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Assessing the sectoral and cross-sectoral impacts of new European Union broiler chicken welfare measures in Hungary as proposed by the European Food Safety Authority

This research, focusing on Hungary, aims to analyse the comprehensive economic impact of proposed changes in daily weight gain and stocking density for broilers, as outlined in the European Food Safety Agency's (EFSA) 2023 Scientific Opinion "Welfare of Broilers on Farm". Hungary is a significant player in the Central and Eastern European (CEE) poultry industry and was the second-largest chicken meat producer and exporter in the CEE region in 2022. Utilising the dynamic econometric model AGMEMOD for impact assessment, we explore the economic repercussions on not only the broiler sector but also on the maize and pork sectors in Hungary. Our findings indicate that simultaneous implementation of the EFSA recommendations - reducing the growth rate to 50 g/day and lowering the stocking density to 11 kg/m² - could result in a substantial 72.4% reduction in chicken meat production in Hungary from the presumed enforcement year of 2023 through 2032, the end of the AGMEMOD baseline projection period. This reduction could not only impact the broiler industry but also have ripple effects on related sectors such as pork and maize. However, if only EFSA's recommendation to reduce the growth rate to 50 g/day is considered, an 18% reduction in chicken meat production is projected for Hungary.

Keywords: broiler, animal welfare, stocking density, growth rate, agri-economic modelling.

JEL classifications: Q13, Q18.

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Introduction

The broiler industry holds significant promise for enhancing food security and it is projected to lead global animal protein consumption attributed to its cost-effectiveness, short production cycle, and efficient feed utilisation (Alkhtib *et al.,* 2023). Nevertheless, there are some challenges which require attention, including reducing infectious diseases and enhancing broiler well-being. To address these issues, the EFSA recommended in its 2023 Scientific Opinion on the Welfare of Broilers on Farm a maximum stocking density of 11kg/m² and a growth rate of 50 g/day for conventional broilers (EFSA, 2023).

Our research focuses on the economic effects of the potential implementation of these recommendations for the Hungarian broiler sector. Hungary was the second-largest chicken meat producer and exporter in the CEE region in 2022 (AVEC, 2023). In the domestic market, this sector ranks second in production volumes after pork. In 2022 it produced 345.1 thousand tonnes (AKI ASIR, 2023).

Advancements in genetics and feed efficiency have resulted in accelerated chicken growth rates, exceeding 60 g/day. Concerning stocking density, our study follows the methodology outlined in the Ross 308 Broiler Management Handbook (2018) aligning with the European Union Broiler Welfare Directive (2007) guidelines, which recommend a stocking density of 33 kg/m^2 under typical conditions. Other manuals, like the Cobb 500, recommend stocking densities between 30 to 42 kg/m^2 (Cobb, 2018), reflecting typical European practices, ranging between 22 and 42 kg/m^2 (CIWF, 2005).

We analysed data from two quantitative national-level surveys conducted by the Institute of Agricultural Economics (AKI) for the years 2019 and 2021, collecting data on Hungarian poultry production metrics and the nutritional composition of four different broiler compound feed output categories. These surveys, encompassing 24 enterprises in 2019 and 23 in 2021, represented 61.7% and 71.7% of total annual chicken meat production, respectively. These comprehensive quantitative studies enabled the construction of a scenario based on reliable information, specifically focusing on reducing the growth rate to 50 g/day and the stocking density to 11 kg/m^2.

Reducing stocking density and growth rates can benefit the broiler industry, as noted by Lim *et al.* (2019). These benefits include mitigating health issues such as infections, footpad dermatitis, and poor feathering, as well as improving growth performance. However, it is important to acknowledge a potential drawback: the implementation of these strategies may pose economic challenges, as addressing stocking density requires a larger spatial allocation to effectively house the avian population, resulting in additional costs for farmers (Hamed, 2020).

Reducing the stocking density may lead to underutilised space and resources, resulting in less efficient resource management. Slower growth in broiler chickens extends the time required to reach the appropriate weight demanded by the customer, thereby increasing feeding and labour costs over time. Decreasing the meat yield per unit of area can escalate production costs due to inefficiencies during the growth stage, potentially impacting overall profitability (Kumar, 2016).

