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MODELING THE INFLUENCE OF SELECTED ECONOMIC PROCESSES ON THE LONG-TERM DEVELOPMENT OF THE POLISH ECONOMY[21]

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Introduction

Over the past 15 years the Polish economy has experienced strong fluctuations in economic growth. After the slowdown in 2002–2003, Poland's accession to the European Union contributed to a significant acceleration. However, as a result of the global economic crisis, the dynamics of development slowed down substantially. Yet, it did not lead to such a recession as in other EU countries and in the USA. The Polish economy continued to develop, being the only "green island" among the EU countries. Will this optimistic picture change in the longer term? This paper does not aim at answering this question, but it tries to estimate the potential influence of selected (considered as crucial) processes occurring in the first decades of the 21st century on the perspectives of the further development of the Polish economy.

The purpose of the paper is to analyze basic mechanisms and processes that emerged in the Polish economy in the 21st century. Identification of these phenomena through empirical verification is complemented by scenario analyses to quantify their possible impact on Poland's future economic development. These phenomena and processes are as follows.

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- Demographic phenomena, including changes in the population size and population structure by age, with particular focus on forecasts for the increase in the number of retirees. The analysis does not take into account migration.
- Changes in the intensity and structure of Polish foreign trade related to the deepening of the globalization process, which means the increase of Poland's involvement in the phenomenon of fragmentation of production processes.
- Technological progress and growth of knowledge capital in the economy, which plays an important role in the process of long-term growth. Knowledge capital can be identified with human capital, innovation and the ability to acquire knowledge from abroad.

It should be stressed that the intention of the authors was not to create any projection of the most likely development of the Polish economy. If the simulations presented in this paper were to be considered as forecasts, they would certainly be judged as imperfect, and some of them unquestionably unrealistic. The variety of phenomena and processes occurring in the modern world undermines the reasonableness of predicting the future based on the belief that we are able to take into account all, or at least the "most important" factors affecting economic development.

The structure of the paper is as follows. First, we present the model. Then the assumptions for three scenarios are given, each of the scenarios concerns the particular phenomena listed above. Results are shown for 4 scenarios; the additional one is a combination of the three. The results are followed by conclusions.

1. The model

The model consists of a three-element core and satellite models (see Fig. 1). The core (or central model) is an input-output model, based on tables excluding imports. The source of data is the set of such tables for 2010, published by the Polish Statistical Office (Input-Output Table at Basic Prices in 2010, 2014). These tables show the economy aggregated into 77 branches. The input-output model is supplemented with a sequence of national accounts by institutional sectors as an identity centered model derived from the methodology proposed by Almon (Almon, 1995, 2011). The third, original element of the central model is the flow of funds model, based on the philosophy of the input-output model, with disaggregation of accounts by institutional sector and type of financial instrument (see, e.g. Tsujimura & Mizoshita, 2003;

Tomaszewicz & Trebska, 2013). It allows decomposition of money demand and supply of financial instruments on individual financial markets to be treated as one of the investment determinants.

Satellite models are used to develop simulation scenarios and include a set of equations describing the consumption of households, number of employees, number of retirees and pension transactions, R & D outlays and labor productivity, exports, and import intensity.

Although the authors were strongly inspired by the INFORUM modeling philosophy, the model does not follow it fully. The main difference is the lack of loops (or feedbacks) in the sequence of equations. The model is strictly recursive. No price submodel is present, the assumption is made that prices do not change over the whole analyzed period.

The sequence of national accounts starts from an input-output table, showing accounts of products and income generation for the entire economy. On the basis of this part, the output and value added are determined by final demand.

