TIME-SERIES ANALYSIS AND ARIMA-BASED FORECASTING OF AGRICULTURAL RAW MATERIAL IMPORTS IN CENTRAL AND EASTERN EUROPE

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Abstract:
The paper analyzes the long-term dynamics and short-term forecasts of agricultural raw material imports in Central and Eastern European countries, with an emphasis on structural trends, regional convergence and the performance of ARIMA-type econometric models. The study employs annual data for the period 1995–2024 and focuses on seven economies in the region: Romania, Poland, Hungary, the Czech Republic, Slovakia, Bulgaria, and Croatia. The research methodology combines inferential statistical analysis, Spearman's correlation coefficients, time-series stationarity testing through the Augmented Dickey–Fuller test and univariate ARIMA modeling following the Box–Jenkins methodology. The results highlight a clear downward trend in the share of agricultural raw material imports in total merchandise imports for all analyzed countries, reflecting processes of structural transformation, agricultural modernization and integration into the European single market. The correlation analysis indicates a high degree of synchronization and regional convergence, particularly among Central European economies, while Romania exhibits a relatively distinct profile characterized by higher volatility. Stationarity tests reveal differing degrees of series integration and the estimated ARIMA models provide high-quality short-term forecasts. Projections for the 2025–2027 period suggest stabilization or a slight decline in agricultural raw material imports, with no significant structural shifts, which are useful in managerial policies at the level of the analyzed countries

Keywords: time series, ARIMA forecasting, agricultural import, CEE countries, managerial policies.

1. Introduction

European economic integration and the structural transformations of the past three decades have led to significant changes in the structure of foreign trade in Central and Eastern European countries. A relevant component of these changes is the evolution of imports of agricultural raw materials, which reflects the dynamics of the primary sector, the degree of industrialization and the adaptation of national economies to the European Single Market. The analysis of these trade flows provides insight into processes of economic convergence and the level of food self-sufficiency, which are essential for the formulation of agricultural and trade policies at the regional level.

In the post-transition period (1995–2024), countries such as Romania, Poland, Hungary, the Czech Republic, Slovakia, Croatia, and Bulgaria have undergone distinct stages of economic modernization, marked by accession to the European Union and access to Common Agricultural Policy (CAP) funds. These processes have directly influenced the structure of domestic production and the agri-food trade balance, leading to a significant reduction in the share of gross agricultural imports in total merchandise imports. At the same time, structural transformations driven by industrialization, the development of regional value chains, and a shift toward processed agri-food products have contributed to a decline in dependence on external agricultural raw materials.

The purpose of this study is to analyze the evolution of agricultural raw material imports over the period 1995–2024 for a group of Central and Eastern European countries and to identify common trends and structural differences among them. By applying statistical and econometric tools—such as descriptive analysis, normality and stationarity tests (Shapiro–Wilk, Augmented Dickey–Fuller), Spearman correlations, and ARIMA models—the study aims to highlight the dynamic behavior of these imports and to formulate forecasts for the period 2025–2027. This article contributes to the academic literature by providing an in-depth comparative analysis of dependence on agricultural imports in the post-EU accession context, offering insights into regional economic convergence and into the ways in which agricultural and trade policies have shaped structural transformations in Central and Eastern Europe.

The structural transformation of agricultural trade has represented a central dimension of economic transition and European integration in Central and Eastern Europe (CEE). The literature has extensively examined agricultural trade from perspectives such as material use intensity and input–output relationships (Baer-Nawrocka and Mrówczyńska-Kamińska, 2019), sectoral import dependence (Szczepaniak, 2023), trade resilience to external shocks (Kos-Łabędowicz and Talar, 2024), global commodity cycles (Guerov et al., 2024), as well as the broader effects of European Union enlargement and trade liberalization (Papazoglou et al., 2006; Kuc-Czarnecka et al., 2021). While these contributions provide valuable insights, they generally focus either on national case studies, limited time horizons, or aggregated indicators, leaving the long-term structural dynamics of agricultural raw material imports in the CEE region insufficiently explored.

In particular, the share of agricultural raw material imports in total merchandise imports is a relevant indicator of structural transformation, production modernization, and integration into regional value chains, yet it has received limited attention in systematic comparative analyses conducted over extended time horizons.

Moreover, existing studies rarely address the degree of convergence or synchronization among CEE economies with respect to the dynamics of agricultural imports, despite the common institutional framework created by European Union accession and the Common Agricultural Policy.

Against this background, the present study contributes to the literature by conducting a comparative time-series analysis of agricultural raw material imports in seven Central and Eastern European countries over the period 1995–2024. By focusing on the relative share of agricultural imports rather than on absolute values, the analysis captures structural transformations in foreign trade while simultaneously accounting for differences in economic size across countries. From a methodological perspective, the research combines descriptive statistical analysis, nonparametric correlation techniques, time-series stationarity testing, and univariate ARIMA modeling within a unified analytical framework. This approach enables the identification of long-term trends, patterns of convergence across countries, and economy-specific dynamics, as well as the formulation of short-term forecasts. In contrast to recent contributions that favor complex multivariate models or hybrid forecasting approaches, the results demonstrate that classical ARIMA models remain effective tools for modeling mature and relatively stable trade series in the Central and Eastern European (CEE) region.

The findings indicate a pronounced and broadly synchronized decline in the share of agricultural raw material imports at the regional level, reflecting a process of structural maturation, increased domestic production capacity, and deeper integration into European agri-food value chains. At the same time, the analysis reveals significant cross-country differences: Central European economies exhibit a high degree of convergence, whereas Romania follows a more volatile and relatively distinct trajectory, associated with delayed structural adjustments and a mixed role as both an exporter of agricultural raw materials and an importer for processing purposes.

By examining these long-term developments and providing forecasts for the immediate future, the study extends the literature on agricultural trade in Central and Eastern Europe and offers relevant benchmarks for the formulation of agricultural and trade policies.

Given the overall objective of the study, the methodology employed, and the reviewed literature, the present research is structured around the following research questions:

RQ1. What has been the long-term evolution of the share of agricultural raw material imports in total merchandise imports in the analyzed Central and Eastern European countries over the period 1995–2024?

RQ2. Are there significant structural differences among the analyzed countries in terms of the level, volatility, and dynamics of agricultural raw material imports?

RQ3. Is there evidence of a process of regional convergence in the evolution of agricultural raw material imports among Central and Eastern European countries?

RQ4. To what extent does Romania follow a similar or distinct pattern compared with other countries in the region with respect to agricultural raw material imports?

RQ5. What are the statistical properties of the time series on agricultural raw material imports (normality and stationarity), and what economic implications can be inferred from them?

RQ6. Can ARIMA-type econometric models be used to generate reliable short-term forecasts of agricultural raw material imports?

RQ7. What is the short-term future trend (2025–2027) of agricultural raw material imports in the analyzed countries?

The paper is organized as follows. The introductory section presents the theoretical and economic context of the research, the study objectives, and the research questions. The second section describes the database used, the indicators analyzed, and the statistical and econometric methodology applied, including descriptive analysis, normality and stationarity tests, Spearman correlations, and ARIMA modelling. The third section provides a literature review, synthesizing the main relevant contributions from the academic literature and positioning the study in relation to existing research. The fourth section presents the empirical results, including the evolution of agricultural raw material imports, comparative and regional convergence analyses, and the outcomes of the forecasting models. Finally, the conclusions section summarizes the main findings, highlights the economic and public policy implications, and proposes directions for future research.

2. Literature Review

The study by Baer-Nawrocka and Mrówczyńska-Kamińska (2019) primarily aims to assess the intensity of direct material consumption and imports in the agricultural sector of European Union countries. Conducted in the context of the importance of agriculture in national economies and the level of economic development of the Member States, the analysis is based on input–output tables for the years 1995, 2005, and 2014. The results indicate an increase in material consumption intensity in the EU-15 countries, as well as in Latvia, Lithuania, and the Czech Republic, while other EU-13 states experienced stability or a slight decline (such as Slovakia and Bulgaria). At the same time, the new Member States exhibited structural changes in material supply, driven by the growing role of agriculture-related services and a reduced share of the agricultural sector itself. Differences between country groups are also evident in terms of the intensity of indirect imports. The study's conclusions confirm the persistence of well-known trends in agricultural economics, alongside the emergence of new processes in the agriculture of developed European countries.

In the study conducted by Bodo, Golinelli, and Parigi (2020), several alternative short-term forecasting models were proposed, covering a broad methodological spectrum—from simple ARIMA models to cointegrated VAR models and more sophisticated conditional models—with the objective of anticipating the dynamics of the industrial production index in the euro area. The authors' analysis shows that the most accurate model in forecasting terms is a conditional error-correction model, in which changes in the aggregate euro-area industrial production index are explained by developments in the U.S. industrial production index and by the business confidence index derived from the European Commission's harmonized survey of manufacturing firms.

