

A Case Study of EU Economic Formation with System Dynamic Method

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ABSTRACT

The formation of the European Union (EU) is the one of the biggest political – economic events of the last 50 years. EU development and optimization process is still incomplete, with still evolving EU economic foundations and financial system. The aim of this study is to develop EU economy functioning system dynamic model, taking into account the main economic indicator changes of EU countries since the EU enlargement. The paper focuses on such indicators as GDP, employment, public debt, and reflects its dynamics in periods of the years 1995, 2004 and 2010. The study uses traditional mathematical, statistical and economic analysis methods, such as data grouping, comparison, average level and trends detection, regression method, as well as visual analysis (graphical) method. Main research method is system dynamics. Study result – author divides EU countries into several groups based on their economic specifics (it is possible to use similar development politics for these groups). For these groups within the paper, EU economy system dynamic model is developed. Model is tested only for one EU country, Latvia. The results from the paper show failure of the mechanism of EU operations: the available mechanism contradicts EU principles; it doesn't promote the cohesion in European Union, but quite opposite - leads to solving problems of well-developed EU countries at the expense of developing countries. In the given conditions, the example of Latvia shows that there is no possibility to overcome the system crisis. These circumstances specify a necessity of changes in EU internal migratory policy, changes in principles of developing countries' support in EU, and changes in distribution of EU means, taking into account internal migration.

Keywords: European Union, integration, GDP, employment, debt, international trade, investments, migration.

1. INTRODUCTION

After formation of the European Union (EU) enough time has passed to make conclusions, as to what member countries gained from the accession to the Union. The EU has definite advantages: free trade, free movement of labour force and capital. Participation in the union involves other Member States' support during the times of economical difficulties. Despite the advantages, the crisis in 2008 underscored the union's problems: some states do not fulfill the basic financial and economical conditions; some try to improve their internal well-being at the expense of others. These conditions have highlighted actuality of the study; they require defining the functioning economic models of EU, as well as defining the differences and similarities of these models.

The problem researched in the paper is related to economic evaluation of EU member states, as well as development of a functioning EU economy system dynamic model.

Paper's novelty elements are related both to quantitative evaluation on the impact of political - economic union formation on its member states' economies and the functioning EU economy model development with system dynamics method. At the present, union formation process is topical not only for EU countries; the integration processes take place worldwide: CIS, etc. Paper's results could be used in planning union, regional public

policies, economics, as well as for academic and scientific purposes.

The research objects are the integration of the EU and the development of a functioning EU economical model. The research subject is the changes of EU member states' economies, which have occurred as a result of EU enlargement.

The paper's aim is to develop an EU economy functioning system dynamic model, taking into account the EU countries' main economic indicator changes since the EU enlargement. To achieve this aim the following tasks are set: 1) to analyze the GDP, employment level, public debt, foreign trade, investment and its dynamics of the EU countries, 2) to analyze scientific literature and previous experience in EU model development with system dynamics method, 3) to develop a conceptual scheme and involved sub-models of the EU system dynamic model, 4) to test developed model.

The study will use traditional mathematical, statistical and economic analysis methods, such as data grouping, comparison, average level and trend detection, regression method, as well as visual analysis (graphical) method. Main research method is system dynamics.

The system dynamics method is chosen taking into account EU specifics – rapid changes to the economy, in these circumstances econometric methods do not operate correctly, and the system method specifics – it allows to combine analytical reasoning and mathematical, statistical calculations. It is the study limitation.

As the information base of study the European Community's, Eurostat data [7] are used. Some materials are taken from experts, news agencies, newspapers and the Internet. Methodological basis of research is based upon the world top scientist's works on the international economic theory - MacConell C. and S. Brue [13], system dynamics - Sterman J. [16], Yamaguchi K. [18], Wheat D. [17], Chevalley T. [2].

The study focuses on the EU expansion in 2004, and its results; it is the limitation of the paper.