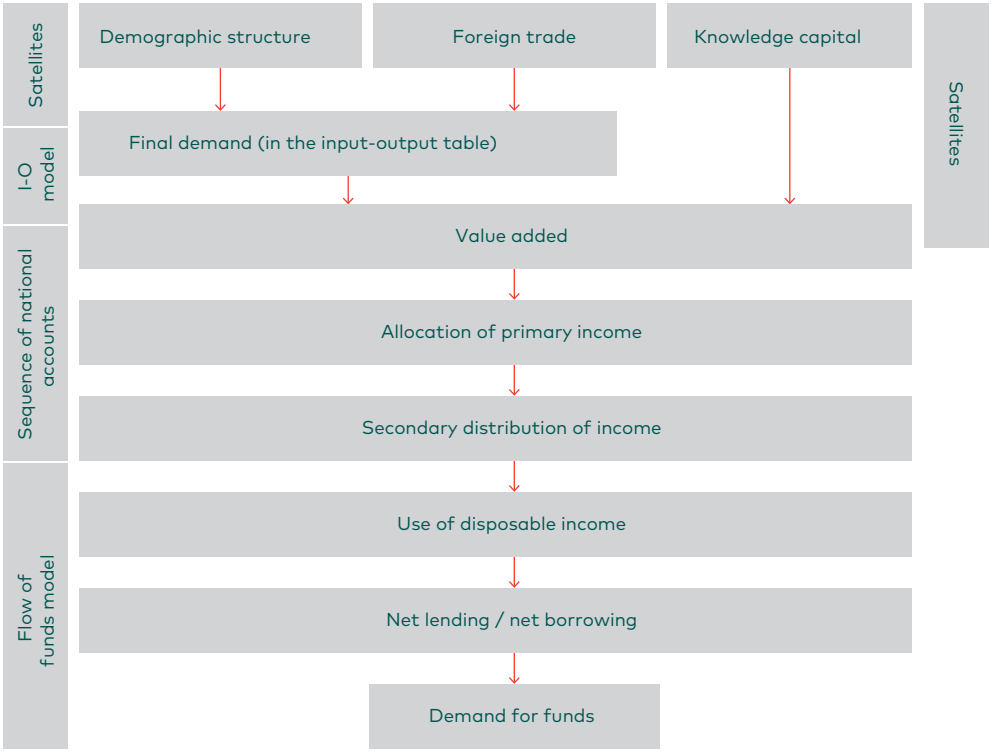

Fig. 1. Scheme of the model.

Then, using tables of cross-classification of activity (industry) and sector, value added data by NACE are transformed into value added by institutional sectors. Value added for the total economy is decomposed into compensation of employees – costs incurred by employers from each institutional sector, which are the primary income of households presented on allocation of primary income account; taxes less subsidies on production that are the general government's primary income and operating surplus of all institutional sectors.

Subsequent equations refer to the transactions recorded on the secondary distribution of income account, which determine gross disposable income as the sum of primary incomes and net of current transfers. On the expenditure side of the use of the disposable income account is consumption, whereas the balancing item is gross savings, determined as a residual in this model. Gross savings are the revenues on capital account, which together with the net of capital transfers and net borrowing constitutes the sources of the accumulation financing. The balancing item of the capital account is net lending – in the national accounts recorded as a positive value (when the net acquisition of financial assets exceeds the net incurrence of liabilities) or net borrowing (the opposite situation).

The identity centered model based on the sequence of national accounts is followed by the model describing the supply of financial instruments and the demand for them.

2. Assumptions

As mentioned above, the three analyzed scenarios assume isolated changes, so all exogenous variables (except for the chosen ones) remain at the level of 2010. This also concerns prices, which are kept constant. Scenario 4 was created as a combination of Scenarios 1–3.

Scenario 1

In the first scenario it is assumed that the consumption of households results from the changes in the population size of different age groups (the proportion of retired and non-retired persons) – see Fig. 2. The population size was taken from the forecasts of the Polish Central Statistical Office (Population Projection 2014–2050, 2014). This forecast does not consider migration.

A diminishing population, together with constant unemployment and labor activity ratios obviously lead to a reduction in the number of employees. As can be seen in Fig. 3, this assumption seems unrealistic.

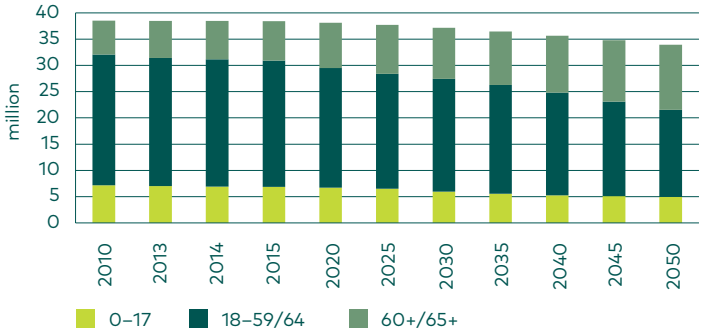

Fig. 2. Population size by age group, million. (Source: Polish Central Statistical Office)

In the economy, adjustment processes are launched that counteract the effects of demographic change.

