European Union Economy System Dynamic Model Development

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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. The aim of this study is to develop EU economy functioning system dynamic model. Main research method is system dynamics. General scheme of EU economy system dynamic model is shown. Implementing the model in practice, new EU member economic integration model in EU is developed. Model is tested only for one EU country, Latvia. Results of 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 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.

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 economic difficulties. Despite the advantages, the crisis in 2008 underscored the union's problems: some states do not fulfill the basic financial and economic 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 functioning economic models of EU, as well as defining the differences and similarities of these models.

In the paper researched problem 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 of 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 EU economical integration and EU economy functioning model development. The research subject is the changes of EU member states' economies, which have occurred as a result of EU enlargement.

Paper's aim is to develop EU economy functioning system dynamic model. To achieve this aim, the following tasks are set: 1) to develop a conceptual scheme of EU economy system dynamic model, 2) to develop scheme of model of a new EU member state's economic integration in the EU, 3) to develop a flow - stock model for a new member state's economic integration in the EU, 4) to test developed model.

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

As the information base of study the European Community's, Eurostat data (2012) are used. Some materials are taken from experts, news agencies, newspapers and the Internet. Methodological basis of research is based on the world top scientist's works on the international economic theory - MacConell C. and S. Brue (2003), system dynamics - Sterman J. (2000), Yamaguchi K.(2010), Wheat D. (2009), Chevalley_T.(1992).

2. European Union Economy System Dynamic Model Development

2.1. General scheme of EU economy system dynamic model

Creating a general scheme of 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 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: develop macro-models for similar states groups and merge them into one model. 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 then middle level of the EU, import dominates over export. It is typical characteristic for 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, which economies are based on investments and export. In this group domestic production development and its efficiency are higher then middle level of the EU. Conclusive leader of this group is Germany.

First step in the EU economy model's shows a simplified model of states economy, which is reflected in the Fig.1.

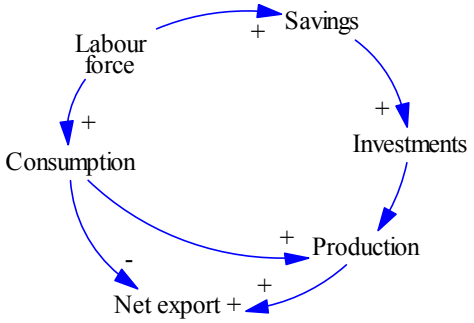

Fig. 1: Simplified model of state economy.

In 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. 1 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 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. 2.

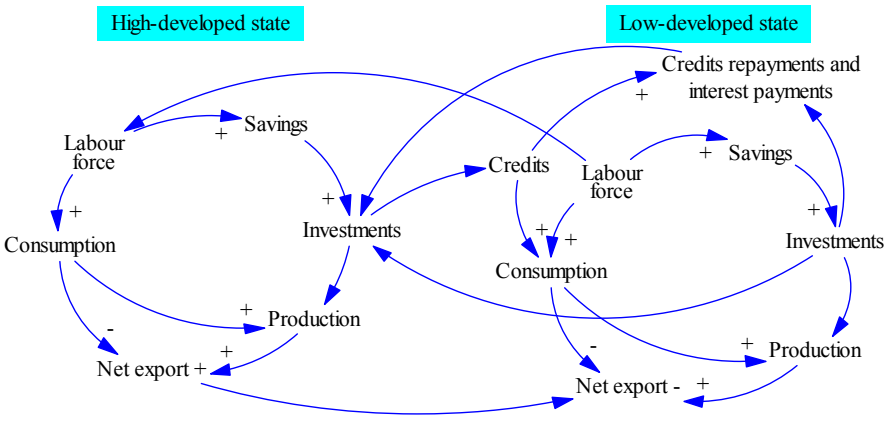

Fig. 2: States economies relation model.