Szczepaniak (2023) examines the role of imports in securing raw materials for Poland's food processing industry. Although Polish food production has grown rapidly and relies primarily on domestic agricultural resources, globalization and economic integration into the European Union have led to a steady increase in imports. Based on statistical data for the period 2003–2021 provided by the Central Statistical Office and the Ministry of Finance, the study shows that following EU accession, the share of imported raw materials nearly doubled, reaching approximately 40% of total resources used. Most of these imports originate from regions with different climatic conditions. Nevertheless, the core of food production remains domestic. Different branches of the food industry adopt distinct strategies for sourcing, production, and trade risk management, depending on the specific characteristics and ownership structure of each sector.

Kos-Łabędowicz and Talar (2024) analyze the impact of the armed conflict between Russia and Ukraine on the trade resilience of Central and Eastern European countries through a Trade Vulnerability Index (TVI) specifically developed for this research. Using data for the period 2016–2023, the study reveals that in the first year of the conflict, trade flows generally remained stable, with the exception of the Baltic States and Poland in 2023. Although Slovakia and the Czech Republic were classified as vulnerable economies based on TVI values, they demonstrated a significant capacity to adapt to the new external conditions. The authors conclude that a high level of trade vulnerability does not necessarily imply low adaptability to exogenous shocks, offering relevant insights for the design of economic policies aimed at strengthening trade resilience in the region.

The study by Guerov, Blagoeva, and Georgieva (2024) investigates the impact of the Raw Materials Supercycle (RMSC) on agriculture in the European Union, focusing on major crops such as wheat, maize, barley, sunflower, and potatoes, which are strategically included due to their food role, adaptability, and substitution potential during periods of market instability. Using a multi-method approach (regression models, comparative analyses, and trend analyses), the research examines how global commodity price fluctuations affect production, exports, and the structure of the EU agricultural market, as well as the role of domestic policy factors, particularly the Common Agricultural Policy (CAP). The results reveal a significant relationship between the commodity supercycle and crop performance in Europe. France and Italy remain leading wheat exporters, while Bulgaria emerges as a new producer. Potatoes prove to be a key crop due to their flexibility, contributing to reduced vulnerability of the agricultural sector to price volatility. Although the CAP partially mitigates market effects through subsidies, its influence is limited. The study offers an innovative perspective on the relationship between global commodity cycles and European agricultural systems, highlighting the importance of crop diversification and resilience strategies to address future economic fluctuations.

Three decades after the collapse of communist regimes and more than fifteen years after the major European Union enlargement of 2004–2007, Kuc-Czarnecka, Saltelli, Olczyk, and Reinert (2021) revisit divergent views on the impact of trade liberalization and EU enlargement on Central and Eastern European (CEE) countries. The study distinguishes three categories of states: EU Member States prior to 2004, CEE countries that acceded between 2004 and 2007, and non-EU countries such as Belarus, Moldova, and Ukraine. The analysis is structured around two time periods: the first spans from 1991—the year of the dissolution of the Council for Mutual Economic Assistance (COMECON), the former Eastern European free trade area—to the present; the second corresponds to the post-2004–2007 EU enlargement period. The findings suggest that the accelerated integration of CEE countries into the global and European economy generated significant adverse effects, materialized in substantial economic losses. The authors compare this evolution to the processes of deindustrialization and migration experienced by Latin America following trade liberalization in the 1970s.

Thom et al. (2023) analyze the vulnerabilities of European Union agriculture in the event of a potential halt in food and feed imports, using the global CAPRI model to simulate economic and environmental impacts. The results show that oilseeds are the most affected due to high import dependence, while the meat sector is indirectly impacted through reduced availability of soy used in animal feed. Products with a high degree of self-sufficiency are only marginally affected. Following an import halt, EU domestic production increases; however, this leads to nitrogen surpluses in already vulnerable regions and a partial relocation of meat production outside the EU, contributing to higher global greenhouse gas emissions. For consumers, the effects are negative, manifested through higher food prices and an overall decline in welfare across most Member States. EU exports also decrease, adversely affecting international markets. Least developed countries experience a sharp rise in food prices, particularly for essential products already consumed below recommended levels. Overall, the study highlights the deep interdependence of EU agriculture with global trade and demonstrates that disruptions to imports would generate significant economic, social, and environmental effects both within the Union and worldwide.

Pilinkienė (2016) examines the impact of trade openness on economic growth and competitiveness in eleven Central and Eastern European countries over the period 2000–2014. Although these economies are characterized by high levels of trade openness, they display divergent trajectories in terms of economic development and competitive performance. Most CEE countries pursue trade policies oriented toward regional cooperation, with the aim of facilitating integration into the global economy.

The study by Ionițescu et al. (2024) explores the complexities and opportunities of agricultural value chains from international, European, and Romanian perspectives. Emphasizing the importance of effective value chain management, the analysis first examines the global context in economically advanced countries—such as the United States, China, Germany, Japan, and India—as a reflection of how global and regional policies shape agricultural production and distribution. The dynamics of raw materials and high-technology products and services in terms of exports, imports, and trade balance within the EU over the period 2012–2022 are analyzed using Eurostat data, highlighting the EU's role in shaping value chains. The European perspective focuses on the Common Agricultural Policy (CAP) and its implications for Member States, while the Romanian context highlights local challenges and strategies for integration into broader value chains. Methodologically, the study employs a range of methods, including descriptive literature analysis, trend dynamics in raw materials and high-technology products and services using regression equations and R-squared values, fixed-base indices to display growth rates, comparative analysis, and illustrative tabular and graphical representations. By analyzing case studies and current trends, the research provides insights into improving economic efficiency, sustainability, and competitiveness in agricultural sectors.

The empirical analysis relies on econometric methods, including correlation analysis, Granger causality tests, and vector autoregression (VAR) models, to assess the dynamic relationships between trade openness, economic growth, and competitiveness in both the short and long run. The results highlight a significant interdependence among the three dimensions: economic growth stimulates trade openness, while increased competitiveness contributes to accelerated economic growth. According to the econometric findings, the effects of economic growth on trade openness materialize in the long term, whereas competitiveness exerts a substantial influence on GDP per capita in the CEE region.

Lima, Gonçalves, and Costa (2023) evaluate and compare the performance of three traditional time-series forecasting methods: ARIMA models and their extensions, time-series decomposition combined with linear regression, and the Holt–Winters method. These techniques are applied to retail sales data from seven European countries characterized by pronounced trends and seasonality. The results show that all examined models successfully replicate the seasonal structure of the data; however, ARIMA models provide the highest forecasting accuracy according to MSE, RMSE, and MAPE indicators. At the same time, the Holt–Winters method proves to be a robust and efficient alternative capable of delivering comparable results, thus representing a viable option for the analysis of strongly seasonal time series.

Melnychenko, Matskul, and Osadcha (2022) investigate the monthly dynamics of exports, imports, and the trade balance between Ukraine and Romania over the period 2005–2021. For modeling and forecasting purposes, the authors use time-series data for 2015–2021, corresponding to the period following the entry into force of the EU–Ukraine Association Agreement. Econometric models were developed using the Box–Jenkins methodology, applying additive seasonal ARIMA (SARIMA) models as well as the Holt–Winters method with exponential smoothing and damped trends. Forecasts for exports, imports, and the trade balance for the fourth quarter of 2021 and the first quarter of 2022 revealed small forecast errors relative to observed values. For example, in the Holt–Winters model applied to the trade balance, relative forecast errors were 1.3% for October 2021, 2.6% for November 2021, and 0.4% for December 2021, confirming the high accuracy of the proposed approach.

Papazoglou, Pentecost, and Marques (2006) apply a gravity model to estimate the effects of the 2004 EU enlargement on trade balances and trade flows of the countries involved. The results show that approximately 25% of candidate countries' trade in 2003 can be attributed to trade expansion generated by the accession process. The authors emphasize, however, that EU integration not only stimulates trade volumes but also redirects trade flows, reducing the share of trade between new Member States and non-EU countries. In the immediate post-accession period, these economies experience widening trade deficits, as imports grow faster than exports. The impact of enlargement on trade balances varies significantly depending on the degree of economic integration and income levels of the new Member States. Consequently, the authors conclude that economic integration follows a differentiated dynamic, suggesting that the European Union should account for these specificities in future enlargements toward the Western Balkans and Southeast Europe.

Dziubanovska, Aliluiko, and Tymkiv (2024) investigate the forecasting of key international trade indicators within the European Union by applying hybrid prediction models. The study proposes an innovative methodological approach that combines statistical methods, machine learning techniques, and econometric models to enhance forecasting accuracy. In addition, the research examines the influence of external factors on EU international trade and develops integrated hybrid models capable of incorporating these explanatory variables into the forecasting process. The results contribute to a deeper understanding of trade flow dynamics within the

European Union and provide advanced analytical tools for anticipating trade developments under complex and volatile economic conditions.