Consumption per capita of various age groups as well as their propensity to consume, income and other factors do not change. This, of course, implies a reduction in household consumption proportionally to the size of the population. Other elements of final demand remain constant. Total final demand falls, but not as much as the employment.

The average annual increase in labor productivity, needed to produce final production in accordance with the adopted assumptions is relatively low, moreover, it is lower than the growth rate of accumulation of fixed capital (which translates into an increase in the capital / labor ratio), see Fig. 4. It should be considered as achievable.

Although Scenario 1 seems quite unlikely to happen, it is possible from a theoretical point of view. Analysis of its assumptions does not lead to any contradiction or impossibilities.

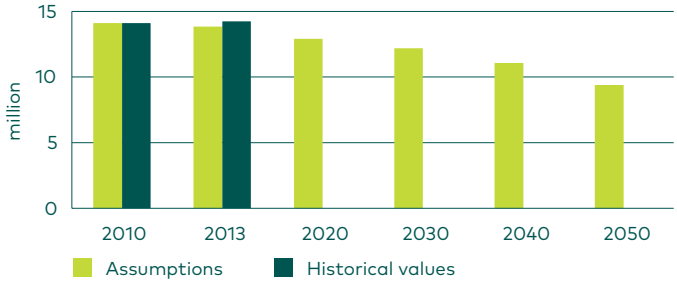

Fig. 3. Number of employed persons, million. (Source: Own calculations, Polish Central Statistical Office)

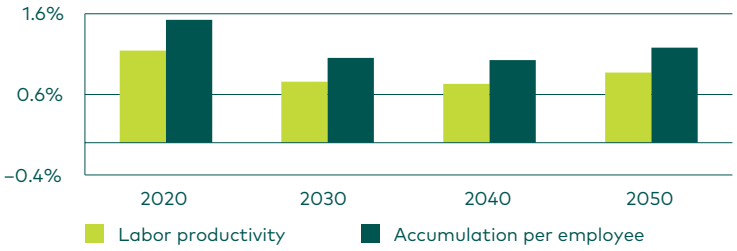

Fig. 4. Labor productivity and accumulation of fixed capital per employee (annual growth rates, %). (Source: Own calculations)

Scenario 2

The second scenario aims at estimating the influence of trends in trade patterns. Changes in imports result from import intensity coefficients, which are projected by log-logistic trend; exports increase due to observed trends for various products. The increase in the intensity of trade that took place in Poland after 1990 was primarily the result of the transition and the process of Poland's accession to the EU. At the same time, becoming a country with an open market economy, Poland joined the processes of globalization, such as increased involvement in international fragmentation of production. These processes led to changes in the product structure of foreign trade. In a situation where political transformation has already been completed and the process of integration with the EU has long passed its main

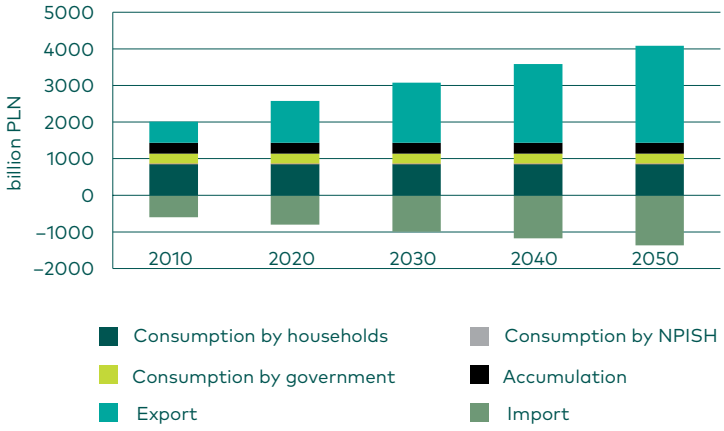

Fig. 5. Final demand and import, billion PLN. (Source: Own calculations, Polish Central Statistical Office)

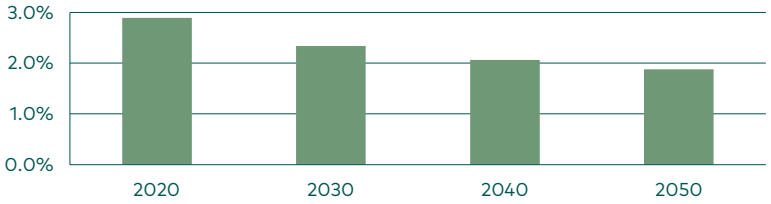

Fig. 6. Labor productivity (annual growth rates, %). (Source: Own calculations.)

phase, the future development of Polish foreign trade depends on factors characteristic for modern, open economies. The projections based on trends show a significantly higher growth rate of exports than imports, which causes an increase of the balance of trade. The macroeconomic sum of sectoral projections is presented in Fig. 5.

