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MEAT TRADE DYNAMICS: MONTHLY PATTERNS IN ROMANIA'S IMPORTS (CMA AND HOLT-WINTERS METHODS)

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Abstract

This study examines the trend of meat imports from Romania using monthly data from January 2011 to May 2024. The analysis aims to project the values of meat imports until May 2025 by using various forecasting algorithms to understand import trends and seasonality. The study used the TempoOnline database for data analysis, and the forecast used two methods: a seasonally adjusted regression model and the Holt-Winters methodology. The regression model integrated seasonal indices to forecast future imports, while the Holt-Winters method, which adjusts for trends and seasonality with smoothing constants, provided a more advanced prediction. The forecast results indicate that meat imports have increased significantly, especially after 2022, influenced by factors such as the pandemic and geopolitical instability. The regression model (Model 1) predicted a decrease in imports for 2024 compared to 2023, while the Holt-Winters model (Model 2) projected a substantial increase. The Holt-Winters model showed higher accuracy with lower RMSE and MAPE values than the regression model. In conclusion, both forecasting models provided valuable information on the trends in Romanian meat imports. The Holt-Winters model proved more accurate, predicting higher future imports with more appropriate values. The findings suggest that meat imports from Romania will continue to grow, with significant fluctuations due to seasonal effects. We recommend the Holt-Winters approach for more accurate future planning due to its superior forecasting performance.

Key words**:** *meat imports, time series forecasting, Holt-Winters method, seasonality index, trend analysis*

INTRODUCTION

Meat is an essential food that meets the protein and fat intake requirements for adults and professionally active people [10]. Consumption has been increasing in recent decades and increased even more amid the COVID-19 pandemic crisis because active people who worked from home had to cook at home as all the restaurants in the HoReCa system were closed. The only campaigns that had already implemented the online sales system were able to continue their activity. At the global level, the EU is the second largest producer of pork and the most important exporter of meat from pork products [17], and a European citizen consumes an average of 35 kg of pork per year, exceeding the average three times [13]. However, the EU faces many challenges in the field, such as global population growth, geopolitical conflicts, increased volatility of food prices, food insecurity, and environmental needs in the agricultural sector [5].

Thus, at the European level, it was discovered that the number of animals and meat production has decreased continuously in recent years [16]. To ensure all the meat it needs, the EU must integrate CAP reforms that focus on economic, social, environmental, and food security performance [15]. It is also necessary to support farmers if we take into account the increase in production costs and the long-term objectives of reducing meat consumption [4].

Although Romania has exceptional agricultural conditions and is considered an agricultural power among EU member states, it depends on agri-food product imports [2]. However, Romania remains an exporter of beef, especially in the category of live animals [11]. Regarding the import of meat, it continues to play the most important role in the supply chain of the meat market in Romania, especially given that meat and meat products are among the most consumed agri-food products in our country. In Romania, the most consumed meat which occupies the first

position among consumers' preferences is pork, preceded by poultry [17][9], while the consumption of beef is low because its price is too high. Domestic meat production is not sufficient to satisfy domestic demand [12][6], and this has decreased a lot in recent decades, especially due to various epizootics [20]. Also, because some live or semi-finished animals were exported, the domestic meat industry suffered a trade imbalance and lost income [18]. Romania can reduce its dependence on imports by allocating more resources and investments to the livestock sector to provide part of the meat needed for consumption [14].

MATERIALS AND METHODS

The study investigates the trends in Romania's meat imports. The Tempo Online database used in this study consists of monthly recordings from 2011. We accessed the data from January 2011 to May 2024 and projected the imports of meat products until May 2025 using the employed forecasting algorithms.

The last observed month was May 2024, and we made a forecast using MO Excel. We used a combination of time series analysis techniques to forecast the monthly meat import values for 2024 and 2025. We used a forecast that included seasonality and a forecast based on the Holt-Winters Method.

