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THE STRUCTURAL MODEL OF THE LODZ REGION SCENARIOS OF REGIONAL DEVELOPMENT

Abstract. Prospects for regional development are the subject of wide interest to the authorities and the academic community. This interest is reflected LORIS VISION project, including the regional technology foresight. The part of the project was to built a macroeconometric structural model of the Lodź region "Loris", which together with the adapted model of the Polish economy W8-LW provides a tool in economic analysis. In this paper the structure of the model and the results of economic analysis for the Lodz region resulting from the assumptions and solutions of the models are prezented. An attempt to quantify the impact of changing external conditions and remedial actions for the development of the Polish economy and the region. Accepted assumptions resulted directly from the earlier rounds of Delphi surveys conducted within the project Loris Vision. It has been shown that a change in assumptions and taking action locally obsen/ed so far go beyond the framework may lead to changes in growth rates and achieve different levels of development of the region, increased its share in domestic production or growth of population wealth.

1. LORIS MODEL

Both the authorities and the academic community are widely interested in the regional development prospects to. This interest is reflected in the LORIS Wizja project including the regional technology foresight. Among other things, the project aimed to build a macroeconometric structural model of the Lodz region "Loris", which together with the adapted model of the Polish economy W8-LW provides a tool of economic analyses.

The Macromodel LORIS for the Lodz region's economy is a medium-size system of interdependent equations. It consists of 57 equations, of which 27 equations are stochastic and 30 are identities. The LORIS model is strongly linked with the national economic environment, which is described by the W8-

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LW model (figure 1). The models complement each other and constitute a single system. All eight exogenous variables of the Lodz region model are endogenous to the W8-LW model. On the other hand, the changes in the Lodz region's economy affect the solution obtained under the model W8-LW. This ensures consistency between the regional economy and the national economy.

The LORIS model was constructed under the "Loris Wizja" project to be used subsequently in simulation analyses and in short-term forecasting. Hence the degree of disaggregation and the structure represent a compromise between the capacity of the team, the availability of statistical data and fidelity to the description of the regional economy's functioning.

Taking as a starting point the equation explaining production in the region we can state that the model is demand oriented[1]. This follows from the belief that the demand of the domestic users offers a whole range of opportunities to take and its size determines the volume of production and thus employment and investment. At the same time, there is a surplus of production capacity and workforce. The entire history of Polish transition suggests that economic processes are largely determined by demand, which should be appropriately reproduced by the model.

Fig. 1. Simplified diagram of the region's economy LORIS model and its relationship with model W8-LW
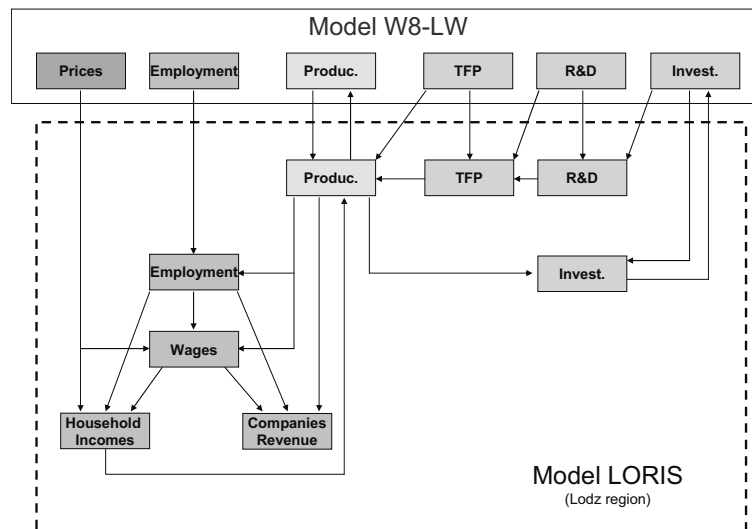
Source: developed by the authors.

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[1] Welfe W., Welfe A., Forczak W., [1996], *Symulacyjny, makroekonomiczny model W8 gospodarki Polski*, Gospodarka Narodowa, No 12, pp. 32-46.