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, debt growth in short time causes consumption increase, but in 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 (Ganov, 2011) told that those changes in capital flow might be as main reason of economic situation destabilization. Paraphrasing and supplementing the said, it is possible to conclude, that money can be an economic capture tool. This model 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 high-developed countries competes with low developed production of low-developed countries. In the Fig. 2 high developed states' net export have "+"sign, that means, that export exceeds import; and vice versa, low developed states' net export have "-" sign, that means, that import surpasses export. And in these circumstances high-developed countries win again.

In the Fig. 2 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 conceptual scheme of EU economy model. Taking into account, that this paper is the first attempt to develop model, author describes only part of the model, which shows how entering the EU has changed its (new EU state's) economy.

2.2. A new EU member economic integration model in EU

The sub-model of a new EU member economic integration in the EU is developed. The general scheme of the sub-model is shown in Fig. 3. The general scheme of the sub-model reflects the interaction of included indicators, without specifying how much indicators affect each other, and does not show the factors determining the strength of the interaction between mentioned indicators. These questions will be considered in the next sub-section.

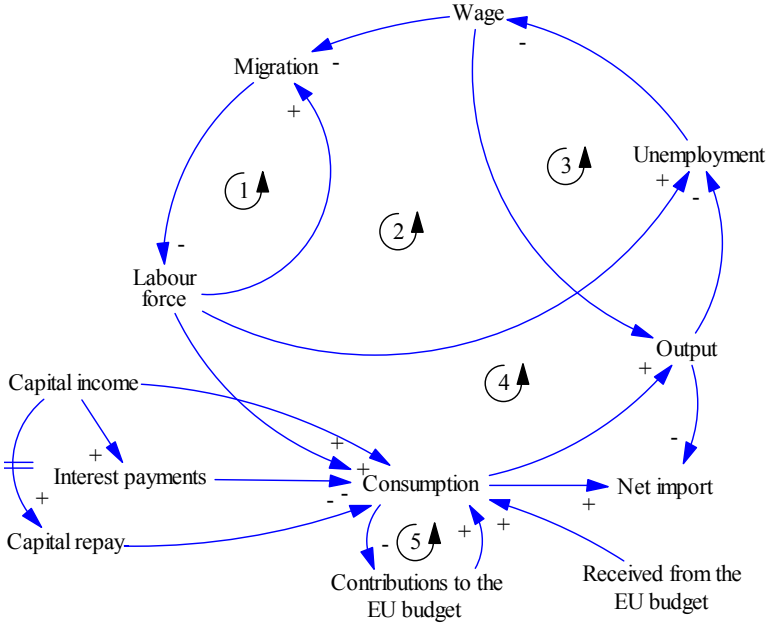

Fig. 3. Conceptual sub-model of a new member economic integration in the EU

The Fig. 3 shows that the model consists of parameters that affect integration: migration; contributions to the EU budget, subsidies from the EU, net import and the movement of capital, as well their impact on key macroeconomic processes in a new member state is shown. We consider these processes separately.

The greatest influences on a new member state economy have migration processes. Migration is formed by the difference of wages in the EU and a new member state. A new member accession to the EU did not change wages in the EU, thus the wages in the EU are taken as a constant pointer. Low wages in a new member state defines migration from the state. Wage increases in a new member state will reduce migration. Between these parameters there is a negative relationship, as indicated by a minus sign near the arrows.

With migration increasing, size of the workforce also will be reduced. Migration has a negative impact on the workforce. Workforce reduction will lead to a reduction in migration that means, the amount of labour

has a positive effect on migration. The relationship between migration and amount of labour describes the first feedback loop displayed in the Fig. 3.

Changes in labour force volume cause changes in the same direction among the unemployed. In circumstances of constant number of jobs, labour force reduction leads to a reduction in the number of unemployed. Increase in the labour force, with constant number of jobs, leads to an increase in unemployment. Between these indicators there is a positive relationship. Changes in the labour force have influence not only on the number of unemployed, but also on consumption. In this case, the labour force serves as a measure of the population, which can be changed only with mentioned factors of the model that means, based on the migration processes. Changes in consumption are proportional to changes in the labour force, between these relationships there is a positive relationship.