Initially, we employed Excel for forecasting seasonality and trends, which involved creating a regression function to determine the trend and calculating a seasonality index to produce a seasonal prediction that integrated the trend. We utilized the computation approach suggested by Canbolat M. (2006) [3].

The second method employed was the Holt-Winters methodology, an advanced time series forecasting approach that enhances simple exponential smoothing by integrating both trend and seasonal elements. This method is very effective for predicting monthly meat import amounts because the data displays both trends and seasonal fluctuations. The Holt-Winters approach comprises three primary components (level, trend, and seasonality) and considers three smoothing constants (α, β, and γ).

The optimum values of α, β, and γ are determined by minimizing the sum of the square of error using Solver in Excel, with the stipulation that α and β must be less than or equal to 1, and the sum of α and γ must be less than 1. We utilized the computation approach suggested by Major L. (2020) [8].

For both techniques, we conducted a forecast accuracy evaluation by calculating MAPE (the relative percentage error corresponding to the average of the absolute error) following Lee et al. (2018) [7]. These measurements provide insight into the precision of the forecasts and facilitate the comparison of the employed models.Ultimately, the results were graphed in conjunction with the original monthly data to enhance comparison and explanation of the trends.

RESULTS AND DISCUSSIONS

Background data

Meat imports increased during the analyzed period and almost doubled in the last years due to the pandemic and geopolitical instability (Table 1).

Table 1. Imported meat value (January 2011-May 2024)

	Total Thou euro	Month	Monthly average	Min (thou euros)	Max (thou euros)
2011	456,909.0	1	54,860.4	23,172.0	125,680.0
2012	479,422.0	2	58,094.9	26,643.0	122,681.0
2013	487,174.0	3	65,493.9	30,829.0	130,217.0
2014	551,691.0	4	62,573.6	33,629.0	132,699.0
2015	571,892.0	5	67,463.7	34,842.0	130,124.0
2016	645,829.0	6	66,665.9	36,697.0	132,426.0
2017	760,265.0	7	68,405.8	38,578.0	125,183.0
2018	820,597.0	8	74,238.2	42,684.0	137,032.0
2019	940,884.0	9	78,749.9	43,273.0	135,030.0
2020	910,481.0	10	77,982.3	43,394.0	150,321.0
2021	977,651.0	11	76,493.8	35,557.0	149,564.0
2022	1,300,744.0	12	76,662.5	35,145.0	150,014.0
2023	1,534,844.0				
2023/2011	336.0%				
Monthly Mean 2011- 2024					68747.8
Monthly Min 2011-2024					23,172.0 (January 2012)
Monthly Max 2011-2024					150,321.0 (October 2023)
Monthly Median 2011-2024					61,868.0
Monthly Sd Dev 2011-2024					30,679.0

Source: Own calculation based on data from Tempo Online database 2011-2024, NIS [19].

In 2023, the total value of meat imports reached 1,534.8 million euros, the largest value since 2011. Imports have a monthly average value of 68.8 million euros. The data also reveals seasonality, a factor we must take into account in our research. In March and

November Romania imports more meat, while in January, it imports less. Figure 1 shows the monthly meat import model in Romania for the years 2011-2024. We can observe an increase in imports since 2017, particularly after 2022. The import value diminishes in specific months, such as January, due to an oversaturation of local supplies on the domestic market during the holiday period.

Figure 2 illustrates the time series of meat import values from January 2011 to May 2024.

