 + \pi_{44}x_4 + \pi_{45}x_5 + \pi_{46}x_6$$

where y – endogenous variables, x – exogenous variables, π – parameters of the equations.

After checking the adequacy of the studied equations. To check the adequacy of the model, we will use the F-criterion, the empirical value of which for the first equation is equal to $F_{em} = 12.93349646$ (F-statistic). Equating with the critical $F_{kp} = 0.0000808$, we conclude that the null hypothesis about the zero value of the multiple regression coefficients can be rejected. So, with a confidence probability of $p=0.95$, it can be stated that the constructed first equation of the simultaneous model is adequate. The same situation with other equations.

Empirical results. To calculate the unknown parameters, it is necessary to replace the endogenous variables in the structural model with the estimated values of the endogenous variables depending on all the exogenous values of the model. The following equations are obtained, the first equation:

$$y_1 = 536,957 - 0,004\tilde{y}_2 + 0,778\tilde{y}_3 + 0,009x_4 - 19151,145x_5 .$$

– An increase in gross foreign debt has a negative impact on the volume of foreign direct investment in Ukraine.

– The increase in the export of goods and services contributes to the increase in the volume of direct foreign investment in Ukraine.

– An increase in the import of goods and services contributes to an increase in the volume of direct foreign investment in Ukraine.

– A decrease in the exchange rate of the national currency against the US dollar contributes to an increase in the volume of direct foreign investment in Ukraine. Thus, an increase in the export of goods and services and a decrease in the exchange rate of the national currency against the US dollar can be favorable conditions for attracting foreign direct investment to Ukraine. However, an increase in gross external debt and imports of goods and services may negatively affect this process.

The second equation with parameters:

$$y_2 = -4660,247 + 1252,077 \tilde{y}_1 - 0,009 \tilde{y}_4 + 0,502 x_3 + 1,432 x_5 + 193541,262 x_6 .$$

– An increase in the volume of foreign direct investment may lead to an increase in the gross external debt.

– An increase in the import of goods and services can lead to a decrease in the gross external debt.

– An increase in GDP can lead to an increase in gross external debt.

– An increase in the exchange rate of the national currency against the US dollar may lead to an increase in the gross external debt.

– An increase in the level of the shadow economy may lead to an increase in the gross external debt.

The third equation:

$$y_3 = 0,009 - 0,002 \tilde{y}_4 - 0,034 x_4 + 0,752 x_2 + 8826,747 x_1 .$$

According to the equation, it can be seen that an increase in the volume of direct foreign investment in Ukraine (y_1) and gross foreign debt (y_2) can contribute to an increase in the export of goods and services (y_3). However, an increase in the import of goods and services (y_4) may reduce the volume of exports (y_3). In addition, the equation reflects the impact of production (x_1), state budget expenditures (x_2), GDP (x_3), tax revenues (x_4), the exchange rate of the national currency (x_5) and the level of the shadow economy (x_6) on the export of goods and services (y_3).

The fourth equation:

$$y_4 = -247,012 + 0,018 \tilde{y}_1 - 0,002 \tilde{y}_3 + 1,268 x_3 - 0,076 x_4 - 9605,979 x_5 .$$

An increase in foreign investment can lead to a decrease in imports of goods and services, as foreign companies can produce more goods in Ukraine instead of importing them from other countries.

An increase in exports can lead to an increase in imports because more foreign currency will be available to buy imported goods and services.

An increase in GDP can lead to an increase in imports because a higher level of income can lead to a higher demand for imported goods and services.

An increase in tax revenue can lead to a decrease in imports, as more funds can be directed to the production of domestic goods and services.

A decrease in the exchange rate of the national currency against the dollar can lead to an increase in imports, since imported goods and services can become cheaper for domestic consumers.

Conclusions. The proposed simultaneous model can be useful for studying the interaction of various factors on the country's economy and for forecasting the possible consequences of various economic decisions.

The amount of foreign direct investment and gross external debt are important factors affecting a country's ability to attract foreign investment and repay external debts. Export and import of goods and services are important indicators that affect the country's external balance and, therefore, its economic stability. The volume of industrial output and GDP indicate the general state of a country's economy, while tax revenue can reflect a state's ability to collect taxes and finance various projects. The exchange rate of the national currency against the US dollar can affect the competitiveness of goods and services of domestic producers on the international market. The level of the shadow economy can indicate shortcomings in the management of the country's economy and can affect the overall economic development.