The mainstay of the LORIS model of the Lodz region is production – measured as an added value – of each section of the region, expressed in constant prices of 1995. GDP is used as the main link between the LORIS model and the W8-LW model. This relationship requires some additional assumptions, since GDP is the sum of value added generated in each section[2]. In the long run, the volume of production in the Lodz region is also affected by the ratio of the total productivity of production, in both the country and the region. Productivity growth in the region is assumed to be higher, resulting in more rapid conversion to the more developed regions of the country. At the same time, the total factor productivity depends on national and regional investments, and expenditure on research and development (R&D).

Total employment in the Lodz region is explained as a stochastic approximation by changes in the domestic labor market and regional demand for labor. The specification of wage equations takes account of the impact of maintenance costs – represented by the price deflator of personal consumption - and of labor productivity measured by the value added to regional employment ratio. The hypothesis about a linkage between wages and labor market (unemployment) was not confirmed empirically by statistics[3].

2.   REGIONAL ECONOMIC DEVELOPMENT IN LODZ REGION TO THE YEAR 2020

When a forecast of the regional economic development was being constructed it was assumed that the historical ties linking the region with the Polish economy were preserved, which determined the design of the LORIS model. The unchanging structure of the model was used to produce baseline projections about the future. While they may be either overly optimistic or pessimistic, the baseline simply replicates the historical relationships with the national and global economic environments that were observed in the sample. This limited the possibility of introducing *a priori* additional information.

The observed economic crisis adds an element of uncertainty that was not observable in the available sample. Notwithstanding, we assumed that the forecasts for the country and the region of Lodz were moderately optimistic. Poland's accession to the European Union attracted a significant inflow of funds, and - not without a cause - aroused expectations of further assistance. In spite of the country's technological backwardness compared to developed countries, the

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[2] Zienkowski L., [2001], *Co to jest PKB? Jego rola w analizach ekonomicznych i prognozowaniu*, Dom Wydawniczy Elipsa, Warszawa.

[3] A description of all model's equations can be found in the monograph: Welfe W., Świeszewska I., Florczak W., Karp P., [2008], *Rozwój regionalny – ujęcie ekonometryczne*, Łódź.

free movement of capital and technology justifies a relatively rapid growth and improvement of the living standard. This suggests that in the coming years Poland will develop relatively fast, and so will the Lodz region. However, the forecast for the region of Lodz alone is less optimistic. If appropriate actions to increase the R+D expenditures are not taken, the economic importance of the region will slide steadily and the socio-economic disparities between the region's inhabitants and the rest of the country's population will increase.

3.   MACROECONOMIC SCENARIOS FOR THE POLISH ECONOMY AND THE REGION OF LODZ

Changing assumptions and taking local actions that go beyond the recent plans may affect growth rates and lead to different development levels in the region, thus increasing its share in domestic production and its population's wealth. We attempted to quantify the impacts of changing external conditions and of remedial actions on the course of development of the national economy and the regional economy. The assumptions we made resulted directly from the earlier rounds of the Delphi surveys conducted under the Loris Wizja project.

The first scenario presents the results of research that attempted to quantify the macroeconomic impact of a significant increase in world oil prices on the Polish economy and the region of Lodz based on the simulations with two macro-econometric models, i.e. W8-LW and LORIS.

Crude oil is a key, strategic raw material determining the economic development of the modern world. This probably results from a very limited substitution of energy sources and the fact that all areas of human economic activity, e.g. transportation, modern agriculture, chemical industry or pharmaceutical industry, depend either directly or indirectly on its availability. There is little exaggeration in saying that oil consumption underpins to a large extent almost everything that is modern in the contemporary world. Under relatively rigid accessibility of oil resources, rising extraction costs and decreasing EROEI ratios, and with stable or growing demand, sharply rising prices will be the only effective tool for balancing economic demand and supply.

