Bridging Different Modelling Tools For Studying The Case Of Belarusian European Integration

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Abstract

This paper examines the potential macroeconomic consequences of Belarusian European integration, a complex transformation that would unfold through several stages. The process is likely to begin with a significant external shock associated with the removal of implicit energy subsidies and the restructuring of external economic relations, followed by a transition period of macroeconomic adjustment and sectoral reallocation. Only after these adjustments can the economy reach a new post-integration steady state and enter a phase of long-term convergence-driven growth. To analyze these phenomena, the study adopts a multi-model analytical framework combining several modelling tools, including CGE, QPM, DSGE, debt sustainability analysis, and LTGM. The outputs of some models serve as inputs for others, allowing the construction of a consistent macroeconomic narrative of Belarus's potential integration path. The simulations suggest that the post-integration steady state of the Belarusian economy would likely be moderately weaker than the current one, with potential GDP declining by approximately 2.7–3.9 percent depending on the availability of external support. However, none of the simulated scenarios produces an uncontrolled collapse of output despite the magnitude of the energy price shock. The transition period appears significant but manageable, although its trajectory will depend strongly on policy responses and institutional conditions. Long-term simulations indicate that, while an inertial development path would lead to relative economic impoverishment, European integration fundamentally alters the trajectory toward gradual convergence with more advanced economies. The ultimate outcomes depend critically on the activation of productivity growth mechanisms and the effectiveness of economic and institutional policies during the transition period.

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1. Introduction

From today's policy status quo and perspective, Belarusian accession to the European Union (EU) can be treated as a structural counterfactual scenario. However, this does not imply that it will necessarily remain so in the future. Regardless of how one assesses the probability of such a scenario, studying it has substantial analytical value. It represents a coherent and economically meaningful regime shift. From a research perspective, EU integration is not merely a geopolitical reorientation, but a deep transformation of trade patterns, institutional arrangements, policy frameworks, macroeconomic mechanisms, and long-run growth determinants. As such, it provides a unique case for studying the interaction between structural change, macroeconomic adjustment, and income convergence.

Belarus differs markedly from most Central and Eastern European economies that have already joined the EU or are currently candidates. First, its trade and integration structure has been strongly oriented toward Russia for an extended period. The country has been embedded in a number of Russia-led integration arrangements, including the Eurasian Economic Union, which shaped tariff structures, technical regulations, and energy pricing mechanisms. Second, the domestic production structure has been characterized by a comparatively large state-owned enterprise (SOE) sector. Soft budget constraints, cross-subsidization, directed lending, and capital-investment dirigisme have played a significant role in sustaining economic activity. Third, the broader policy regime has involved a higher degree of administrative intervention, including price controls and limited institutional autonomy of macroeconomic policymaking.

Taken together, these features imply that the starting point for Belarus differs fundamentally from that of countries such as Ukraine, Moldova, or the Western Balkan economies. In the Belarusian case, EU integration would not simply require regulatory harmonization and incremental institutional upgrades. It would entail a more profound restructuring of the institutional underpinnings, trade linkages, energy supply conditions, fiscal relations, enterprise governance, and economic policy mix. For this reason, the transition path is likely to be more complex and potentially longer than in comparator cases.

At the same time, the core economic motivation for EU integration remains analogous to that observed in other accession episodes: the possibility of accelerated income convergence and more sustainable long-run growth. Integration into the EU single market opens access to a larger demand base, facilitates capital inflows, and strengthens technological diffusion channels. Institutional upgrading, including improvements in governance quality, competition policy, and legal enforcement, enhances total factor productivity and investment efficiency. Furthermore, macroeconomic anchoring and increased policy credibility tend to reduce risk premia, stabilize expectations, and lower volatility. In this sense, the ultimate prize of integration is not only a higher level of income, but also a more resilient and less crisis-prone growth regime.

However, the logic of EU accession implies that the convergence dividend is conditional. In order to approach the long-run convergence benchmark associated with EU-type institutions and market structures, a candidate country must first transform its domestic economy in line with European standards. For Belarus, this would also imply withdrawal from existing Russia-centered integration frameworks and an adjustment to market-based energy pricing. From the perspective of economic theory, such a process can be interpreted as a transition from the current steady state to a new post-integration steady state.

Crucially, the post-integration steady state may initially be inferior to the current one in certain dimensions. The removal of preferential energy prices, the termination of fiscal transfers, and potential deterioration in the terms of trade could lower real incomes in the short term. Fiscal consolidation pressures and enterprise restructuring may also dampen output and employment. Thus, the first equilibrium after regime switching – the post-integration steady state – is not necessarily associated with an immediate welfare gain. In the Belarusian case, it may even be worse than the current one.

The major challenge is that the transition between the current steady state and the post-integration one is neither automatic nor guaranteed to be smooth. The parameters of the post-integration steady state are themselves uncertain and depend on policy choices, the speed of reforms, and external support. The duration and depth of the transitional recession are unknown ex ante. Moreover, institutional capacity constraints may limit the ability of economic policy to manage adjustment costs effectively. Sectoral reallocations, labor market frictions, inflationary pressures, and external imbalances can amplify short-run instability.

Only having reached a post-integration steady state does the economy potentially begin to converge toward higher income levels observed in the EU. In this sense, EU integration creates the conditions for gradual convergence toward the average income level of EU economies. The distinction between the starting point of the post-integration structural regime (post-integration steady state) and this long-run convergence benchmark is important. The former captures the baseline configuration of the economy after the break with the previous integration model, while the latter reflects the income level that may be gradually approached through convergence dynamics under improved institutions, deeper market integration, and stronger productivity growth.

This combination of structural uncertainty, transitional risks, and long-run convergence potential raises a fundamental research question. What is a realistic medium- and long-term path of the Belarusian economy under EU integration, and what are the key challenges along that path? Addressing this question requires an integrated analytical framework capable of linking structural steady state changes, short-run macroeconomic adjustment, external sustainability constraints, and long-run convergence dynamics.

From a chronological perspective, the economic logic of EU integration therefore follows a relatively intuitive sequence. First, the economy experiences a transitional period accompanied by macroeconomic adjustment and sectoral reallocation. In the conceptual framework outlined above, the transition can be represented as a movement from the current steady state associated with the existing integration model toward a new post-integration structural regime. Presumably, this period might be characterized by macroeconomic turbulence and structural adjustments. Output, real incomes, inflation, and the external balance may temporarily deviate from their previous trajectories as the economy adapts to new relative prices, trade patterns, and policy constraints.

Second, in addition to macroeconomic adjustment (likely simultaneously), the shift toward the new post-integration steady state is likely to generate substantial sectoral effects. Certain industries may experience rapid expansion, while others may face contraction or restructuring. A particularly illustrative example concerns the energy sector. Membership in the Eurasian Economic Union and the Union State has historically been associated with access to energy resources at prices below prevailing market levels. The loss of this implicit price advantage would likely constitute a significant shock to the energy sector. Given the strong intersectoral linkages of energy with other branches of the economy (Kruk & Panasevich, 2023), disturbances in this sector may propagate across the production structure, affecting costs, competitiveness, and profitability in multiple industries. Similar adjustment pressures may arise in other sectors as a result of changing trade regimes, competitive conditions, and institutional constraints. Although sectoral effects may constitute an important part of the Belarusian EU integration story, within the scope of this paper we consider them only partially, to the extent allowed by the modelling framework used. Nevertheless, a deeper focus on specific sectors and industries—along with their linkages to the macroeconomic level, beyond the exercises presented in this paper—could further enrich the overall analysis.

Third, after these stages have taken place, the economy is expected to approach a new post-integration steady state, which is characterized by a new structural regime, meaning new institutional underpinnings, environment, and intrinsic regularities. This new regime reflects the economic environment that emerges after the reconfiguration of trade relations, energy pricing mechanisms, fiscal arrangements, and institutional rules. Importantly, this structural shift does not automatically imply an immediate improvement in economic outcomes. On the contrary, the post-integration regime may initially be associated with lower income levels and significant adjustment pressures.

Fourth, as new institutions stabilize and the economy adapts to the new environment, the process of income convergence may begin to unfold. In this latter stage, growth dynamics are driven by the gradual narrowing of the productivity and income gap relative to more advanced EU economies. In analytical terms, this corresponds to convergence toward a long-run benchmark income level, which reflects the conditional steady state level compatible with EU-type institutional and market structures.

This chronological sequence is intuitive and important for policy communication and expectation management. At the same time, it is not a convenient starting point for economic analysis. For research purposes, the central analytical object is the post-integration steady state itself. The characteristics of this steady state, such as the initial level of output, the structure of demand and production, fiscal balances, and the external position, largely determine both the magnitude of the adjustment required to reach it and the dynamics of the transition process. In other words, the post-integration steady state acts as a reference point for evaluating the trajectory of the economy. Without a clear understanding of the economic configuration associated with this regime, it is difficult to assess how large the transition costs might be, which sectors may face the strongest adjustments, or how long the transitional period may last. For this reason, the analytical sequence adopted in this study differs from the chronological order described above.

The analysis therefore begins with the identification of the post-integration steady state and its key macroeconomic characteristics. In the second step, the study examines the transitional dynamics of the economy as it moves from the current steady state toward the new one. Sectoral effects represent an additional important dimension of the adjustment process, although they are not the primary focus of the present paper. Finally, the analysis turns to long-run convergence dynamics and the prospects for sustained economic growth associated with gradual convergence toward the benchmark income level.

Addressing these steps requires the use of several different classes of economic models. Economic theory does not provide a single unified modelling framework capable of simultaneously capturing structural regime shifts, short-run macroeconomic dynamics, and long-run growth processes. Instead, different analytical tools are typically used to address different segments of the problem. In particular, computable general equilibrium (CGE) models provide a natural framework for analyzing the structural properties of the post-integration steady state. By capturing economy-wide resource allocation and intersectoral linkages, CGE models allow researchers to evaluate how changes in trade policies, energy prices, or fiscal arrangements affect the overall equilibrium configuration of the economy. To study the macroeconomic dynamics of the transition period, structural and semi-structural macroeconomic models are more appropriate. Dynamic stochastic general equilibrium (DSGE) models and semi-structural policy models such as the Quarterly Projection Model (QPM) are designed to analyze macroeconomic fluctuations as responses to shocks and policy changes. These models provide a framework for evaluating the depth and duration of transitional recessions, inflationary pressures, and external imbalances that may arise during the adjustment process. Finally, the analysis of long-run growth prospects requires a different conceptual perspective, focusing on supply-side determinants of economic expansion such as capital accumulation, productivity dynamics, and technological diffusion. Models rooted in the theory of economic growth allow the evaluation of convergence dynamics and the potential speed at which the economy may approach the long-run benchmark income level.

Because these modelling frameworks operate with different assumptions, scales, and analytical languages, they are not naturally integrated into a single unified system. The central methodological idea of this paper is therefore to construct analytical bridges between them. In practical terms, this means using the outputs of one class of models as inputs or calibration targets for another. At the same time, this strategy inevitably involves a degree of approximation. Differences in model structures, parameterizations, and variable definitions mean that shocks or outcomes generated in one framework cannot always be transferred directly into another. In some cases, translating results across models requires additional assumptions or expert judgment. This limitation represents an inherent drawback of the approach. Nevertheless, the ability to analyze the economic consequences of Belarusian EU integration within a single coherent analytical narrative outweighs these limitations. Even if the bridges between models are imperfect, their joint use makes it possible to evaluate the transition process in a comprehensive manner that would be difficult to achieve within any single modelling framework.

The remainder of the paper is structured as follows. Section 2 outlines the methodological framework and describes the algorithm of inter-model interactions, as well as the methodological aspects of the modelling tools employed. Section 3 reports the simulation results. Section 4 provides their interpretation and further discussion. Section 5 concludes.

2. Methodology

2.1. Algorithm of Inter-Model Interactions and Simulations

The analytical framework developed in this paper relies on a multi-model architecture designed to capture different stages of the economic transformation associated with Belarusian EU integration. This type of multi-model analytical framework is used in policy-oriented economic analysis, where different modelling tools are combined in order to capture structural change, macroeconomic adjustment, and long-run growth dynamics. For instance, a similar logic underlies the studies by Roeger et al. (2019) and Varga & Veld (2014). Because the economic processes examined in this study operate across different time horizons and involve distinct economic mechanisms, no single modelling framework is capable of capturing the full range of relevant dynamics. Instead, the analysis is organized across three interconnected analytical levels that correspond to different temporal horizons and modelling traditions. These levels are linked through a structured algorithm of inter-model interactions in which the outputs of one model serve as inputs or calibration parameters for another.

The first analytical level corresponds to the medium- and long-term horizon of economic development. At this level the analysis focuses on two closely related objectives. The first objective is the identification and characterization of the post-integration steady state of the Belarusian economy. This steady state represents the structural configuration of the economy after the transition away from the existing integration framework and the adjustment to the economic conditions associated with EU integration. The second objective concerns the long-term dynamics of economic convergence that may unfold once this post-integration steady state has been reached. In particular, the analysis investigates the long-run growth trajectory that may emerge as the Belarusian economy begins to converge toward the income levels observed in more advanced EU economies.

The second analytical level focuses on the short-term macroeconomic horizon. At this level the central objective is the analysis of the transitional dynamics associated with the movement of the economy from its current steady state toward the post-integration steady state. In other words, this level captures the macroeconomic adjustment process that occurs during the transition period. The analytical tools used at this stage are traditional macroeconomic models designed to simulate short-run fluctuations and macroeconomic responses to structural shocks. In the present study, two such modelling frameworks are employed: QPM and DSGE models. These models allow the analysis of macroeconomic volatility, inflation dynamics, external imbalances, and the evolution of key macroeconomic aggregates during the transition period.

The third analytical level addresses issues of macrofinancial sustainability. Within the inter-model framework this level performs a dual role. First, it acts as a robustness check for the results obtained at the previous stages of the analysis. In particular, it allows the assessment of whether the macroeconomic trajectories implied by the transition scenario are compatible with sustainable macrofinancial conditions. Second, it serves as an analytical environment for identifying potential macrofinancial risks associated with the transition process. In this context, the analysis focuses primarily on the evolution of public debt dynamics and the potential fiscal pressures that may arise during the transition period.