One of the factors determining the level of wages from the supply side is the level of unemployment. The fewer unemployed in the system, the higher wage growth. In conditions of high unemployment wage growth stops, and wages may decrease. The unemployment has a negative impact on wages.

Wages, migration, labour force, unemployed form a second feedback loop displayed in the Fig. 3. Low wages lead to migration, which reduces the amount of labour force and unemployed in the system, reduction of the number of unemployed will increase wages. This part of the system will be closer to equilibrium when the level of wages in a new member state will be approximately at the average level of wages in the EU.

Wages growths in the country not only affects on the willingness of labour force to participate in the labour market, but also the demand of it. Wage growth reduces the business profitability, and the output level of production in the country decreases. This reduces employment and increase unemployment. Unemployment growth reduces wages, which again increases production. It describes the third feedback loop, shown on Fig. 3.

EU policies through subsidies encourage business development and growth of a new member state production. The model envisages that increase in subsidies increases production volume in a new member state. Production increase is also affected by the growth of the consumption. The relationship between consumption and production are included in the fourth feedback loop. Changes in consumption and production change the number of unemployed, wages, migration and amount of labour force.

As shown above, changes in the labour force change consumption. Without taking into account other feedback, this loop can exponentially affect the system. Any increase in consumption causes forced growth of consumption, as well as any reduction in consumption causes forced reduction in consumption. This is a very important element of the system, because contributions to the EU budget and capital flows affect consumption.

It was determined that contributions to the EU budget depend on consumption, and likewise they reduce consumption in a new member state. This is shown in the fifth feedback loop. Consumption growth in a new member state will increase payments to the EU budget, and these payments will reduce consumption.

More significantly consumption affect capital flows. Firstly, the inflow of capital causes increase of consumption in a new member state. After some time, capital leaves the system, which leads to decrease in consumption. Inflow and outflow of capital will form a cyclical loop in consumption by increasing consumption when capital inflows and reducing consumption when capital goes out.

The inflow of capital has one more effect. Incoming capital increases the cost of maintenance of capital, i.e., interest payments. These payments are taken out of the economic system and are transferred to owners of capital. Interest payments for foreign capital decrease consumption in a new member state.

There is no feedback in the capital flows, because usually in a new member state capital is not reinvested, it has mostly speculative nature that was shown in the previous section. Fig.3 also shows net imports. The indicator of imports has an important role in the economy of a new member state. A new member state cannot produce all necessary goods, import substitute domestic production.

The aim of the European subsidies is to create a competitive environment in a new member state, assisting substituting import with internal production. Fig. 3 shows that development of production (output grow) reduces import. These indicators have negative relationship. Import changes also have influence on the changes in consumption. Increase in consumption will increase net import, because the production can not satisfy growing demand. These indicators are connected with positive relationship. In fact, increase in consumption is distributed between increase in production and increase of import.

Developing model in practice, the main task was to research the direct impact of integration on the state economy. The developed model flow - stock diagram is shown in Fig. 4.

The Fig. 4 shows the model relationships, all constants are specified as variables from other sub-models. This allows us to avoid explanations of the essence of the constants. In fact, the model has no sub-models; the whole diagram is shown in Fig. 4.

Comparing the diagram to the general scheme of the sub-model we can see some differences. In the diagram, there is no indicator “unemployed”. The workforce reduction has a direct impact on wage growth. Labour migration is determined not only by the quantity of labour, wages in the EU and Latvia, but also by the propensity to migrate. This ratio generally reflects all non-formalized migration barriers, such as the language barrier, patriotism, etc.

Production and consumption are analyzed in two parts: in a long-term and in actual indicators. Actual output and consumption are based on a long time period output and consumption, taking into account the short-term influencing factors. They are for consumption - the inflow of capital and payments to the EU budget, for the production - changes in consumption.

Capital inflow and payments to the EU budget are considered as short-term factors, because as soon as their effect will disappear, the volume of consumption will return to a balanced level in the long run. Similarly, short-term fluctuations in production are determined by changes in consumption. The reaction of production to changes in consumption shows factor "Output response to changes in consumption".