The macroeconomic implications of the rising oil prices for the Polish economy are significant. Declining global demand directly contributes to a decline in Polish exports. The downturn in the global markets and the decreasing competitiveness of the Polish economy – as shown by deteriorating macro-economic indicators – reduce the inflow of foreign direct investment. The effects of rising world prices make domestic prices grow, following higher import costs. The overall increase in prices entails higher interest rates.

As a result, investment demand contracts and the accelerator mechanism of this effect becomes even more complicated. Consequently, a significant decline in final demand is recorded, despite the volume of imports decreasing due to lower GDP. Ultimately, the demand sinking because of declining production causes a clear decline in labor demand, which under only a slightly decreasing growth rate of labor productivity drastically increases unemployment.

Fig. 2. GDP percentage deviation from the forecast
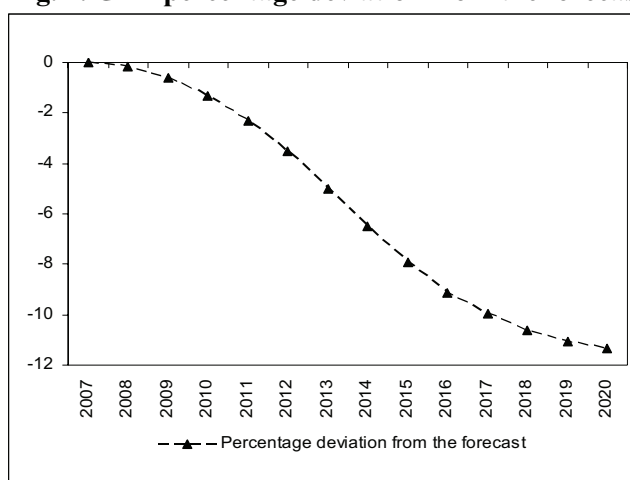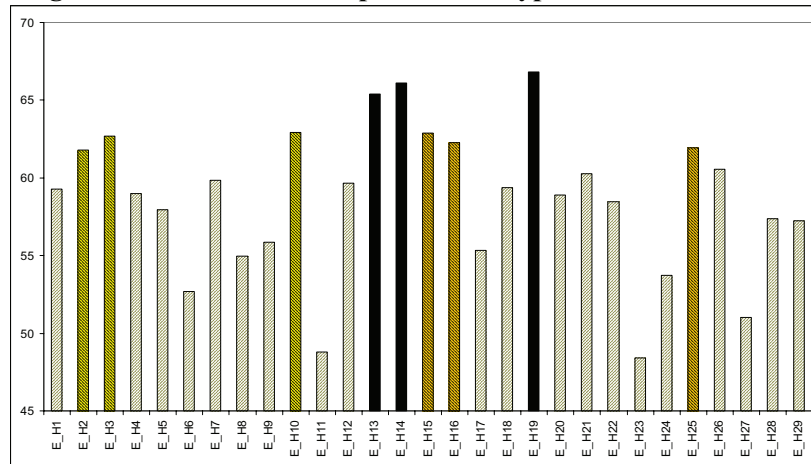

Source: developed by the authors.

The effects or rising world oil prices can also be seen on the supply side of the economy. First of all, lower investment costs cause slower accumulation of physical capital, and consequently make capital-labor ratio decline – in relation to the baseline. Along with the general decelerating economic activity fewer resources can be allocated for development and education, the result of which appears to reduce human capital growth and total factor productivity.

The Lodz Region is the largest agricultural region in Poland, taking into account the contributions of the area under cultivation. Additional investment in fixed capital as well as R+D to increase value added generated by the region's agriculture could partially mitigate adverse economic changes.

To identify potential areas of eco-business and agriculture development in the region the results of the Delphi rounds conducted under the LORIS Wizja project were used. Attention was directed to the answers given by experts having very good or good knowledge of the subject matter. As a result of the weighing procedure, the results of the Delphi rounds generated three hypotheses about potential opportunities for the Lodz region:

   –   Biorefineries (E_H19) - bio-refinery industry develops strongly in the region Lodz, where the plant material will be extracted using high-quality chemicals and the remaining biomass will be converted to bioenergy and other precursors for the chemical industry. The waste materials will be used to manufacture fertilizers.

