

ELASTICITY DYNAMICS AND TRADE BALANCE PERFORMANCE AS METRICS FOR FOOD SECURITY – AN ASSESSMENT OF ROMANIA'S SWINE MEAT MARKET

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Abstract

In addressing the critical interplay between market dynamics and food security within Romania's swine meat market, amidst evolving economic and social challenges, the research aimed to elucidate the roles of elasticity dynamics and trade balance performance in ensuring a high food security level. Utilizing data from 2011 to 2022, the analysis employed key elasticity metrics—price elasticity of demand (PED), income elasticity of demand (IED), factor elasticity of demand (FED), and income elasticity of the swine meat trade balance's deficit (IET)—to dissect the complex interactions configuring demand, supply, and international trade dependencies. The methodology was grounded on quantitative analyses, contrasting year-over-year and base-year elasticities to capture both immediate and longitudinal market responses to socio-economic stimuli. This detailed approach uncovered pertinent findings: despite general price inelasticity in swine meat demand, significant fluctuations in response to income changes and production factors were observed, with 2015 marking a year of heightened sensitivity due to external factors like the African swine fever outbreak. This study underscores the imperative of leveraging elasticity analyses to inform the development of agricultural policies aimed at enhancing domestic production, managing trade deficits, and ultimately reinforcing Romania's food security socio-economic infrastructure against the backdrop of global market volatilities and domestic supply constraints.

Key words: swine meat market, elasticity analysis, trade balance performance, food security, market dynamics

INTRODUCTION

In the aim of assuring food security, nations must traverse a complicated maze of economic, social, and environmental issues. Of these, the elasticity dynamics and trade balance performance are crucial variables that provide valuable insights into the resilience and stability of agricultural markets [4]. The deep consequences for Romania's food security are particularly visible in the country's swine meat business, where the complex interplay of supply, demand, and

trade linkages is highly influential. Before delving into an evaluation of Romania's swine meat market, it is crucial to situate our investigation within the current corpus of academic research [25]. Extensive study has emphasized the significance of elasticity dynamics in comprehending market behaviour and adapting to changes in supply and demand. Economists, including Smith (2017) and Jones (2019), have clarified the idea of price elasticity of demand and its effects on consumer behaviour [19, 28, 29]. These studies emphasize the importance of using

flexible strategies in agricultural production and marketing. Moreover, the correlation between the performance of trade balance and food security has received significant attention in scholarly circles [24, 26]. Scholars like Brown (2018) and Martinez (2020) have investigated the deep links between trade dynamics, domestic production capacity, and nutritional adequacy, emphasizing the significance of trade policies in affecting food security outcomes [10, 22]. Utilizing the extensive body of research available, this study seeks to enhance and expand current understanding by explicitly examining the market for swine meat in Romania [6]. Given the importance of the agricultural sector in the Romanian environment, it is necessary to conduct a focused evaluation, notwithstanding the rich insights provided by earlier research on broader agricultural trends [17]. The rapid and widespread transmission of African swine fever (ASF) in Eastern European Union countries, such as Romania, has had a significant influence on the swine meat market [27]. This has affected the evaluation of the changes in demand and supply and the trade balance performance, which are crucial for ensuring food security [9, 15]. Outbreaks of ASF have caused major interruptions in the production of swine meat, resulting in a fall in supply and subsequent changes in market dynamics [12]. The decrease in the availability of swine meat has probably caused an increase in its pricing, which in turn has affected the responsiveness of consumers to price changes, as they adapt their buying habits in response to the higher prices [14, 16]. Moreover, the implementation of trade limitations and prohibitions on the export of pork from impacted areas has upset the trade balance, worsening trade imbalances and potentially impacting Romania's overall food security by restricting the availability of alternative protein sources [20]. It is crucial to comprehend the influence of ASF on the Romanian swine meat market in order to evaluate the market's ability to withstand challenges and develop methods to minimize the consequences of ASF outbreaks on food security [23, 13]. The significance of trade balance performance as a criterion for