The algorithm of inter-model interactions (see Figure 1) begins at the first analytical level with the identification of the post-integration steady state. This task is performed using a CGE model. Within the conceptual framework of the paper, the post-integration steady state represents a hypothetical point B toward which the Belarusian economy may move once the transition process associated with EU integration has been completed. This point reflects the structural equilibrium of the economy after the institutional and economic adjustments implied by the integration scenario have taken place.

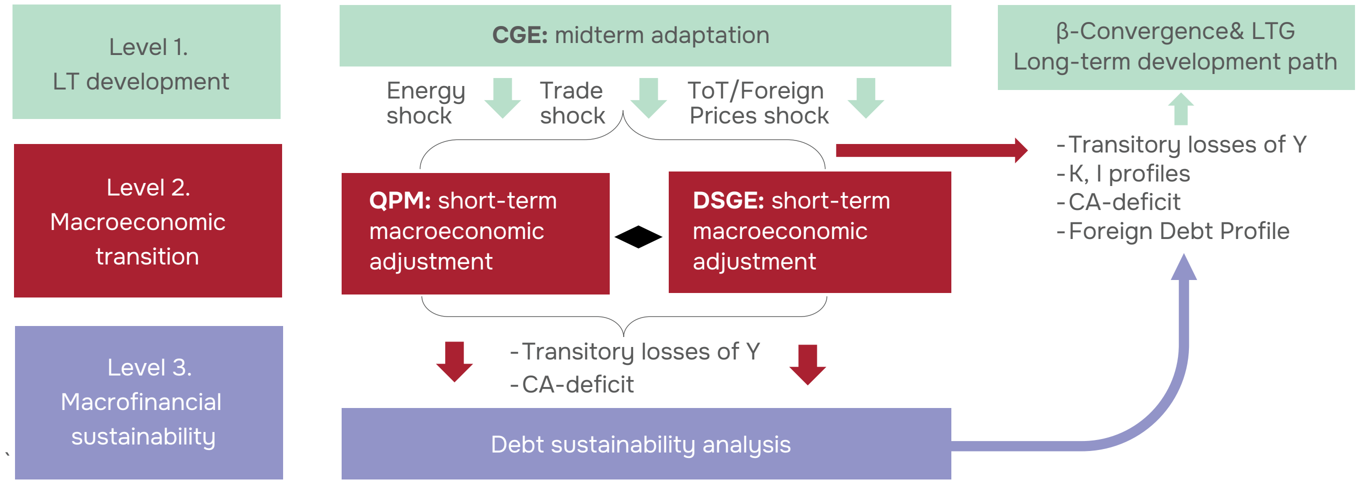

Figure 1. Summary of the Algorithm of Inter-Model Interactions

Source: Own elaboration.

In practical terms, the CGE model is used to simulate the structural changes associated with the transition toward the EU integration framework. These simulations are implemented by introducing a set of shocks that reflect the economic implications of integration. In the context of the Belarusian economy, one of the most important shocks is associated with the adjustment of energy prices. Under the current integration model Belarus benefits from preferential access to energy resources at prices that are significantly below market levels. The transition toward EU-compatible energy pricing implies a substantial increase in the effective price of energy inputs. In the CGE simulations this adjustment is represented by an energy price shock corresponding to an increase of approximately 60 percent in the weighted average price of energy resources. In addition to the energy price shock, the transition scenario also incorporates shocks related to changes in trade patterns and the terms of trade. These shocks reflect the reorientation of external economic relations and the adjustment of relative prices that accompany the shift from the existing integration framework to deeper integration with the European Union.

The role of the CGE model is therefore to describe the macroeconomic and structural characteristics of the post-integration steady state. These characteristics are important for several reasons. First, they provide insight into the structural transformation of the economy that may occur as a result of EU integration. In particular, the model allows the identification of sectoral changes in production and value added. Some industries may experience contraction due to changes in energy costs or competitive pressures, while others may expand as new opportunities emerge in the integrated European market. Second, the CGE framework allows the assessment of the export potential of different sectors of the national economy under the new trade configuration. This information is important for understanding the future structure of Belarusian exports and the potential for integration into European value chains. Third, the CGE model provides an estimate of the overall level of output associated with the post-integration steady state. This estimate serves as a first approximation of the potential welfare implications of the structural transformation implied by EU integration.

Beyond their intrinsic analytical value, the results obtained from the CGE model also play a critical role in the inter-model interaction algorithm. In particular, the estimated magnitudes of the energy shock, trade shock, and changes in output serve as input parameters for the second analytical level of the framework. These parameters are used to calibrate the shocks introduced in the short-term macroeconomic models.

At the second level of the framework the transition dynamics of the economy are analyzed using the QPM and DSGE models. The shocks identified at the CGE stage are introduced into these models in order to simulate the macroeconomic response of the economy to the structural transformation implied by EU integration. The energy and trade shocks are implemented directly in the short-term models. The estimated output losses associated with the post-integration steady state, however, are treated as indicative benchmarks rather than fixed constraints. Instead of imposing a new steady state exogenously, the short-term models generate endogenous adjustment paths in response to the introduced shocks.

Within this framework the primary object of interest is the dynamic trajectory of macroeconomic variables during the transition period. In particular, the analysis focuses on the magnitude of output decline, inflation dynamics, the evolution of the current account balance, and other key macroeconomic indicators. The maximum magnitude of the shock is defined as the local minimum or maximum value reached by the relevant variable during the transition period. An additional important aspect of the analysis concerns the duration of the transition process. In the context of this study the duration of the transition is defined as the number of periods required for the economy to recover from the initial shock and move toward the post-integration steady state. Because the QPM and DSGE models differ in their theoretical foundations and simulation methodologies, the study does not impose a strict formal definition of transition completion. Instead, the analysis relies on qualitative criteria indicating that the economy has largely adjusted to the new structural environment.

The analysis of transition dynamics employs two distinct modelling approaches corresponding to the two macroeconomic models used in the study. Within the QPM framework the shocks derived from the CGE simulations are introduced relative to the initial steady state of the economy. In this sense the model evaluates how the economy reacts when shocks associated with the characteristics of the post-integration steady state are imposed on the current economic configuration. The DSGE model adopts a different approach based on the perfect foresight solution (PF) approach. In this framework economic agents are assumed to have full knowledge of the future path of the economy and of the terminal equilibrium toward which the system converges. The model therefore evaluates the transition dynamics that arise when the economy moves from the current steady state toward a new steady state whose characteristics are known in advance. In practical terms, the post-integration steady state is imposed as the terminal condition of the model, and the transition path is computed as the deterministic trajectory connecting the initial and terminal equilibria. In the context of the present study, the PF framework is used to analyze the macroeconomic transition under the assumed process of economic integration with the European Union.

These differences in modelling methodology imply that the transition paths generated by the QPM and DSGE models may differ substantially. In the QPM framework the economy tends to revert toward the initial steady state after the shock, which generally produces more moderate responses in key macroeconomic variables. As a result, the QPM simulations tend to provide a more informative representation of the immediate macroeconomic effects observed during the early stages of the transition. By contrast, the perfect foresight solution in the DSGE framework explicitly incorporates the expectation that the economy will eventually reach the new post-integration steady state. This assumption typically produces stronger adjustment dynamics, particularly in variables related to investment and capital accumulation. Large structural shocks that reduce output relative to the initial steady state may lead to declines in the optimal capital stock and discourage investment, thereby amplifying the depth and persistence of the transition recession.

Furthermore, the perfect foresight environment affects the behaviour of forward-looking variables such as the stochastic discount factor, which reflects the intertemporal valuation of consumption and investment decisions. When agents fully anticipate the structural changes associated with the new equilibrium, they may adjust their expectations about future income and returns, leading to significant revaluations of present and future economic conditions. On the one hand, this feature represents an advantage of the DSGE framework because it captures an important behavioural channel related to expectations. On the other hand, it may exaggerate the degree of rationality and information available to economic agents, potentially leading to an overestimation of the initial magnitude of the shock. From this perspective, the QPM simulations can be interpreted as representing a baseline transition scenario that is particularly informative for the early stages of the adjustment process. The DSGE results, in turn, can be interpreted as a stress scenario reflecting stronger and more persistent adjustment dynamics. Together, these two modelling approaches provide complementary insights into the potential range of macroeconomic responses during the transition period.

The macroeconomic trajectories generated at the second analytical level also provide essential inputs for the third level of the framework, which focuses on macrofinancial sustainability. In particular, the transition scenarios derived from the QPM and DSGE simulations generate projections for key macroeconomic variables including economic growth, inflation, interest rates, exchange rate depreciation, and the primary fiscal balance. These variables are used as inputs in the debt sustainability analysis, which evaluates the evolution of the public debt-to-GDP ratio during the transition period. The purpose of this exercise is to determine whether the macroeconomic trajectories implied by the transition scenario are compatible with sustainable public debt dynamics. If the simulated transition path leads to excessive levels of public debt, the corresponding scenario may be interpreted as internally inconsistent or economically unsustainable. In this sense, the debt sustainability analysis acts as an additional robustness check for the transition scenarios generated at the previous stages of the framework.

Finally, once the characteristics and duration of the transition period have been identified, the analysis returns to the first analytical level in order to evaluate the long-run growth prospects of the Belarusian economy. At this stage the analysis draws on the empirical literature on income convergence following the framework developed by Barro and Sala-i-Martin (1992) and further elaborated in Sala-i-Martin (1996). At this stage the analysis focuses on the potential convergence of Belarus toward higher income levels observed in the European Union. The primary analytical tool used for this purpose is the World Bank Long-Term Growth Model (LTGM) developed by Loayza and Pennings (2022). This Solow-style growth model allows the simulation of long-term economic growth based on assumptions about key supply-side determinants such as capital accumulation, labour force dynamics, human capital formation, and technological progress. The model also incorporates a number of macroeconomic constraints that may influence long-term growth prospects, including the current account balance and the evolution of public debt.

In the inertial scenario (no EU integration), the LTGM simulations rely on default assumptions embedded in the model. These assumptions typically involve extrapolating recent historical trends for the relevant variables. For example, total factor productivity growth is often approximated by the average growth rate observed in the previous two decades. Investment dynamics are linked to medium-term projections from sources such as the IMF World Economic Outlook, while demographic variables are based on long-term population forecasts produced by the United Nations. Labour force participation is generally assumed to remain close to its current levels. Within this modelling framework the EU integration scenario for Belarus is represented by the introduction of a convergence premium to long-term economic growth. In practice this convergence premium is implemented primarily through an increase in the growth rate of total factor productivity, reflecting the expected effects of institutional improvements, technological diffusion, and deeper integration with European markets.

For the purposes of international comparison, the inertial LTGM projection for Belarus is evaluated alongside the corresponding projection for Poland, which serves as a benchmark economy in the analysis. Poland provides a useful reference point because it represents a successful example of economic convergence within the European Union. The EU integration scenarios therefore compare the projected growth trajectory of Belarus under the convergence assumptions with the inertial long-term trajectory observed in the Polish economy.

2.2. Computable General Equilibrium Model

A CGE model is a system of equations that describes an economy as a whole and the interactions between its parts. The standard CGE model explains all the payments recorded in the social accounting matrix (SAM) – a form of data input in the model. SAM is the square matrix that describes the circular flow of income and spending in a national economy during a specific time period, usually a year. It reports the values of all commodities that are produced and the income generated from their sales (Burfisher, 2021).

CGE models offer a consistent framework that links sectoral interactions, resource allocation, and household welfare in a general equilibrium setting. These models are particularly suited for simulating scenarios that involve large, economy-wide adjustments – such as trade liberalization, integration into new production chains, or energy price shocks. By considering both direct and indirect effects across industries and households, they allow the assessment of the full range of potential impacts, rather than focusing on isolated sectors.

The Belarusian case is a clear example where such modeling is crucial. Structural shocks, such as a sharp increase in energy prices or a reorientation of trade toward the EU, affect not only the directly exposed sectors but also the wider economy through changes in costs, relative prices, and resource allocation. A CGE framework is therefore indispensable for capturing these linkages and providing a comprehensive view of possible outcomes. Simulations based on the CGE model allow us to assess changes in the steady state of the Belarusian economy in the long term in the event of its integration with the EU.

The model for the Belarusian economy is based on the basic postulates of the CGE modeling. The baseline specification includes 17 production sectors, with the external sector represented by four counterparties – Russia, the EU, China, and the rest of the world. The introduced model uses 2019 Input–Output table data published by the Belarusian National Statistical Committee (Belstat) as input. The choice of this year is explained by the fact that it was the most recent with a complete set of available data and did not reflect significant external shocks.

The developed CGE model has been used to simulate several scenarios relevant to Belarus (BEROC, 2025). In this paper, we use the results of a CGE-based simulation of the scenario of Belarus's integration with the EU under conditions of an energy shock. This scenario assumes a threefold increase in the import price of natural gas, a 10% increase in the import price of oil and the elimination of interbudgetary transfers between Belarus and Russia. Also, it is assumed that import tariffs on goods from the EU to Belarus are reduced to zero, while for other countries they are set equal to the EU’s 2021 weighted average tariffs. At the same time, the scenario reflects the likely imposition of import tariffs by Russia on Belarus should Belarus reorient itself toward the EU. The simulation also accounts for possible EU financial support to Belarus, which could partially offset the negative consequences of an energy shock for Belarus. Overall, EU assistance of €870 million is incorporated into the simulation scenario.

2.3. Quarterly Projection Model

The Quarterly Projection Model (QPM) is a semi-structural macroeconomic gap model (Mæhle et al., 2021). QPM has a flexible structure that allows incorporating expert judgments, is relatively simple to maintain, and enables users to explain the story of what is happening in the economy in a clear and internally consistent way, to form forecast scenarios, and to develop recommendations for the application of certain measures of economic policy.

The key equations in QPM are presented in deviations (gaps) of macroeconomic variables from their equilibrium levels, where equilibrium is defined as a level of an economic indicator that does not exert upward or downward pressure on inflation (inflation level corresponds to inflation expectations).

In contrast to econometric models, semi-structural gap models have a more robust theoretical foundation, primarily based on microeconomic principles. Unlike full structural models (DSGE), semi-structural model parameters do not impose strict structural constraints, and microeconomic variables are approximated by macroeconomic indicators.