   –   Trans-disciplinary education (E_H14) - the Lodz region develops trans-disciplinary education about environmental protection for employees provided by international consortia (EU, UN).

   –   Biotechnology for fuels production (E_H13) - biotechnology will play an increasingly important role in the production of fuels and in environmental and human life protection, creating also new opportunities for business development.

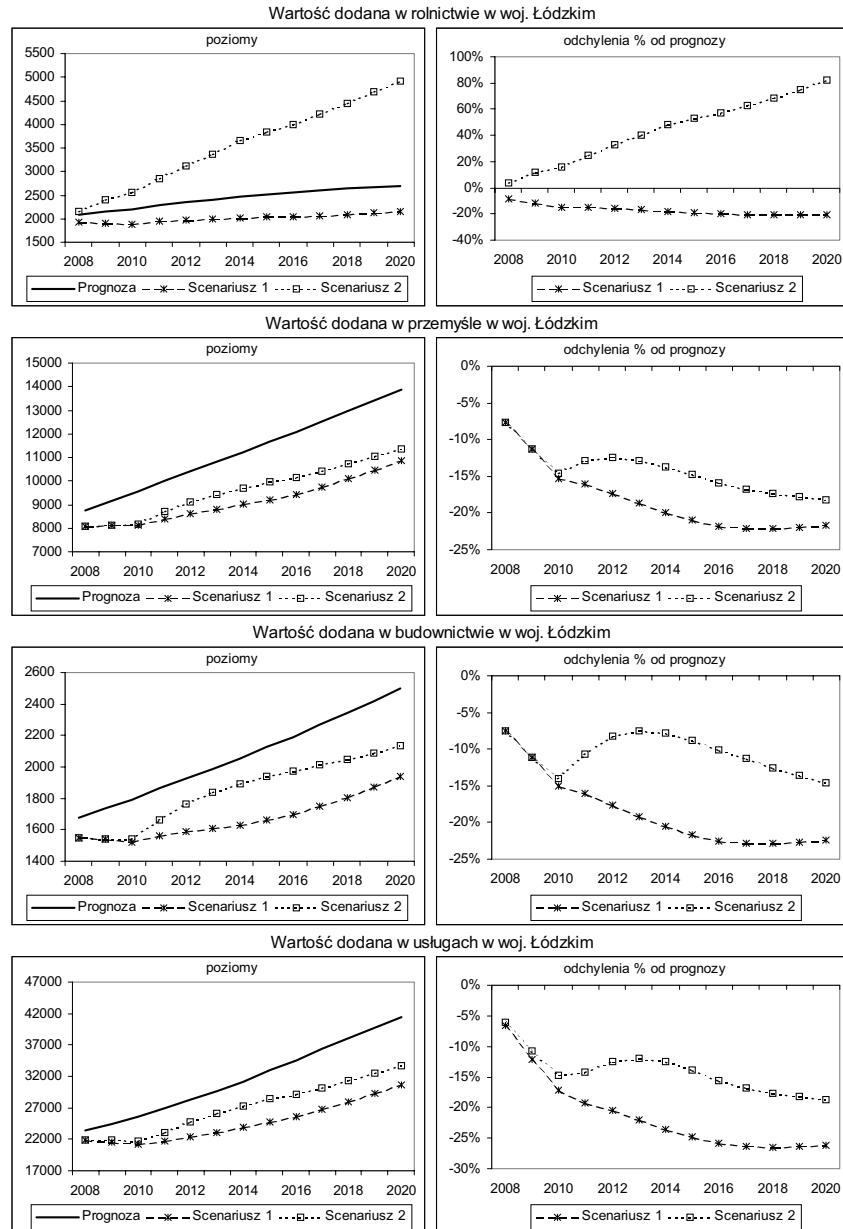**Fig. 3. Classification of Delphi rounds hypotheses - ecobusiness**

Source: developed by the authors.

Actions focused on the implementation of these scenarios would improve the situation of the region, while mitigating the adverse effects of changing energy prices. Therefore, two simulation scenarios were developed.