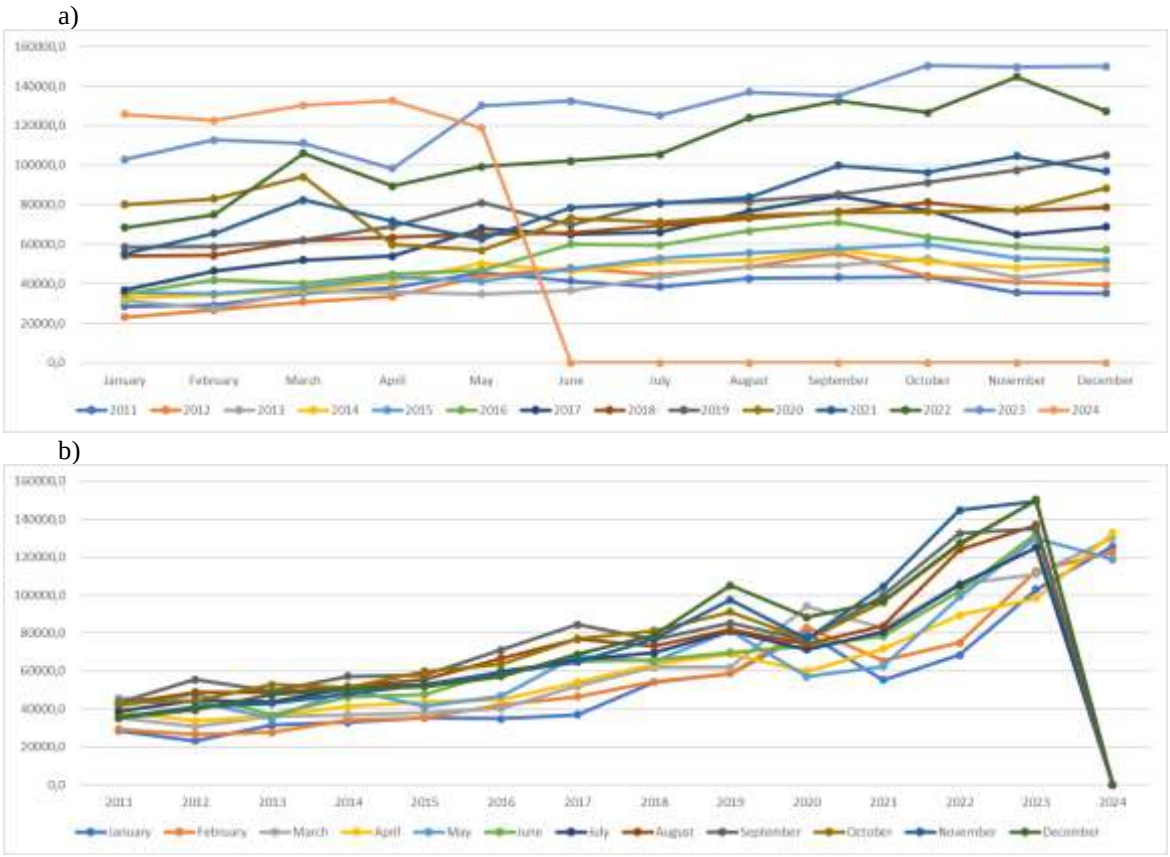

Fig.1. Meat imports (2011-2024): a) Monthly values each year; b) Annual values each month
Source: Own calculation based on data from Tempo Online database 2011-2024, NIS [19].

In 2022-2023, the meat import reached a value of 150 million euros due to the increase in prices, while its lowest point occurred in 2012 when the market remained oversaturated after the winter holidays (23.2 million euros). Starting from this trend we projected the imports until the end of 2024 and May 2025 using two methodologies of time series analysis.

Figure 3 illustrates the actual meat imports (depicted in blue) from January 2011 to May 2024, with the projected imports (shown in red) derived from the first forecasting model (regression function with seasonality index adjustment) extending to May 2025.

Although it is a simple forecasting method, it effectively predicts the pattern of the actual data, but with less variability compared to the original data. The future model projection indicates an increase in seasonality accompanied by an upward trend.

The forecasted data are lower than the original data with errors varying on average between 6 and 12 million euros (Table 2).

We obtained an RMSE value of 33,754.4. The MAPE value of 14.6% proves that we created good forecasting [7].

