INTEGRATED INPUT–OUTPUT MODELLING FOR ECONOMIC CONVERGENCE AND INVESTMENT IMPACT ASSESSMENT: A STRUCTURAL FORECASTING FRAMEWORK FOR THE REPUBLIC OF MOLDOVA

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Abstract:

The paper develops an integrated macroeconomic modelling framework designed to strengthen the analytical and forecasting capacity of economic governance in the Republic of Moldova. Based on the reconstruction and extension of Supply-Use and Input-Output Tables (SUT/IOT), the study establishes a structural and methodological foundation for aligning Moldova's national accounts with the standards of the European System of Accounts (ESA 2010) and the System of National Accounts (SNA 2008).

By combining SUT/IOT reconstruction with econometric modelling, the research demonstrates how structural consistency enhances both macroeconomic forecasting and policy evaluation. The model incorporates data for 2005-2023 and captures the dynamic interactions between output, investment, trade, and fiscal aggregates. Through scenario analysis, it assesses how policy shocks and investment programs, particularly those financed through European funds, affect growth, employment, and intersectoral linkages.

The results show that the restoration of Moldova's input–output framework can significantly improve the evidence base for national and European policy coordination, while offering a practical instrument for monitoring convergence and investment efficiency. The study concludes that institutional modernization and digital integration of such models are key prerequisites for sustainable development and effective absorption of European resources.

Keywords: *Input-Output Modelling; Economic Convergence; Investment Impact; Forecasting; SUT/IOT; European Integration.*

JEL Classification: *D57, C68, E01, F15, O47, H54*

1. Introduction

The ongoing process of European integration requires countries in transition to strengthen their analytical and institutional capacity for evidence-based policymaking. In this context, the Republic of Moldova faces a dual challenge: ensuring macroeconomic stability while converging toward the statistical, fiscal, and governance standards of the European Union. A crucial component of this convergence process lies in rebuilding and modernizing the national accounting system, particularly the Supply-Use and Input-Output Tables (SUT/IOT), which constitute the backbone of structural economic analysis and forecasting in all EU member states.

Despite significant progress in the adoption of the System of National Accounts (SNA 2008) and partial harmonization with the European System of Accounts (ESA 2010), Moldova still lacks a functional and regularly updated SUT/IOT framework. The absence of such a system limits the country's ability to analyze intersectoral linkages, assess the structural impact of public policies, or simulate the effects of fiscal and trade reforms. Consequently, policymaking remains heavily dependent on aggregate indicators, without a detailed understanding of the transmission mechanisms across economic sectors.

This research aims to fill that institutional and analytical gap by proposing an integrated modelling framework that combines the reconstruction of SUT/IOT tables with econometric forecasting techniques. The approach is both structural and data-driven, designed to be applicable even in environments with incomplete or inconsistent statistical information. The model is built upon national accounts data for 2005–2023 and incorporates key macroeconomic variables such as GDP, consumption, investment, trade, prices, and labor market indicators.

Beyond its technical value, this study positions the reconstruction of Moldova's input–output system as a cornerstone of economic convergence and sustainability. By establishing structural consistency and sectoral transparency, such a model enhances the government's ability to monitor economic performance, evaluate the impact of European investments, and anticipate the effects of exogenous shocks. Moreover, the proposed framework supports the transition toward a modern, digital, and interoperable infrastructure for macroeconomic analysis, an essential prerequisite for Moldova's long-term integration into the European statistical and policy architecture.

The rest of the paper is structured as follows. Section 2 reviews the theoretical and methodological background of SUT/IOT-based macroeconomic modelling and its role in convergence analysis. Section 3 presents the methodological framework adopted for reconstructing and estimating the Moldovan system. Section 4 discusses the empirical implementation and results, while Section 5 analyses their policy relevance. The final section concludes with recommendations for sustainable institutional development and digital integration.

2. Literature and Conceptual Background

The integration of Supply-Use and Input-Output Tables (SUT/IOT) into macroeconomic modelling has a long and well-established tradition in both theoretical and applied economics. Originating from the work of Wassily Leontief (1936), the input–output framework has evolved into a cornerstone of modern economic analysis, enabling the quantification of intersectoral linkages, multiplier effects, and structural dependencies within an economy. In the European Union, the methodology has been standardized and continuously updated under the *European System of Accounts (ESA 2010)*, which explicitly defines SUT/IOT as the central framework for measuring production, income, and expenditure flows in a consistent, sectoral disaggregated manner (Eurostat, 2018).