In relation to the reviewed literature, which predominantly focuses on national case studies, limited time horizons, or aggregated indicators of agricultural trade, the results of the present study extend the analytical framework through a comparative and longitudinal approach to the share of agricultural raw material imports in total merchandise imports in Central and Eastern European countries. The findings highlight both the existence of common trends of structural convergence and the persistence of significant national differences, while also demonstrating the relevance of ARIMA econometric models for the analysis and forecasting of this segment of agricultural trade.

3. Research methodology

The analysis presented in this study is based on annual statistical data on agricultural raw material imports, expressed as a share of total merchandise imports (% of merchandise imports), for the period 1995–2024. The data are drawn from standardized international sources provided by the World Bank.

(https://data.worldbank.org/indicator/TM.VAL.AGRI.ZS.UN)

The countries analyzed are Romania, Poland, Hungary, the Czech Republic, Slovakia, Bulgaria, and Croatia, states that are representative of the Central and Eastern European region. The data are expressed in percentage terms in order to eliminate distortions arising from differences in economic size. The statistical and econometric analysis was conducted using the EViews and SPSS software packages, which were employed for model estimation and the implementation of validity tests.

For each country, descriptive indicators of central tendency and dispersion were calculated (mean, standard deviation, coefficient of variation, skewness, excess kurtosis, and minimum and maximum values). These indicators allowed for a comparison of the stability and variability of the time series, providing an overall picture of regional convergence in the evolution of the share of agricultural raw material imports. The Shapiro–Wilk test is one of the most widely used statistical methods for assessing the normality of a data distribution. Originally proposed by Shapiro and Wilk (1965), the test is based on the comparison of observed values with the theoretical values expected under a normal distribution, using a correlation coefficient constructed from the ordered data. Statistical significance is determined using the p-value, as follows:

• if $p > \alpha$ (where α denotes the significance threshold, typically 0.05), the null hypothesis H_0 that the data are drawn from a normal distribution is accepted;

• if $p \leq \alpha$, the null hypothesis is rejected, leading to the conclusion that the data distribution deviates significantly from normality.

The stationarity of the time series was evaluated using the Augmented Dickey–Fuller (ADF) test. The Dickey–Fuller test (Dickey & Fuller, 1979) is a widely used statistical procedure for assessing whether a time series is stationary. Stationarity is a key property in time series analysis, indicating that the series' statistical characteristics, such as mean and variance, remain constant over time. The Dickey–Fuller test specifically investigates the presence of a unit root within an autoregressive (AR) model, as the existence of a unit root implies that the series is non-stationary. The test formulates the null hypothesis H_0 that the time series possesses a unit root (i.e., it is non-stationary), against the alternative hypothesis H_1 that the series does not contain a unit root (i.e., it is stationary). Interpretation of the results involves comparing the computed test statistic or its associated p-value with critical values at conventional significance levels of 1%, 5%, and 10%. If the test statistic is lower than the relevant critical value, the null hypothesis is rejected, indicating stationarity. Likewise, a p-value below 0.05 suggests that the series can be considered stationary at the 5% significance level. The Dickey–Fuller test is commonly employed in time series analysis to determine whether a series is stationary or whether differencing is required to achieve stationarity. Establishing stationarity is essential for many forecasting and estimation procedures, including ARIMA modeling.

The ARIMA (AutoRegressive Integrated Moving Average) framework (Box et al., 2015) is among the most widely employed methods for time series modeling and forecasting. It effectively captures and predicts patterns in time series that exhibit autocorrelation, reflecting the dependence of current values on past observations..The ARIMA model consists of three main components:

- *Autoregressive* (AR). The autoregressive (AR) component of the model posits that the current value of the series can be expressed as a linear function of its past observations. In an AR(*p*) specification, the parameter *p* indicates the number of lagged values incorporated in the prediction of the current observation. The general form of the AR component is:

$$X_t = c + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + \epsilon_t,$$

where $\phi_1, \phi_1, \ldots, \phi_p$ are the autoregressive coefficients, *c* is a constant, and ϵ_t is the random error at time *t*.

- *Integrated* (I). The integrated (I) component indicates the number of differences needed to render a non-stationary time series stationary, where stationarity implies constant statistical properties over time. For a differencing order of *d*, the transformed series is given by

$$Y_t = (1 - B)^d X_t,$$

where *B* is the lag operator and *d* is the number of differentiations.

- *Moving Average* (MA). The moving average (MA) component models the current value of the series as a linear combination of past error terms. In an MA(*q*) specification, *q* denotes the number of lagged errors included in the model, and the general expression for the MA component is:

$$X_t = c + \epsilon_t + \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2} + \cdots + \theta_q X_{t-q},$$

where $\theta_1, \theta_2, \ldots, \theta_q$ are the coefficients of the moving average.

An ARIMA(*p, d, q*) model is defined by: *p* (order of the autoregressive component); *d* (order of the differencing; *q* (order of the moving average component).

The ARIMA model combines these three components into a general model:

$$X_t = c + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + \epsilon_t + \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2} + \cdots + \theta_q X_{t-q},$$

where the series X_t was differencing *d* times to make it stationary

The selection of optimal models was based on the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC), together with accuracy measures such as MAPE (Mean Absolute Percentage Error) and RMSE (Root Mean Squared Error). MAPE expresses the mean absolute error as a percentage of the actual values; in other words, it indicates, on average, by how many percentage points the model's forecasts deviate from the observed values. Conventionally, the following thresholds are used:

• MAPE < 10% – excellent forecasting performance
• 10% ≤ MAPE < 20% – good forecasting performance
• 20% ≤ MAPE < 50% – acceptable forecasting performance
• MAPE ≥ 50% – poor forecasting performance

Model validation was carried out using the Durbin–Watson and Breusch–Godfrey tests (to detect residual autocorrelation) and the ARCH test (to assess the presence of heteroscedasticity). The Durbin–Watson test produces a test statistic, denoted *DW*, which is based on the differences between residuals at two consecutive points in time. The null hypothesis H_0 assumes no first-order autocorrelation, while the alternative H_1 indicates its presence. The Durbin–Watson (*DW*) statistic is compared with the lower (d_L) and upper (d_U) bounds at a typical 5% significance level. If the *DW* statistic lies within (d_U,4−d_U), H_0 is not rejected, suggesting that the residuals are uncorrelated.

The Breusch–Godfrey test (Breusch, 1978; Godfrey, 1978) detects higher-order autocorrelation in regression residuals, extending the Durbin–Watson test, which is limited to first-order correlations. A p-value greater than 0.05 indicates that the null hypothesis of no autocorrelation cannot be rejected at the 5% significance level.

The ARCH test examines whether the squared residuals display autoregressive dependence, signaling conditional heteroscedasticity. If the associated p-value exceeds 0.05, the null hypothesis of homoscedasticity is not rejected at the 5% significance level.

4. Results and discussion

It can be, using also the Figure 1, that the average values for 1995–2004 (the pre-EU accession period) range between 1.5% and 3.0%, indicating that agricultural raw material imports represented a significant share of total imports. However, calculating the average for 2005–2024 shows values between 0.9% and 1.5%, revealing a clear downward trend, generally linear, reflecting processes of industrialization and European integration.

Among the possible economic explanations, EU accession between 2004 and 2013 stands out, which facilitated integration into the European single market and easier access to EU-produced agricultural goods, thereby reducing imports from outside the EU. Additionally, the growth of exports of processed food products reduced the need for raw material imports.

Following accession, European funds, particularly under the Common Agricultural Policy (CAP), were accessed, leading to increased domestic productivity. Countries such as Poland and Romania became exporters of cereals and food products, further reducing raw material imports. Slovakia, the Czech Republic, and Hungary developed into industrial economies (automotive, electronics), shifting import demand from agricultural raw materials toward industrial raw materials. Post-crisis fluctuations (2008–2012) are also evident, with a slight increase in imports during the crisis years, driven by price variations or temporary import needs. However, after 2010, all countries stabilized below 1.5%.