To check the adequacy of the model, we will use the Fisher criterion (F-criterion), the empirical value of which, for example, for the first equation is $F_{em} = 9.940766954$ (F-statistic). Based on the comparison of the empirical value with the critical value ($F_{kp} = 3, 2.901294536$ at the given level of significance $\alpha = 0.05$ and the number of degrees of freedom $v_1 = 5$ and $v_2 = 15$), we conclude that the null hypothesis about the zero value of the multiple regression coefficients can be rejected. So, with a confidence probability of $p=0.95$, it can be stated that the constructed first equation of the simulative model of the relationship of foreign trade and investment is adequate. The same situation with the following equations.

It can be concluded that each equation of the simultaneous model is adequate, since the coefficients of multiple determination are greater than 0.72, in particular: R-square 0.73, which indicates that the model explains about 73% of the variation in the volume of foreign direct investment in Ukraine. R-squared 0.91 indicate that the model explains about 91% of the variation in gross external debt. R-squared 0.84 indicating that the model explains about 84% of the variation in exports of goods and services. R-squared 0.81 indicating that the model explains about 81% of the variation in imports of goods and services.

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ЗОВНІШНІЙ СЕКТОР УКРАЇНИ: ТЕНДЕНЦІЇ, ДЕТЕРМІНАНТИ ТА ВЗАЄМНІ ЗАЛЕЖНОСТІ МІЖ ІНДИКАТОРАМИ

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У дослідженні реалізовано симультаивну економетричну модель зовнішнього сектора економіки України. У якості ендогенних змінних обрано: обсяг прямих іноземних інвестицій в Україну, валовий зовнішній борг, експорт товарів і послуг та імпорт товарів і послуг. Екзогенними змінними моделі є: обсяг промислового виробництва, видатки з державного бюджету, валовий внутрішній продукт (ВВП), податкові надходження, курс національної валюти до долара США; рівень тіньової економіки. Усі дані зібрано по Україні за період 2002–2021 років.

Метою дослідження є виявлення та інтерпретація індикаторів, що впливають на зовнішній сектор української економіки, а також виявлення взаємозалежностей між такими показниками зовнішнього сектора, як обсяг прямих іноземних інвестицій в Україну, валовий зовнішній борг, експорт товарів і послуг та імпорт товарів і послуг, за допомогою кількісних методів економетричного аналізу.

Використано метод симультаивних економетричних моделей (систем одночасних рівнянь), що дає змогу дослідити не лише залежність ендогенних змінних від екзогенних, а також взаємозалежність між екзогенними та ендогенними змінними

Запропоновано систему чотирьох одночасних рівнянь, яка описує залежність між показниками зовнішнього сектора та показниками економічного стану України. Модель перевірено на адекватність та проведено економетричний аналіз якості моделювання.

Виявлено, що збільшення валового зовнішнього боргу негативно впливає на обсяг прямих іноземних інвестицій в Україну, а збільшення експорту товарів і послуг сприяє збільшенню обсягу прямих іноземних інвестицій в Україну (перше рівняння). Друге рівняння довело, що збільшення обсягу прямих іноземних інвестицій в Україну може призвести до збільшення валового зовнішнього боргу, а збільшення імпорту товарів і послуг може призвести до зменшення валового зовнішнього боргу. Відповідно до третього рівняння збільшення обсягу прямих іноземних інвестицій в Україну та валового зовнішнього боргу може сприяти збільшенню експорту товарів і послуг. Четверте рівняння підтвердило, що збільшення прямих іноземних інвестицій в Україну може призвести до зменшення імпорту товарів і послуг, а збільшення експорту може призвести до збільшення імпорту, оскільки більше іноземної валюти буде доступно для купівлі імпортованих товарів і послуг.

Ключові слова: модель, експорт, імпорт, прями іноземні інвестиції, валовий зовнішній борг, зовнішній сектор, показники, економічний розвиток, симультаивні рівняння.