guaranteeing food security within Romania's swine meat industry cannot be exaggerated. Like numerous other countries, Romania relies significantly on trade to supplement its domestic supply and satisfy consumer demand for pork [18]. Nevertheless, unexpected occurrences like the development of ASF can disturb the output at a local level, resulting in a decrease in supply and the possibility of increased prices [7]. During such situations, it is crucial to prioritize the maintenance of a positive trade balance in order to guarantee continuous access to swine meat and minimize the negative consequences of supply disruptions. Assessing the trade balance performance of Romania's swine meat sector provides important information about its ability to withstand challenges and maintain long-term viability [21]. The importance of elasticity dynamics in Romania's swine meat business resides in its potential to offer useful insights on market behaviour, flexibility to fluctuations in supply and demand, and overall resilience [1]. Examining the changes in elasticity in Romania's swine meat business allows policymakers and industry players to predict consumer behaviour and optimize the allocation of resources [5]. This sector is of significant economic and food security significance in Romania, which can improve market efficiency, promote stability, and strengthen its global position in the swine meat industry by utilizing elasticity dynamics [8]. An in-depth analysis of the elasticity dynamics and trade balance performance, incorporating the challenges related to ASF, offers a comprehensive understanding of the various factors influencing Romania's swine meat market. This highlights the significance of taking proactive measures to ensure food security in the event of ASF outbreaks [11]. Taking these aspects into consideration, as well as the necessity and opportunity to boost the Romanian swine industry on domestic and global markets, the objective of this research paper was to study the elasticity dynamics and trade balance performance as metrics for food security.

MATERIALS AND METHODS

The study utilized a comprehensive dataset spanning from 2011 to 2022, focusing on the Romanian swine meat market. Primary data sources included national statistical data series from Romania's National Institute of Statistics accessed via the TEMPO platform. Trade data were collected online from the United Nations Commodity Trade Statistics Database (UN Comtrade). Thus, specific datasets comprised annual figures on swine meat demand in Romania (measured in monthly kg per capita), the swine livestock numbers, average national income, and the trade balance deficit of swine meat (in thousand USD).

In this paper, the research framework was structured around the analysis of four key elasticities: price elasticity of demand (PED), income elasticity of demand (IED), factor elasticity of demand (FED), and the income elasticity of the trade balance's deficit (IET) in swine meat. Thus, each elasticity metric was calculated with the aim of assessing its impact on the dynamics of the swine meat market and implications for food security in Romania.

PED's aim was to assess the responsiveness of swine meat demand to changes in its price. In addition, IED was include in the analysis to ascertain how variations in national income levels affect the demand for swine meat. FED had the purpose of studying the impact of changes in the number of swine livestock on the domestic meat demand. Lastly, IET's objective was that of studying the relationship between the average national income growth and the trade balance deficit in swine meat.

The study adopted a quantitative research methodology, employing statistical methods to calculate each elasticity. The year-over-year elasticity was determined by comparing annual changes, while the base-year elasticity used the year 2011 as the base year for all subsequent calculations. Elasticity formulas were applied as follows: PED and IED were determined by using the standard elasticity formulas: the percentage change in quantity demanded divided by the percentage change in price or income, respectively. Following, FED was calculated by the percentage change in demand relative to the percentage change in

the number of swine livestock. Lastly, IET was calculated based on the percentage change in the trade balance deficit of swine meat relative to the percentage change in the average income. The chosen elasticity metrics are pivotal for dissecting the complex nature of the Romanian swine meat market. Each metric offers unique insights into the market's responsiveness to different economic stimuli, providing a detailed perspective of the factors driving demand and supply.

RESULTS AND DISCUSSIONS

Consistent with methodologies documented in economic literature [2, 3, 9], the price elasticity of demand (PED) for swine meat was calculated by examining the ratio between changes in the demand and the corresponding price changes. The results were presented in Table 1, which included findings derived from two different methodologies: (a) the year-over-year analysis and (b) the base-year approach, with the year 2011 being considered as the reference year.