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2. EUROPEAN UNION MAIN ECONOMIC INDICATOR ANALYSIS

Traditionally, the state economy is measured by several most relevant indicators, including GDP, number of employed, the amount of investment, exports and public debt. Evaluating the EU's national economies, the author has combined both absolute and relative indicators. This approach makes it possible to assess the scale of an individual country within the EU context, and to compare the development among the countries.

2.1. GDP dynamic analysis in the EU countries

The first indicator analysed, which reflects the economic development of the EU countries, is GDP. GDP in general is measured by a relative indicator “GDP per capita.” The dynamics of these development indicators displays the Fig.1, but Fig.2 displays the latest available results in 2010.

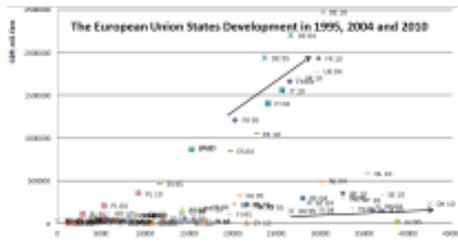


Fig. 1: The Development Dynamics of the EU memberstates.



Fig. 2: The Development of the EU Countries in 2010.

After analyzing the development among the EU countries and their dynamics, the following conclusions could be drawn:

- Countries could be grouped accordingly to the dynamics of development: economically larger countries (Germany, France, United Kingdom, Italy, and Spain) increase the size of their economies and at the same time increase the income per capita, while the smaller countries do not fundamentally change the economic level, but increase their per capita income.
- Countries could be grouped according to the level of their population wealth (welfare). By this feature, "wealthy" countries differ considerably from the middle class countries; middle class countries differ substantially from the "poor" countries, and the "wealthy" countries significantly suppress the "poor" countries. To the "wealthy" countries could be added economically relatively small countries such as Denmark, Belgium, Netherlands, etc. Middle class form the biggest EU economies - Germany, France, United Kingdom, Italy, and Spain. It is important to note that by the wealth (welfare), middle-level countries could be close to an existing group (e.g., Spain by the welfare level is closer to Greece, Germany to Belgium), but the scale of these economies could differ 2-6 times. The group of "poor" countries mainly consists of the new EU member states, with exception of Greece.

Analyzing the reflected development dynamics of the countries from the point of view of system dynamics, it could be said that the EU is characterized by self-reinforcing economic growth processes. All the countries use it to increase their standard of living, but some also to expand their economic power. Larger countries are unable to provide higher improvement of well-being, but smaller countries cannot significantly develop their economical capacity. These specifics of the economic development need to be considered in the development of the EU economic system dynamics model.

The EU economically geographic structure is also interesting, which is shown in the Fig.3. EU economically-geographic structure is observed here to test the hypothesis: the EU, depending upon the stages during its development, was divided into the wealthy Western Europe and the poor Eastern Europe [3]. However, recently there has been a thesis that the EU is composed of wealthy, stable northern countries and unstable southern countries [1].



Where: 28 - 46 46 - 65 65 - 99 99 - 118 118 - 271 N/A

Fig. 3: GDP per capita in PPS in 2010.

The Fig.3 shows that, comparing countries by the level of GDP per capita, rich northern countries and poor eastern countries can be clearly distinguished. Southern countries do not significantly differ from the average EU level.

2.2. Population and labor force dynamic analysis in the EU countries

Country's economic power is also characterized by the population and the proportion of the employed. These indicators for EU countries are shown in Figure 4.

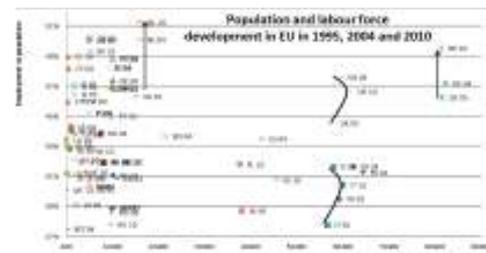


Fig. 4: Population and labor force dynamic in EU.