In this scenario the number of employees is kept constant at the level of 2010. To allow for increment in the balance of trade, a suitable growth in labor productivity is necessary (see Fig. 6).

The highest growth of labor productivity is needed at the beginning of the analyzed period. Around 2040 the growth rate drops to about 2 %.

Scenario 3

In the third scenario, the impact of domestic R & D expenditures on the changes in labor productivity and, consequently, changes in the number of employees was analyzed. It is assumed that labor productivity is a function of capital-to-labor ratio and total factor productivity (TFP). TFP is a function of domestic and foreign knowledge stock, measured by the amount of accumulated R & D expenditure (domestic and foreign (Coe, Helpman, & Hoffmaister, 1997; Coe, Helpman, & Hoffmaister, 2009). The effects of diffusion of knowledge among sectors (industries) in the Polish economy are also taken into account. In the case of domestic knowledge stock, it is assumed that the process of diffusion of knowledge takes place through the flows of goods and services used as intermediate goods in the production process. In the case of diffusion of knowledge from abroad, it is assumed that transfer of this kind of knowledge takes place through imports, foreign direct investments and in a disembodied form.

This, of course, required the estimation of parameters of TFP functions at the level of industries. Subsequently, it is assumed that changes in labor productivity in the branches of the Polish economy are only the result of changes in the domestic knowledge stock. The values of all other variables included in the model (capital to labor ratio, foreign knowledge stock, etc.) are set at the level observed in 2010.

In order to estimate the amount of accumulated R & D expenditure in the perspective up to 2050, the growing share of these expenditures in relation to GDP is assumed. Part of the assumptions (until 2030) is consistent with the provisions from the long-term strategy for Polish economic development. The share of R & D expenditure in GDP is projected to increase to 1.7 % in 2020, 3 % in 2030, 4 % in 2040, and 5 % in 2050. To obtain the level of value added, the potential levels of labor productivity in individual branches of the Polish economy were multiplied by the number of employees observed in 2010.

Scenario 4

The last scenario puts all three scenarios together in a way that the value added that begins the sequence of national accounts equations results from the cumulated changes in the value added due to changes in the population size of different age groups (causing the changes in consumption of households), the changes in the foreign trade structure and the changes in domestic stock of knowledge.

The assumptions that concern final demand in all of four scenarios are showed in Fig. 7.

As a result of the projected changes in the demographic structure that are reflected by Scenario 1, the total final demand will decrease in

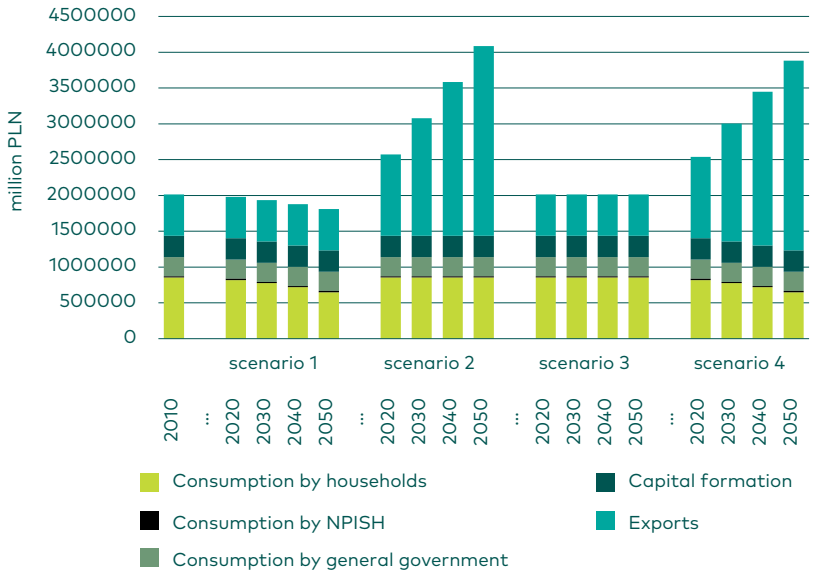

Fig. 7. Final demand – simulation assumptions, million PLN. (Source: Own calculations.)