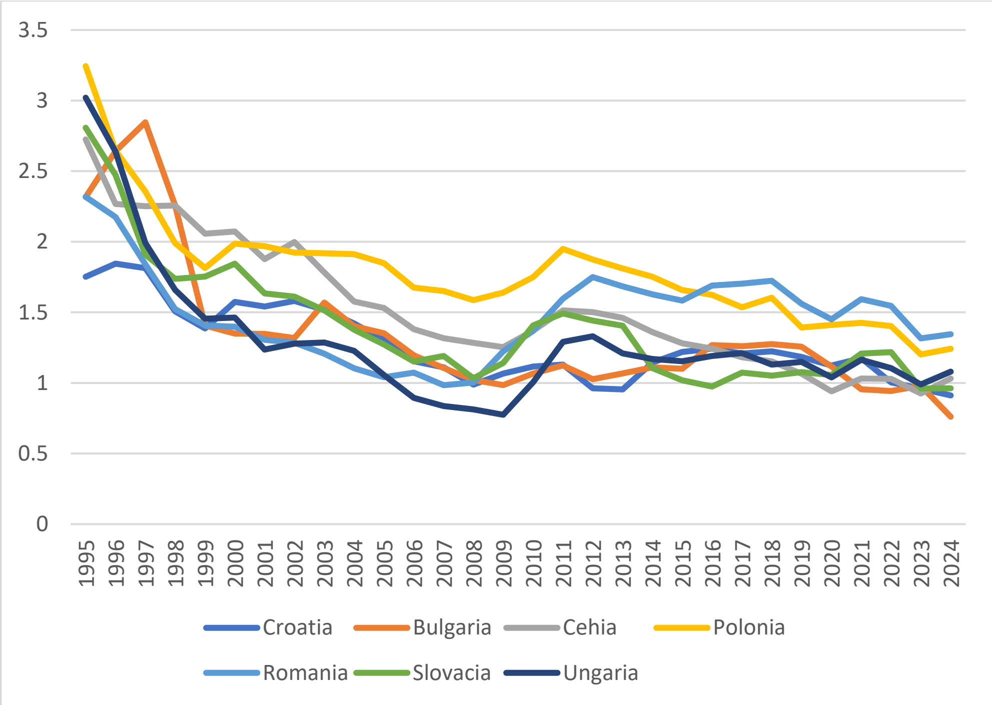


Figure 1. Agricultural raw materials imports (% of merchandise imports)

Following accession, European funds, particularly under the Common Agricultural Policy (CAP), were accessed, leading to increased domestic productivity. Countries such as Poland and Romania became exporters of cereals and food products, further reducing raw material imports. Slovakia, the Czech Republic, and Hungary developed into industrial economies (automotive, electronics), shifting import demand from agricultural raw materials toward industrial raw materials. Post-crisis fluctuations (2008–2012) are also evident, with a slight increase in imports during the crisis years, driven by price variations or temporary import needs. However, after 2010, all countries stabilized below 1.5%.

In summary, there is a general and significant declining trend in the share of agricultural raw material imports in total imports (−50% to −70%), primarily driven by industrialization, EU integration, increased domestic production, and economic diversification. By 2024, the values are relatively convergent (0.7%–1.3%), reflecting regional economic maturation and a similar degree of trade integration among these countries. Table 1 summarizes the evolution of agricultural raw material imports as a share of total merchandise imports across seven Central and Eastern European countries, highlighting trends, extremes, relative changes over nearly three decades, and the main economic drivers behind these developments.

Table 1. Evolution of agricultural raw material imports

Country	General Trend	Maximum Value	Minimum Value	2024 vs 1995 Change	Key Observations
Croatia	Slow decline, stabilization after 2010	1.84 (1996)	0.91 (2024)	−48%	Reduced dependence on agricultural raw materials; economic diversification.
Bulgaria	Sharp decline	2.85 (1997)	0.76 (2024)	−73%	Shift toward light industry and services; agricultural modernization.
Czech Republic	Slight decline, stabilization	2.72 (1995)	0.92 (2023)	−62%	Strong industrialization; competitive domestic production.
Poland	Moderate decline	3.24 (1995)	1.20 (2023)	−63%	Significant growth of the domestic agricultural sector; net exporter of food products.
Romania	Sharp decline until 2005, then stabilization	2.31 (1995)	0.98 (2007)	−42%	Post-2007 slight increase due to EU value chain integration and imports for processing.
Slovakia	Significant decline until 2006, then plateau	2.81 (1995)	0.96 (2024)	−66%	Development of the automotive industry and decline of traditional agriculture.
Hungary	Sharp decline	3.02 (1995)	0.77 (2009)	−64%	Modernization and orientation toward processed agri-food exports.

Table 2 presents the results of the Shapiro-Wilk test (p-value) for checking the normality of the distributions. Only Romania has a distribution that tends towards the normal distribution, and for the other countries the distributions are not normal. This fact justifies the choice of the Spearman correlation coefficient. However, the Spearman and Pearson values are very close (differences <0.03), so the relationships are mostly monotonic and almost linear, although not perfectly normal. In this case, the Pearson analysis remains interpretable, but Spearman is statistically more appropriate due to the non-normal nature of the data.

Table 2. Shapiro-Wilk test for normality of distributions

	Croatia	Czechia	Hungary	Poland	Romania	Bulgaria	Slovakia
Shapiro-Wilk test (p-value)	0.028	0.020	0.000	0.001	0.225	0.000	0.000

The Spearman correlation levels (Table 3) indicate an overall average of ρ ≈ 0.79, reflecting a high degree of correlation between the trajectories of European countries regarding agricultural raw material imports. The highest correlations (>0.9) are observed between the Czech Republic–Slovakia, Poland–Slovakia, and Slovakia–Hungary, indicating an almost perfect economic synchronization. Moderate correlations (0.7–0.85) occur among Croatia, Bulgaria, Hungary, the Czech Republic and Poland, suggesting similar directional trends but differing in intensity. In contrast, weak correlations (<0.6) are observed for Romania relative to the other countries, reflecting a distinct trajectory influenced by local agricultural factors.

Table 3. Correlation matrix, Spearman coefficient

	Croatia	Bulgaria	Czechia	Poland	Romania	Slovakia	Hungary
Croatia	1						
Bulgaria	0.872	1					
Czechia	0.841	0.802	1				
Poland	0.775	0.771	0.902	1			
Romania	0.402	0.505	0.364	0.558	1		
Slovakia	0.789	0.783	0.918	0.936	0.561	1	
Hungary	0.768	0.826	0.812	0.889	0.779	0.918	1

From an economic interpretation standpoint, the Central European bloc (Czech Republic–Slovakia–Poland–Hungary) exhibits Spearman coefficients above 0.88, indicating nearly identical trends. This can be attributed to shared industrial structures, similar EU policies, integrated markets, and regional agri-food value chains. The Balkan bloc, represented here by Croatia and Bulgaria with a coefficient of 0.87, shows regional synchronization at a lower level, characterized by mixed economies (tourism and agriculture).

Romania displays a distinct profile, with ρ ≈ 0.50–0.55 relative to other countries, reflecting an agricultural model with idiosyncratic variations influenced by the slow transition of the primary sector and its role as a raw cereal exporter after 2010. Romania's distinctiveness is also evident in its higher temporal volatility (sharper increases and decreases), delayed agricultural reforms (1990–2000), and, after 2007, a mixed import pattern focusing on raw materials for processing rather than for direct consumption.

From the analysis of the descriptive statistics (Table 4), it is observed that Poland exhibits the highest mean value (1.79%), reflecting an initially strong dependence on agricultural imports and a large domestic agricultural base. The lowest mean is recorded for Croatia (1.27%), indicative of an economy more oriented toward services and tourism. Romania (1.48%) is slightly above the regional average (≈1.44%), reflecting a balance between domestic agriculture and moderate import dependence. Overall, all countries display mean values between 1% and 2%, signaling economic convergence and a reduction in gross agricultural imports during the post-EU accession period.

Table 4. Descriptive statistics of imports

	Mean	Standard deviation	Coefficient of variation (CV)	Kurtosis	Skewness	Min	Max
Croatia	1.270	0,264	20,83	-0,390	0,727	0,911	1.844
Bulgaria	1,347	0,504	37,40	3,017	1,902	0,760	2.846
Czechia	1,523	0,4678	30,70	-0,047	0,849	0.925	2.724
Hungary	1,294	0,485	37,53	6,252	2,391	0.774	3.020
Poland	1,793	0,408	22,77	4,868	1,753	1.202	3.244
Romania	1,480	0,316	21,37	0,748	0,627	0.984	2.317
Slovakia	1,396	0,439	31,44	3,113	1,666	0.961	2.807

Regarding the volatility of the series over time, the most stable trajectories were observed in Croatia (CV = 20.83%) and Romania (CV = 21.37%), with Poland (CV = 22.77%) showing relatively small variations and a consistently linear downward trend. The highest volatility was observed in Hungary (CV = 37.53%), Bulgaria (CV = 37.40%), Slovakia (CV = 31.44%), and the Czech Republic (CV = 30.7%), reflecting significant fluctuations likely due to the 2008 financial crisis and structural changes.

Economically, Central European countries experienced a more abrupt adaptation to the European single market, whereas the Balkan countries (Croatia and Romania) underwent a slower but more stable transition. All countries exhibit positively skewed distributions, indicating that the share of imports declined progressively over time. Bulgaria, in particular, shows high volatility and pronounced skewness, reflecting an unstable transition with periods of intense adjustment during the 1990s. Concerning the amplitude of variation, the largest differences between minimum and maximum values were recorded in Hungary (0.774–3.020) and Poland (1.202–3.244), signaling a substantial reduction in agricultural imports. The smallest variations occurred in Croatia (0.911–1.844) and Romania (0.984–2.317), indicating a more gradual and stable transition.