Analyzing the labour and employment dynamics, two groups of countries can be pointed out: countries with employment growing steadily throughout the test period (Germany, the Netherlands) and the states, which due to the 2004 -2010 crisis had a reduction in employment (UK, Italy, France, Spain). The EU countries do not have a common employment policy, e.g. Germany is sharply criticized for its cheap labour policy, which increases the competitiveness of the country compared to the other EU countries [8], destabilizes fewer capable EU countries, develops domestic economy and promotes internal employment growth.

Analyzing the Fig.4 data, individual countries have an increase in population at the same time with a reduction in employment level (see Fig. 4 bows). This could be the result of the free movement of labour, which got a new impetus in 2004.

The next phase of the employment analysis is related to the geographic breakdown of employment, see Fig.5.



Where: 43.5 - 57.8 57.8 - 59.7 59.7 - 65.6 65.6 - 72.7 72.7 - 78.6 N/A

Fig. 5: Employment rate in age group 15-64, in 2010, %.

When analyzing a geographical breakdown of the employment, Fig. 5 clearly shows that central and northern Europe countries (Germany, Sweden, and Finland) hold leading position in comparison to other EU countries. Employment level outsiders are Eastern and Southern European countries.

2.3. Debt dynamic analysis in EU countries

The state's welfare can also grow by living on account of credit means. The EU public debt and its ratio to GDP are analyzed in Fig.6.

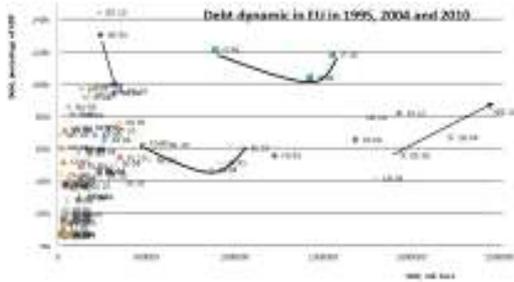


Fig. 6: Debt dynamic in EU.

Public debt dynamics are different among the EU countries. On the one hand, there have been found positive dynamics in countries such as Belgium, the Netherlands, which, by increasing GDP, reduced the debt to GDP ratio, but on the other hand, some countries (for example, Germany) have a growing public debt and its ratio to GDP. Some countries (Italy, Spain) in a stable stage of development (1995 - 2004) have shown an increase in debt, while decreasing its ratio to GDP. This development could be described as balanced, with GDP growing faster than the growing debt. However, during the crisis, the GDP growth came to a halt, causing an increase in the debt to GDP ratio.

It is believed that the debt is one of the major causes of economic destabilization in Europe [5]. Analyzing the reflected statistics, it is evident that some countries are able to deal with their mounting debt problems. There are obvious problems in Greece and Italy. Nevertheless, more anxiety causes the fact that economically most important EU countries (Germany, France), without limitation, continue to increase the public debt, as well as growing its ratio to GDP.

2.4. International trade analysis in the EU countries

In today's world, the fastest way for economic development is connected with the export promotion, the introduction of cheap resources from other countries, i.e., the international economical development. The Figure 7 describes the EU's external trade.

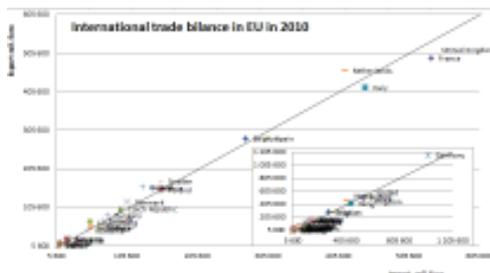


Fig. 7: International trade balance in EU in 2010.

Fig. 7 shows that the largest external turnover is in Germany, it is nearly two times higher than in the closest countries, France and United Kingdom. Unlike them, the Germany's amount exceeds the volume of imports. It is important to note that in the major countries, where export volumes are higher than import volumes (Germany, Netherlands) (from the Fig.7) the employment rate is higher than in the countries, where imports are exceeding exports (UK, France, Italy) (see the Fig.4).