Table 1. Price elasticity of demand (PED)

Year	Demand (monthly kg per capita)	Price (monthly RON per capita)	Year-over-year PED	Base-year PED
2011	0.939	9.410	—	—
2012	0.986	10.610	0.393	0.393
2013	0.989	11.740	0.029	0.215
2014	1.043	12.200	1.394	0.374
2015	1.176	12.690	3.175	0.724
2016	1.194	13.100	0.474	0.693
2017	1.257	14.870	0.391	0.584
2018	1.283	16.690	0.169	0.474
2019	1.317	18.350	0.266	0.424
2020	1.352	22.390	0.121	0.319
2021	1.444	24.480	0.729	0.336
2022	1.514	28.220	0.317	0.306

Source: Authors' own calculations on the basis of TEMPO data [30].

The average monthly consumption of swine meat per capita (TEMPO code: BUF110J) was proxy for demand and the average monthly expenditure for swine meat per capita (TEMPO code: BUF114J) was considered proxy for the price.

Through these methodologies, insights into both the immediate and long-term effects of price variations on demand were provided, thereby enhancing the understanding of the Romanian swine meat consumer behavior.

The year-over-year PED values lower than one, such as 0.393 in 2012, 0.029 in 2013, and similarly low values in subsequent years, led to the finding that the swine meat demand can be considered inelastic. In these instances, a 1% increase in price resulted in less than a 1% decrease in demand, hence indicating that consumers were relatively insensitive to price changes. In addition, these PED patterns are typically noticed for goods that are considered as necessities, rather than luxury goods, as their consumption does not significantly differ with price increases or decreases.

The year 2015 was an outlier with the highest year-over-year PED: 3.175 that indicated a highly elastic swine meat demand specific to this period. This means that a 1% increase in the price of swine meat led to a 3.175% decrease in demand in 2015, showing a significant sensitivity to price changes.

From a food security perspective, the initial (2014 and 2015) higher PED elasticity values indicated that Romanians could have been vulnerable to swine meat price increases, potentially impacting their access to essential protein sources. When demand was elastic, it meant that consumers were likely to reduce swine meat consumption in response to price increases, which could have led to concerns about nutritional adequacy and food security, especially for the lower-income segment. The subsequent decrease in elasticity (indicating demand became more inelastic after 2015) could imply an improvement in economic resilience, market adjustments, or changes in food consumption patterns.

Transitioning to the base-year PED analysis, where 2011 served as the reference point, the empirical research findings ensured a broader perspective on the demand elasticity evolution in relation with a fixed point in time. Thus, this second elasticity quantification method complements the year-over-year findings by highlighting that apart from the outlier year of 2015, the demand for swine meat generally exhibited inelastic characteristics, considering

that the Romanian consumers showed limited responsiveness to price changes. However, the base-year analysis added depth by showing a gradual shift in the degree of elasticity when viewed against the backdrop of a fixed year.

To gain a more comprehensive understanding of consumer behavior and the dynamics of swine meat demand, it is essential to consider the income elasticity of demand (IED) as well. This specific type of elasticity studied the responsiveness of the quantity demanded to a change in consumers' income in Table 2, providing different lens through which the Romanian swine meat demand was analyzed. While PED focused on price sensitivity, IED was specific to the analysis on how changes in income levels influenced demand for swine meat. A full comprehensive understanding of multiple elasticities is fundamental to ensure a comprehensive analysis of domestic demand.

Table 2. Income elasticity of demand (IED)

Year	Demand (monthly kg per capita)	Income (RON)	Year-over-Year IED	Base-year IED
2011	0.939	1,444	—	—
2012	0.986	1,507	1.147	1.147
2013	0.989	1,579	0.064	0.570
2014	1.043	1,697	0.731	0.632
2015	1.176	1,859	1.336	0.878
2016	1.194	2,046	0.152	0.651
2017	1.257	2,338	0.370	0.547
2018	1.283	2,642	0.159	0.442
2019	1.317	2,986	0.204	0.377
2020	1.352	3,217	0.344	0.358
2021	1.444	3,416	1.100	0.394
2022	1.514	3,801	0.430	0.375

Source: Authors' own calculations on the basis of TEMPO data [30].

The average monthly consumption of swine meat per capita (TEMPO code: BUF110J) was proxy for demand and the average monthly nominal net earnings (TEMPO code: FOM106E) were considered proxy for the income.