To examine the stationarity properties of the series on agricultural raw material imports, the Augmented Dickey-Fuller (ADF) test was applied (Table 5). The results of the test applied to the level series (IMPORT) show that for Hungary, Poland, and Slovakia, the p-values are below the 5% significance threshold, indicating that these series are stationary in level. Therefore, they can be considered as integrated processes of order zero, I(0). In contrast, for Bulgaria, Croatia, the Czech Republic and Romania, the p-values exceed 0.05, meaning the null hypothesis cannot be rejected. Consequently, the series for these countries are non-stationary in level and require differencing to achieve stationarity.

After applying first-order differencing (D(IMPORT)), the ADF test results show a significant improvement in the statistical values for Bulgaria, Croatia and the Czech Republic, with all p-values falling below 0.05. This confirms that these series become stationary after first differencing and are thus first-order integrated processes, I(1).

For Romania, however, the series remains non-stationary after first differencing (p = 0.1387), requiring second-order differencing to achieve stationarity (p = 0.0001).

In conclusion, agricultural raw material imports exhibit stationary behavior in level for Hungary, Poland, and Slovakia, whereas Bulgaria, Croatia, and the Czech Republic require first-order differencing, and Romania requires two differences. From an economic perspective, this suggests that shocks to imports have temporary effects in the first three countries, whereas in the latter three countries, shocks tend to have persistent long-term effects, reflecting a more unstable import dynamic relative to past trends.

Table 5. Augmented Dickey-Fuller test for agricultural raw materials imports

	Bulgaria	Croatia	Czech Republic	Hungary	Poland	Slovakia	Romania
IMPORT (p-value)	0.6148	0.6094	0.3507	0.0038	0.0001	0.0160	0.0715
D(IMPORT) (p-value)	0.0174	0.0048	0.0000				0.1387
D(IMPORT,2) (p-value)							0.0001

Source: Made by the authors with Eviews software

4.1 ARIMA forecasting

4.1.1 Romania

The analysis of Romania's foreign trade structure reveals a downward trend regarding imports of agricultural raw materials, relative to total merchandise imports. Over the period 1995–2024, a significant decline was observed in the share of this category within total imports. Thus, in 1995, imports of agricultural raw materials accounted for 2.31% of total imports, reaching a minimum value of only 0.98% in 2007. For the purpose of applying the ARIMA model for forecasting, an essential initial step consists of testing for stationarity (Table 5). Using the correlogram of D(IMPORT,2), several potential ARIMA models of the form (p,2,q) were examined. Multiple valid models were identified as a result (Table 6).

Table 6. AIC, SC, diagnostic tests and prediction errors for Romania

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(1,2,1)	-1.614	-1.472	1.98	0.63	0.06	0.245	16.11%
ARIMA(1,2,6)	-1.404	-1.263	1.21	0.07	0.47	0.304	20.13%
ARIMA(1,2,7)	-1.835	-1.694	1.37	0.12	0,79	0.321	21.11%
ARIMA(2,2,1)	-1.384	-1.241	1.13	0.06	0.31	0.250	16.57%

Source: Made by the authors with Eviews software

The optimal ARMA(1,2,1) model was selected, exhibiting the lowest values of MAPE (16.11%) and RMSE (0.245), as well as the smallest Akaike and Schwarz information criteria compared to other models, though the differences were marginal. The coefficients are statistically significant, with associated p-values for the t-statistic effectively zero (Annex: Table A1). The F-test value of 90.16 confirms the overall validity of the ARIMA model.

It was also verified that the model residuals are not autocorrelated, using the Durbin-Watson test (value 1.98) and the Breusch-Godfrey test (associated p-value 0.63). These results indicate that the model accurately captures the dynamics of the time series without residual autocorrelation. The absence of heteroscedasticity was confirmed using the ARCH test, with an associated p-value of 0.06 (Table A1). This indicates that the error variance is constant over time, which is essential for the reliability of forecasts. The ARIMA model's forecast is presented in Table 7 and graphically depicted, including the confidence interval, in Figure 2. The ARIMA(1,2,1) model provides forecasts for IMPORT, showing a slight upward trend in 2025, followed by a decrease in agricultural product imports in subsequent years.

Table 7. Romania import forecasts

Romania	Forecast 2025	Forecast 2026	Forecast 2027
ARMA(1,2,1)	1.427%	1.412%	1.401%

Source: Made by the authors with Eviews software

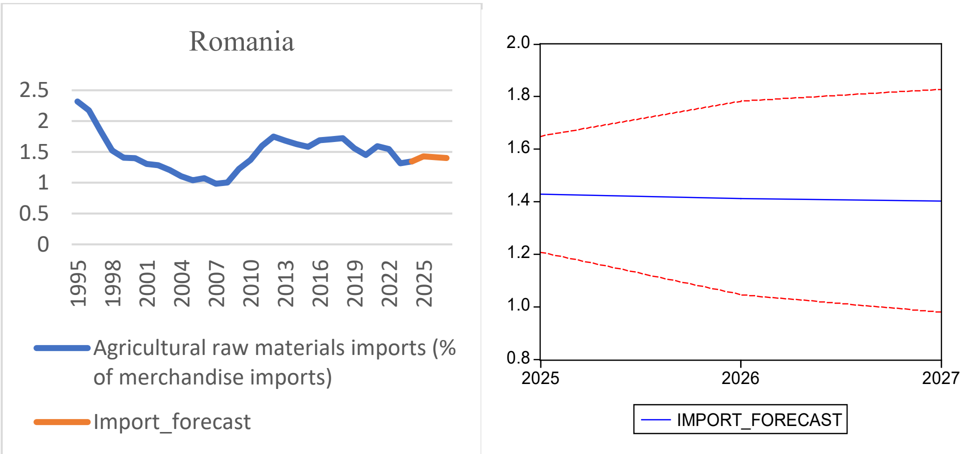


Figure 2. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in Romania

4.1.2 Croatia

Between 1995 and 2024, Croatia experienced a consistent decline in the share of agricultural raw materials within total merchandise imports. The highest level of this indicator was recorded in 1992, when imports of agricultural raw materials accounted for 3.65% of total imports. Subsequently, this share followed a downward trend, reaching a minimum of 0.95% in 2013. In 2023, the indicator remained at a low level of 0.96%. This evolution clearly reflects a structural transformation in Croatia's foreign trade, influenced by the growth of domestic agricultural production capacity, diversification of supply sources and integration into European value chains. Furthermore, beginning in 2013, Croatia began to register a surplus in agri-food trade, indicating an improvement in the trade balance in this sector.

For the purpose of applying the ARIMA model for forecasting, it is necessary to verify the stationarity of the time series. A first-order differencing was applied, producing the stationary series D(IMPORT) (Table 5). Using the correlogram, several potential ARIMA models were examined, given in Table 8.

Table 8. AIC, SC, diagnostic tests and prediction errors for Croatia

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(1,1,1)	-1.574	-1.431	2.01	0.99	0.22	0.194	14.94%
ARIMA(2,1,2)	-1.690	-1.546	1.66	0.57	0.45	0.202	14.98%
ARIMA(2,1,4)	-1.749	-1.605	1.81	0.09	0.33	0.332	26.88%

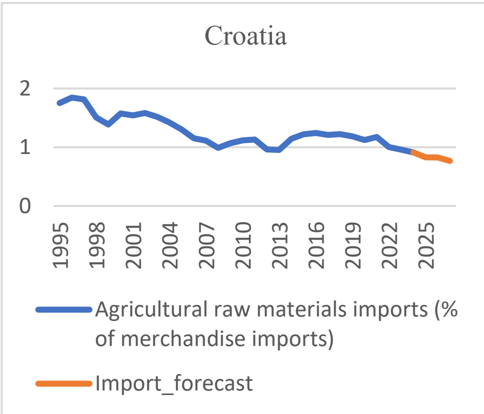
Source: Made by the authors with Eviews software

The optimal model was selected as ARIMA(1,1,1), as it satisfies all validation tests (Annex: Table A2), is free from residual autocorrelation and heteroscedasticity and exhibits the lowest RMSE and MAPE values. Although the AIC and SC values are slightly higher, the differences are marginal. The forecast generated by the ARIMA(1,1,1) model is presented in Table 9 and graphically depicted, including the confidence interval, in Figure 3. The ARIMA(1,1,1) model provides forecasts for the period 2025–2027, indicating a downward trend in agricultural product imports.