2.5. Investments dynamic analysis in EU countries

Sustainability of national development is characterized by the amount of investments and its proportion of GDP. These indicators and their dynamics are analyzed in the Fig.8.

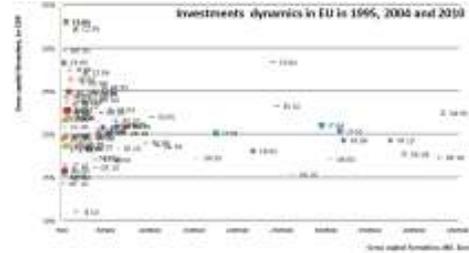


Fig. 8: Investment dynamic in EU.

2008 economic crisis has affected the amount of investments in EU countries more significantly than the EU enlargement. Very positive is the French experience, which in turn increased the investment amounts and gradually its proportion in GDP. It shows a sustainable development. During the crisis, for the major group of countries the investment ratio to GDP decreased (Germany, Spain); this means that countries are trying to solve the current problems by not implementing programmes of sustainable development.

3. LITERATURE REVIEW

Process of EU formation wasn't widely discussed in system dynamics community. There was only one attempt to create a model which would explain formation processes of the EU. This model was developed by Thierry Chevalley [2]. If to divide the EU formation into three stages: association of the Western Europe countries, joining of the Central Europe countries to the EU and joining of Eastern Europe countries; than this model describes the beginning of the second stage. Chevalley's paper describes and understands the transition in the Central Europe. Regions considered in this study include Poland, former East Germany, former Czechoslovakia, Hungary, Rumania, Bulgaria and former Yugoslavia. The author criticizes the approach of Chevalley to the model development. It is not advisable to develop a model for such a large group of states. Chevalley has united absolutely different countries in one group. From this group Hungary and Bulgaria have entered EU only in 2007, three years later then the Baltic States joined the EU. After several wars, Yugoslavia has been split into seven small countries. Chevalley has prepared paper, disregarding the specificity of the analyzed countries, i.e., not considering political, social and economic characteristics - presence of natural resources in the country, industrial development, economic specialization of the country, etc. However, Chevalley has offered theoretically qualitative, correct model scheme for the cohesion of technologies and life standard levels in the analyzed countries. Chevalley has developed model of movement from the centralized planning economy to market economy. Important steps in this transition are the privatization of state-owned enterprises, the reorganization of ministries, creation of a modern communications infrastructure, and the introduction of financial intermediation and legal operating frameworks. Today, the given paper and its offered model are already outdated. Privatization basically was completed ten years ago; in all European countries the market economy dominates. However, the formation process of the EU continue, that once again underlines importance of this research. It is interesting, that in system dynamics community, some problems topical for some or all EU countries are discussed, e.g., euro zone crisis by Domen Zavrl and Miroljub Kljajić [4] or debt crisis by Klaus [9]. These papers are scientists' reaction to increasing problems. From author's point of view, it is important to solve problems not in critical cases, as it happened with financial and euro crisis, but to understand problem's main reasons. It underlines the necessity to develop the whole EU economy system model. If in a close future, it is possible to

solve euro and debt crisis problems, the future problems can be related to the lack of labour force or production problems.

It is important to note that in the system dynamics, many models of regional development planning are produced. Their updates are developed almost every year in different countries, adapting models to current conditions (Stark K. et al. [15], Rivera [14], Zhou Li and Zhou Yong [11], Lytchikina [12], Lektavers A. et al. [10]). One of the ways to develop a model of European formation can be by a revising of an existing regional model. In other words, it is a formation of macro - regional model. The author hasn't chosen this way considering the restrictions of paper topic - to deal only with economic formation of the EU.

In the system dynamics community models of macroeconomic development are formed (Yamaguchi K. [18], Wheat D. [17]). The author suggests partly adapting them to development model of the EU economic formation. Existing macroeconomic models do not display broadly international economy; therefore, without improvements these models can't be applicable to estimate the EU economy.