The first scenario (passive) shows regional development without any measures taken to restructure agricultural production and other industries. The second scenario (active) provides for strong regional policy aimed at acquiring investment funds to improve the environmental conditions (particularly water supply, which involves the construction of reservoirs, etc.), to modernize agriculture and to research how productivity of the cultivated areas can be improved, taking into account the results accepted during the Delphi rounds.

Fig. 4a. Forecast and scenarios for the region of Lodz allowing for changes in world oil prices

Wartość dodana w rolnictwie w woj. Łódzkim

Wartość dodana w przemyśle w woj. Łódzkim

Wartość dodana w budownictwie w woj. Łódzkim

Wartość dodana w usługach w woj. Łódzkim

Source: developed by the authors.

Fig. 4b. Forecast and scenarios for the region of Lodz allowing for changes in world oil prices

Source: developed by the authors.

Fig. 4c. Forecast and scenarios for the region of Lodz allowing for changes in world oil prices
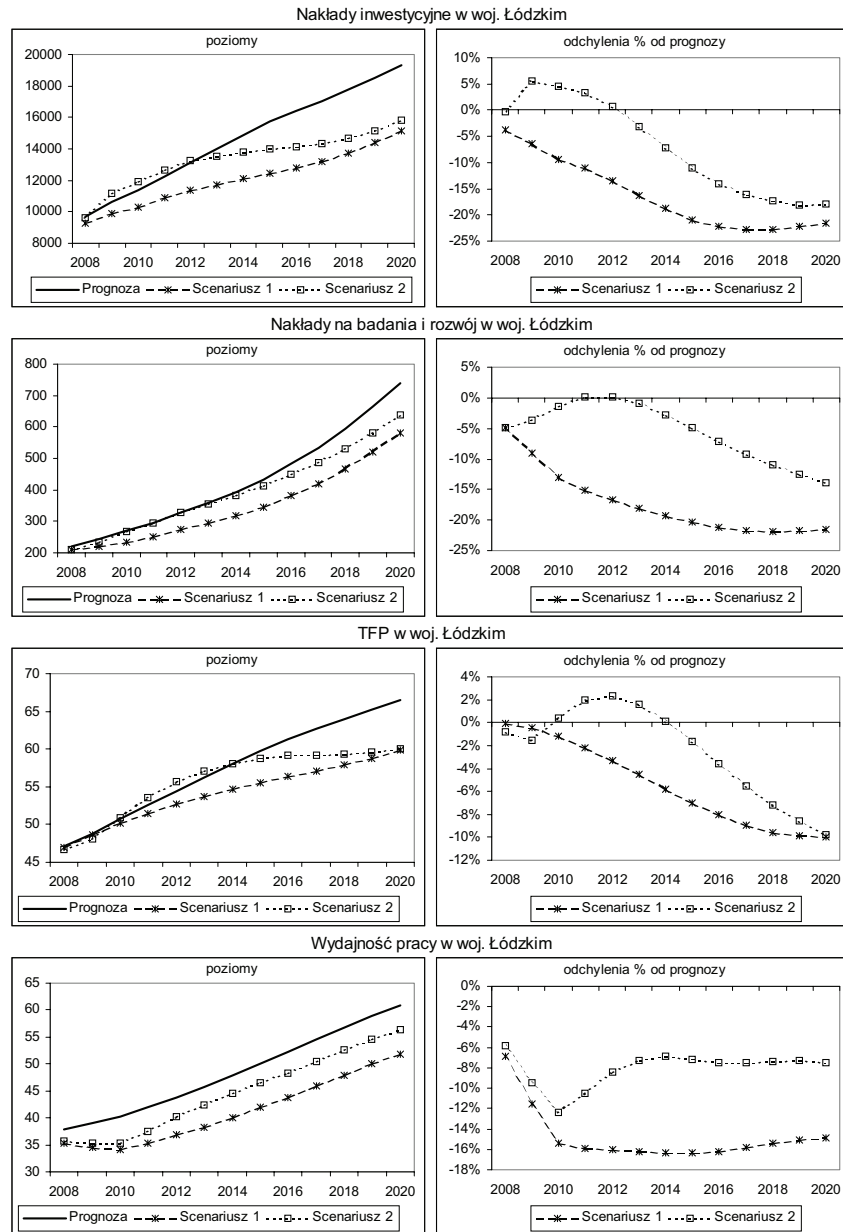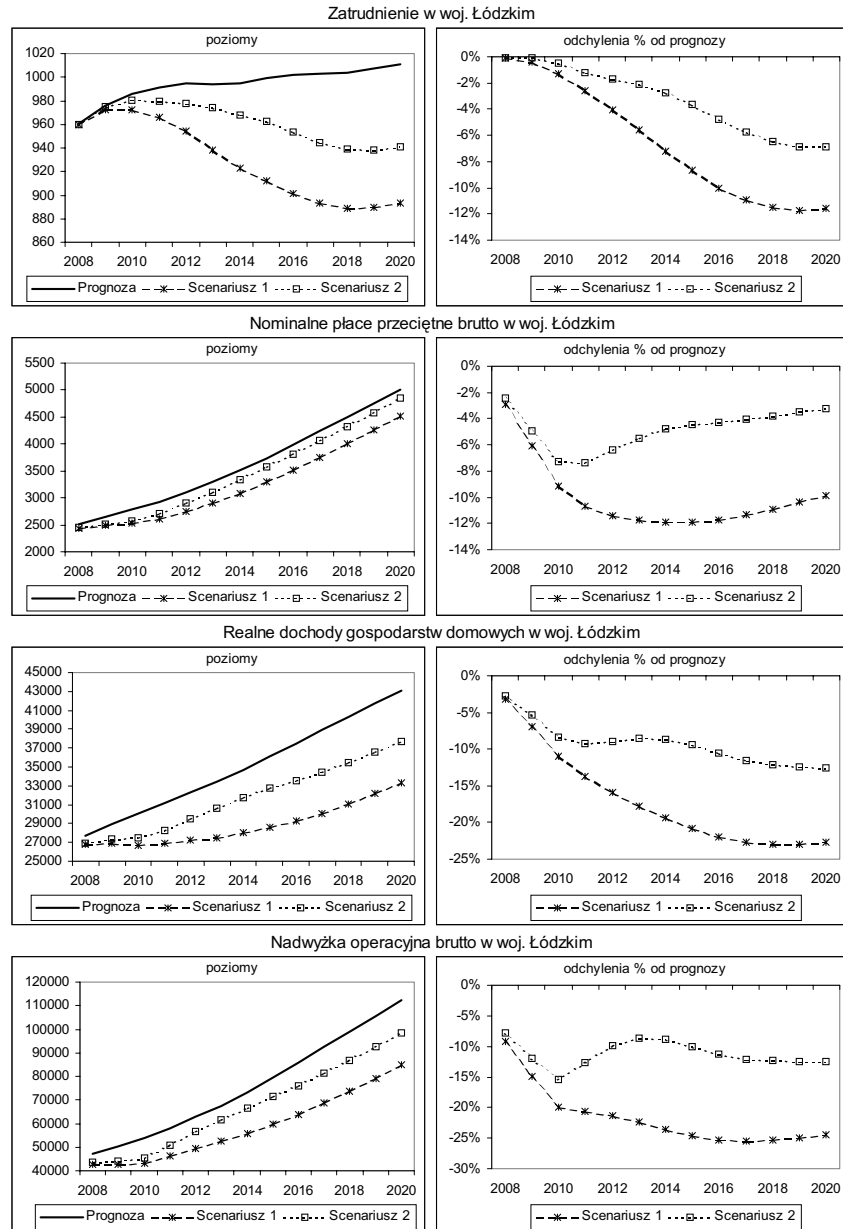
Zatrudnienie w woj. Łódzkim

Nominalne płace przeciętne brutto w woj. Łódzkim

Realne dochody gospodarstw domowych w woj. Łódzkim

Nadwyżka operacyjna brutto w woj. Łódzkim

Source: developed by the authors.