Table 9. Croatia import forecasts

Croatia	Forecast 2025	Forecast 2026	Forecast 2027
ARIMA(1,1,1)	0,829%	0,826%	0,766%

Source: Made by the authors with Eviews software



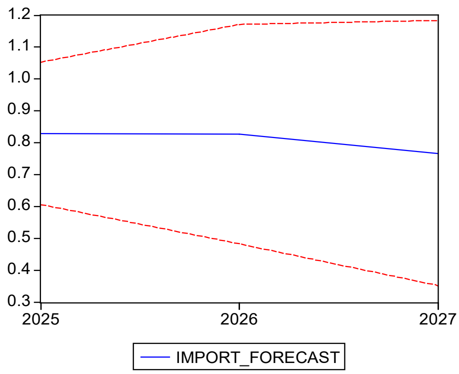


Figure 3. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in Croatia

4.1.3 Bulgaria

The data indicate a long-term downward trend in Bulgaria's imports of agricultural raw materials, expressed as a share of total merchandise imports. In the period 1995–1997, the level was relatively high (above 2.3%, peaking at nearly 2.85% in 1997), followed by a sharp decline until around 2000, when the share fell to approximately 1.3–1.4%. Between 2000 and 2015, the share remained relatively stable, fluctuating around 1–1.1% with moderate variations. Between 2016 and 2019, a slight recovery is observed, reaching approximately 1.27%, possibly associated with agricultural trade dynamics or domestic demand. After 2020, the trend resumes a downward trajectory, reaching the lowest value in the series in 2024 (approximately 0.76%). This evolution suggests either a reduced dependence on agricultural raw material imports or a diversification of the import structure, with a greater share of industrial or processed goods. Applying the Dickey-Fuller test to the initial IMPORT, indicating that the series is non-stationary. A first-order differencing was applied, resulting in a stationary series D(IMPORT) (Table 5). Using the correlogram, several potential ARIMA models were identified, as given in Table 10.

Table 10. AIC, SC, diagnostic tests and prediction errors for Bulgaria

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(1,1,5)	-1.724	-1.581	1.92	0.88	0.57	1.065	91.25%
ARIMA(2,1,4)	-1.296	-1.152	2.36	0.30	0.14	1.251	109.00%
ARIMA(4,1,4)	-1.913	-1.767	1.97	0.92	0.53	0.279	20.11%

Source: Made by the authors with Eviews software

The optimal model selected was ARIMA(4,1,4) (Annex: Table A3), as it exhibits lower Akaike and Schwarz information criteria compared to other models, as well as the lowest RMSE and MAPE values. The model's forecast is presented in Table 11 and graphically depicted, including the confidence interval, in Figure 4. The ARIMA(4,1,4) model provides forecasts for the period 2025–2027, indicating a slight downward trend in agricultural product imports.

Table 11. Bulgaria import forecasts

Bulgaria	Forecast 2025	Forecast 2026	Forecast 2027
ARIMA(4,1,4)	0,686%	0,644%	0,6222%

Source: Made by the authors with Eviews software

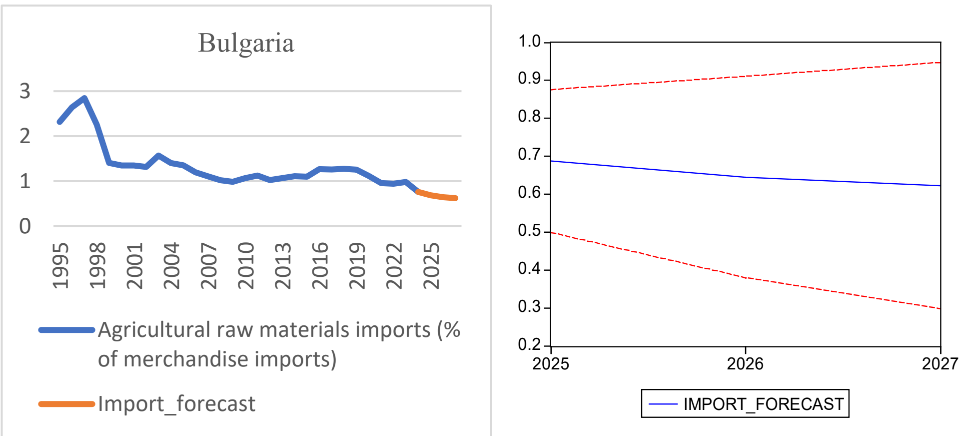


Figure 4. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in Bulgaria

4.1.4 Czech Republic

Between 1995 and 2024, the Czech Republic experienced a significant decline in the share of agricultural raw material imports within total merchandise imports. In 1995, this share was 2.72%, decreasing to only 0.92% in 2023. This decline indicates a reduced dependence of the Czech Republic on agricultural raw material imports, which can be interpreted as a sign of economic maturation and an increase in domestic agricultural production capacity. To verify the stationarity of the initial series, the Dickey-Fuller test was applied, considering a model with both constant and trend. The resulting p-value was 0.3507, indicating that the initial IMPORT series is non-stationary. A first-order differencing was applied, producing the stationary series D(IMPORT) (Table 5). Based on the analysis of the correlogram, several potential ARIMA models of the form (p,1,q) were tested (Table 12).

Table 12. AIC, SC, diagnostic tests and prediction errors for Czech Republic

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(2,1,2)	-1.819	-1.675	2.16	0.85	0.14	0.335	22.52%
ARIMA(6,1,1)	-2.084	-1.936	2.31	0.56	0.99	0.208	12.84%
ARIMA(6,1,6)	-2.579	-2.431	1.89	0.94	0.79	0.478	37.64%

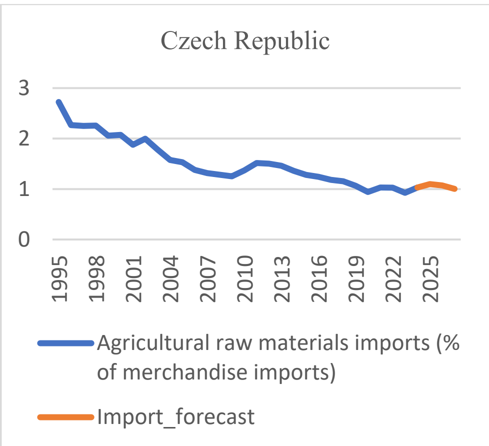
Source: Made by the authors with Eviews software

After evaluating various options, ARIMA(6,1,1) was selected as the optimal model (Annex: Table A4). The forecasts are presented in Table 13 and graphically illustrated, including the confidence interval, in Figure 5. The ARIMA(6,1,1) model anticipates a downward trend in agricultural raw material imports for the period 2025–2027.

Table 13. Czech Republic import forecasts

Czech Republic	Forecast 2025	Forecast 2026	Forecast 2027
ARIMA(6,1,1)	1,097%	1,072%	1,003%

Source: Made by the authors with Eviews software



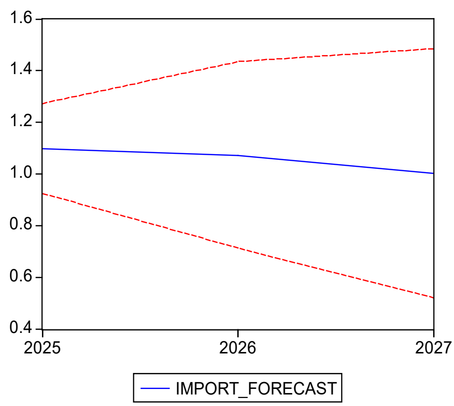


Figure 5. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in the Czech Republic

4.1.5 Poland

Between 1995 and 2024, the share of agricultural raw material imports in Poland's total merchandise imports decreased significantly, from 3.24% to 1.24%. This trend reflects a reduced dependence of Poland on external markets for such products and suggests a profound transformation in the structure of the country's agricultural and trade economy. The decline in the share of agricultural raw material imports indicates that Poland has moved from a position of reliance on external agricultural inputs to one of relative autonomy, relying more on domestic resources and developing internal capacities. This serves as an indicator of modernization in the agricultural sector as well as of an increasingly competitive economy within Europe.

To verify the stationarity of the initial series, the Dickey-Fuller test was applied, (Table 5). Based on the correlogram analysis, several potential ARMA models of the form (p,0,q) were examined.

Table 14. AIC, SC, diagnostic tests and prediction errors for Poland

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(1,0,5)	-1.987	-1.845	1.64	0.84	0.49	0.335	14.60%
ARIMA(1,0,6)	-1.947	-1.806	1.73	0.62	0.99	0.235	11.10%
ARIMA(1,0,7)	-1.932	-1.791	1.39	0.125	0.95	0.238	11.58%

Source: Made by the authors with Eviews software

Several valid models were identified, and the ARIMA(1,0,6) model was selected (Annex: Table A5). The forecast is presented in Table 15 and graphically illustrated, including the confidence interval, in Figure 6. The model provides forecasts for the period 2025–2027, indicating an upward trend in the final period.