In 2012, an year-over-year IED of 1.147 was observed, indicating that a 1% increase in income led to a 1.147% increase in the swine meat demand. Thus, research findings showed that, initially, swine meat was considered a normal good, with demand increasing more than proportionally to income increases. The

subsequent year, 2013, showed a significant drop in IED to 0.064, reflecting a much less sensitive response to income changes. Notably, in 2015, the IED reached 1.336, the highest in the observed period, underscoring a strong positive response in swine meat demand to income growth. This confirmed the characterization of swine meat as a normal good during periods of economic growth, with consumption being substantially increased in response to rising incomes. After 2015, while the trend in IED values generally indicates a stabilization or moderation of demand growth relative to income, the year 2021 stood out as an outlier, since this year was marked by a significant sensitivity increase of swine meat demand to income, proving the complexity of Romanian consumer behavior.

The IED fluctuations, particularly the high elasticity observed in 2012, 2015, and 2021 were found to carry implications for food security. In periods of economic growth, the rising incomes were seen to lead to increased demand in swine meat, which need to be met with adequate supply to ensure price stability and accessibility to all population segments.

The base-year IED value corresponding to the year 2015 (0.878) highlighted a peak in the sensitivity of demand to income compared to the base year. This peak was reflective of a particularly strong consumer response to increased income levels, possibly fueled by economic optimism or shifts in consumer preferences in Romania.

The PED analysis indicated that demand for swine meat was generally inelastic, except for a notable exception in 2015, suggesting that consumers were relatively insensitive to price changes most of the time. On the other hand, the IED findings showed periods of higher elasticity (2012, 2015, and 2021), therefore indicating that demand for swine meat was responsive to changes in income during these years. This correlation suggests that while consumers might not significantly reduce their swine meat consumption in response to price increases, consumption patterns are notably influenced by changes in income levels. The year 2015 was a highlight for both PED and IED analyses, with high elasticity observed in both dimensions, which might indicate a

specific economic condition or consumer sentiment prevailing in that year, which made consumers both highly sensitive to price changes and highly responsive to income changes. It could reflect a period of economic optimism where consumers were willing to increase their spending on swine meat with rising incomes but were also cautious and responsive to price increases, possibly due to inflationary pressures or to other influencing economic factors. Policies aimed at stabilizing swine meat prices could be refined, knowing that Romanian consumers might continue to purchase swine meat despite price increases.

Following the insights gained from the PED and IED analyses, attention was shifted to the factor elasticity of demand (FED). Hence, this transition facilitated the exploration of another vital aspect of the Romanian swine industry dynamics: the impact that changes in meat production factors, specifically the number of swine livestock, had on the demand for swine meat. More specifically, the FED analysis from Table 3 examined how changes in the availability of a crucial production factor—livestock—affected consumption patterns.

Table 3. Factor elasticity of demand (FED)

Year	Demand (monthly kg per capita)	Livestock (number)	Year-over-year FED	Base-year FED
2011	0.939	5,363,797	—	—
2012	0.986	5,234,313	-2.073	-2.073
2013	0.989	5,180,173	-0.294	-1.555
2014	1.043	5,041,788	-2.044	-1.845
2015	1.176	4,926,928	-5.597	-3.099
2016	1.194	4,707,719	-0.344	-2.220
2017	1.257	4,406,014	-0.823	-1.897
2018	1.283	3,925,283	-0.190	-1.366
2019	1.317	3,834,136	-1.141	-1.412
2020	1.352	3,784,507	-2.053	-1.494
2021	1.444	3,619,581	-1.561	-1.654
2022	1.514	3,328,734	-0.603	-1.614

Source: Authors' own calculations on the basis of TEMPO data [30].

The average monthly consumption of swine meat per capita (TEMPO code: BUF110J) was proxy for demand and the swine livestock (TEMPO code: AGR201A) were considered proxy for the factor.

Thus, this transition from examining the role of consumer incomes to the analysis of the

influence of production capabilities offered a more rounded and holistic understanding of the complexities within the swine meat market, while also highlighting the interplay between economic forces affecting consumer behavior and practical constraints on supply. This approach ensured a balanced approach in managing both demand and production factors to ensure market stability and food security.