Changes in long time period output and consumption are associated with fundamental factors. For the production it is amount of EU subsidies, which are aimed to foster the business environment, and the efficiency ratio of these grants. For consumption it is capital withdrawn from the system (interest payments for foreign capital) and the ratio of consumption reaction to capital withdrawal. EU subsidies are defined as long-term influencing factor, because at the expense of an effective entrepreneurial activity it continues to operate despite the termination of grants.

Similarly, withdrawn from the system capital (interest payments) reduce the consumption forever. According to economic theory capital inflow, its removal, as well as maintaining costs (interest payments) are associated with the development of production output. In Latvia, capital flows are directed to the speculation and to consumption, thus repayment of capital and interest payments in the model are also associated with the consumption.

In the diagram (Fig. 4) production and consumption are combined within the inventory reservoir. The output increase material reserves in the system and the consumption reduces them. The difference between consumption and production is covered with material stock changes, as well as net imports. After consumption and output changes follow changes in imports and / or in material stock.

The capital flows in the diagram fully display the general scheme of the sub-model, so there is no need to analyze them again.

3. Calibration of the model. Simulation runs results

Model is tested only for one EU country, the new EU member - Latvia. This section shows test assumptions and results. It is the study limitation. In future, author has plans to develop and test this model for a wide range of countries.

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 consumption. To obtain information on the effect of these coefficients to the system, author has conducted several experiments with the model. Firstly, for all 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 level. In 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 is related with changes in inventories. The results of experiments are the following.

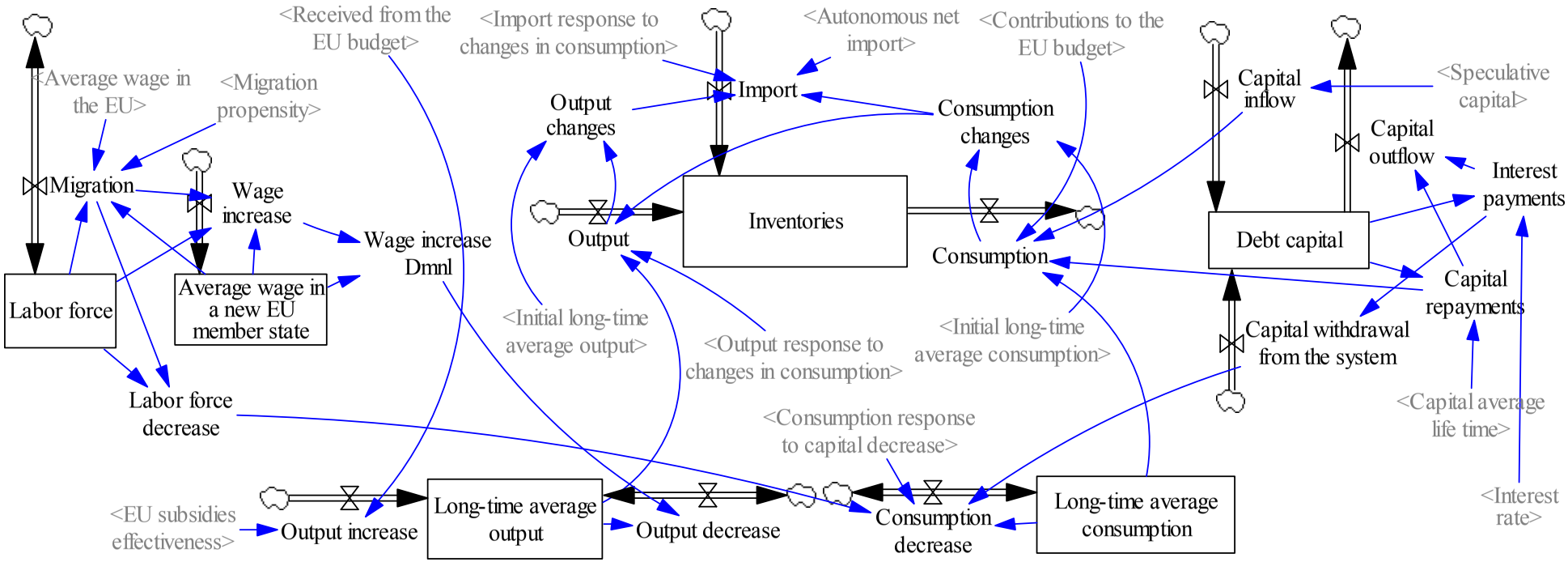

Fig. 4. Flow - stock diagram of model of a new member state economic integration in the EU