Table 15. Poland import forecasts

Poland	Forecast 2025	Forecast 2026	Forecast 2027
ARIMA(1,0,6)	1.188%	1.190%	1.253%

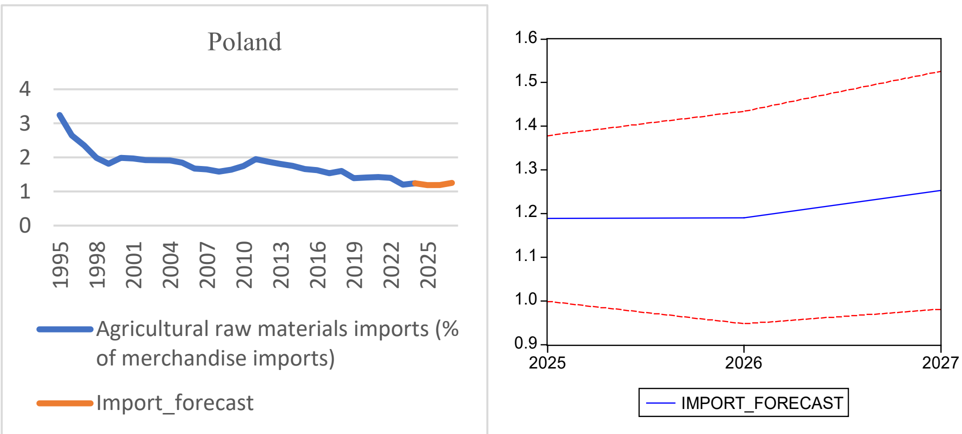


Figure 6. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in Poland

4.1.6 Slovakia

Between 1995 and 2008, Slovakia experienced a downward trend in the share of agricultural raw material imports within total merchandise imports. After 2010, this share stabilized around 1%, with the lowest value recorded in 2023 at 0.92%. To evaluate the stationarity of the initial IMPORT series, the Dickey-Fuller test was applied using a model that includes both a constant and a trend. The test yielded a p-value of 0.0165, allowing the null hypothesis of a unit root to be rejected. Therefore, it can be concluded that the IMPORT series is stationary (Table 5). Based on the analysis of the series correlogram, several potential ARIMA models were tested, and the validated models are presented in Table 16.

Table 16. AIC, SC, diagnostic tests and prediction errors for Slovakia

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(1,0,3)	-1.256	-1.114	2.01	0.50	0.21	0.155	9.93%
ARIMA(1,0,4)	-1.329	-1.188	2.16	0.53	0.67	0.155	9.47%
ARIMA(1,0,5)	-1.378	-1.236	1.74	0.25	0.87	0.165	9.79%
ARIMA(1,0,6)	-1.376	-1.235	1.90	0.61	0.31	0.166	10.27%
ARIMA(2,0,1)	-1.204	-1.062	1.57	0.38	0.55	0.172	11.65%

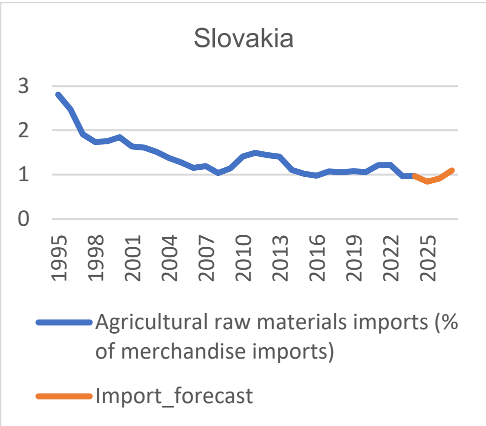
Source: Made by the authors with Eviews software

Among the validated models, the optimal model selected was ARIMA(1,0,4) (Annex: Table A6). The forecasts generated by the chosen model for the period 2025–2027 are presented in Table 17 and graphically illustrated, including confidence intervals, in Figure 7. The results indicate a downward trend in imports in 2025, followed by a slight increase thereafter.

Table 17. Slovakia import forecasts

Slovakia	Forecast 2025	Forecast 2026	Forecast 2027
ARIMA(1,0,4)	0.839%	0.913%	1.092%

Source: Made by the authors with Eviews software



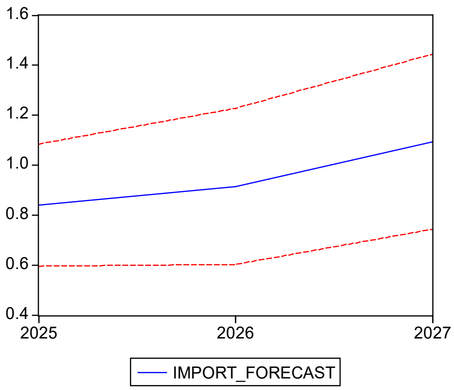


Figure 7. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in Slovakia

4.1.7 Hungary

Between 1995 and 2024, Hungary experienced a significant decline in the share of agricultural raw material imports within total merchandise imports. This trend suggests a reduced dependence of the Hungarian economy on imports of agricultural raw materials. This change may result from more efficient domestic production as well as economic strategies aimed at achieving greater autonomy in agricultural products. To evaluate the stationarity of the IMPORT series, the Dickey-Fuller test was applied (Table 18). Among the validated models, the optimal model selected was ARIMA(1,0,3), as it exhibits the lowest prediction errors, even though the Akaike and Schwarz selection criteria are not the lowest; the differences are marginal. The validity of the model was also confirmed through residual analysis (Annex: Table A7). The forecast results are presented in Table 19 and graphically illustrated, including the confidence interval, in Figure 8. The results indicate a slight increase in agricultural raw material imports in the forthcoming period.

Table 18. AIC, SC, diagnostic tests and prediction errors for Hungary

Model	AIC	SC	DW	B-G test p-value	ARCH test p-value	RMSE	MAPE
ARIMA(1,0,3)	-1.786	-1.644	1.85	0.95	0.64	0.142	10.50%
ARIMA(1,0,5)	-1.748	-1.606	1.70	0.24	0.31	0.157	11.29%
ARIMA(1,0,6)	-1.893	-1.752	1.46	0.20	0.87	0.148	10.73%

Source: Made by the authors with Eviews software

Table 19. Hungary import forecasts

Hungary	Forecast 2025	Forecast 2026	Forecast 2027
ARIMA(1,0,3)	1,091%	1,151%	1,068%

Source: Made by the authors with Eviews software

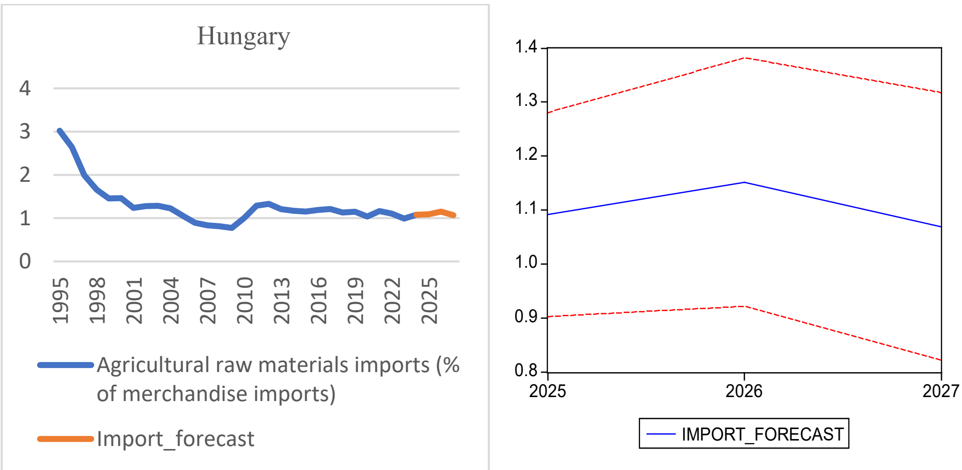


Figure 8. Imports in the period 1995-2024 and the forecast with confidence interval for 2025-2027 in Hungary

5. Conclusions

Analysis of Agricultural Raw Material Imports in Central and Eastern Europe (1995–2024)

The analysis of agricultural raw material imports between 1995 and 2024 for Central and Eastern European countries highlights profound structural transformations associated with industrialization, European integration, and agricultural modernization. Empirical results indicate a general downward trend in the share of these imports, with reductions ranging between 50% and 70% compared to pre-EU accession levels.

The significant decrease in gross agricultural imports reflects the growth of domestic production capacity, improvements in agricultural efficiency, and the diversification of national economies through the expansion of industrial and service sectors. Countries such as Poland, Slovakia, and Hungary have become net exporters of processed agri-food products, while Romania and Croatia exhibit a slower but steady transition, characterized by a moderate and relatively constant share of agricultural imports.

Inter-country correlation analysis (average Spearman coefficients ≈ 0.79) confirms a high degree of regional synchronization in the evolution of agricultural imports, especially among Central European countries (Czech Republic, Slovakia, Hungary, Poland). The Balkan block (Croatia and Bulgaria) shows lower convergence, attributable to the mixed structure of their economies, partly oriented toward tourism and services. Romania stands out with a distinctive profile, showing specific dynamics and lower correlation with other countries, reflecting the slower agricultural transition and its role as a net exporter of raw cereals.

Augmented Dickey–Fuller (ADF) tests confirm stationarity for Hungary, Poland, and Slovakia, whereas Bulgaria, Croatia, and the Czech Republic require first-order differencing, and Romania requires second-order differencing. This distribution suggests varying degrees of adaptation to external trade shocks: temporary effects for the first group and more persistent effects for the latter.

ARIMA Forecasts for 2025–2027

ARIMA models applied for short-term forecasting indicate stabilization of agricultural raw material imports at low levels (0.8–1.4%), suggesting the attainment of a structural balance between domestic production and import needs. Economically, this reflects the maturation of regional agricultural markets and advanced trade integration within the European Union.