From a theoretical standpoint, input-output systems bridge the gap between *national accounting* and *economic modelling*. They serve as a quantitative backbone for various analytical frameworks, including *Computable General Equilibrium (CGE)* models, *Social Accounting Matrices (SAM)*, and hybrid econometric-structural models. The capacity of these models to simulate the propagation of shocks across sectors and to trace the cumulative effects of investments, fiscal stimuli, or trade variations makes them indispensable tools for policy analysis in both developed and emerging economies (Miller & Blair, 2022; Round, 2003).

Recent literature emphasizes that countries undergoing structural transformation, such as those in Central and Eastern Europe, can benefit substantially from rebuilding and institutionalizing their SUT/IOT systems (Radev & Mitra, 2021). In the context of EU integration, these frameworks not only enhance the comparability of national statistics but also enable consistent evaluation of convergence and sustainability indicators. For instance, Finland's *ENVIMAT* model, the Netherlands' *GINFORS* and *CPB* frameworks, and France's *INSEE-CGE* platform all demonstrate how input-output structures underpin multi-sector forecasting, environmental modelling, and long-term policy planning.

Empirical research shows that countries aligning their accounting frameworks with ESA standards gain a higher analytical capacity for tracking the efficiency of public and European funds (OECD, 2020). Input-output models allow for an explicit estimation of the multiplier effects of EU investments, quantifying how funds allocated to infrastructure, industry, or social programs generate value added, employment, and tax revenues across the economy. In this sense, the SUT/IOT system becomes not only a statistical instrument but also a *strategic governance tool* for ensuring accountability and impact assessment.

For transition economies such as Moldova, the absence of an updated input-output framework constrains the ability to conduct rigorous macroeconomic and structural analyses. While aggregate national accounts offer insight into total production and expenditure, they do not capture the underlying interdependencies that define structural resilience or vulnerability. The establishment of a coherent, EU-aligned SUT/IOT structure thus represents both an analytical necessity and a condition for effective convergence. Furthermore, integrating such data into econometric forecasting models provides a dynamic and operational mechanism for testing alternative policy scenarios, bridging statistical modernization with strategic economic governance.

3. Methodological Framework

The methodological design of this research combines structural reconstruction, econometric estimation, and simulation analysis into an integrated framework capable of producing consistent macroeconomic forecasts and policy evaluations. The approach is based on three complementary pillars:

- ✓ the reconstruction and balancing of the national Supply-Use and Input-Output Tables (SUT/IOT);
- ✓ the integration of these tables with macroeconomic aggregates in a hybrid econometric model; and
- ✓ the simulation of alternative fiscal and investment scenarios to assess structural and dynamic responses of the Moldovan economy.

3.1 Reconstruction of Supply-Use and Input-Output Tables

The initial step involved rebuilding a consistent series of SUT/IOT for the period 2014-2023 in current prices, using available data from national accounts, business statistics, and trade databases. Due to gaps and inconsistencies in the published information, interpolation and extrapolation procedures were applied to intermediate years using growth indicators from GDP, industrial output, and trade statistics.

The balancing of the reconstructed matrices was achieved through an iterative RAS algorithm (Stone, 1961), ensuring that both row and column totals matched the official macroeconomic aggregates. For selected years where relative price changes or structural shifts were more pronounced, a generalized RAS (GRAS) procedure was used to maintain the positivity of coefficients and better reflect nonlinear adjustments in sectoral relationships. These adjustments were validated by comparing sectoral value-added and employment shares with those published by Eurostat and the National Bureau of Statistics of Moldova.

The resulting SUT/IOT matrices allowed for the estimation of inter-industry multipliers and the identification of key sectors driving value-added creation, import dependence, and employment. This reconstruction provides the empirical foundation for integrating structural consistency into the econometric component of the model.

3.2 Econometric Model Integration

The econometric model was constructed to align with the macroeconomic identities derived from the input-output framework. The system includes behavioral equations for aggregate demand components, private consumption, investment, exports, and imports, combined with structural equations linking sectoral output to final demand and relative prices. The estimation was performed using annual data from 2005-2023 through Ordinary Least Squares (OLS) and Seemingly Unrelated Regressions (SUR), depending on the cross-equation error structure.

The model enforces key accounting identities to ensure internal consistency between the income, production, and expenditure sides of the economy. This hybrid approach allows macroeconomic forecasting to incorporate both behavioral dynamics and intersectoral dependencies. Diagnostic tests confirmed parameter stability, absence of serial correlation, and overall model adequacy, with goodness-of-fit indicators ($R^2 > 0.85$ for major equations) supporting predictive robustness.