Some components of QPM are ad-hoc elements, which distinguish it from DSGE. QPM has a rudimentary supply block, where most trends (equilibrium components) of economic variables are represented as stochastic processes that guarantee convergence of indicators to an exogenously defined steady state in the medium term (Berg et al., 2006). Since QPMs are generally used by central banks to support monetary-policy decision-making, simplifying the supply block is justified: monetary policy does not have a direct effect on the long-term trends of real economic variables, but it is a crucial stabilization tool for the business cycle in the short and medium term.

The gap model for Belarus comprises eight blocks:

1. The aggregate demand block describes the dynamics of the output gap $(\hat{y}_t)$, which is the deviation of the real GDP (y_t) from its potential (equilibrium) level $(\bar{y}_t)$.

2. The fiscal policy and wage block determines the dynamics of consolidated budget expenditures in Belarus and wages.

3. The inflation block, which is represented by modified New Keynesian Phillips curves.

4. The external trade block determines the dynamics of Belarus's trade in goods and services.

5. The exchange rate block determines the dynamics of the effective exchange rate of the Belarusian ruble.

6. The reaction function of monetary policy, which is represented by a modified Taylor rule for flexible inflation targeting with incomplete control of the National bank for the interbank interest rate.

7. The block of interest rates on the credit and deposit market determines the behavior of interest rates on new time deposits and new market loans for organizations and the population in Belarusian rubles.

8. The external sector block describes the dynamics of output gap, inflation, money market interest rates, and exchange rates in Belarus's trading partner countries, as well as oil prices.

The model parameters were calibrated to account for stylized facts of the Belarusian economy, considering changes in its functioning after 2022, such as increased financial sector isolation, shifts in trade flows towards Russia, and changes in monetary and exchange rate policies (BEROC, 2023).

Since changes in the trend values of macroeconomic variables in the developed QPM have an extremely limited effect on the equilibrium state of the economy described by the model, within this framework it is reasonable to simulate only those shocks that can lead to economic imbalances in the short and medium term. Simulating such shocks will show the trajectory of deviations of GDP from its potential level (regardless of changes in the potential output itself), deviations of inflation from the National Bank's target, and will make it possible to determine the optimal monetary policy response of the National Bank to these shocks. Thus, using the QPM to study the economic consequences of Belarus–EU integration is appropriate for designing monetary policy measures aimed at restoring macroeconomic stability after the inevitable short-term disruptions associated with the severing of economic ties with Russia.

In line with the simulations conducted in the CGE model, the following shocks were incorporated into the QPM-based simulations:

1. A 200% increase in the import price of natural gas. This assumption was introduced through shocks to core and non-core inflation. The magnitudes of the shocks were calibrated at 6 p.p. for each inflation component, based on the facts that fuel expenses account for about 5% of the cost structure of Belarusian firms, and natural gas represents around 60% of domestic energy consumption.

2. A 10% increase in the import price of oil. This assumption was introduced through a shock to non-core inflation, which includes changes in fuel prices. The shock size was calibrated at a 1 p.p. increase in non-core inflation, given that fuel accounts for about 10% of the non-core consumer price index.

3. A reduction in general government budget expenditure of 1.4 p.p. of GDP. It is assumed that the loss of transfers from the Russian budget will lead to a 2 p.p. decline in government revenues and, accordingly, expenditures. At the same time, activation of the "frozen" EU assistance package could compensate for about 0.6 p.p. of GDP in lost revenues and expenditures.

The effect of tariff changes on inflation was not included in the QPM simulations, since the expected change in the average import tariff is small (a decline of approximately 0.4 p.p.) and can be offset by firms' profits.

2.4. Dynamic Stochastic General Equilibrium Model

2.4.1. Overview

The DSGE framework employed in this paper is built on the dynamic stochastic general equilibrium model developed for the Belarusian economy in BEROC (2020), but introduces a number of substantial revisions and extensions designed specifically for the analysis of structural regime change. That model was originally designed as a structural macroeconomic tool for analyzing macroeconomic fluctuations, policy transmission mechanisms, and external shocks in a small open economy with features characteristic of Belarus. For the purposes of the present study, however, the model has been substantially revised, recalibrated, and extended. The revisions were motivated both by structural changes in the Belarusian economy since the original model was developed and by the specific analytical objective of the present paper, which focuses on the macroeconomic dynamics associated with a potential regime shift linked to EU integration.

In its core structure, the model belongs to the class of New Keynesian DSGE models for a small open economy and incorporates the key mechanisms typically used to analyze macroeconomic adjustment in open economies with nominal rigidities. Production is organized through a standard two-tier structure in which wholesale firms produce intermediate goods using capital and labor, while retail firms operate under monopolistic competition and face nominal rigidities in price adjustment of the Calvo type. Wage formation is also subject to nominal rigidity, reflecting institutional characteristics of the Belarusian labor market. These features allow the model to generate realistic inflation dynamics and transmission of cost shocks into prices.

Households make intertemporal consumption and labour supply decisions, hold financial assets, and allocate their deposits between domestic-currency and foreign-currency instruments. Although financial dollarization is incorporated in the model through the structure of household deposits and interest rate premia, this mechanism plays a relatively limited role in the simulations performed in this paper. Capital accumulation follows the standard law of motion with investment adjustment costs, which generate gradual responses of investment and capital to macroeconomic shocks. The external sector is represented through export demand, import demand, terms-of-trade dynamics, and an uncovered interest parity condition augmented by a country risk premium related to external debt exposure. Monetary policy is described by a rule-based reaction function in which the policy interest rate responds primarily to deviations of inflation from its target.

An important feature of the model is its ability to capture structural characteristics that are specific to the Belarusian economy. The baseline specification therefore incorporates several institutional and macroeconomic mechanisms that distinguish Belarus from a typical small open market economy. In particular, the model reflects the relatively high degree of wage rigidity and administrative influence in the labor market, which is partly associated with the large role of state-owned enterprises and coordinated wage setting practices. These features are captured through parameters governing wage adjustment and the degree of nominal rigidity in the labor market. The model also accounts for specific characteristics of the Belarusian financial system, including the coexistence of domestic- and foreign-currency financial instruments and the presence of a risk premium associated with external borrowing conditions. In addition, the specification incorporates the sensitivity of the economy to external shocks transmitted through trade flows, foreign demand, and changes in international financial conditions, which historically have played a significant role in Belarusian macroeconomic fluctuations. Furthermore, an important structural feature incorporated in the model relates to the historically important role of preferential access to energy resources provided within the framework of economic relations with Russia.

For the purposes of the present paper the model has been substantially recalibrated and extended. First, the parameterization has been updated so that the steady state of the model reproduces the current macroeconomic proportions of the Belarusian economy. In particular, key ratios such as the shares of consumption, investment, government spending, and trade in GDP are aligned with contemporary macroeconomic data. The recalibration ensures that the initial steady state used in the simulations corresponds to the current structural configuration of the Belarusian economy.

Second, the mechanism linking energy prices and productivity has been refined. While the baseline model already allowed energy price advantages to affect total factor productivity, the revised specification introduces a more explicit representation of the transmission channel through which energy prices influence economic performance. This mechanism is represented as a productivity wedge affecting total factor productivity, allowing preferential energy pricing to operate as a structural determinant of the equilibrium level of output. Lower effective prices of energy inputs increase the efficiency of production and therefore raise the level of output that can be sustained in equilibrium (see Equation 1).

$$lnA_t = ln\left(\overline{A}_t\right) + (\vartheta_e + \vartheta_{adapt})*\left(ln\left(P_{e,t}\right) - ln\left(\overline{P}_{e,t}\right)\right) \tag{1}$$

where A_t – is actual TFP, $\overline{A}_t$ – TFP frontier mainly associated with technology level and modelled as AR(1) stochastic process, $P_{e,t}$ - actual energy price, $\overline{P}_{e,t}$ - expected market price without special conditions, ϑ_e - parameter responsible for transmitting preferences in energy price into productivity gains, for initial steady state ϑ_e =-0.05, ϑ_{adapt} – the parameter responsible for weakening the specific productivity gains accumulation once the EU integration started, ϑ_{adapt} =0 for initial steady state, gradually tends to ϑ_{adapt} =-0.01 since the start of the EU integration.

This specification allows the model to reproduce one of the key structural advantages that has historically influenced the Belarusian economic equilibrium. Lower energy prices can be interpreted not only as a direct cost advantage but also as a structural productivity bonus that increases the efficiency of production across sectors. ϑ_e =-0.05, implies that a 1% lower energy price increases effective productivity by about 0.05%. Consequently, the approximately 60% energy price preference embedded in the initial steady state corresponds to a productivity bonus of about 2.3%. In the EU integration scenario considered in this paper, this energy subsidy is removed, implying that the associated productivity advantage disappears following the energy price shock.

Third, the updated model introduces a direct link between energy prices and firms' marginal costs. Energy price increases therefore affect the production cost structure of the economy and propagate through the price-setting mechanism of firms. This channel allows energy price shocks to generate cost-push inflation dynamics that are consistent with the macroeconomic structure of an energy-intensive economy. Fourth, the inflation block of the model has been extended in order to incorporate an explicit energy component in consumer price dynamics. Energy prices influence consumer price inflation both directly, through the energy component of the consumption basket, and indirectly through their impact on marginal costs and production prices. This modification allows the model to capture the transmission of energy price shocks into broader inflation dynamics more realistically. Finally, the model now includes a separate component of energy imports. This extension makes it possible to track the effects of energy price changes on the real volume of energy imports as well as on the broader structure of external trade. In the context of the transition scenarios analyzed in this paper, this feature is particularly important because changes in energy pricing represent one of the key structural shocks associated with the transition toward EU-compatible economic relations.

Taken together, these revisions transform the original DSGE framework into an analytical tool specifically designed to study the macroeconomic consequences of structural regime change and the adjustment dynamics associated with the transition toward a new steady state configuration. While preserving the core logic of the original model, the updated specification provides a more detailed representation of the energy channel and aligns the steady-state structure of the model with the current characteristics of the Belarusian economy. As a result, the model provides a suitable analytical environment for studying the macroeconomic adjustment dynamics associated with the transition from the current economic regime toward a potential post-integration steady state.

2.4.2. Perfect Foresight Solution

DSGE models are typically used to analyze the dynamic responses of macroeconomic systems to structural shocks and policy changes. While stochastic simulations are appropriate for studying fluctuations around a stationary equilibrium, many policy questions, like ours in this paper, involve structural changes that permanently alter the economic environment. In such cases, the relevant analytical framework is a PF transition experiment, in which economic agents are assumed to fully anticipate the new economic regime and adjust their decisions accordingly.

Perfect foresight simulation is different in nature from studying the shocks given the initial steady state. Alternatively, it computes the entire transition path between two steady states of the model. Instead of focusing on local impulse responses around a fixed equilibrium, the PF approach explicitly characterizes the dynamic adjustment of the economy when a structural change permanently shifts the equilibrium configuration. This methodology is particularly suitable for the analysis of large structural transformations, such as institutional reforms, trade regime changes, or energy market liberalization.

A PF experiment computes the sequence of endogenous variables for periods (0, T) (where T – is the PF horizon) subject to three boundary conditions:

1. **Initial condition.** The economy starts from the initial steady state (SS0) that represents the pre-reform economic environment with subsidized energy prices.

2. **Structural change.** The reform is introduced in the 1st period by modifying the parameter governing the effective price of energy. This permanently alters the equilibrium conditions of the model and defines a new steady state (SS1), which is the post-integration steady state in the terminology of our study.

3. **Terminal condition.** The transition path must converge to SS1 in the final period (T) of the PF horizon.

The PF solver therefore computes the sequence for periods (0, T) such that the equilibrium conditions of the model hold in every period, while the terminal state coincides with the new steady state. Numerically, the PF problem is solved as a large nonlinear system of equations using Newton-type algorithms implemented in Dynare's perfect foresight routines. Because agents anticipate the full transition path, forward-looking variables such as consumption, investment and asset prices adjust immediately once the reform is announced.

In our case, the main structural change and simultaneously terminal condition for the new steady state is associated with the energy shock stemming from the elimination of the Russia-related energy price subsidy. Historically, Belarus has benefited from preferential energy pricing arrangements, particularly with respect to imported hydrocarbons. This forms part of the initial steady state of the model through the introduction of a permanent wedge into the dynamics of energy prices in the model, which are specified according to Equation 2.

$$ln\left(P_{e,t}\right) = (1-\rho_e)*ln\left(\overline{P}_{e,t}\right) + \rho_e*ln\left(P_{e,t-1}\right) + \omega_{e,t} + \sigma*\varepsilon_{e,t} \quad (2)$$

where $P_{e,t}$ – actual energy price, $\overline{P}_{e,t}$ – expected market price without special conditions, $\omega_{e,t}$ – permanent energy price wedge associated with the special conditions in relations with Russia, $\varepsilon_{e,t}$ – stochastic shock, ρ_e – parameter, σ – scaling parameter.

In the initial steady state permanent wedge is calibrated negatively:

$$\omega_{e,t} = (1-\rho_e)*ln(0.625) = -0.0893 \quad (3)$$

This implies that the nullification of the preferential conditions results in a 60% increase in the energy price. The elimination of these subsidies represents a permanent change in the relative price of energy faced by domestic producers.

As shown above, this energy shock is going to spread through the economy through different channels, the main of which are: (i) productivity, (ii) marginal cost, (iii) direct impact on prices. The PF approach is therefore well suited to answering the central research question of the paper: how the economy reallocates resources and capital when the energy pricing regime changes permanently.

The PF experiment proceeds in several steps. First, the model is calibrated and solved for the initial steady state representing the pre-reform economic environment. This equilibrium corresponds to an economy operating under subsidized energy prices. Second, the structural reform is introduced (mainly through modifying the parameter governing the effective price of energy). Third, the perfect foresight solver is used to compute the deterministic transition path from the initial steady state to the new equilibrium implied by the reform. Agents in the model are assumed to perfectly anticipate the future path of the economy and therefore adjust consumption, investment, and production decisions immediately after the policy change. Formally, the PF solution computes the sequence of endogenous variables that simultaneously satisfies the model's equilibrium conditions in every period while converging to the new steady state in the terminal period of the simulation horizon.