In the first scenario, the economic downturn in the country and the world reduces demand for agricultural production by about 20% compared with the forecast. A similar reaction can be observed in the other sectors of the Lodz region, where production does not grow in the first years of the simulation, or even slightly declines. It takes about four years before the region's value added starts to grow slowly. However, the growth is much slower than in the baseline forecast. The services sector shows the most significant deviations, as its 2020 value added is more than 26% lower than in the forecast. As a result, investments in fixed assets and R+D are very limited. Likewise, production is 21% lower at the end of the sample than in the forecast, making TFP grow much more slowly than in the baseline. Consequently, employment in the region falls by more than 10% to be below 900 thousand.

The application of preventive measures such as strong investments in eco-business and agricultural development largely improves the situation of the Lodz region.

Increased investments in fixed capital and R&D in agriculture make this sector's value added grow over forecast periods that are longer than in the initial simulation. In the next years, larger demand for agricultural production and its improved efficiency will result in further rapid growth, doubling agricultural production at the end of the simulation horizon. Of course, this will affect other sectors in the region and after three years the adverse effects of the increases in world energy prices will slow down. Value added in industry, services and construction will be about 10% higher than in the passive scenario. Consequently, a further increase in investments in fixed capital and R+D will take, making total factor productivity grow even higher than in the forecast.

Both above outlined scenarios demonstrate the national economy and the Lodz economy exposure to the global downturn, mainly caused by the fluctuations in oil markets.

Another scenario for the Lodz region is also closely linked to the course of development of the national economy, because it assumes that the national R+D spending will increase to around 3% of GDP. This would bring Poland closer to the more developed EU member states, where this share is much higher than in Poland. The baseline forecast for the Polish economy assumes that the share will oscillate around 1.5%. According to many experts it is far too little for the Polish economy to compete in quality products and total factor productivity with the more developed countries. This situation is further deteriorated by the ever-increasing labor costs and long-term appreciation of the zloty that reduce the profitability of exports. Therefore, actions are needed to make the economy more innovative, preferably by increasing the R&D allocations to make Poland more absorptive and creative in the field of leading technologies.

The availability of sufficient resources is vital to make the analyzed scenario come true. The R+D outlays can be financed from European Union funds, the state budget and from the private sector. The acquisition of funds from the EU as well as appropriately strong motivation of enterprises – e.g. boosted by policies offering tax reliefs or tax exempts – is therefore a necessary condition for this scenario to materialize without exposing the state to an excessive burden. However, this requires proper targeting to maximize benefits, and the outcomes of the Delphi rounds of the LORIS Wizja Project perfectly serve the purpose.

This scenario additionally assumes that an increase in R & D expenditures leads to augmented spending on higher education, which then translates into more intensive formation of human capital and TFP in the national economy.

As well as making TFP grow, the increased spending on research and development and higher education directly contributes to a rise in incomes. This activates the consumption multiplier and thus production grows in the final periods of the simulation by 10% compared with the baseline.

The increasing technological and organizational progress renders domestic production more effective and much more competitive in relation to imported goods, despite the deep appreciation of the zloty. The growth of exports on the demand side and higher R&D spending on the supply side increase in labor productivity. As a result, real wages and incomes go up, thus improving the economic situation in the country and the region.

As in the previous investigations exploring the effects of rising world oil prices, two development scenarios for the Lodz region were considered. In the first scenario – let us call it passive - the regional government and local businesses raise no additional funds for R&D activities. Their involvement is similar to that observed in the sample and remains relatively constant. The second scenario, an active one, assumes, however, that both regional authorities and entrepreneurs take efforts to improve the R&D's share in the regional economy. Their activities are so effective that the volume of resources allocated to R&D goes up by an additional 50% compared with the passive scenario.