3.3 Scenario Simulation and Structural Impact Analysis

To evaluate the policy relevance of the model, several counterfactual simulations were conducted. These included:

- a fiscal stimulus scenario (increased public investment by 1.5% of GDP),
- an EU-funded investment inflow scenario, and
- an external trade shock scenario reflecting export contraction.

The simulations used the estimated parameters to project the short and medium-term effects on GDP, employment, and sectoral output. The structural decomposition derived from the input-output matrix enabled tracing the propagation of each shock through intermediate demand chains, identifying the most sensitive and responsive sectors.

Results revealed that investment-oriented stimuli, particularly when co-financed through European funds, have the highest multiplier effects (ranging from 1.4 to 1.8 across scenarios). In contrast, trade shocks exhibited asymmetric effects, with stronger negative impacts on manufacturing and transport sectors. These findings confirm the strategic relevance of a coherent SUT/IOT-based system for ex-ante policy evaluation and economic convergence monitoring.

4. Empirical Implementation: The Case of the Republic of Moldova

4.1 Data Foundation and Model Calibration

The empirical implementation was based on national accounts and sectoral statistics covering the period 2005–2023, combined with trade, employment, and fiscal data from the National Bureau of Statistics, the Ministry of Finance, and international databases (IMF, World Bank, Eurostat). All variables were harmonized with the ESA 2010 classification to ensure comparability with EU structural indicators.

The reconstructed Supply-Use and Input-Output Tables for 2014-2023 served as the analytical backbone for computing intermediate demand coefficients, value-added ratios, import shares, and Leontief multipliers. These parameters were subsequently incorporated into the econometric model to preserve structural proportionality across production, income, and expenditure accounts.

Model calibration focused on maintaining three fundamental consistencies:

1. Accounting consistency, ensuring equality between aggregate demand and supply components.
2. Structural consistency, derived from the fixed-coefficient relationships of the IOT matrix.
3. Dynamic consistency, introduced through lagged behavioral equations capturing short-term adjustment processes.

4.2 Estimation and Validation

The behavioral block of the model included seven key equations: real GDP growth, private consumption, gross capital formation, exports, imports, employment, and consumer prices. Parameters were estimated using the Ordinary Least Squares (OLS) and Seemingly Unrelated Regressions (SUR) methods. Diagnostic results confirmed satisfactory statistical performance, with adjusted R^2 ranging between 0.82 and 0.91 for the main relationships and Durbin–Watson statistics close to 2.0, indicating no autocorrelation.

The model's stability was tested through recursive estimation and Chow break tests, showing robust parameter constancy even during periods of external stress (e.g., 2020 pandemic shock and 2022 energy crisis). Forecast accuracy was evaluated through Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) metrics, with average deviations below 5%, validating the model's predictive credibility.

4.3 Structural Multipliers and Sectoral Linkages

Input-output multipliers derived from the reconstructed IOT revealed that Moldova's economy remains moderately open but highly dependent on imports in industrial sectors. The average output multiplier was estimated at 1.58, implying that every additional monetary unit of final demand generates 1.58 units of total output across the economy. The value-added multiplier averaged 1.22, with the strongest effects in construction, manufacturing, and transport sectors.

Backward linkage indicators identified manufacturing, trade, and energy as key propagation channels of demand, while forward linkages highlighted agriculture, utilities, and logistics as crucial suppliers to downstream industries. These structural findings underscore the importance of coordinated investment policies targeting high-linkage sectors to enhance overall economic resilience.

4.4 Scenario-Based Insights

Three baseline scenarios were simulated using the integrated model:

Scenario 1: Fiscal Stimulus. A 1.5% of GDP increase in public investment led to a GDP rise of approximately 2.1% after one year, with strongest spillovers in construction and industrial services;

Scenario 2: EU Investment Inflow. The absorption of an additional 200 million EUR in EU funds produced a cumulative GDP impact of 3.4% over two years, with employment gains concentrated in manufacturing and infrastructure;

Scenario 3: External Trade Shock. A 10% decline in exports reduced GDP by 2.6% and employment by 1.8%, exposing vulnerabilities in the trade-dependent sectors.

These results confirm that input–output–based macroeconomic models not only enhance the precision of national forecasts but also enable policymakers to anticipate the structural consequences of external or policy-driven shocks. The capacity to link fiscal, investment, and trade channels within a unified analytical system constitutes a decisive step toward evidence-based policymaking and EU-style convergence monitoring.

5. Discussion and Policy Relevance

The empirical findings confirm that Moldova's economic structure retains strong sectoral asymmetries, high import dependence, and limited domestic value-added generation, characteristics typical of small, open transition economies. However, the integrated input-output modelling framework developed in this study provides a strategic basis for overcoming these limitations by linking structural analysis to macroeconomic forecasting and policy evaluation.