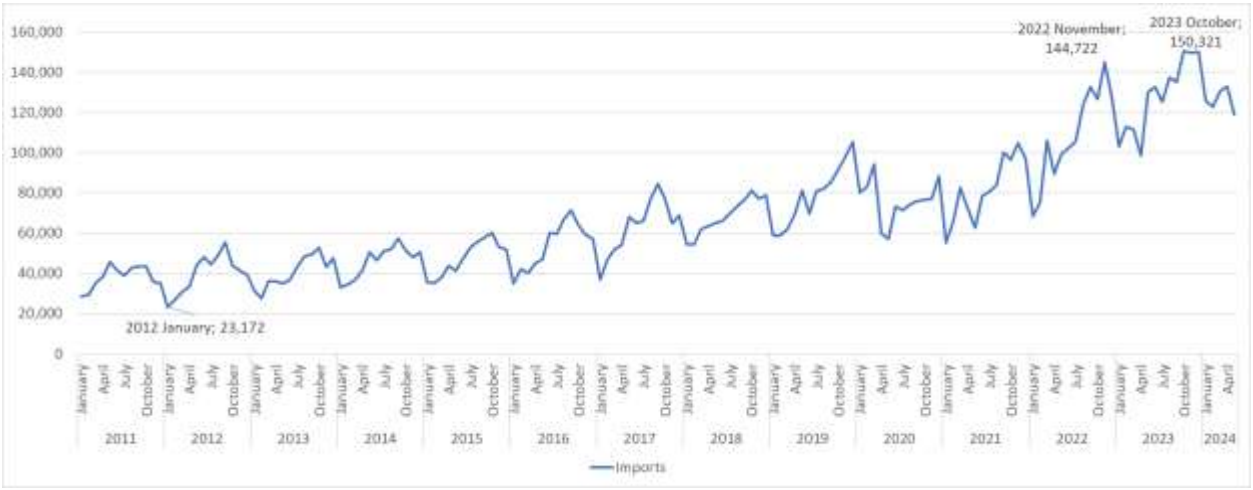

Fig. 2. Value of imports by months
Source:Own calculation based on data from Tempo Online database 2011-2024, NIS [19].

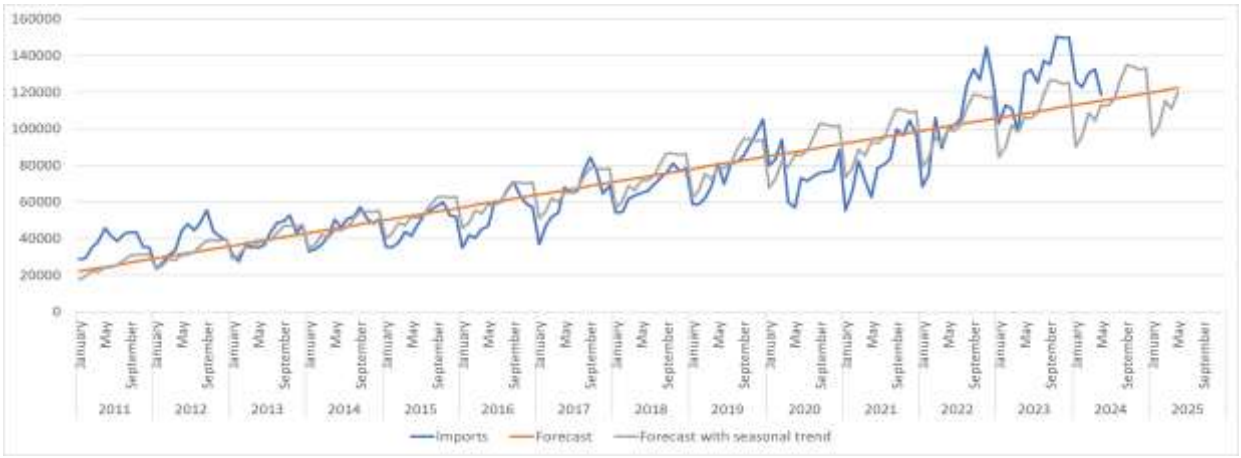

Fig. 3. Actual values of import and forecast
Source: Own calculation in Excel based on Canbolat M. (2006) [3].