2050 by 10.1 % because of the 24 % decrease in household consumption. The biggest changes in final demand result from the growth in exports of 359 % that is estimated according to observed trends in the period 2010–2050. This will increase total final demand by 103 %. Assumptions concerning the domestic stock of knowledge do not take into consideration final demand. The cumulated changes in final demand assumed in the fourth scenario form a 93 % increase in 2050 (compared to 2010).

Results – value added by institutional sectors and income circulation

As was mentioned before, in Scenarios 1 and 2 value added is determined using the input-output model with assumed final demand values. Whereas in Scenario 3 value added results from the changes in labor productivity, which in turn result from the increase in domestic R & D activity.

The decrease in final demand (consumption of households), assumed in the first scenario, causes value added to decline by 9.7 % (in total) in 2050 compared to 2010 (see Fig. 8). In turn, Scenario 2 assumes the increase in final demand resulted from the increase in exports, which causes the 96.4 % increase in value added in 2050. Growing domestic R & D activity increases value added by 20.3 % (in 2050 compared to

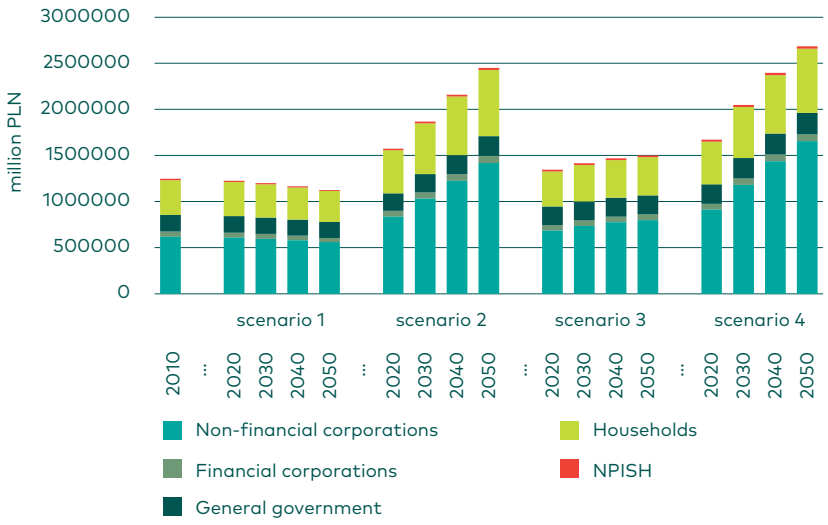

Fig. 8. Value added by institutional sectors, million PLN. (Source: Own calculations.)

2010). In Scenario 4, which puts all three scenarios together, the value added gradually grows by 34.1 % in 2020, 64.2 % in 2030, 92.1 % in 2040, and 115.2 % in 2050 compared to 2010. The biggest increase concerns non-financial corporations as a sector that is most involved in the process of value added generation.

As a consequence of the allocation of primary income, compensation of employees (reported in the system of national accounts on the uses side of the generation of income account of all institutional sectors) becomes the resource of households (as well as for the rest of the world sector), whereas taxes on production and imports, paid by all sectors, are then obtained by general government (and the rest of the world). The balance of primary income (see Fig. 9) results from the operating surplus generated by all sectors, the balance of property incomes and the transactions in the field of compensation of employees and taxes mentioned above. It is obvious that changes in primary incomes are proportional to changes in value added in individual scenarios. However, changes in primary incomes are characterized by reduced differentiation between sectors. In Scenario 4 the balance of primary income of all domestic institutional sectors increases by 109.3 % in 2050 compared to 2010, which is less than the increase in value added