Recently, some regional macro-economic models have been developed, for example, Yamashita [19] model. This model is developed for Japan's economy, Shizuoka prefecture. Theoretical basis and structure of this model can be useful in the development of the EU economy model.

4. DEVELOPMENT OF THE SYSTEM DYNAMIC MODEL FOR THE EU ECONOMY

Creating a general scheme of the EU economy system dynamic model, the author was faced to choose what approach to model is better: to estimate EU economy as complex, which is similar to a one-state macro-model by structure, but different by the scale, or develop macro-models for separate states and integrate them into one model. Decision was the merging of both approaches: to develop macro-models for similar state groups and merge them into one model. Based on the previous chapter analysis, similar state groups are defined as follows:

- States which economies are based on labour force export. In this group domestic production development and its efficiency are less than middle level of EU, import dominates over export. It is a typical characteristic for the Western European countries.
- States which economies are based on public debt grow. Biggest of this group's countries are Southern European countries, Greece, Spain and Italy.
- States with economies based on investments and export. In this group, domestic production development and its efficiency are higher than the middle level of the EU. Conclusive leader among this group is Germany.

The first step in the EU economy model shows a simplified model of state economy, which is reflected in the Fig.9.

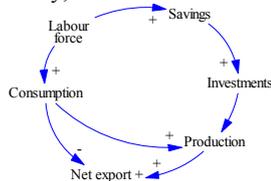


Fig. 9: Simplified model of the state economy.

In the simplified model of state economy, labour force forms consumption and savings in the system. Increase in savings causes investments growth. Investments increase can cause both production increase and production efficiency grows. If other pointer relations in Fig. 9 are related directly, positive or negative, relation "investment - production" has more difficult character. Production level depends on both consumption and investments. In case, if production cannot produce goods

according to the demand, it causes import grows. In case, if production is developed very well, its production is competitive in foreign markets, it causes the export grows. Net export is depended from both consumption and production. This model will be used for all state groups.

The next step in the EU economy model explains relations between states' economies, which are shown in the Fig. 10.

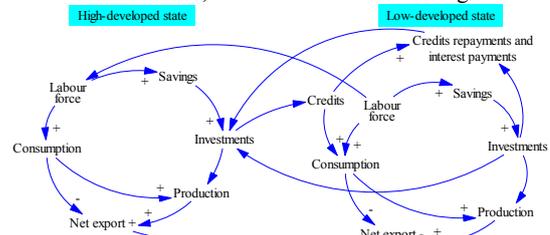


Fig. 10: States' economies relation model.

First of all, labour force moving from low-developed countries to high-developed countries causes direct consumption and savings decrease. Its results will be that poor countries become poorer.

Secondly, the debt growth in short time causes consumption increase, but in the long run, it withdraws capital from investments in form of credit repayments and interest payments. Again poor countries become poorer. Ex- IMF managing director Dominique Strauss-Kahn [6] told that those changes in capital flow might be as the main reason of economic situation destabilization. Paraphrasing and supplementing the said, it is possible to conclude, that money can be an economical capture tool. This situation is not acceptable for Europe.

Otherwise, states with high-developed economies get benefits from labour force income and financial help to low-developed countries. Additionally, high developed production of highly-developed countries competes with the low developed production of low-developed countries. In the Fig. 10, highly-developed states' net export have a "+" sign; that means that export exceeds import, and vice versa - low developed states' net export have a "-" sign which means that import surpasses the export. In these circumstances highly-developed countries win again.

In the Fig. 10 shown relations can be used for all kinds of countries, combining two, three or more state groups into the model, depending on countries' specifics. In the next section, author describes practical realization of the EU economy model.

5. CALIBRATION OF THE MODEL. SIMULATION RUNS RESULTS.

Model is tested only for one EU country, the new EU member-state - Latvia. This section shows test assumptions and results. Implementing the model in practice, some parameters are impossible to obtain from the statistics or to calculate from available data using mathematical methods. That would be the propensity to migrate, the effectiveness of EU subsidies, the consumption reaction to capital decrease in the country, the output response to changes in the consumption. To obtain information regarding the effect of these coefficients for the system, author has conducted several experiments with the model. Firstly, for all the coefficients boundary fluctuations from 0 (no influence) to 1 (fully correlated) were determined.