A key technical issue in PF simulations concerns the choice of the transition horizon. Because the terminal condition requires the economy to reach the new steady state in the final period of the simulation, a horizon that is too short may artificially accelerate the adjustment process. Conversely, an excessively long horizon increases computational costs without materially affecting economically relevant dynamics. In the present study the horizon length is determined using a combination of numerical and graphical diagnostics. Multiple PF simulations are performed using horizons ranging from 60 to 200 quarters. The trajectories of core macroeconomic variables then are compared across simulations. The comparison shows that for horizons shorter than approximately 100 quarters the adjustment of capital is artificially accelerated in order to satisfy the terminal condition. However, for horizons of 120 quarters and above the trajectories of the main macroeconomic variables become nearly identical during the economically relevant portion of the transition. This behavior reflects a standard property of DSGE models with physical capital: because capital depreciates slowly, the final approach to the new steady state can take a very long time. Increasing the PF horizon therefore mainly affects the far tail of the transition rather than the economically meaningful short- and medium-run dynamics. On the basis of these diagnostics, a horizon of 200 quarters was adopted in the baseline simulations. This value ensures numerical convergence of the PF solution while leaving the economically relevant transition dynamics unaffected.

To ensure the numerical validity of the PF results, several diagnostic checks are conducted. First, the convergence of the simulation is verified by examining whether endogenous variables become approximately constant in the final periods of the horizon. This check confirms that the simulated trajectory approaches the terminal steady state. Second, the residuals of the model's equilibrium equations were evaluated using the final simulated values of the endogenous variables. Residuals close to zero confirm that the terminal point of the simulation satisfies the model's equilibrium conditions. Third, robustness tests were performed by comparing PF trajectories across alternative horizons. Particular attention is paid to the behavior of capital, which typically exhibits the slowest convergence in DSGE models. If the capital trajectories coincide during the early periods of the simulation, the PF horizon can be considered sufficiently long.

Finally, several graphical diagnostics are used to analyze the mechanisms driving capital adjustment, including decompositions of investment and depreciation flows, and channels that drive investments. Together, these checks confirm that the PF simulations used in this study provide a numerically stable and economically meaningful representation of the transition dynamics following the removal of energy subsidies.

2.5. Debt Sustainability Analysis

Public debt can be regarded as sustainable when the primary balance needed to at least stabilize debt under both the baseline and realistic shock scenarios is economically and politically feasible, such that the level of debt is consistent with an acceptably low rollover risk and with preserving potential growth at a satisfactory level (IMF, 2013).

To project the public debt dynamics during the transition period the "automatic" debt dynamics equation was used (Acosta-Ormaechea & Martinez, 2021):

$$d_t = \varphi_t d_{t-1} - pb_t \qquad (4)$$

where d_t – is public debt (relative to GDP); pb_t – is the primary fiscal balance (relative to GDP).

The coefficient for automatic debt dynamics, $\varphi_t = \dfrac{1 + r_t}{1 + g_t}$ measures how the previous-period debt ratio affects the current-period ratio, where g_t is the real GDP growth rate, $r_t$is the (gross) real cost of debt that includes exchange rate valuation effects. Information on the currency composition of Belarus's public debt has not been published since 2022. Prior to this period, public debt was almost entirely denominated in foreign currencies, with the US dollar dominating. Due to the impact of sanctions on Belarus and Russia, the debt structure could have shifted in 2022-2025, with a significant increase in the share of the Russian ruble, but the public debt itself would likely remain overwhelmingly denominated in foreign currencies. For this reason, further calculations assume that Belarus's public debt is in foreign currency.

The baseline transition scenario should be consistent with the macroeconomic framework used to construct the Belarus-EU integration scenario. The results of CGE and QPM were used to construct the baseline transition path. In the stress transition scenario the results of CGE and DSGE simulations were incorporated. We do this not fully straightforwardly, but with the inclusion of expert assessments of the results of the corresponding model simulations. The assumption is also made for a significant increase in the cost of debt for Belarus amid a deeper economic downturn. The primary budget balance has been recalculated in line with the change in GDP growth compared to the baseline transition scenario.

2.6. Long-run Convergence and Long-Term Growth Model

2.6.1. The concept of long-run convergence and its application for the study

The concept of beta-convergence originates from the neoclassical growth framework and was formalized empirically by Barro and Sala-i-Martin (1992). The central idea is that economies with lower initial levels of income tend to grow faster than richer ones, conditional on structural characteristics. This mechanism reflects diminishing returns to capital and technological diffusion, which together generate a tendency for poorer economies to catch up with richer ones over time. In empirical work, beta-convergence is typically tested by regressing the average growth rate of income on the initial level of income (see Equation 5).

$$\frac{1}{T} ln\left(\frac{y_{t+T}}{y_t}\right) = \alpha - \beta * ln\left(y_t\right) + \gamma' * X_{i,t} + \varepsilon_t \tag{5}$$

where y_t - is the level of income (typically GDP per capita) at time t, T – is the time horizon over which growth is measured, $X_{i,t}$ – the vector of conditioning variables, α – is a constant, β – the speed of convergence, ε_t – error term.

The vector X_i includes structural and institutional characteristics that influence the long-run equilibrium level of income. Typical examples include investment rates, education, institutional quality, macroeconomic stability indicators, and openness to trade. Including these variables allows the regression to capture conditional convergence rather than absolute convergence. Hence, β is interpreted as the speed of conditional convergence, of just β-convergence. A useful interpretation is that beta represents the proportion of the income gap closed each period due to convergence forces, i.e. in addition to those associated with structural variables X_t. For example, if beta equals 0.02, approximately 2 percent of the gap between current income and the steady state level is eliminated each year.

In the context of policy-oriented macroeconomic analysis, β-convergence can also be interpreted as a mechanism describing how quickly an economy approaches its long-run steady state. This interpretation makes the framework particularly useful when analyzing structural transformations such as economic integration, institutional reforms, or large shifts in external economic conditions.

The standard beta-convergence regression can be reinterpreted in terms of the distance between the current level of income and the steady state level y^*, for which the expected growth rate is zero. Solving the Equation (5) for the level $ln\left(y^*\right)$ gives:

$$ln\left(y^*\right) = \frac{\alpha + \gamma' * X_{i,t}}{\beta} \tag{6}$$

Substituting the steady state expression into the original regression yields an alternative representation of the growth process.

$$g_t = \beta * \left(ln\left(y^*\right) - ln\left(y_t\right) \right) \tag{7}$$

where g_t - is the average GDP growth rate.

For long-run macroeconomic projections, it is often useful to respecify the logic of 'only convergence' to the logic 'frontier/baseline growth plus convergence markup'. So, 'only convergence' in this case is decomposed to two drivers. The first, baseline growth reflects frontier technological progress and structural trends that affect all economies. These may include frontier productivity improvements, demographic developments, and long-term technological diffusion. The second, still denotes convergence, but in a sense of 'pure convergence', i.e. in addition to growth due to structural factors. In this case, Equation (7) is re-specified to:

$$g_t = g_{baselne} + \beta * \left(ln\left(y^*\right) - ln\left(y_t\right) \right) \tag{8}$$

where $g_{baselne}$ - is the growth rate due to structural factors.

As shown in the Sections 2.1 and 2.4, the start of the EU integration for Belarus might lead to a transitional recession. Taking it into account, we adjust the Equation (8) with a term denoting the contribution of the transitional recession. This term is expected to be negative during the period of the transitional recession, and zero afterwards. Finally, Equation (9), which allows combining exogenous assumptions about frontier productivity trends with endogenous catch-up dynamics, and contribution of the transitional recession is used for long-run projections:

$$g_t = g_{baseline} + g_{tr\_r} + \beta * \left(ln\left(y^*\right) - ln\left(y_t\right) \right) \tag{9}$$

where g_{tr_r} - is the drop rate due to the transitional recession.

Empirical literature on economic convergence typically finds a β-convergence speed of about 2% per year. The classical works of Barro and Sala-i-Martin show a robust negative relationship between initial income levels and subsequent growth and estimate convergence speeds of roughly 1.5–2% annually in cross-country and regional data (Barro & Sala-i-Martin, 1992; Sala-i-Martin, 1996). This result has become the standard benchmark used to calibrate the β parameter in long-run growth models. For applied studies, the β parameter can also be estimated using cross-country or panel data. Because the available time series for a single country are often too short to produce reliable estimates, panel estimates across many countries provide a more robust empirical benchmark. For transition economies and countries undergoing structural transformation, it is common to calibrate β using empirical estimates obtained from comparable countries that previously experienced similar convergence processes.

The studies focusing on the EU suggest that institutional and economic integration with the EU may accelerate the catch-up process. Empirical estimates of EU membership effects show significant positive deviations of observed income trajectories from counterfactual scenarios. For example, Campos, Coricelli and Moretti (2019) find that on average GDP per capita was about 10% higher ten years after accession compared with a synthetic counterfactual without EU membership. Similar conclusions regarding the positive impact of institutional integration on growth and productivity are reported in subsequent work (Campos, Coricelli & Franceschi, 2022) and in reviews of the economic consequences of EU enlargement and integration into the Single Market (Pasimeni, 2024). In addition, research on convergence within the EU emphasizes that the speed of convergence can vary substantially depending on macroeconomic conditions, institutional quality, and the depth of economic integration (Coutinho & Turrini, 2019).

Taken together, this gives us the background to consider β for the Belarusian case within the 0.02 to 0.03 interval. The value of 0.02 might be considered as the lower bound peculiar to more conservative assumptions, the value of 0.03 might be associated with no-headwinds convergence process.

2.6.2. LTGM

To analyze long-run growth dynamics and convergence prospects, we employ the World Bank Long-Term Growth Model (Loayza & Pennings, 2022). This is a transparent spreadsheet-based framework relying on the standard Solow–Swan growth model. The LTGM is designed for long-horizon scenario analysis and has been widely used in country growth diagnostics and policy studies. The model links long-run output dynamics to investment behavior, productivity growth, human capital accumulation, and demographic trends.

The analytical structure of the LTGM is built around three fundamental blocks: the production side, capital accumulation, and demographic-labor dynamics. The production side of the model is represented by a Cobb–Douglas production function in which output depends on total factor productivity (TFP), physical capital, effective labor, and human capital. Effective labor is defined as the product of the number of workers and the level of human capital per worker. This specification implies that long-run growth may arise from improvements in productivity, increases in the capital stock, demographic expansion, or human capital accumulation. The second block of the model describes capital accumulation. The evolution of the capital stock follows the standard law of motion. Consequently, the investment-to-GDP ratio plays a central role in determining the long-run growth trajectory of the economy. The third block of the LTGM captures demographic and labor market dynamics. GDP per capita growth is decomposed into several components reflecting population growth, the working-age population share, and labor force participation rates. In this framework, the number of workers depends on the size of the working-age population and the labor force participation rate. As a result, demographic transitions, such as population aging or changes in labor participation, can significantly affect long-run economic growth. In addition to these core blocks, the LTGM also incorporates an external financing constraint linking investment to savings and the current account balance. Investment may be financed through domestic savings or external sources such as foreign direct investment and external borrowing. This feature allows the model to examine whether projected investment paths are compatible with sustainable external balances.

The model requires a relatively small number of structural parameters, including the labor share of income, the depreciation rate of capital, and the initial capital-to-output ratio. These parameters are typically calibrated using international datasets, first of the Penn World Tables (for majority of countries). Furthermore, several key variables must be specified through forward-looking assumptions. These include the growth rate of total factor productivity, the rate of human capital accumulation, demographic trends, and labor force participation rates. The default projections embedded into the baseline version of the LTGM typically base main demographic variables on the UN population projections to 2100, while other core variables are extrapolated based on either current values (e.g. labor participation ratios), or on actual averages from past 10 to 20 years. For instance, the baseline growth rate of human capital is the extrapolation of the actual 10-year average growth in a country, while TFP growth rate is the one of the actual 20-year average growth rate (with Penn World Tables as the data source).

2.6.3. Long-run projections combined with transitional dynamics

The long-run simulations implemented within the LTGM framework are designed to visualize the potential long-term economic implications of Belarusian EU integration. While the macroeconomic models discussed in previous sections focus on the transitional adjustment period, the LTGM provides a complementary perspective by tracing the long-run trajectory of the economy once transitional shocks have been absorbed. In particular, the LTGM simulations allow the evaluation of long-run income dynamics, the potential scale of convergence toward more advanced European economies, and the comparison of alternative long-term development paths under different integration scenarios.

The natural benchmark for evaluating these trajectories is the inertial scenario. In the context of this study, the inertial scenario corresponds to the default baseline configuration of the LTGM model. This configuration combines the extrapolation of historical trends for several key variables with externally provided demographic projections. In particular, long-term assumptions for total factor productivity growth, human capital accumulation, and the investment share of GDP are constructed through extrapolation of historical trends observed in recent decades. Demographic dynamics are based on the long-term baseline projections of the United Nations population forecasts. This configuration therefore represents a continuation of the existing structural and institutional trajectory of the Belarusian economy in the absence of major structural shifts. The resulting LTGM baseline can thus be interpreted as a policy-neutral or inertial development path.

While the inertial trajectory provides an internal benchmark for the Belarusian economy, the analysis also requires an external reference point. The purpose of this external benchmark is to illustrate the distance between Belarus and a plausible regional convergence frontier. For reasons of transparency and empirical relevance, Poland is chosen as this benchmark economy. In the LTGM simulations the Polish economy is represented by its own inertial baseline scenario extending to the end of the simulation horizon. The assumptions underlying Belarusian and Polish LTGM inertial scenario are summarized in Table 1.

Table 1. Inertial Scenario: the assumptions for LTGM simulations and its results

Indicator	Belarus	Poland
Labor share, %	57	54.8
Depreciation rate, %	4.4	5.3
Investment to GDP ratio, %	28	18
Population growth rate, %	-1.0	-0.9
Labor participation rate, %	79.2	74.6
Human capital growth rate, %	0.8	0.5
TFP growth rate, %	0.1	0.7
Outcome: average annual GDP growth rate, 2026-2100	0.2	0.9
Outcome: average annual per capita GDP growth rate, 2026-2100	1.2	1.9

Source: LTGM, version 5-72, November, 2025 (World Bank, 2025).