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 important to tell, that in this experiment inventories show a slight growth, i.e. import and production were slightly higher than consumption. This experiment is the starting point, which allows to estimate and to compare the net effect of factors on the behavior of the system.

The first examined parameter is propensity to migration. Its influence on the system is reflected in Fig. 5.

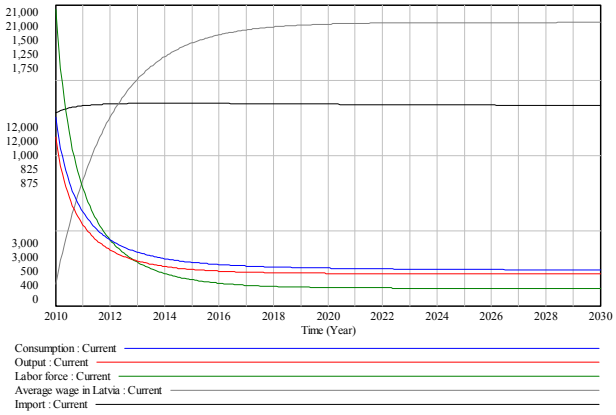

Fig. 5. Migration propensity influence on the system

Fig. 5 shows that with migration propensity coefficient increasing to 0.5 in Latvia 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 leads to migration, a direct consequence of migration - rising wages and decreasing labor force (population).

Reduction of population causes reduction of consumption. Both consumption reduction and wages increase cause the decline of producing. Migration propensity coefficient 0.5 is a very high coefficient. In 6-8 years it will reduce the population almost 3 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. 6.

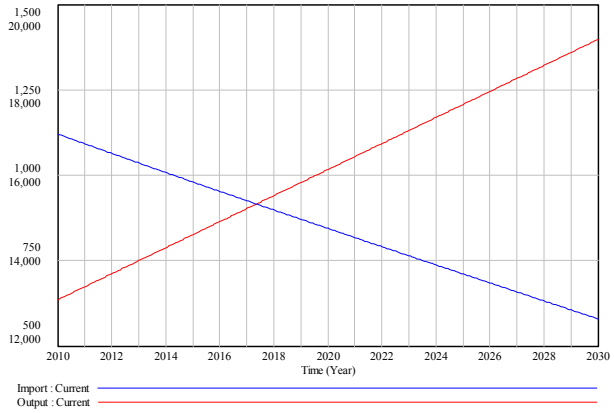

Fig. 6. EU subsidies efficiency influence on the system

In Fig. 6 the amount of analyzable indicators is considerably abated, because, according to the results of the experiment, EU subsidies does 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 old. Employment does not change, consumption and wages in the country remain unchanged, but increased production displaces import, as shown in Fig. 6.

From the author 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. In Latvia the EU subsidies efficiency coefficient should be around 0.25.

In the next Fig. 7 there is analyzed the influence of coefficient "consumption reaction to capital decrease" on the system.