Table 2. Import forecasting – average monthly data (Model 1)

Month	**Imports (thou euros)**	**Seasonality Index** (the average of the values obtained by reporting the imports of the month (1,2, ...12) to the total of months in the database)	**Forecast (thou euros)**	**Forecast with seasonal trend (thou euros)**	**Errors**
January	54,860.4	0.80	71,075.5	56,717.9	-5,514.9
February	58,094.9	0.85	71,657.5	60,553.7	-6,331.8
March	65,493.9	0.95	72,239.4	68,820.2	-7,692.6
April	62,573.6	0.91	72,821.4	66,281.4	-7,879.3
May	67,463.7	0.98	73,403.3	72,032.3	-9,066.1
June	66,665.9	0.97	70,493.6	68,358.9	-6,454.8
July	68,405.8	1.00	71,075.5	70,722.0	-7,202.3
August	74,238.2	1.08	71,657.5	77,380.3	-8,444.8
September	78,749.9	1.15	72,239.4	82,749.6	-9,624.6
October	77,982.3	1.13	72,821.4	82,603.1	-10,190.9
November	76,493.8	1.11	73,403.3	81,673.9	-10,643.9
December	76,662.5	1.12	73,985.2	82,503.0	-11,316.3
RMSE 33,754.4 MAPE 14.6 %					

Source: Own calculation in Excel based on Canbolat M. (2006) [3].
Note: RMSE "represents the square root of the variance of the residuals" ("distance between the observed data values and the predicted data values") [1].

The results obtained by the Holt-Winters approach are depicted in Figure 4 and Table 3. The forecast results start from January 2012, and seasonality from previous data was used to forecast grain imports from 2024-2025. The future model projection indicates a higher increase in trend. The forecasted data are generally higher than the original half of the

year, with errors varying on average between 0.6 and 10 million euros (Table 3). We obtained an RMSE value of 12,536.26. The MAPE value of 12.41% proves that we created good forecasting [7].

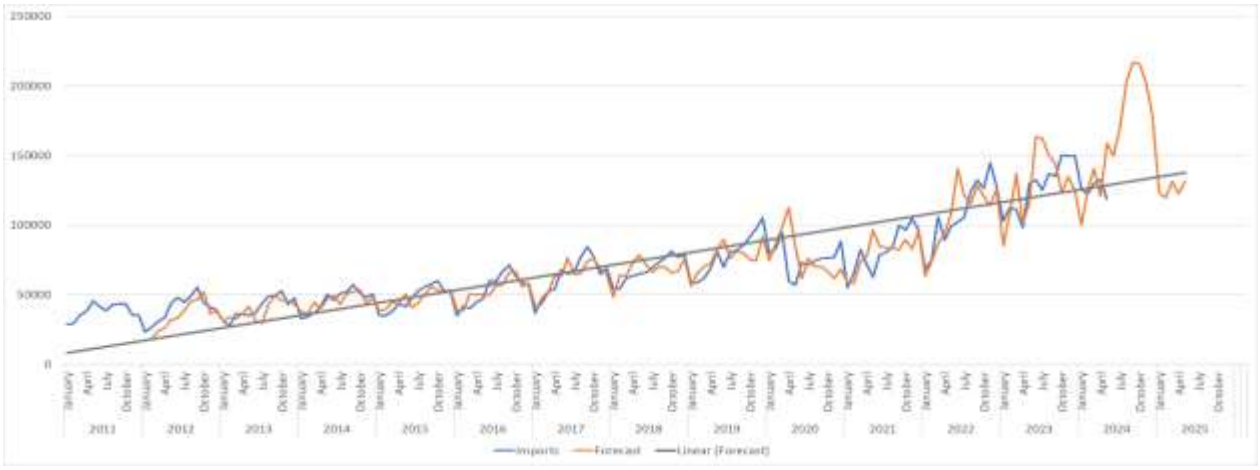

Fig. 4. Actual values of import and forecast
Source: Own calculation in Excel based on Lee et al. (2018) [7].