The choice of Poland as a reference economy is motivated by several considerations. First, Poland represents one of the most relevant comparators for Belarus in terms of geographical proximity and historical development patterns. Second, the two economies share several structural characteristics, including relatively similar human capital profiles and comparable levels of labor force participation. Third, in a scenario of Belarusian EU integration Poland is likely to function as an important regional economic anchor. Through mechanisms such as trade integration, foreign direct investment, technological diffusion, and the development of cross-border value chains, the Polish economy may serve as a practical convergence frontier for Belarus in the medium and long run. Within this framework the central indicator of convergence used in the analysis is the relative income level (GDP per capita, PPP approach, constant 2021 int.$) of Belarus compared with Poland. In the inertial scenario this ratio reflects the evolution of relative income under the default LTGM assumptions for both economies. It therefore provides a transparent benchmark against which alternative EU integration scenarios can be evaluated.

The EU integration pathway is analyzed using a scenario-based approach. Because the economic consequences of integration depend on a variety of uncertain factors, including the magnitude of transitional adjustment costs and the strength of long-run convergence mechanisms, it is not appropriate to rely on a single deterministic projection. Instead, the analysis considers a set of alternative scenarios representing different combinations of transitional dynamics and long-run growth mechanisms. Each scenario is evaluated relative to the inertial trajectory of Belarus and compared with the corresponding Polish inertial projection. The design of these scenarios reflects three key dimensions of economic adjustment. The first is the depth and duration of the transitional recession. Estimates of the transitional shock are summarized from the macroeconomic simulations in QPM and DSGE modelling frameworks. The second dimension is the speed of convergence (β), which varies in terms of how quickly it begins to affect the economy and its long-term level. The third dimension reflects the possibility that EU integration may directly influence the long-run rate of productivity growth (e.g. through improvements in institutional quality, increased competition, technological diffusion, and stronger integration into European value chains).

Based on these three dimensions, three EU integration scenarios are considered. The first scenario, 'EU integration: Stress' represents a stress case and is characterized by the most challenging transition environment. In this scenario the Belarusian economy experiences a relatively deep and prolonged transitional recession, the convergence mechanism activates only gradually, and the speed of convergence is assumed to be slow (β=0.02). Moreover, no direct positive effect of EU integration on the long-run growth rate of total factor productivity is assumed. Under these conditions convergence toward the frontier occurs solely through the gradual closing of the income gap. The second scenario, labelled the 'EU integration: Convergence only' scenario, represents a moderately conservative integration path. In this case the transitional recession is less severe and shorter than in the stress scenario. Convergence dynamics begin earlier and its speed is somewhat higher than in the stress-scenario, but still pretty modest (β=0.025). Furthermore, similarly to the stress scenario, no additional direct productivity acceleration is assumed. Long-run growth improvements therefore arise exclusively through the convergence mechanism. The third scenario, 'EU integration: Baseline' represents an EU integration scenario, without facing extra-obstacles. In this case the transitional recession remains moderate (the same as in the 'Convergence only' scenario), while convergence dynamics activate relatively quickly after the transition phase and the speed of convergence lies at the upper boundary of the empirically plausible range (β=0.03)[1]. However, the latter – given that we use Poland as the regional frontier for Belarus rather than the global technological frontier – should still be interpreted as remaining within conservative limits. In addition, the scenario assumes that EU integration generates a direct improvement in productivity growth. Specifically, the long-run growth rate of total factor productivity is assumed to converge toward the level currently observed in Poland, which is approximately 0.7% per year. Given the significant structural distortions historically present in the Belarusian economy, such an increase in productivity growth can be interpreted as a moderate assumption. The Belarusian economy has got huge accumulated distortions, which restrict the growth of productivity in Belarus (Kruk, 2020) from today's perspective. But for the future, it means that potential productivity gains associated with institutional reform and deeper market integration are quite high. The narrative characteristics of the scenarios are reported in Table 2.

Table 2. The characteristics of the scenarios for long-term projections

Scenario\Indicator	Transition Drop	Convergence Speed	TFP Growth Markup
EU integration: Stress	Deep	Slow	None
EU integration: Convergence only	Moderate	Modest	None
EU Integration: Baseline	Moderate	Moderate	Positive

Source: Own elaboration.

[1] We report a full list of the numerical values of the assumptions in Section 3.

Importantly, the scenario design intentionally avoids overly optimistic assumptions. The scenario set consists of one baseline integration scenario and two downside scenarios rather than including any explicit upside case. This conservative approach ensures that the analysis does not exaggerate the potential benefits of EU integration and instead focuses on trajectories that remain plausible even in the presence of substantial adjustment challenges.

Together, these scenarios provide a structured framework for evaluating the long-run implications of Belarusian EU integration. By combining long-run LTGM projections with transitional dynamics derived from macroeconomic models, the analysis makes it possible to assess how different adjustment paths may translate into long-term convergence outcomes relative to the regional frontier represented by the Polish economy.

3. Results

3.1. Computable General Equilibrium Model

The liberalization of trade in goods with the EU, combined with a significant increase in oil and gas import prices for Belarus will lead to significant sectoral changes (see Figure 2).

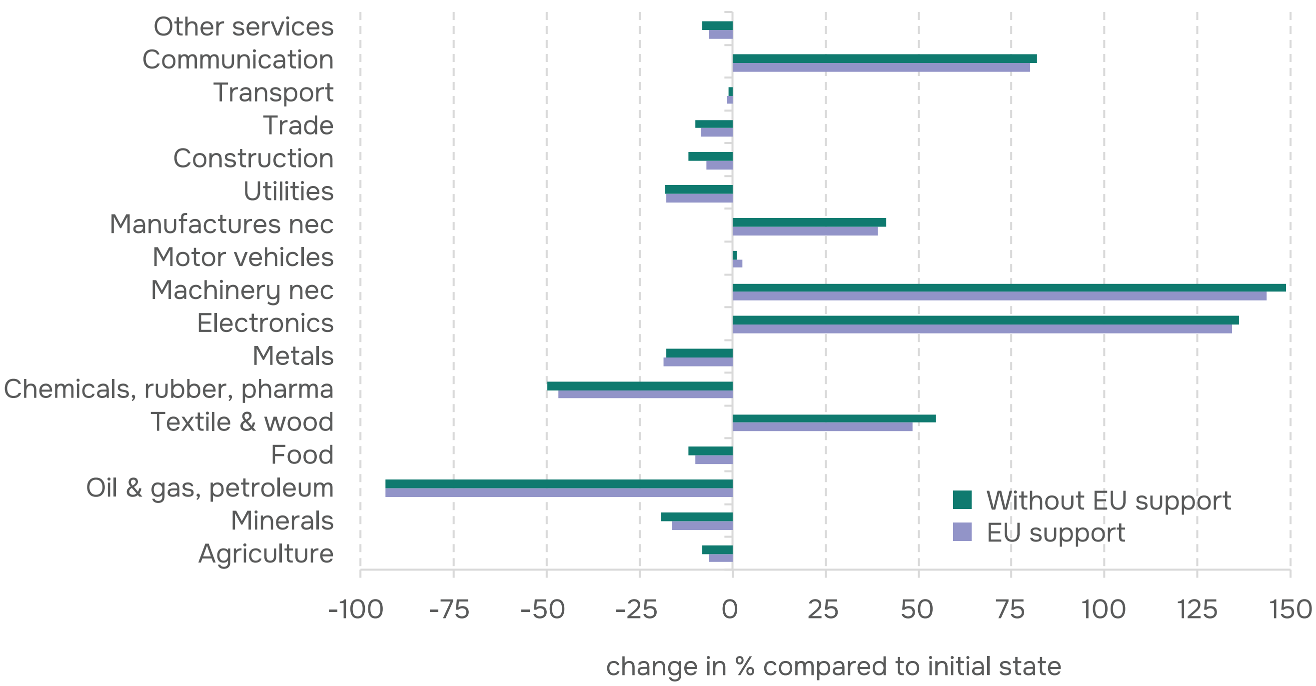

Figure 2. Sectoral value added: results of CGE-based simulation

Source: Own elaboration.

Domestic production and exports of petroleum products practically cease, while the country's demand for energy resources is met entirely through imports. The outsiders are the industries engaged in primary processing of raw materials, for which fuel resources are highly significant: the chemical industry, the production of plastic and rubber products, metallurgy, the extraction of non-oil-and-gas minerals, and the production of other non-metallic products. Output also declines in the electricity and water supply sectors, as well as in construction and trade. Agriculture and the food industry are also suffering losses in output, value added and exports due to their dependence on the Russian market. These sectors would probably face difficulties adjusting to EU competition and new trade barriers with Russia.

Labor and capital resources from the predominantly low- or medium-technology industries mentioned above flow into sectors with higher value added and export potential. Output, exports, and value added increase in the sectors of mechanical engineering, other manufacturing, light industry, woodworking, and information and communications. These findings reflect higher capacity of more sophisticated sectors to integrate into European markets and adapt to new competitive conditions.

The macroeconomic effects of Belarus's trade liberalization with the EU and its complication with Russia under energy shock conditions will be reflected in declining government and household incomes, which will lead to reduced public and private consumption as well as investment. As a result, GDP will contract by 3.9% in the long run. EU financial support of €870 million makes it possible to reduce GDP losses by about 1.2 p.p. by mitigating the decline in consumption and investment (see Figure 3).

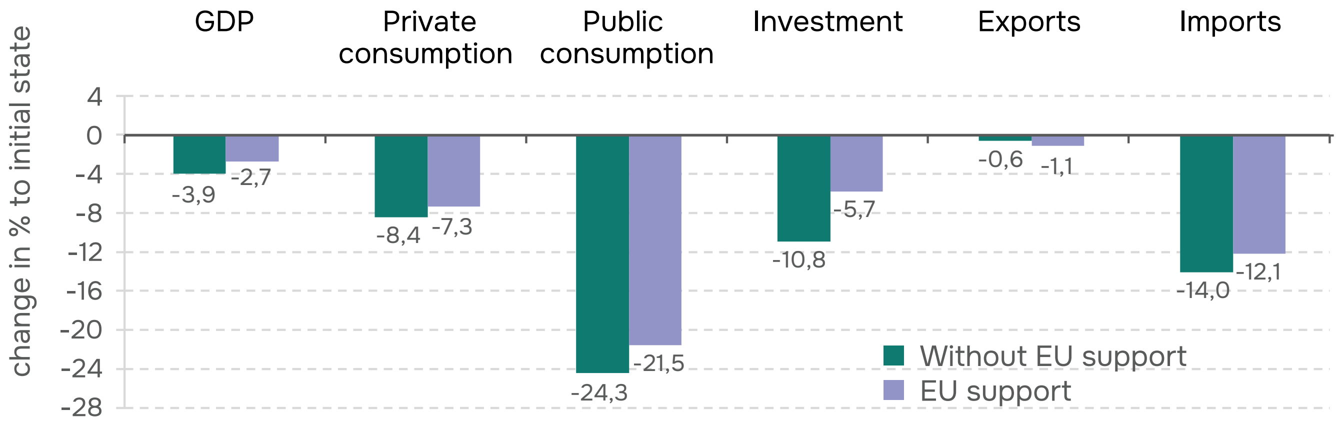

Figure 3. Macroeconomic effects: CGE-based simulation results

Source: Own elaboration.

3.2. Quarterly Projection Model

Figure 4 presents the results of the QPM-based simulation. The variables in Figure 4 are shown as deviations from their steady state levels. The sharp increase in import prices for energy resources generates a large inflationary shock. Due to the inertia of inflationary processes and rising inflation expectations, annual consumer price inflation may exceed the National Bank's target by about 14 p.p. one year after the shock.

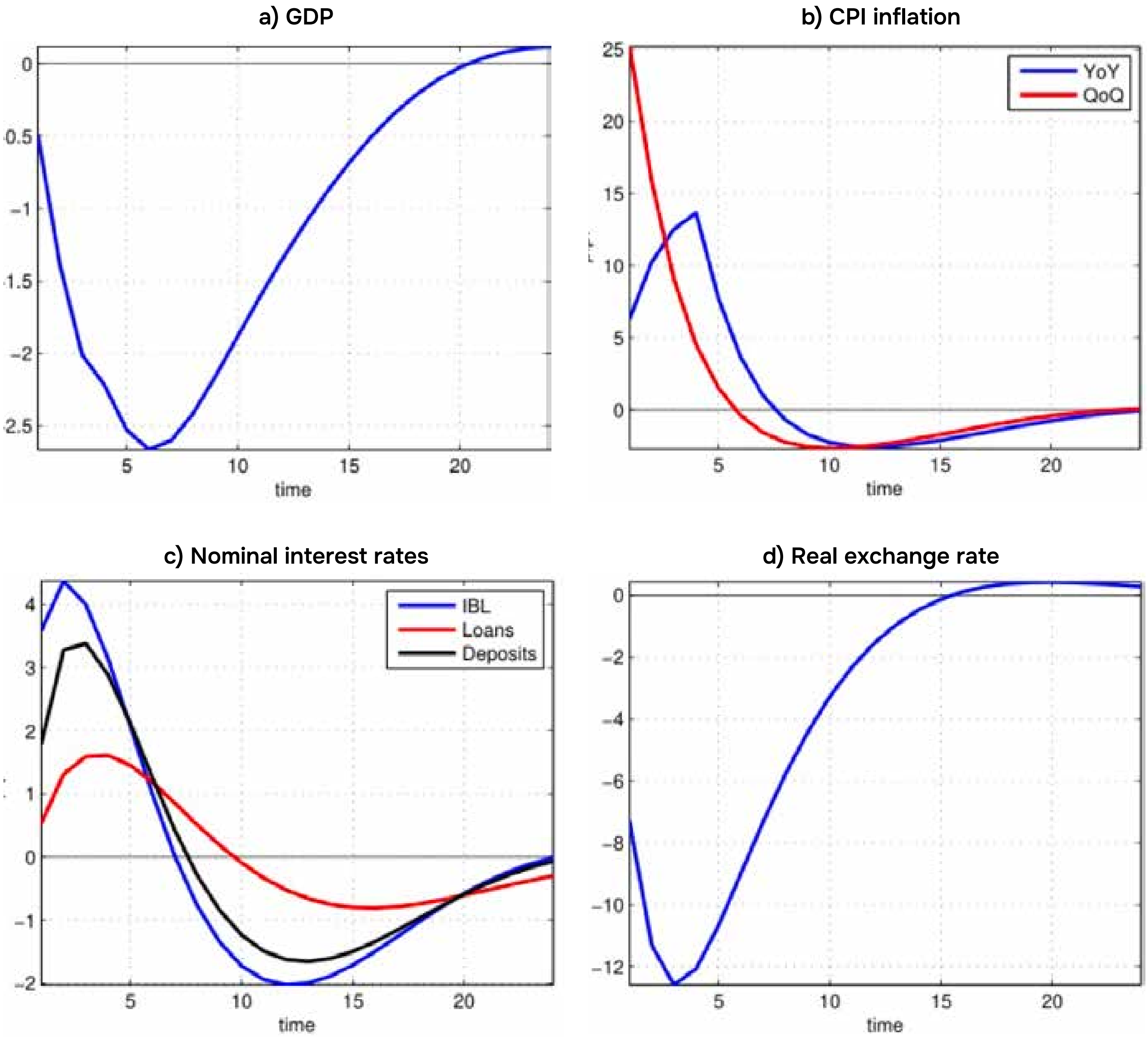

Figure 4. Macroeconomic effects: QPM-based simulation results

Source: Own elaboration.