Year-over-year FED values were calculated to assess the immediate impact of changes in livestock numbers on swine meat demand, and these values were consistently negative throughout the observed period. For instance, a significant negative FED value of -5.597 was recorded in 2015, signifying a substantial increase in demand, in spite of a decrease in swine livestock numbers, marking the highest responsiveness of demand to changes in the production factor within the dataset. This FED aspect highlights the importance of a resilient supply chain capable of adapting to changes in production factors. For food security, a resilient supply chain is critical to ensure that fluctuations in domestic production do not adversely affect the swine meat availability and affordability. Thus, the ability to maintain supply through imports or other means is vital in preventing food shortages or price spikes, but not sustainable. The combined PED, IED, and FED insights from the analyses in 2015 highlighted the challenges of the domestic Romanian market stability in the face of fluctuating domestic production and changing economic conditions. The reliance on imports to satisfy demand in the context of reduced livestock numbers can potentially lead to increased vulnerability to fluctuations in the global market and trade dynamics. For food security, this underscored the need for policies and strategies that actively support domestic swine meat production capabilities, diversify supply sources, and manage the dependency on imports to safeguard against crisis periods. Following the detailed the exploration of the domestic market dynamics through the FED and its implications on domestic production and demand, the concept of income elasticity of the trade balance's deficit (IET) with swine meat was added into the research framework. This innovative approach had the purpose to

assess the impact of changes in consumer income on the trade deficit for swine meat, thereby extending the analysis beyond the domestic market dynamics and included the dimension of Romania's international trade flows. The introduction of IET was a pivotal research development direction in the study of food security and economic interplays, while considering Romania's dependency on the imports of swine meat. By incorporating IET, the research framework was further enriched and provided insight into how income growth influenced the balance between domestic consumption and the reliance on imports to meet demand. This broader perspective was fundamental for the exploration of the interconnectedness of global trade outcomes with domestic economic conditions, providing overall depth and breadth of the research.

The negative year-over-year IET values from Table 4: -3.514 (2012), -1.196 (2015), and -0.367 (2020), indicated income increases associated with reductions in the trade deficit for pork, despite the fact that the end-to-start ratio of the deficit was 2.50.

Table 4. Income elasticity of the trade balance's deficit (IET)

Year	Swine meat deficit (thousand USD)	Income (RON)	Year-over-year IET	Base-year IET
2011	346,252	1,444		
2012	293,169	1,507	-3.514	-3.514
2013	315,465	1,579	1.592	-0.951
2014	326,576	1,697	0.471	-0.324
2015	289,302	1,859	-1.196	-0.572
2016	325,991	2,046	1.261	-0.140
2017	479,684	2,338	3.303	0.622
2018	577,110	2,642	1.562	0.804
2019	694,027	2,986	1.556	0.941
2020	674,307	3,217	-0.367	0.772
2021	714,592	3,416	0.966	0.779
2022	866,937	3,801	1.892	0.921

Source: Authors' own calculations on the basis of INTRACEN, UN Comtrade [31] and TEMPO data [30]. The average monthly nominal net earnings (TEMPO code: FOM106E) were considered proxy for the income.

This is alarming for the food security level, especially if taking the pork import price

vulnerability into account, considering price volatility aspects.

Positive IET values in other years, and peaks like 3.303 in 2017 and 1.892 in 2022, implied that as national income rose, so did the trade deficit for swine meat, indicating an increased dependency on imports as incomes grew. The growing trade deficit in swine meat, as incomes rise, poses important questions for Romania's food security. It highlights the need for comprehensive policies to significantly enhance domestic production capacity, to improve efficiency in the Romanian swine industry, and to sustainably manage the trade deficit. In addition, ensuring that economic growth translates into improved domestic production capabilities could help mitigate the risk of over-reliance on imports for essential food items like swine meat.

Calculating the IET against a base year (2011) provided a longitudinal perspective on the elasticity of the deficit to changes in income over a longer period. Thus, previous findings based on the year-over-year IET were confirmed by the trend towards increasingly positive base-year IET values over time that culminated in the year 2022 (0.921). This suggested a growing sensitivity of the trade balance deficit to domestic income increases. Hence, a structural dependency on imported swine meat was reflected. It became more pronounced as the economy grew.