Table 3. Import forecasting – average monthly data (Model 2)

Month	**Imports (thou euros)**	**Seasonality Index** (month value/annual average)	**Forecast with seasonal trend (thou euros)**	**Errors**
January	37,949.4	0.72	56,202.4	3,486.4
February	47,994.5	0.76	60,886.5	-568.8
March	56,642.4	0.88	70,621.9	-2,798.6
April	46,559.9	0.92	70,206.3	-5,758.2
May	39,435.1	1.08	77,676.0	-8,527.2
June	26,875.8	1.18	80,177.5	-5,599.6
July	41,731.5	1.20	79,505.6	-1,050.1
August	50,467.2	1.27	83,499.1	3,369.2
September	41,289.5	1.29	87,372.9	5,129.8
October	39,416.7	1.20	84,967.1	6,796.9
November	46,615.5	1.05	79,890.6	10,202.9
December	42,767.6	1.00	81,942.3	6,134.8
RMSE 12,536.26 MAPE 12.41 %				

Source: Own calculation in Excel based on Lee et al. (2018) [7].

As we can see, both forecasting models are suitable for our research. For 2024, Model 1 forecasts a decrease compared with 2023 to 1,401.1 million euros, and the second model shows an increase to 1,981.6 million euros.

Fig. 5. Forecasted values for 2024 and 2025
Source: Own calculation in Excel.

The values forecasted by the Holt approach are higher but follow the same trend as in the first model (Fig.5).

Model 2, on the other hand, has the lowest RMSE and MAPE, indicating that it is better able to fit the forecast of meat imports (Table 4).

Thus, we consider that the values predicted by model 2 (by the Holt-Winters Method) can be more accurate (as Lee et al. proved [7]). Model 2 predicts the future is non-linear and has a general upward trend, with obvious decreases in April and January.

Table 4. The forecast for 2024-2025 – Model 1 and Model 2

	Model 1	**Model 2**
	RMSE 33,754.4 MAPE 14.6 %	RMSE 1,253,6.26 MAPE 12.41
2024 (January-December)	1,401,214,4	1,981,548.9
2025 (January-May)	543,753.9	628,182.4

Source: Own calculation in Excel.

CONCLUSIONS

The analysis of the value of Romanian meat imports reveals a strong upward trend, particularly from 2022 on, influenced by global disruptions and increased demand. The use of time series forecasting techniques, including a regression model and the Holt-Winters methodology, provided valuable projections for the future.

Model 1, which combined regression analysis with seasonal adjustments, predicted a decrease in meat imports for 2024, estimating a total of approximately 1,401.1 million euros. However, this model showed less accuracy, with an RMSE greater than 33,754.4 and a MAPE of 14.6%, indicating some discrepancies between predicted and actual values.

In contrast, Model 2, using the Holt-Winters method, predicted a significant increase in meat imports, projecting a total of approximately €1,981.6 million for 2024. The lower RMSE (12,536.26) and MAPE (12.41%) show that this model works better than others. This is because it can better account for both trend and seasonal changes in the data. The Holt-Winters approach has demonstrated a better fit for historical data and more accurate forecasts, particularly in capturing non-linear trends and seasonal fluctuations. Projected values for 2025 also indicated a continued increase in imports, with model 2 predicting around 628,182.4 thousand euros, compared to the regression model's estimate of 543,753.9 thousand euros.

In general, the results underline the need for accurate forecasting methods in the management and planning of meat import strategies in Romania. The Holt-Winters model's higher accuracy indicates its preference for future projections, providing stakeholders in the meat import industry with more reliable data. This approach not only improves forecast accuracy but also supports better decision-making in response to evolving market conditions.

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