Note: the figures show deviations of variables from their long-term sustainable levels (steady states). Time is measured in quarters.

The substantial increase in domestic prices leads to a significant appreciation of the Belarusian ruble in real terms – the real exchange rate falls well below its equilibrium level. Combined with the reduction in budget expenditure, the overvaluation of the national currency exerts a restraining effect on aggregate demand. As a result, GDP falls more than 2.5 p.p. below its potential level within two years of the shock. Such a magnitude of the negative output gap corresponds to a severe recession. Taking into account the likely losses of potential GDP – which the CGE model estimates at around 2.7–3.9% – the total decline in output may exceed 5–6% within two years after the shock.

In an environment combining a steep downturn in output and a powerful inflationary shock, the National Bank faces a dilemma: either tighten monetary policy substantially to counter inflation (but risk a collapse in the real sector and a financial crisis), or allow inflation to deviate significantly from the target in order to support economic agents' adjustment to the shock by maintaining a neutral or moderately accommodative monetary policy stance. The second option can be pursued only if supported by comprehensive communication by the National Bank, aimed at explaining such actions in order to prevent a sharp rise in long-term inflation expectations. In the QPM, it is assumed that the National Bank will respond not only to the inflation shock but also to the significant deviation of GDP from its potential level. As a result, the interbank market interest rate is expected to rise by more than 4 p.p. within two quarters of the shock. This will be reflected quickly in higher interest rates on ruble deposits, but more slowly and with greater inertia in lending rates. Since interest rates rise by less than inflation, their real levels decline and fall below neutral. This means that monetary policy provides support to economic agents during the adjustment process, though at the cost of higher inflation.

Roughly one year after the shock, inflationary pressures begin to ease due to weak aggregate demand and the overvaluation of the national currency. As a result, inflation returns to the target within two years of the shock and may subsequently fall slightly below target due to the prolonged process of restoring economic equilibrium. As price pressures weaken, the National Bank has an opportunity to lower nominal interest rates to prevent monetary policy from drifting into a restrictive stance. Consequently, a monetary policy stance close to neutral creates conditions for the gradual recovery of GDP toward its equilibrium level. However, given the scale of the simulated shock and the absence of any additional fiscal loosening in the simulations, the recovery process is expected to be prolonged and may take around five years.

3.3. Dynamic Stochastic General Equilibrium Model

3.3.1. Transition dynamics

Figure 5 reports the results of a DSGE-based PF simulation of the EU-integration scenario for Belarus.

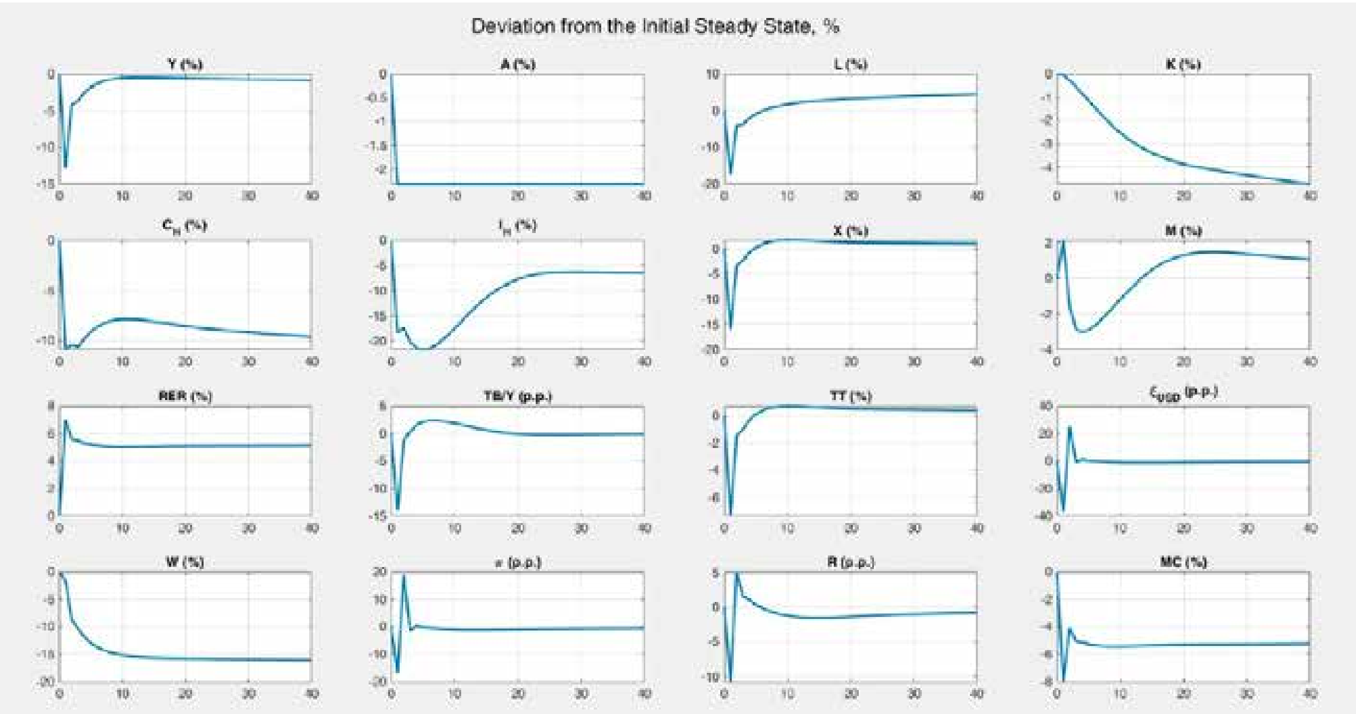

Figure 5. Macroeconomic effects: DSGE-based simulation results

Source: Own elaboration.

Note: Y – real GDP, A - TFP, L – labor employment, K – capital stock, C_H – household consumption, I_H – capital investments, X – exports, M – imports, RER – real exchange rate, TB/Y – trade balance, % of GDP, TT – trade conditions, ξ_{usd} – depreciation rate, % per annum, W – real wages, π – inflation rate, % per annum, R – nominal interest rate, % per annum, MC – marginal cost.

Note: the figures show deviations of variables from the initial steady state. Time is measured in quarters.

The perfect foresight simulation reveals a sharp but short-lived contraction in economic activity following the removal of the implicit energy subsidy. Output falls rapidly in the first quarters of the transition, reaching a trough of approximately 12.8% below the initial steady state at the onset of the shock. Despite the magnitude of this initial decline, the recovery is relatively fast. By around the 10th quarter, output returns close to its original steady-state level, remaining only about 0.5% below it. This pattern reflects a strong front-loaded adjustment of demand and prices combined with a gradual structural transition of the production side.

Among the demand components, investment exhibits the most pronounced cyclical response. The energy price shock leads to a reassessment of the expected profitability of capital, generating a sharp contraction in investment in the first periods of the transition. Over the medium term investment partially recovers, but does not return to its initial steady-state level. This reflects the fact that the reform implies a lower long-run equilibrium capital stock, causing the economy to gradually drift toward a new steady state characterized by reduced capital intensity.

Household consumption also declines substantially following the shock, falling by roughly 10% relative to the initial steady state before stabilizing at a level close to 9.5% below it. This adjustment is driven by a combination of intertemporal substitution in household consumption decisions and a decline in real wages. In order to preserve external competitiveness after the increase in production costs, firms reduce real wages, lowering marginal costs and contributing to the restoration of export competitiveness. The resulting decline in wages increases labor demand, leading to a gradual increase in employment over the transition.

External trade dynamics play an important stabilizing role during the adjustment process. Exports initially contract sharply – by roughly 15% – but recover rapidly and already exceed their initial steady-state level by about 1% after several quarters. This recovery is largely driven by the decline in marginal costs and the associated improvement in price competitiveness. Imports fall less strongly at the beginning of the transition due to the adverse price shock and deteriorating terms of trade, but subsequently recover and also rise to levels slightly above the initial steady state. As a result, the trade balance temporarily deteriorates, reaching a deficit of roughly 14% of GDP for about two quarters, but stabilizes quickly and eventually improves relative to the initial steady state.

The dynamics of nominal variables exhibit a somewhat counterintuitive pattern. Inflation initially declines sharply, temporarily even turns negative, before experiencing a significant rebound and gradually converging back to its steady-state level of around 5% annually. Similar dynamics are observed in the depreciation rate. These patterns are largely driven by the behavior of the stochastic discount factor, which increases sharply at the moment the shock becomes known. Under perfect foresight, households immediately internalize the future deterioration of economic conditions and increase the relative value of future consumption. This leads to a temporary contraction in current demand and downward pressure on inflation. Although such dynamics may appear unusual, they reflect a standard implication of perfect-foresight DSGE frameworks and illustrate how expectations and forward-looking behavior can become a major driver of macroeconomic adjustment.

3.3.2. Capital stock and mid-term adjustments

An important structural mechanism underlying the transition period and beyond is the gradual decline of the capital stock toward a lower steady-state level. The removal of implicit energy subsidies generates a substantial structural adjustment in the model economy. Because energy enters production as an intermediate input, the reform permanently changes the relative profitability of production technologies. This shift in the cost structure alters firms' investment incentives and ultimately leads to a lower equilibrium level of capital in the new steady state.

Investment decisions in the model are governed by firms' intertemporal optimality conditions. Firms choose investment taking into account expected returns on capital, financial conditions, and adjustment costs. Diagnostic calculations (see Figure 6) show that the Euler condition for capital accumulation is satisfied along the simulated transition path after the initial adjustment periods (because of the sharp swing in the stochastic discount factor). The difference between the marginal return on capital and the required return implied by financial conditions remains close to zero, indicating that the simulated transition path is consistent with optimal intertemporal investment behavior. A key indicator summarizing investment incentives in the model is Tobin's Q, which measures the value of installed capital relative to its replacement cost. Immediately after the energy price reform, Tobin's Q declines below unity, reflecting the deterioration in the expected profitability of new capital formation following the increase in production costs.

The decline in Tobin's Q provides a direct explanation for the sharp reduction in investment observed in the early stages of the transition. As firms perceive lower returns to additional capital, they optimally scale back investment expenditures. Over time, however, the gradual reduction in the capital stock partially restores investment incentives. As capital becomes relatively scarcer within the production structure, Tobin's Q stabilizes and investment slowly converges toward the level consistent with the new steady state.

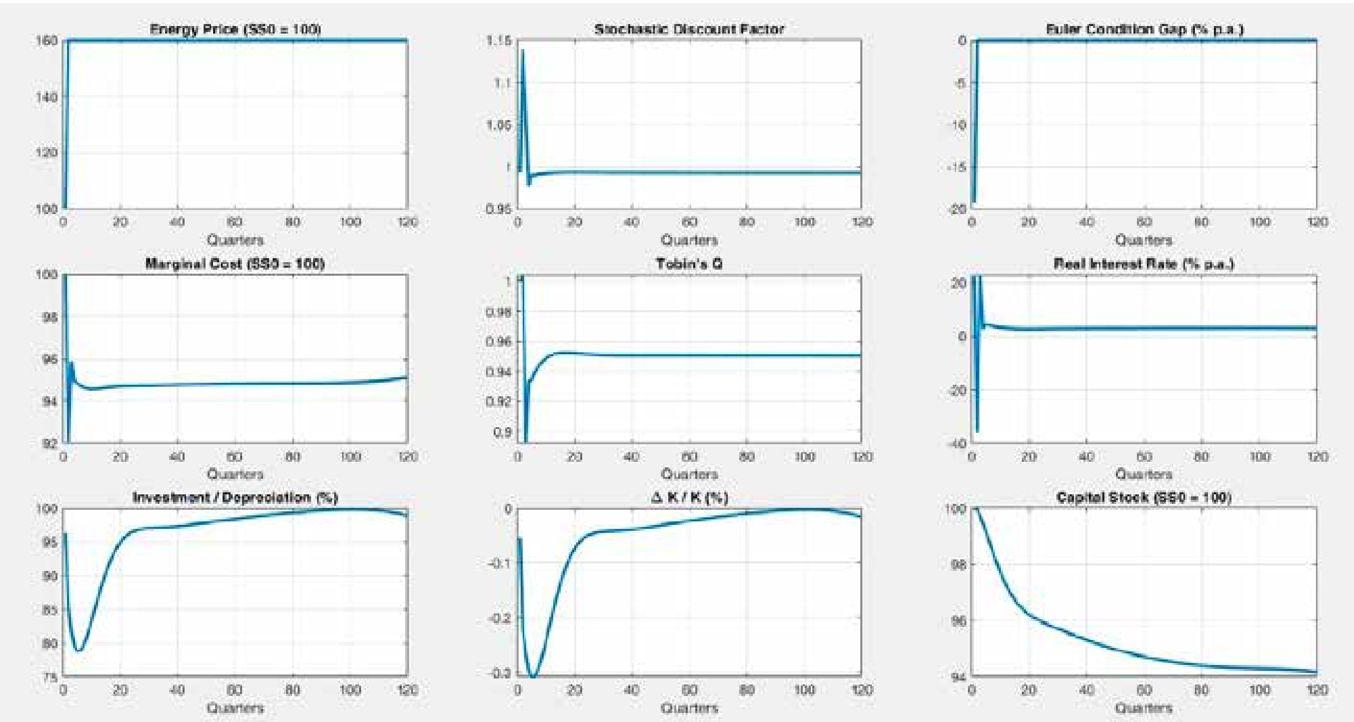

Figure 6. Capital stock adjustment and its channels

Source: Own elaboration.