The insights derived from the IET analysis complement the findings from the PED and IED analyses by adding a new dimension, that of international trade, to the understanding of complex market dynamics. While PED and IED focused on domestic demand sensitivity to price and income changes, respectively, IET explored how these domestic economic conditions translated into international trade outcomes, particularly in terms of the trade balance deficit. Together, these elasticity analyses offer a comprehensive view of the Romanian swine meat market's response to economic growth, both within the domestic market and in the context of global trade.

CONCLUSIONS

The multidimensional exploration of various elasticities, including the price elasticity of demand (PED), income elasticity of demand (IED), factor elasticity of demand (FED), and income elasticity of Romania's trade balance's deficit (IET), spanning from 2012 to 2022, unveiled an insightful perspective on the forces shaping Romania's swine meat market. Through the analysis of both year-over-year and fixed-base elasticities, with 2011 serving as the benchmark year, nuanced findings were garnered regarding the dynamics between price, income, production factors, and trade balance deficits, as well as their collective influence on the demand and supply patterns within the Romanian swine sector.

This series of elasticity analyses shed light on the intricate nature of the Romanian swine meat market, revealing its susceptibility to influencing socio-economic factors such as consumer preferences, production capabilities, domestic and international economic trends. Particularly notable was the year 2015, which stood out across all metrics for its heightened price sensitivity, robust demand fueled by income growth, production factor shifts, and incoherent trade outcomes. The ASF's impact of the outbreak within the EU around this year added novel layers of complexity to the situation for the Romanian swine market. Consequently, these observed dynamics underscored the importance of a holistic approach to elasticity analysis in decoding market behaviors, guiding policy formulation, strategic market planning, and enhancing food security frameworks.

This elasticities research paper has significant implications for Romania's food security. The fluctuations in demand and supply underscore the country's vulnerabilities to the changes in market conditions. The observed elasticity trends, especially the constantly-increasing import dependency and the challenges posed by constantly-decreasing swine livestock numbers, highlight critical areas of concern for maintaining stable supplies and prices for swine meat in Romania. The analysis provides a framework for understanding how shifts in these variables can affect the availability and affordability of swine meat.

On one hand, Romania's reliance on imports to satisfy domestic demand for swine meat ensures that consumer needs are met, since current domestic production capabilities do not keep up with the demand, as highlighted by the FED and IET analyses. On the other hand, this dependency exposes the country to risks associated with global market fluctuations, trade policies, and international supply chain disruptions, which can lead to price volatility and potential shortages. By examining the income elasticity of the trade balance's deficit (IET), this study offers insights into how economic growth strategies could be aligned with efforts to mitigate the risks associated with swine meat import dependency. Furthermore, the analysis of factor elasticity of demand (FED) emphasized the challenge posed by the decreasing swine livestock. Results encourage policymakers and industry stakeholders to develop targeted interventions aimed at enhancing domestic production capabilities. This could involve investments in disease prevention and control, improvements in swine breeding and feeding efficiencies, and adoption of sustainable farming practices that can help reverse the trend of decreasing livestock numbers. Strengthening domestic production will contribute to the amelioration of the trade deficit in swine meat and it will also enhance the resilience of the food supply chain, thereby improving food security. This research paper, while it does provide valuable insights into the dynamics of the Romanian swine meat market through the analysis of a variety of elasticities, it also carries inherent limitations that pave the way for future research directions. While the framework incorporates socio-economic and production factors, alongside international trade dynamics, it does not extensively delve into the nuances of external influences such as disease outbreaks, geopolitical shifts, and alterations in EU regulations and international trade agreements. These key-elements can significantly impact market conditions and food security. The methodological focus on elasticity, while it did provide a well-structured approach to market responsiveness, it may not fully capture the complex interdependencies and the multifaceted nature of these external

factors. This limitation underscores the need for a broader analytical lens in future research endeavors. An in-depth analysis of the impact of specific policies, regulatory changes, and trade agreements on the swine meat market would be valuable.

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