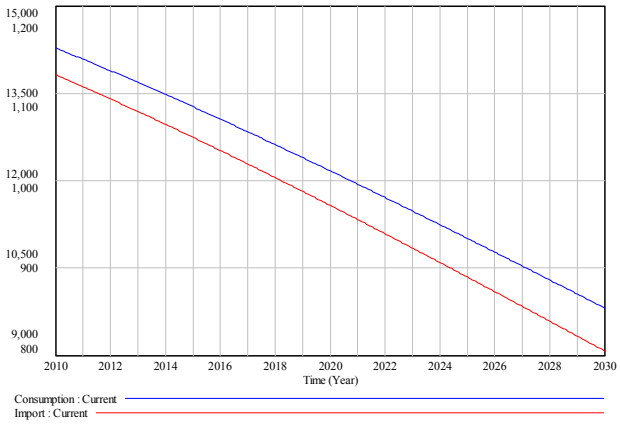

Fig. 7. Coefficient "consumption reaction to capital decrease" influence on the system

The Fig. 7 shows that coefficient "consumption reaction to capital decrease" affects only consumption and imports. Capital reduction in the system reduces consumption, reduction of consumption reduces import (in this experiment, the output does not react to changes in consumption). All other indicators do not depend on reduction of capital in the system.

According to experiment's logic, next experiment should be carried out with coefficient "output response to changes in consumption". Unfortunately, this experiment is not possible to implement, according to the above scheme. If all other parameters have no effect on the system, then there is no change in consumption. In the absence of changes in consumption, it is impossible to study the reaction on it.

The impact of 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 economy integration into the EU.

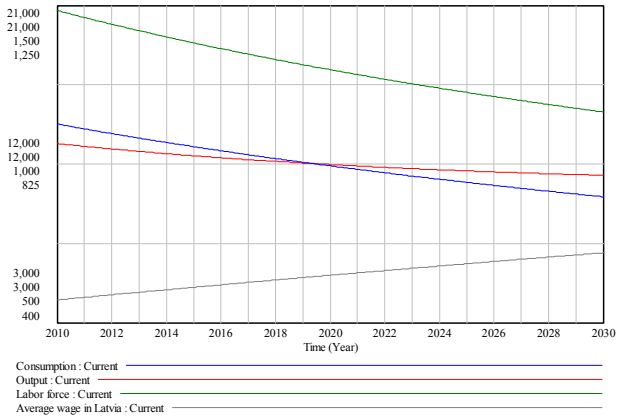

Fig. 8. Coefficient "output response to changes in consumption" influence on the system

The Fig. 8 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 decrease in output will happen. 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 reduction of consumption in the country. Therefore, the import remains unchanged, at steady state. EU subsidies will contribute to industrial development, despite of increase in labor force cost. Production will exceed consumption, there can be over-production in the system and 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 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 half smaller changes in output. The following Fig. 9 analyzes the behaviour 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.

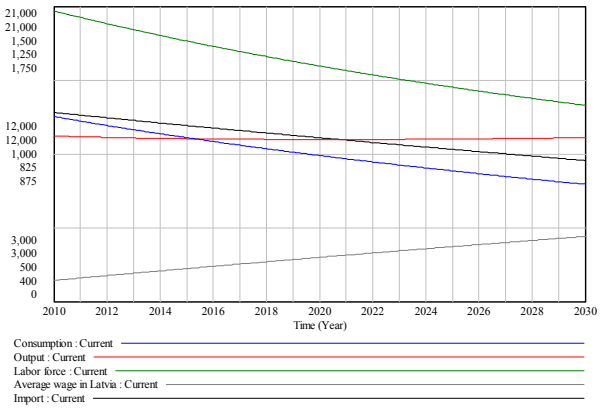

Fig. 9. Production reaction to changes in consumption analyse and its influence on the system

The Fig. 9 shows that the production has remained almost unchanged. In a previous experiment constant import at this time will decrease. 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 export capacity. But this is utopian situation.

Export potential form 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. Also 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 labor force will diminish and a wages will be near to the EU level.

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

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

4. Conclusions.

In the paper the effects of international integration process in EU are comprehensively analysed, the work purpose is reached, all planned tasks are reached.

In the paper the first attempt to develop European Union economy system dynamic model is undertaken. General scheme of EU economy system dynamic model is shown. Implementing the model in practice, new EU member economic integration model in EU is developed. Model is tested only for one EU country, Latvia. In following papers authors will try to complete the model, develop it considering the specifics of all EU countries.

Results of 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 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. The author will show the study of migration economic indemnification mechanism in a following paper.

5. Acknowledgements

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