5.1 Structural and Convergence Implications

The reconstruction of Supply-Use and Input-Output Tables (SUT/IOT) offers far more than a statistical improvement; it represents a step toward institutional convergence with European Union practices. In the EU, the regular compilation of input-output frameworks is not merely a reporting requirement but a fundamental component of the macroeconomic governance cycle, informing budget planning, investment programming, and the assessment of structural reforms (Eurostat, 2018).

By aligning its analytical infrastructure with ESA 2010 standards, Moldova strengthens both its statistical comparability and its policy credibility. The model enables quantification of convergence processes not only in nominal or fiscal terms but also in structural dimensions, such as productivity, intersectoral linkages, and multiplier effects. These metrics can serve as inputs for the government's medium-term development strategies and for EU monitoring mechanisms like the European Semester or Structural Reform Support Program.

5.2 Investment Efficiency and European Funds

The scenario simulations underline the decisive role of public and European investments as catalysts for growth. Multipliers ranging from 1.4 to 1.8 indicate that well-targeted capital expenditures, particularly in construction, manufacturing, and infrastructure, generate broad positive spillovers across the economy. In this context, input-output based models become powerful tools for *ex-ante* and *ex-post* evaluation of investment programs, allowing policymakers to assess the efficiency, sectoral transmission, and sustainability of each project.

The capacity to trace how European funds influence domestic production chains offers a practical mechanism for prioritizing projects with the highest structural impact. Moreover, this approach enhances transparency and accountability, aligning Moldova's public investment evaluation framework with EU best practices.

5.3 Institutional and Digital Transformation

Beyond the analytical results, the study emphasizes the institutional prerequisites for embedding such models into the national policy process. Effective application of SUT/IOT and econometric forecasting requires stable data reporting systems, inter-agency coordination, and digital integration.

The digital transformation of macroeconomic modelling, through tools such as the *Oracle APEX–based platform* developed by the author, facilitates data interoperability, automated updating of input-output matrices, and interactive scenario visualization. These capabilities can significantly reduce the time lag between data collection, analysis, and policy response.

By integrating traditional economic modelling with modern digital environments, Moldova can transition from reactive to anticipatory governance, strengthening its resilience to external shocks and its readiness for EU accession.

5.4 Strategic Relevance

Ultimately, the integrated framework proposed in this paper positions input-output analysis as a *strategic policy instrument*, not merely a statistical exercise. It enables evidence-based coordination between fiscal, industrial, and investment policies, transforming the way economic sustainability and convergence are assessed.

Through regular reconstruction of SUT/IOT, coupling them with econometric forecasting and embedding them into digital infrastructures, Moldova can establish a modern, transparent, and adaptable macroeconomic governance model aligned with European standards. This transformation will not only enhance analytical capacity but also institutional credibility, accelerating the country's path toward effective economic integration and sustainable growth.

6. Conclusion

This study demonstrates that the integration of Supply-Use and Input-Output Tables (SUT/IOT) into Moldova's macroeconomic modelling framework can substantially enhance both analytical precision and policy relevance. By reconstructing a consistent system of national accounts matrices and linking them with econometric forecasting tools, the research bridges the gap between structural analysis and decision-oriented economic governance.

The methodological innovation lies in combining statistical reconstruction techniques (RAS/GRAS), econometric estimation, and simulation analysis into a single coherent framework. This integration not only ensures internal accounting consistency but also allows for dynamic scenario

evaluation, revealing how fiscal stimuli, European investments, or trade shocks propagate through the economy and affect growth, employment, and value-added generation.

Empirical results confirm that public and EU-financed investments have strong multiplier effects, while external shocks can rapidly transmit through interdependent sectors. These findings provide policymakers with a quantitative instrument for evaluating convergence progress, designing evidence-based interventions, and enhancing the efficiency of European funds absorption.

Beyond its empirical contribution, the study highlights the institutional and technological implications of adopting input-output modelling as a standard practice in Moldova. A sustainable framework requires digital integration, inter-agency coordination, and transparent dissemination of analytical outcomes. Implementing such systems through modern platforms, like the Oracle APEX-based application developed for this research, can transform static data processing into an interactive, real-time policy support environment.

In essence, rebuilding and operationalizing the SUT/IOT system positions Moldova closer to the analytical standards of EU economies. It establishes the groundwork for a data-driven, digitally enabled governance model capable of anticipating shocks, optimizing investments, and supporting long-term sustainable development. The research thus contributes not only to the modernization of national accounts but also to the evolution of Moldova's macroeconomic strategy toward European convergence and structural resilience.

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