In the passive scenario, the expenditure on R& D increasing in the national economy boosts also inflows of funds directed to the Lodz region. R&D grows faster, raising the level of total factor productivity (TFP), as well as demand for manufactured goods and services. The faster development of the Polish economy additionally translates into larger value added in the region and improvement of its socio-economic situation. Employment grows by 2% and households' real incomes by 6%. In the final simulation years, value added in the region and in individual sectors is around 10% higher than in the forecast. Approximately a 10% increase in fixed investment can be seen, arising from both larger demand for productive assets and reorganization of production processes following from technological progress.

The additional resources acquired in the active scenario improve the overall situation in the region even more than in the country. However, individual regional variables respond asymmetrically. Total value added in the Lodz region grows almost twice faster than in the passive scenario, but fixed investment is only about 14% higher in relation to the baseline forecast (12% in the passive scenario). Despite these reactions from investment outlays, total factor productivity increases by 12%. It should be emphasized that all reactions are positive and having more funds for R&D has very beneficial effects on the region.

Despite the socio-economic situation of the region improving greatly in both scenarios, the realization of the passive scenario would diminish the region's role in the national economy (see Figure 5). The region's contribution to national value added falls from 6.8% to about 6.6%. Although not very significant, the response means that without determined actions to acquire the R&D funds more actively the region will slowly slide into marginalization. Only substantial increases in the inputs – as shown by the active scenario – clearly improve the role of the Lodz region and the region's growth outpaces the entire economy.

Fig. 5. The Lodz region' share in the whole economy' value added
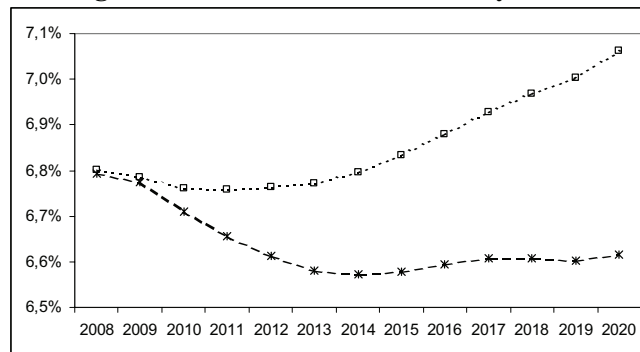
Source: developed by the authors.

4.   CONCLUSION

The analyses presented in the paper confirm the finding that an active regional policy is a key element of regional development. It is even more so, if the policy is appropriately targeted.

The analyses are only an example of the applicability of the W8-LW and LORIS models. In general, the assumptions about the external conditions may present higher or lower levels of realism and then their implications for both the region and the national Polish economy can be analyzed.

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STRUKTURALNY MODEL REGIONU ŁÓDZKIEGO
- SCENARIUSZE REGIONALNEGO ROZWOJU

Perspektywy rozwoju regionalnego są przedmiotem szerokiego zainteresowania zarówno władz jaki i środowisk naukowych. Wyrazem tego zainteresowania jest projekt LORIS Wizja, obejmujący regionalny foresight technologiczny. W ramach projektu zbudowano strukturalny makroekonometryczny model województwa łódzkiego „Loris", który wraz z zaadaptowanym modelem gospodarki Polski W8-LW z serii modeli W stanowi narzędzie analiz ekonomicznych.

W artykule zaprezentowano strukturę modelu oraz wyniki analiz ekonomicznych dla regionu łódzkiego wynikającą z przyjętych założeń oraz rozwiązania zespołu modeli. Przedstawiono próbę kwantyfikacji wpływu zmieniających się warunków zewnętrznych oraz podejmowanych działań zaradczych dla rozwoju gospodarczego Polski oraz regionu łódzkiego. Przyjmowane założenia wynikały bezpośrednio z wcześniej przeprowadzonych badań rund delfickich w ramach projektu Loris Wizja. Wykazano, że zmiana założeń oraz podjęcie działań na gruncie lokalnym wychodzących poza obserwowane dotychczas ramy może prowadzić do zmiany tempa wzrostu oraz osiągnięcia innego poziomu rozwoju regionu, wzrostu jego udziału w produkcji krajowej lub wzrostu zamożności mieszkańców.