Note: the variables are represented in different measurement units, as indicated for each sub-figure. Unless otherwise noted, the path of the variable is presented in its natural measurement units

Because capital is a durable factor of production, this adjustment occurs slowly through reduced investment and depreciation dynamics rather than through immediate capital destruction. As a consequence, while many macroeconomic variables recover relatively quickly after the initial shock, the economy continues to adjust over a much longer horizon as it converges to its new long-run equilibrium. The transition therefore may unfold in two stages. The early phase is dominated by a rapid adjustment of investment and asset valuations. The subsequent phase is characterized by a long period during which the capital stock gradually declines through the cumulative effect of depreciation exceeding investment.

3.4. Summarization of the Transitional Path

As mentioned in Section 2.1, the different logic underlying the simulation of the transition path naturally leads to somewhat different results. We treat the results of QPM simulations as the baseline transition scenario, while those of the DSGE model represent the stress scenario. If the transition path itself is the ultimate object of interest, the properties of these two scenarios may be summarized as follows (see Table 3).

Table 3. Transitional path: key characteristics of the two scenarios

Variable	Characteristic	Transition Baseline Scenario	Transition Stress Scenario
GDP	Maximum deviation from the initial steady state, %	-2.7	-12.8
	Recovery/transition duration, quarters	20	10
	New steady state, % of the initial steady state	98.3	96.8
Inflation, % per annum	Maximum deviation from the initial steady state, p.p.	13.7	18.7
	Recovery duration, quarters	23	6
	New steady state vs. the initial steady state, p.p.	0	-0.4
Real Wages	Maximum deviation from the initial steady state, %	-7.0	-16.0
	Recovery/transition duration, quarters	20	10
	New steady state, % of the initial steady state	91.3	84

Source: Own elaboration.

As shown in Table 3, the baseline and stress scenarios of the transitional path differ significantly in terms of both magnitude and duration. The baseline transition scenario mainly assumes smaller adjustments, but a longer recovery period, with the economy adjusting to the new steady state. The stress scenario assumes sharper adjustments in terms of magnitude, while the main variables recover more quickly toward a new steady state (which is lower than the initial one). To a large extent, these differences are predetermined by the design and logic of the respective modelling frameworks.

For the subsequent steps within the inter-model simulation framework, however, we adjust both scenarios in terms of their duration in order to make them more compatible with the framework of debt sustainability analysis, long-term convergence simulations, and to ensure greater comparability across scenarios. In particular, we preserve the magnitude of the adjustments of the main variables obtained from the macroeconomic simulations, but smooth the duration of the adjustment paths over a five-year horizon (20 quarters). This horizon corresponds to the medium-term horizon typically used in macroeconomic policy analysis and ensures consistency with the debt sustainability framework used in the next stage of the analysis. In addition, we partially reconsider the path of nominal variables in order to make the scenarios more conservative. In particular, adjustments are introduced to the assumed dynamics of inflation, exchange rate depreciation, and interest rates. Furthermore, for the purposes of the debt sustainability analysis, additional assumptions are introduced regarding the nominal effective interest rate (in foreign currency) on public debt servicing as well as the path of the primary fiscal balance. As a result, the transitional scenarios used in the subsequent stages of the inter-model framework represent adjusted versions of the original QPM and DSGE simulations. These adjusted transition paths therefore constitute the transition block of the inter-model framework and serve as inputs for the subsequent stages of the analysis, entering the following inter-model simulations in the form reported in Table 4.

Table 4. Transitional path: key characteristics of the two scenarios for inter-model simulations

Indicator	Initial value	Transition Baseline Scenario (5-year average)	Transition Stress Scenario (5-year average)
GDP growth rate, %	1.3	-0.6	-1.5
GDP deflator, %	11.0	7.5	7.2
Nominal effective interest rate, %	5.0	5.0	8.0
Exchange rate depreciation, %	0.1	5.4	4.4
Primary fiscal balance, % of GDP	0.3	-0.4	-1.3

Source: Own elaboration.

3.5. Debt Sustainability Analysis

For the debt sustainability analysis, we rely on the assumptions reported in Table 4 and start simulations from 2026, relying on the actual data available as of the beginning of 2026. The simulation results are presented in Figure 7.

Under the baseline scenario, the debt-to-GDP ratio could increase by 7.5 p.p. relative to the initial level after five years (Figure 7). The debt-stabilizing primary surplus is estimated close to 1% of GDP on average. For comparison, in 2016–2025 the average primary budget surplus was about 2.2% of GDP and in 2022–2025 – around 0.8% of GDP. Therefore, the debt-stabilizing primary surplus projected under the baseline scenario is realistic, meaning the public debt trajectory can be considered sustainable.

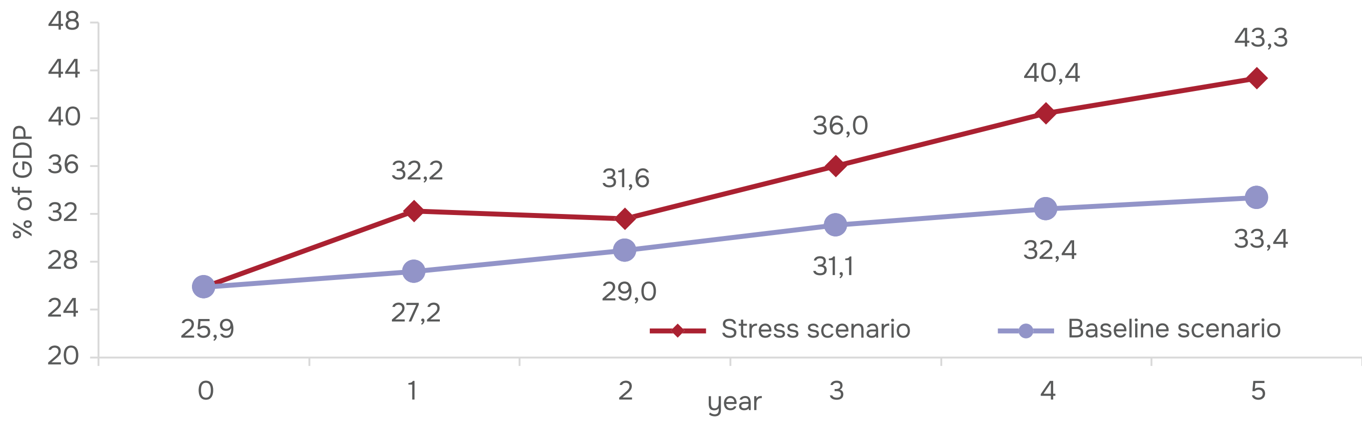

Figure 7. Public debt stress tests

Source: Own elaboration.

Note: year zero is the initial year (before the start of the integration process of Belarus with the EU). The public debt estimate at the beginning of 2026 was used as the baseline.

Under the stress scenario, the debt-to-GDP ratio could increase by 17.5 p.p. relative to the initial level (Figure 7). The increase in debt appears significant, but the debt burden is still not critically high. The debt-stabilizing primary surplus is estimated close to 1.8% of GDP on average. This is still lower compared to the long-run average, but more than two times higher than the average after the start of the war in Ukraine.

This level of surplus still cannot be considered economically unrealistic. However, in the context of a severe recession, such a tight fiscal policy could lead to a significant deepening of the downturn and social unrest. Therefore, the political feasibility of such a budget surplus appears questionable. Consequently, in the stress scenario – a deep transitional economic downturn – the public debt trajectory could be considered unsustainable.

3.6. Long-run Convergence and Long-Term Growth Model

As described in Section 2.6.3, the long-run convergence analysis is conducted for three scenarios. To ensure consistency with the timeline of the LTGM, we treat the year 2028 as t=1 for all scenarios. This year corresponds to the assumed initiation of EU integration and the beginning of the energy price adjustment, which triggers the transitional recession described in the previous sections. The characteristics of the transitional recession are aligned with the assumptions presented in Table 4. For the stress scenario, we apply the trajectory of the transitional decline corresponding to the stress case in Table 4.

For the 'EU integration: Convergence only' and 'EU integration: Baseline' scenarios, we use the baseline trajectory of the transitional recession from Table 4. In the 'EU integration: Stress' scenario, the convergence mechanism is assumed to activate slowly and gradually. The convergence parameter β increases by 0.25 percentage points per year, starting from t=3 (2030), and reaches its maximum value of β = 0.02 only by t=10 (2037). This assumption reflects a delayed and gradual institutional and economic adjustment process. In the "EU integration: Convergence only" scenario, the convergence mechanism activates earlier and more rapidly. The parameter β begins to increase in t=2 (2029) and rises by 0.5 percentage points per year, reaching its maximum level of β = 0.025 in t=6 (2033). In the 'EU integration: Baseline' scenario, we assume a similar activation path for β, increasing by 0.5 percentage points annually starting from t=2 (2029), but reaching a higher maximum convergence speed of β = 0.03 by t=7 (2034). The key distinguishing feature of this scenario is that total TFP growth increases to the Polish level (0.7% annually) already from t=1 (2028). Within the specification of Equation (9), this raises Belarus's baseline growth rate $g_{baselne}$ to a level close to that observed in Poland (see Table 1). The underlying reasoning for this assumption is discussed in detail in Section 2.6.3.

A summary of the assumptions underlying the EU integration scenarios for Belarus is reported in Table 5.

Table 5. Assumptions for the scenarios of long-run projections

Indicator	'EU integration: Stress' Scenario	'EU integration: Convergence only' Scenario	'EU integration: Baseline' Scenario
g_{tr_r}, average during t=1...5, (2028, 2032)	-1.5	-0.6	-0.6
TFP growth rate, % annual average	0.1	0.1	0.7
β, long-run value	0.02	0.025	0.03
The year when β reaches a long-run value	t=10 (2037)	t=6 (2033)	t=7 (2034)

Source: Own elaboration.

The results of the long-run simulations from the national perspective – that is, the projected change in GDP per capita relative to its actual level in 2027 – are reported in Table 6. The year 2027 is used as the benchmark representing the last pre-integration period before the modeled transition dynamics begin.

Table 6. GDP per capita level (PPP, constant 2021 int.$) under different scenarios, index, 2027=100

Year	Scenarios			
	Inertial	'EU integration: Stress' Scenario	'EU integration: Convergence only' Scenario	'EU integration: Baseline' Scenario
2028	102	96	100	101
2029	104	97	101	103
2030	106	99	103	105
2040	125	126	137	150
2050	138	155	169	196
2075	187	261	285	366
2100	240	413	451	612

Table 7 presents the relative outcomes of the three EU integration scenarios compared with the inertial scenario.

Table 7. GDP per capita level (PPP, constant 2021 int.$) under different scenarios vs. inertial scenario (inertial scenario=100)

Year	Scenarios		
	'EU integration: Stress' Scenario	'EU integration: Convergence only' Scenario	'EU integration: Baseline' Scenario
2028	94	98	99
2029	93	98	99
2030	93	98	99
2040	101	110	120
2050	112	122	142
2075	140	153	196
2100	172	188	255

However, for a proper interpretation of long-term convergence dynamics, the international perspective is more informative. In particular, the comparison with the selected benchmark economy (Poland, whose relevance as a comparator is discussed in Section 2.6.3) provides a clearer picture of the potential convergence path. The results of these simulations are presented in Figure 8.

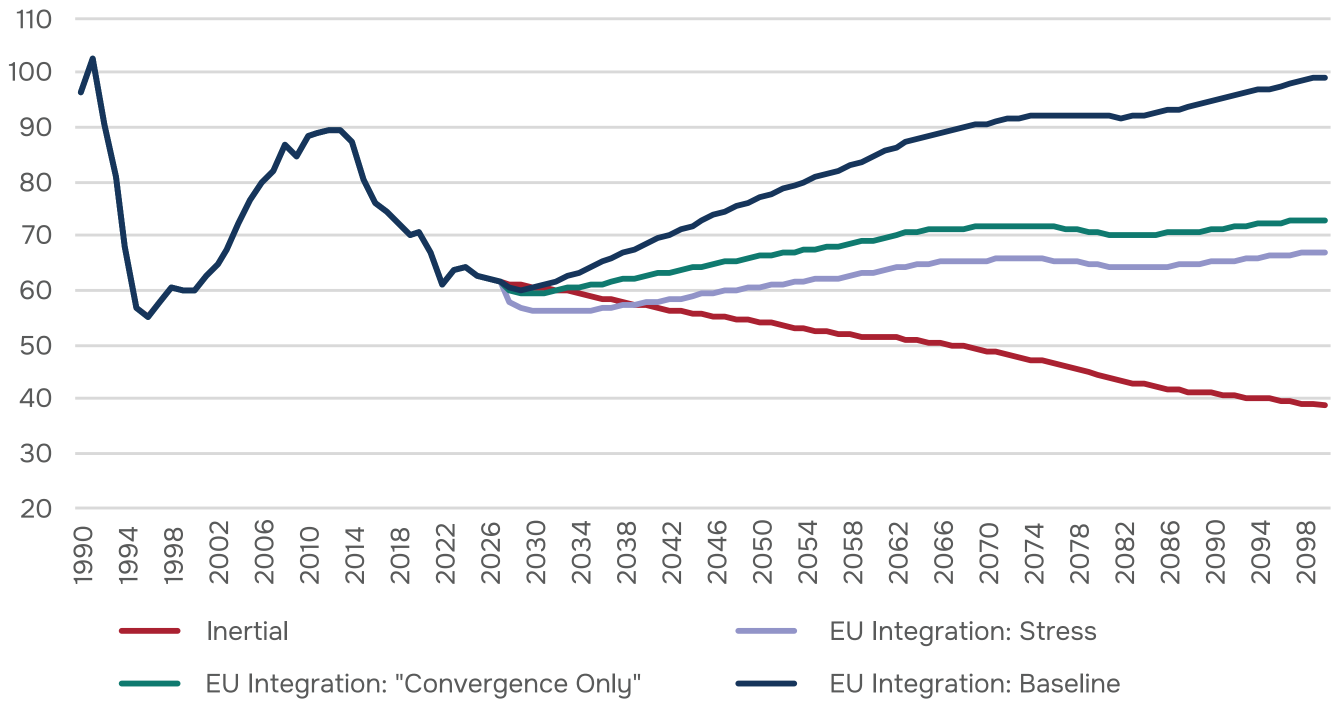

Figure 8. GDP per capita level (PPP, constant 2021 int.$) in Belarus as % of Poland under different long-term scenarios

Source: Own elaboration.