In the medium term, this downward trend is expected to consolidate, supported by:

increased competitiveness of regional agriculture through EU-funded investments (CAP and NextGenerationEU), strengthening the role of high-value-added processed exports, diversification of supply chains and reduced reliance on extra-EU sources.

Overall, the reduction in gross agricultural imports does not signal a contraction of the agricultural sector but rather reflects structural transformation and increased economic resilience in the region. Public policies should continue supporting agricultural modernization, technological innovation, and integration into European value chains while maintaining a balance between food self-sufficiency and active participation in international trade.

Answers to Research Questions Based on Empirical Results

RA1. Empirical analysis indicates a clear and generalized downward trend in the share of agricultural raw material imports in total merchandise imports for all countries analyzed between 1995 and 2024. Pre-EU accession averages (1995–2004) ranged from 1.5% to 3.0%, while post-accession (2005–2024) values fell to 0.9%–1.5%, reflecting industrialization, agricultural modernization, and EU market integration.

RA2. Descriptive statistics reveal structural differences across countries, both in average import levels and volatility. Poland exhibits the highest mean values, while Croatia shows the lowest. Volatility is higher in Hungary, Bulgaria, and Slovakia, indicating rapid structural adjustments, whereas Romania and Croatia experienced a more gradual and stable transition.

RA3. Spearman correlation coefficients indicate advanced regional convergence, with an average correlation of ~0.79. Very high correlations among Central European countries (Czech Republic, Slovakia, Poland, Hungary) reflect near-synchronized developments driven by common agricultural policies, integration into regional value chains, and the effects of the Common Agricultural Policy (CAP). Convergent values recorded in 2024 confirm regional economic maturation.

RA4. Romania displays a relatively distinct profile in the region. Despite the overall downward trend, its lower correlations with other countries reflect specific factors, such as slow post-transition agricultural restructuring and its dual role as a raw cereal exporter and importer of processing inputs. This explains higher variations and unique time-series behavior.

RA5. Shapiro–Wilk and ADF tests show that most series deviate from normality and have varying degrees of stationarity. Hungary, Poland, and Slovakia have stationary levels, suggesting that shocks to imports are temporary. Bulgaria, Croatia, and the Czech Republic require first-order differencing, while Romania requires second-order differencing, indicating more persistent shocks and structurally unstable dynamics.

RA6. Empirical results demonstrate that ARIMA econometric models are appropriate for short-term forecasting of agricultural raw material imports in the analyzed Central and Eastern European countries. The Box–Jenkins methodology, preceded by stationarity testing through the ADF test, allowed for correct specification of models according to each country's series integration order. The selected ARIMA models meet standard statistical validation criteria, with residuals being uncorrelated and homoscedastic according to Durbin–Watson, Breusch–Godfrey, and ARCH tests. Forecast accuracy is confirmed by MAPE values below 20% for all countries, indicating good predictive quality in line with accepted literature standards. ARIMA models therefore provide reliable short-term estimates of import dynamics and serve as useful tools for commercial analysis and economic policy planning.

RA7. Forecasts based on ARIMA models indicate a continued general trend of stabilization or slight reduction in the share of agricultural raw material imports in total merchandise imports for 2025–2027. This is consistent with the downward trend observed in 1995–2024 and reflects the consolidation of structural changes in the analyzed economies.

For Romania, forecasts indicate a slight marginal increase in 2025, followed by gradual decreases in 2026–2027, suggesting relatively stable agricultural imports integrated within European agri-food value chains. For other countries, forecasts show minor variations without major structural changes, confirming economic maturation and regional convergence. Economically, these results suggest that agricultural raw material imports will no longer constitute a short-term trade imbalance, but will fluctuate within a narrow range determined mainly by processing needs, market adjustments, and cyclical factors rather than structural dependence.

Research Limitations

While the study provides robust results on agricultural raw material imports in Central and Eastern Europe, several limitations must be considered:

- the analysis relies on annual aggregated data, suitable for identifying long-term structural trends but unable to capture seasonal fluctuations or very short-term dynamics.
- the study focuses exclusively on raw agricultural imports, excluding processed agri-food products. This allows a clear assessment of dependence on external agricultural inputs but does not fully reflect the complexity of agri-food value chains.
- the use of univariate ARIMA models does not explicitly incorporate exogenous factors such as international prices, climate conditions, or agricultural policy changes. Nevertheless, MAPE values indicate good short-term forecast accuracy.
- the sample is limited to selected Central and Eastern European countries, which restricts generalization to the entire EU but ensures comparative relevance for the region studied.

Future Research Directions

Building on these limitations, future research could explore:

- using higher-frequency data (quarterly or monthly) to capture short-term reactions to economic and trade shocks;
- including processed agri-food products to provide a more comprehensive analysis of integration into European and global value chains;
- applying multivariate or hybrid models (VAR, VECM, ARIMAX) to integrate exogenous factors such as commodity prices, climate change, CAP subsidies, or major geopolitical events;
- expanding the sample to other EU member states or neighboring countries to test convergence processes and trade resilience in the agricultural sector more broadly.

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Annex

Table A1. ARIMA (1,2,1) model at D(IMPORT,2) for Romania

Dependent Variable: D(IMPORT,2)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.375395	0.118681	11.58901	0.0000
AR(1)	0.710609	0.107435	6.614306	0.0000
MA(1)	0.716047	0.137693	5.200318	0.0000
R-squared	0.873994	Akaike info criterion		-1.614327
Adjusted R-squared	0.864301	Schwarz criterion		-1.472883
Durbin-Watson stat	1.987793	F-statistic		90.16964
		Prob(F-statistic)		0.000000

Table A2. ARIMA (1,1,1) model at D(IMPORT) for Croatia

Dependent Variable: D(IMPORT)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.036111	0.022645	-1.594680	0.1233
AR(1)	-0.712327	0.162611	-4.380559	0.0002
MA(1)	0.959545	0.030497	31.46352	0.0000
R-squared	0.103220	Akaike info criterion		-1.574224
Adjusted R-squared	0.031477	Schwarz criterion		-1.431488
Durbin-Watson stat	2.013964	F-statistic		1.438752

Table A3. ARIMA (4,1,4) model at D(IMPORT) for Bulgaria

Dependent Variable: D(IMPORT)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.044688	0.022333	-2.001025	0.0579
AR(4)	-0.384927	0.140197	-2.745617	0.0118

MA(4)	0.915513	0.054852	16.69048	0.0000
R-squared	0.370516	Akaike info criterion		-1.913314
Adjusted R-squared	0.313290	Schwarz criterion		-1.767049
Durbin-Watson stat	1.972057	F-statistic		6.474621
		Prob(F-statistic)		0.006149

Table A4. ARIMA(6,1,1) model at D(IMPORT) for Czech Republic

Dependent Variable: D(IMPORT)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.042220	0.027043	-1.561249	0.1341
AR(6)	-0.200856	0.087697	-2.290345	0.0330
MA(1)	0.934705	0.051161	18.26977	0.0000
R-squared	0.403313	Akaike info criterion		-2.084952
Adjusted R-squared	0.343644	Schwarz criterion		-1.936844
Durbin-Watson stat	2.318618	F-statistic		6.759192
		Prob(F-statistic)		0.005721

Table A5. ARIMA (1,0,6) model at IMPORT for Poland

Dependent Variable: IMPORT				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.398361	0.162022	8.630659	0.0000
AR(1)	0.798600	0.060731	13.14976	0.0000
MA(6)	0.927673	0.037792	24.54659	0.0000
R-squared	0.925917	Akaike info criterion		-1.947828
Adjusted R-squared	0.920218	Schwarz criterion		-1.806383
Durbin-Watson stat	1.728914	F-statistic		162.4786
		Prob(F-statistic)		0.000000

Table A6. ARIMA (1,0,4) model at IMPORT for Slovakia

Dependent Variable: IMPORT				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.109345	0.073603	15.07205	0.0000
AR(1)	0.797319	0.056375	14.14316	0.0000
MA(4)	-0.799659	0.120319	-6.646178	0.0000
R-squared	0.896639	Akaike info criterion		-1.329462
Adjusted R-squared	0.888688	Schwarz criterion		-1.188018
Durbin-Watson stat	2.163868	F-statistic		112.7729
		Prob(F-statistic)		0.000000

Table A7. ARMA (1,3) model at IMPORT for Hungary

Dependent Variable: IMPORT				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.094199	0.021815	50.15730	0.0000
AR(1)	0.694041	0.060394	11.49187	0.0000
MA(3)	-0.903667	0.090372	-9.999467	0.0000
R-squared	0.938592	Akaike info criterion		-1.786129
Adjusted R-squared	0.933868	Schwarz criterion		-1.644685
Durbin-Watson stat	1.852574	F-statistic		198.6974
MAPE	10.50490	Prob(F-statistic)		0.000000

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