Secondly, experiment with zero values of all coefficients was conducted. And thirdly, the experiments were conducted with increasing coefficient values up to 0.5, keeping other coefficients at zero levels. In the experiments, coefficient "import reaction to changes in consumption" refers to the coefficient "output response to changes in consumption," they correlate negatively. Changes in consumption are covered with import or output; small deviations from this rule are related to the changes in the inventories. The results of experiments are the following.

In the first experiment, with all zero coefficients all researched indicators (consumption, output, labor force, the average wage in Latvia, import) were constant, indicators did not respond to Latvia's accession to the EU. Migration did not occur; wages, imports, long-term consumption and production remained unchanged. It is critical to tell that in this experiment, inventories show a slight growth, i.e., import and production were somewhat higher than consumption. This experiment is the starting point which allows to estimate and to compare the net effect of factors to the behavior of the system.

The first examined parameter is the propensity to migration. Its influence upon the system is reflected in Fig. 11.

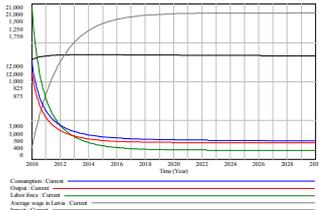


Fig. 11. Migration propensity influence upon the system

Fig. 11 shows that with the migration propensity coefficient increasing to 0.5 in Latvia's consumption, production and labour force will decrease, at the same time the wages will increase. Changes in import are negligible. This situation corresponds to the shown relations. High migration propensity coefficient and low wages in Latvia lead to migration, a direct consequence of migration is rising wages and decreasing labor force (population).

The reduction of the population causes decrease in the consumption. Both consumption reduction and wages increase cause the decline of production. Migration propensity coefficient of 0.5 is a very high coefficient. In 6-8 years it will reduce the population almost three times. In addition, the decrease of consumption and producing will be similar. At the same time, wages in Latvia will reach EU level. Development of the state due to migration is not available. According to the author's opinion, the coefficient of migration propensity should be around 0.01.

The next examined coefficient is EU subsidies efficiency. The reaction of the system on its changes is shown in Fig. 12.

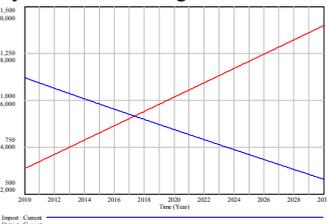


Fig. 12. EU subsidies' efficiency influence on the system

In Fig. 12, the amount of analyzable indicators is considerably abated, because according to the results from the experiment, EU subsidies do not affect consumption, labour force and wages in Latvia. This corresponds to the facts. Most often, with the means from subsidies new, efficient equipment has been bought abroad to replace the old. Employment does not change; consumption wages throughout the country remain unchanged, but the production displaces import, as shown in Fig. 12.

From the author's point of view, in Latvia the EU subsidies' efficiency is not so high; it is closer to zero. The simulation results show, that such high efficiency may lead to overproduction in Latvia because production grows faster than import reduction. The EU subsidies' efficiency coefficient should be around 0.25 in Latvia.

In the next Fig. 13, there is analyzed the influence of the coefficient "consumption reaction to capital decrease" on the system.

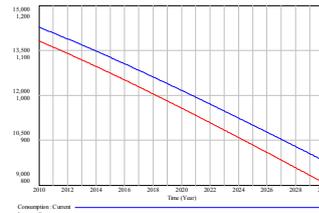


Fig. 13. The coefficient's "consumption reaction to capital decrease" influence on the system

The Fig. 13 shows that the coefficient "consumption reaction to capital decrease" affects only consumption and imports. Capital reduction in the system decreases consumption. The decrease of the consumption diminishes the import (in this experiment the output does not react to the changes in consumption). All other indicators do not depend on the reduction of capital in the system.