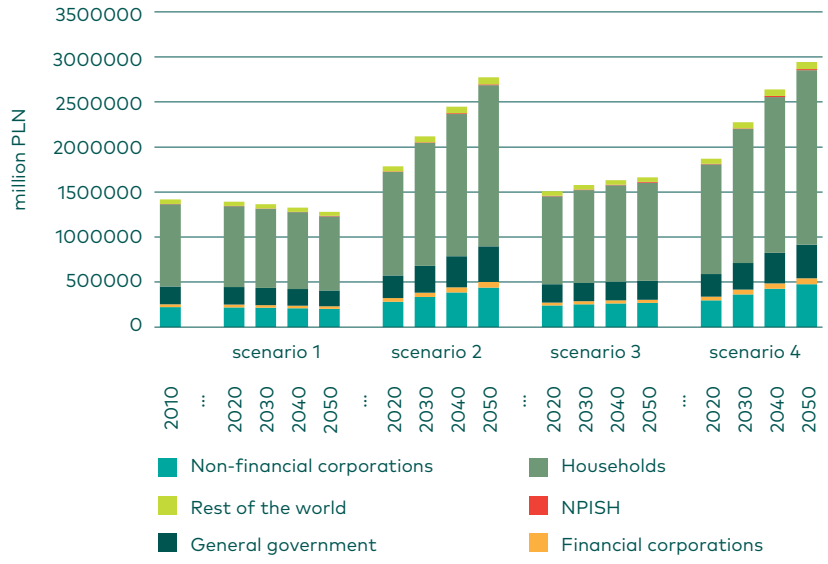

Fig. 9. Primary incomes of institutional sectors, millions PLN. (Source: Own calculations)

because of the circulation of primary income between domestic sectors and the rest of the world (in favor of the latter).

The evaluation of the changes in the process of secondary distribution of income is focused on the most important transactions such as income taxes, social contributions and social benefits. Both taxes and social contributions (assuming a constant rate of fiscal burdens) change in proportion to the changes in primary incomes. The simulation of social benefits increases results from the changes in demographic structure, which are introduced to the pension sub-model (Trebska, 2015). Social benefits depend on the number of pensioners (resulting from the number of elderly and the propensity to retire) and the average amount of pension as well as the number of other kinds of beneficiares and the average amount of social payments (survivors and disability pensions).

On the basis of demographic projections, the number of beneficiaries is estimated, assuming a fixed (as in 2010) propensity to retire at retirement age (0.85), the share of disability and survivors pensioners in the working age population (respectively 5.9 % and 3.9 %). Therefore, an increase in the number of retirees and a slight decrease in the number of people receiving disability pensions and survivors pensions are expected. Moreover, assuming that the average amount of old-age and other pensions will not decrease, a 49 % increase in the amount of social benefits is expected in 2050 compared to 2010 (in all scenarios the percentage change of social benefits is the same). The tendencies in

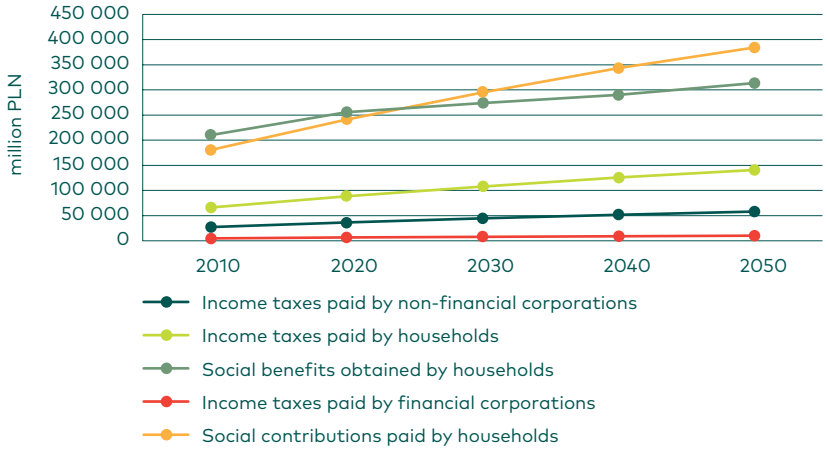

Fig. 10. Transactions of income redistribution, million PLN. (Source: Own calculations)

redistribution of incomes broken down by instruments are presented in Fig. 10.

The changes in primary incomes and current transfers are reflected in the changes in disposable income of individual institutional sectors. In the first scenario only disposable income of households slightly increases (by 1 % in 2050 compared to 2010) as a consequence of a significant increase in social benefits that are obtained by this sector, see Fig. 11. These transfers are paid by general government, so disposable income of this sector decreases to the greatest extent (by 57.2 % in 2050 compared to 2010) in this scenario. The assumed decline in household consumption with the simulated increase in this sector's disposable income contributes to the growth of its gross savings.

In Scenario 2, the disposable income of domestic sectors (in total) increases by 98.5 % in 2050 compared to 2010 with marginal growth of nonresidents' income. The biggest growth concerns general government mainly due to the secondary distribution of income – current transfers (connected with foreign trade) from the rest of the world to general government.