4. Discussion

4.1. Value of a Multi-Model Analytical Framework

An important methodological insight emerging from this study concerns the value of combining several modelling frameworks when analyzing large structural shocks such as the potential EU integration of Belarus. Each of the models used in this paper captures a different dimension of the adjustment process. The CGE framework is well suited for analyzing structural reallocations and long-run sectoral equilibrium under new price conditions. The QPM provides a macroeconomic stabilization perspective and allows the analysis of cyclical adjustment dynamics around potential output. The DSGE framework highlights expectation-driven mechanisms and intertemporal decision making by households and firms. Debt sustainability analysis addresses macro-financial constraints during the transition. The LTGM captures convergence dynamics and productivity-driven development trajectories. Considered separately, each framework would provide only a partial picture. Taken together, however, they allow a more comprehensive understanding of the macroeconomic, structural, and financial dimensions of the integration shock.

4.2. Post-Integration Steady State

The simulations suggest that the post-integration steady state of the Belarusian economy would likely be somewhat weaker than the current one, but not dramatically so. According to the CGE simulations, the long-run level of GDP would decline by approximately 2.7–3.9 percent relative to the initial steady state, depending on the availability of external support. From a policy perspective, such losses appear moderate. They do not suggest a macroeconomic collapse, nor do they imply a scale of disruption that would necessarily undermine public support for the EU integration process. In addition, long-run growth simulations demonstrate that these initial steady-state losses can be more than compensated over time by stronger productivity growth and convergence dynamics associated with integration. This result is particularly important in the context of the widespread narrative that the removal of Russian energy subsidies would inevitably lead to a dramatic collapse of the Belarusian economy. The model results do not support such a view. Instead, they suggest that while the removal of energy subsidies represents a significant structural shock, the economy appears capable of adjusting to the new relative price structure.

At the same time, the relatively moderate steady-state losses should not be interpreted as guaranteed outcomes. Although the CGE framework represents the most appropriate tool for analyzing long-run structural adjustments, it still relies on assumptions about the ability of the economy to reallocate resources efficiently. In particular, the model assumes that export structures gradually adjust as resources move towards sectors that become more competitive under the new price environment. In practice, such restructuring may be considerably slower and more constrained than in the model environment.

Alternative estimates of the potential output losses associated with a breakdown of economic relations with Russia are substantially higher. For instance, Hartwell et al. (2022) provide estimates based on a financial-programming framework that imply much larger contractions (Scenario ‘openly hostile Russia’, especially regarding current account balance). These estimates are derived using a more mechanical methodology that does not incorporate complex structural adjustment mechanisms. However, they highlight an important risk: if labor and capital reallocation across sectors is hindered, or if access to external markets of Belarusian exporters becomes constrained, the realized steady-state outcome could be less favorable than the one obtained in the CGE simulations. This risk may be particularly relevant if Russia attempts to actively obstruct the economic reorientation of Belarus following the launch of the EU integration process. In this sense, the "openly hostile Russia" scenario discussed in Hartwell et al. (2022) should be treated as an extreme but relevant contingency scenario.

From a policy perspective, these risks suggest that steady-state outcomes are not purely structural and can be influenced by policy choices. One particularly important instrument in this regard is external support. The CGE simulations indicate that even relatively modest levels of external financial assistance can noticeably improve the post-integration equilibrium outcome. Given the geopolitical risks associated with potential Russian reactions, the level of external support assumed in the simulations should therefore be interpreted as a minimum baseline rather than an optimal level of assistance. Additional external support may play an essential stabilizing role during the early stages of the integration process.

4.3. Nature of the Transition Period

The estimated transition dynamics also appear relatively moderate. None of the simulated scenarios produces an uncontrolled collapse of output despite the magnitude of the energy price shock. This finding reflects a relatively high degree of macroeconomic resilience in the Belarusian economy. The main policy implication is that the transitional downturn associated with the EU integration appears manageable. Nevertheless, preventive policy actions aimed at mitigating transitional disruptions may still play an important role in limiting the depth and duration of the adjustment period. At the same time, some qualitative variations between QPM and DSGE simulations suggest that the dynamics of the transitional downturn are far from predetermined. The two modelling frameworks highlight different adjustment mechanisms. In the QPM simulations, the transition is characterized by a significant inflationary spike and a relatively gradual recovery path. In the DSGE framework, the adjustment takes the form of an internal devaluation process in which declining real wages reduce firms’ production costs and gradually restore external competitiveness. As a result, nominal variables stabilize relatively quickly, and output recovery occurs faster, but the new steady state is associated with weaker household purchasing power and lower investment activity. These differences indicate that the actual trajectory of the transition period will depend strongly on the policy environment and institutional context in which integration takes place. Monetary and fiscal policy responses, labor market dynamics, and the credibility of economic reforms may all significantly influence the form and duration of the adjustment.

The simulations also highlight several mechanisms that may play an unexpectedly important role during the transition period. One of them concerns the behavior of households and their expectations about future economic conditions. In the DSGE framework, the stochastic discount factor, which captures households' intertemporal preferences, plays a central role in shaping adjustment dynamics. A sharp deterioration in household expectations about future economic prospects could lead to stronger consumption contraction and amplify transitional disturbances. From this perspective, transparent communication and credible policy commitments may become critical elements of the economic policy agenda during the early stages of integration. Another important mechanism identified in the simulations is the risk of gradual decapitalization of the economy. During the transition period, lower profitability and higher uncertainty may lead to reduced investment and a drift toward a lower capital stock equilibrium. Such a process could create a form of capital-based development trap that slows down the realization of long-term growth potential. Addressing this risk may require institutional policies that facilitate the reallocation of capital from declining sectors toward more productive activities and that raise the marginal productivity of capital in the economy. Such measures may include policies that support technological diffusion, reduce barriers to capital reallocation, and implement modern forms of industrial policy aimed at productivity enhancement rather than direct sectoral subsidization.

From a macro-financial perspective, the debt sustainability analysis indicates that public debt dynamics remain manageable under the baseline transition scenario. However, under the stress scenario the debt burden becomes more problematic and may prolong the adjustment period. This suggests that the availability of external financing will be an important stabilizing factor. From this perspective, access to borrowing at rates below market rates – through concessional loans, grants, and EU support programs – might be an important policy priority in the area of public debt management. Furthermore, a similar task will be to ensure that the European integration process itself contributes to improving Belarus's access to international financial markets by reducing the country risk premium and expanding access to new financing instruments.

4.4. Long-Run Development Trajectory

The long-run simulations demonstrate that the inertial development trajectory represents a clear path toward relative economic impoverishment. Under this scenario, Belarus would reach the level of GDP per capita already achieved by Poland in 2025 only around 2061. Given that Poland itself continues to grow, Belarus would experience a widening income gap relative to its regional benchmark. By the mid-2040s, the relative income level would fall to approximately the same level observed in the mid-1990s, and new historical lows would continue to be reached thereafter.

In contrast, all EU integration scenarios fundamentally alter the long-term trajectory of the Belarusian economy. Instead of relative divergence, the economy enters a path of gradual convergence. In the baseline integration scenario, Belarus eventually reaches income parity with Poland by the end of the century. Even in more conservative scenarios, the income gap narrows substantially over time. Importantly, the transitional downturn does not significantly alter this long-term outcome. Even in the deliberately pessimistic stress scenario, the cumulative benefits of integration begin to outweigh the transitional losses approximately eleven years after the start of the integration process. From this perspective, the range of realistic expectations regarding integration outcomes lies between the conservative "convergence-only" scenario and the baseline integration scenario.

A crucial factor behind the long-term convergence process is the potential activation of additional productivity growth mechanisms. EU integration creates favorable conditions for technological diffusion, participation in international value chains, and stronger trade-related productivity effects. However, these mechanisms are not automatically activated by integration itself. Rather, integration creates opportunities for productivity growth, while the actual realization of these opportunities depends on domestic institutional and policy choices. Because productivity growth plays a decisive role in determining the long-term development trajectory (which is the distinctive feature of our 'EU integration: baseline' scenario), effectively transforming these opportunities into actual productivity gains represents a central strategic challenge for the Belarusian economy.

4.5. Policy Implications and Limitations

The results of the analysis suggest that the success of the EU integration process will depend on several key policy factors. First, the scale and effectiveness of external financial support can influence both the parameters of the post-integration steady state and the stability of the transition period. Second, communication and public trust will be critical, as household expectations can significantly affect adjustment dynamics. Third, the quality of macroeconomic policy will influence the management of the transition period, including inflation dynamics, fiscal sustainability, and financial stability. Finally, the effectiveness of institutional policies will determine whether the economy is able to translate integration opportunities into sustained productivity growth and convergence.

Several potentially important factors remain outside the scope of the present study. In particular, the experience of other Eastern European countries suggests that the early stages of EU integration may be accompanied by significant outward migration. Such migration flows may influence labor supply, wage dynamics, and long-term growth prospects. Because the economic and demographic effects of migration are complex and multidimensional, they fall beyond the scope of the current study, which represents an important direction for future research. In addition, the present framework does not analyze sector-specific adjustment effects. Given the strong intersectoral linkages within the Belarusian economy, sectoral restructuring may also play a significant role in shaping the transitional dynamics. Finally, the Belarusian economy currently hosts a substantial presence of Russian capital, particularly in the banking sector and several large industries. A potential withdrawal of this capital could represent an additional source of downside risk and may amplify the scale of economic losses during the transition period.

5. Conclusions

This paper examines a complex hypothetical scenario of Belarusian EU integration and its potential macroeconomic consequences. Such a transformation unfolds through several stages and economic mechanisms. Initially, the launch of EU integration is likely to generate a significant external shock, mainly associated with the removal of implicit energy subsidies and the restructuring of external economic relations. This is followed by a transition period marked by macroeconomic adjustment and sectoral reallocation. Only after these adjustments can the economy reach a new post-integration steady state and subsequently enter a phase of long-term growth driven by convergence with more advanced economies. Because no single modelling framework can capture all these stages simultaneously, the paper adopts a multi-model analytical approach. The analysis combines CGE, QPM, DSGE, debt sustainability analysis, and LTGM, each addressing a specific dimension of the integration process. In this framework, outputs from some models serve as inputs for others, allowing us to construct a coherent macroeconomic narrative of Belarus's potential integration path and to illustrate the analytical value of combining modelling frameworks when analyzing complex structural transformations.

The simulations suggest that the post-integration steady state of the Belarusian economy would likely be somewhat weaker than the current one, but not dramatically so. According to the CGE simulations, the level of potential GDP in the post-integration steady state may decline by approximately 2.7–3.9 percent relative to the initial equilibrium, depending on the availability of external support. From a policy perspective, such losses appear manageable and indicate that the economy is capable of adjusting to a significant relative price shock. This finding is particularly important in the context of widespread narratives suggesting that the removal of Russian energy subsidies would inevitably lead to a dramatic collapse of the Belarusian economy. The results of the structural simulations do not support such a conclusion.

At the same time, the transition period following the integration shock is expected to involve non-trivial macroeconomic adjustments. However, none of the simulated scenarios produces an uncontrolled collapse of output despite the magnitude of the energy price shock. The adjustment appears significant but contained. The exact trajectory of the transition period will depend strongly on the policy environment and institutional context in which integration takes place. The simulations highlight several mechanisms that may amplify transitional disturbances if left unaddressed. In particular, adverse shifts in household expectations may propagate the shock through consumption and investment dynamics, while reduced profitability and uncertainty may create a risk of gradual decapitalization through weakened investment incentives. From a macro-financial perspective, debt sustainability analysis indicates that public debt dynamics remain manageable under the baseline transition scenario, although under more adverse conditions the debt burden may become more problematic and prolong the adjustment period.

The long-term simulations provide an important strategic perspective. Under the inertial development scenario, Belarus faces a trajectory of gradual relative economic impoverishment. In this case, the country would reach the level of GDP per capita already achieved by Poland in 2025 only around 2061, while the income gap with

Poland would continue to widen. By contrast, all EU integration scenarios fundamentally alter the long-term development path of the Belarusian economy. Even under relatively conservative assumptions, integration shifts the economy from a trajectory of relative divergence to one of gradual convergence with more advanced economies. Importantly, the transitional downturn does not significantly alter this long-term outcome: even under the deliberately pessimistic stress scenario, the cumulative benefits of integration begin to outweigh the transitional losses within roughly a decade after the start of the integration process. A crucial determinant of long-term outcomes is the potential activation of additional productivity growth mechanisms. EU integration creates favorable conditions for technological diffusion, deeper participation in international value chains, and stronger trade-related productivity effects. However, these mechanisms are not automatically activated by integration itself. Rather, integration creates opportunities for productivity growth, while the actual realization of these opportunities depends on domestic institutional capacity and economic policy choices. In the favorable scenario where such productivity gains materialize, Belarus may eventually close the income gap with its regional benchmark, Poland. In less optimistic scenarios, convergence still occurs but proceeds more gradually.

The results also highlight several policy factors that will play a decisive role in shaping the integration trajectory. These include the scale and effectiveness of external financial support; effective communication and public trust; the quality of macroeconomic policy during the transition period; and the effectiveness of institutional reforms aimed at strengthening productivity growth and facilitating resource reallocation across sectors.

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