According to experiment's logic, next experiment should be carried out with a coefficient "output response to changes in consumption." Unfortunately, this experiment is impossible to implement, accordingly the scheme above. If all other parameters have no effect on the system, then there is no change in the consumption. In the absence of changes in consumption, it is impossible to study the reaction on it.

The impact of the coefficient "output response to changes in consumption" on the system will be evaluated later. In the next experiment there are examined the parameters defined by the experts. This experiment represents the most likely scenario for the Latvia's economical integration into the EU.

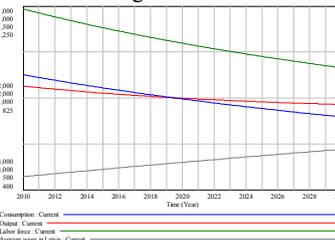


Fig. 14. Coefficient's "output response to changes in consumption" influence on the system

The Fig. 14 does not show a net import, because import and export will be kept at initial level. Changes in other indicators explain the next. Labour force will be reduced, that leads to wages increase and consumption decrease. As a result, the decrease in output will happen. The increasing wages would not only reduce production, but also substitute production with import. This expected increase of import will be compensated by diminishing of import, which will be related to the reduction of consumption in the country. Therefore, the import remains unchanged, at steady state. EU subsidies will contribute to industrial development, despite of the increase in the labor force cost. Production will exceed consumption; there can be an overproduction in the system and an inventories increase. This could mean that EU subsidies have limited effectiveness. After a certain stage, to encourage business development in Latvia would be useless. Deeper crisis will be caused by the lack of demand. Production without the sales market is useless.

For the objectivity, it is important to remind, that previously it was not estimated how production would respond to changes in consumption. In the previous experiment, the reaction level was at the expert determined level of 45%; the change in consumption caused almost by a half smaller changes in output. The following Fig. 15 analyzes the behavior of the system, provided that the production does not respond to changes in consumption (with a zero coefficient), keeping the other coefficients at the level determined by the experts.

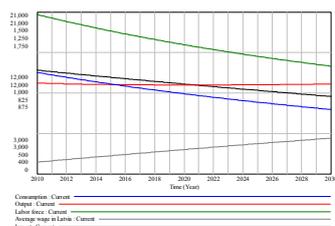


Fig. 15. Production reaction to the changes in the consumption analysis and its influence on the system

The Fig. 15 shows that the production has remained almost unchanged. The import which was constant during the previous experiment will decrease this time. All other indicators (labor force, consumption and wages) are the same as in the previous experiment. This could mean that, if the output does not depend on domestic demand, production could replace imports and form an export capacity. But this is a utopian situation.

Export potential is formed by the stable operating companies whose products are demanded in domestic and foreign markets. In Latvia, there are almost no such companies and the small domestic market does not allow forming them. Furthermore, there are no opportunities that well-known producers will build their factories in Latvia. There are no cheap resources in Latvia. Soon the volume of the labor force will diminish, and the wages will be near EU level.

Unfortunately, Latvia does not look for the exit from this deadlock. Priorities of Latvia at present are the financial stability of the state (avoidance of the default) and, in the long-term, accession to the euro zone.

These scenarios of economic development in Latvia are connected to the integration processes.

Conclusions

In the paper, the effects of the international integration process in EU are comprehensively analysed. Furthermore, the economy system dynamic model is developed, and the general scheme of the model is described. The new EU memberstates' economic integration model is developed. The model is tested only for one EU country, Latvia.

The results of the paper show failure of the mechanism of the EU operations. The available mechanism contradicts EU principles; it doesn't promote the cohesion in European Union, but quite opposite - leads to solving problems of well-developed EU countries at the expense of developing countries. In the given conditions, the example of Latvia shows that there is no possibility to overcome the system crisis. These circumstances specify a necessity of changes in the EU internal migratory policy, changes in principles of developing countries' support in EU, and changes in distribution of EU means, taking into account internal migration.

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