Growing domestic R & D activity causes the increase in disposable income of all domestic institutional sectors (18 % in 2050 compared to 2010) and a slight decrease in the case of the rest of the world.

In Scenario 4, as a result of the three described scenarios, disposable income of all institutional sectors grows by 103.7 % (in total) in 2050 compared to 2010, with the largest increase in the general

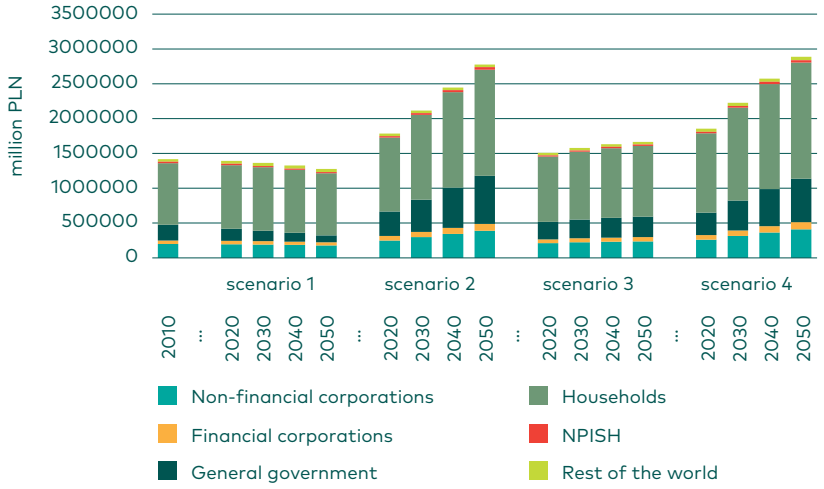

Fig. 11. Disposable income, million PLN. (Source: Own calculations)

government (although the decline of this sector's income is due to the changes in demographic structure).

The complete sequence of national accounts allows us to follow the financial consequences of the changes assumed in individual scenarios. The ending item of the sequence of non-financial accounts, i.e. net lending (positive value) or net borrowing (negative value) can be interpreted from two points of view. On the one hand, as previously stated, this is the difference between the net acquisition of financial assets and the net incurrence of liabilities (balance of intersectoral transactions being the flows of financial instruments). On the other hand, taking into consideration the real sphere of the economy, it is the difference between revenues and expenditures of institutional sectors, both current and capital. The chart below (see Fig. 12) presents the final effects, measured by the excess (or deficit) of income over expenses, putting all three scenarios together.

After determining disposable income from the identity centered model and assuming the values of particular elements of the final demand in individual scenarios, gross savings and net lending / net borrowing are determined as a residual. Since we have made assumptions of a decrease in household consumption, an increase in net exports and a constant value of investments, the simulated increase in disposable income of all domestic institutional sectors causes growing savings and net lending of the Polish economy (growing net borrowing of

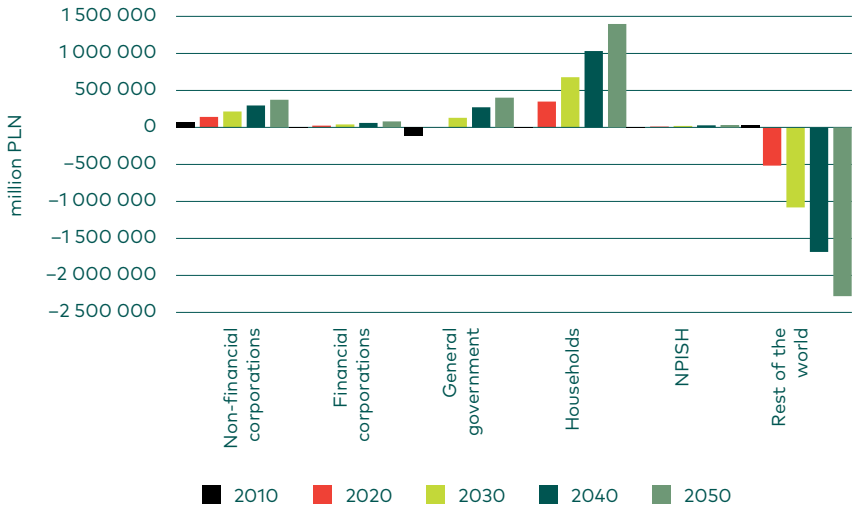

Fig. 12. Net lending / net borrowing simulated in Scenario 4, million PLN. (Source: Own calculations)

the rest of the world). This situation is a consequence of the development trends in the field of foreign trade, which themselves contribute to significant foreign borrowing and the accumulation of net lending of domestic sectors. The household sector seems to be the biggest beneficiary of the changes assumed in the analyzed scenarios. Financial benefits for general government are also worth attention.

Conclusions

The paper presents the results of research carried out as part of a research project on the role of selected determinants of the development of the Polish economy in the 21st century. The system of economic models allows for simulations and forecasts of the development of the Polish economy in the medium and long term. Its advantage is the sectoral level of investigation, both in the sense of the activities and institutional sectors. The system is transparent and enables us to follow economic mechanisms. It is also flexible, which means that it is easy to implement different scenarios. Its very important feature is balancing, which ensures consistency of the obtained results and allows for logic control at every stage of the calculations.

The use of an input-output model in the research (as the central model) allowed us to show the relationship between final demand (and its individual categories) and value added, i.e. the primary income of production factors. The sequence of national accounts describes the primary and secondary distribution of income, specifying the disposable income, which in turn is a decisive factor in the size of final demand. In the central model, the feedback between income and demand was interrupted by exogenizing final demand. The introduction of changes in this economic category results in adjustments in the sequence of national accounts.

The results of simulation analyses presented herein concerned the isolated effects of three processes observed in the Polish economy (changes in the demographic structure, increase in foreign trade intensity and growing activity of the national R & D sphere) and their cumulative impact on the circulation of income in the economy.

Simulation analyses based on the constructed model system indicate that the effects of demographic structure changes will be visible in the structure of revenues and expenditures of individual institutional sectors, in particular on the household and government accounts. Maintaining the current living standard of the population, measured by per capita consumption (assuming a secondary distribution structure of income from 2010), would require a gradual increase in government debt

from 8 % of GDP in 2010 to 14 % in 2030, and 19 % in 2050. However, further changes in the mechanisms of secondary distribution of income, which will transfer the debt of government to other institutional sectors, are expected. The historical data up to 2015 confirm that.

The reduction of the Polish economy's debt in recent years was supported by growing exports, especially exports of services. Maintaining this trend would require a high rate of labor productivity growth (on average by 1.9 % year on year), it would also lead to a growing net lending of domestic sectors relative to the rest of the world to 113 % of GDP in 2050 (from 3 % in 2015) – assuming stability of other model coefficients and variables.

The increase in domestic R & D expenditures combined with greater activity of the enterprise sector in their financing leads ceteris paribus to the increase in labor productivity, and consequently (with the unchanged employment) to an increase in value added by about 20 % in 2050. These conclusions were formulated based on satellite models for individual sectors (understood as groups of branches) of the Polish economy. They also enabled us to determine the role of particular factors related to the broadly understood knowledge capital for TFP growth, and the increase in labor productivity in the Polish economy. An important contribution to value added growth will still be made by traditional sectors of activity, i.e. industrial processing, agriculture and energy sector.

The outcomes of Scenario 4, which put the results of the three analyzed processes together, are the foundations for the following final remarks for the labor market and pension system: firstly, achieving production that meets the assumed final demand will require an average increase of labor productivity by 2.4 % per year (with constant employment). Maintaining constant employment would require an increase in the employment rate to an unrealistic level of 90 % in 2050 against the projection of the decline in the working age population by 39 %. The alternative is inflow of foreign labor. Secondly, the application of the pension sub-model points out that the assumption of a fixed average pension will mean a nearly 2.5-fold decrease in the replacement rate at retirement (which is close to EC-EPC projections (The 2015 Ageing Report, 2015)).

Already during the project implementation, we have witnessed events that may have a significant impact on the trajectory of economic growth in the world's regions. The Russian-Ukrainian conflict, the refugee problem and the related radicalization of European and other societies, Brexit, the uncertain fate of the Transatlantic Trade and Investment Partnership (TTIP) are problems on the international scale directly affecting the future of Poland. During this time, the hopes for a

rapid economic development of Poland, which was to take place due to the exploitation of shale gas deposits, disappeared. Much will depend on the internal policy of the state, which also reveals the features of unpredictability. This problem appeared, for example, during the simulation of the impact of demographic changes on lending (borrowing) of institutional sectors, in the form of a change in the retirement age. 2050 is still far away and many surprising turns likely await us.

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