Our research aims to analyse the economic impact of reducing broiler growth rates to 50 g/day and stocking density to 11 kg/m² in Hungary, considering both sectoral and cross-sectoral effects. To achieve this research objective, we employed complex agri-economic modelling methodologies, particularly multiple linear regression models, as robust tools for comprehending the intricate interplay between animal welfare measures and the economic dynamics within the poultry industry.

The poultry sector in the European Union

The European Union plays a prominent role in the global poultry industry, consistently exceeding poultry meat exports over imports. Additionally, it ranks among the world's largest suppliers of poultry meat, with an annual production of 13.4 million tonnes (EC, n.d.) representing 9.6% of the global market share (FAO, 2023).

The EU primarily imports high-value poultry products, such as breast meat and poultry preparations, predominantly from Brazil, Thailand, and Ukraine. In contrast, it tends to export poultry products of lower value (EC, n.d.).

In 2022, the EU poultry sector faced considerable challenges, surpassing the difficulties experienced in previous years due to the COVID-19 pandemic. The direct impact of the war in Ukraine on global energy prices, fertilisers, and feed commodities further intensified the complexities faced by the industry. Skyrocketing feed and energy prices, compounded by ongoing uncertainties in their future trajectories, have added to the sector's challenges. By the end of 2023, the poultry industry was still grappling with the enduring repercussions of the COVID-19 pandemic and one of the most severe avian influenza seasons on record, contributing to an increase in chicken meat prices during 2021 and 2022 (AVEC, 2023).

Despite concerns about inflation, chicken meat remains a relatively affordable protein source compared to other options. In 2022, the European Union witnessed a 13% increase in chicken meat imports, primarily driven by robust demand from the hospitality, restaurant, and institutional sectors. Notably, the EU's demand for chicken meat from Ukraine experienced a remarkable upswing of 60% in 2022. This surge can be attributed to temporary measures in support of Ukrainian exports to the EU, bolstering imports. Conversely, EU chicken meat exports registered a decline of 6.1% in 2022. Factors contributing to this decline include restrictions related to highly pathogenic avian influenza (HPAI) and the EU's reduced price competitiveness compared to other global suppliers (Global Ag Media, 2023).

The poultry industry in Hungary

In 2022, Hungary ranked as the seventh-largest poultry meat producer within the EU member states (AVEC and Eurostat, 2023), with broilers contributing to roughly 72% of Hungary's total poultry meat output (EC, 2023; AKI ASIR, 2023). Backyard poultry farming plays a minor role in Hungary, with the predominant commercial production of hybrid breeds on specialised farms. The efficiency indicators and production costs of backyard poultry farms aptly reflect the heterogeneity of their technical conditions (AKI, 2021). Small-scale poultry farms play a significant role in rural areas' economies and contribute to the diversity of chicken supply in the market by swiftly responding to consumer preferences (Farkas *et al.,* 2023).

The Hungarian poultry sector operates through both vertical and horizontal collaborations, with approximately 90 per cent of the production being fully integrated. In these arrangements, Hungarian investors typically own the slaughtering and processing facilities. Processors (integrators), manage the production of compound feed, breeding, and hatching eggs, aiming for comprehensive coordination to enhance efficiency. Broiler chicken farming in Hungary shows a high level of concentration, with the top three companies holding a combined market share of approximately 55 per cent in 2021 (AKI, 2021).

Poultry meat has been the preferred meat choice in Hungary, experiencing a notable rise in per capita consumption from 2017 to 2022. By 2021, consumption had reached 33.5 kilograms, surpassing the EU average by 27.3 per cent (AVEC, 2023). A contributing factor to the growth in consumption was the VAT reduction for poultry meat and eggs from 27 to 5 per cent, effective from January 1, 2017 (Ván and Olah, 2018).

Poultry meat exports constituted 5.3 per cent of Hungary's total agricultural exports in 2021, amounting to EUR 566.5 million. This marked a 9 per cent increase from 2015 (AKI, 2016; 2022). Hungary's self-sufficiency in poultry meat was approximately 129 per cent in 2021 (AVEC, 2023), which is outstanding among EU Member States and underscores Hungary's robust orientation towards poultry meat exports.

The Hungarian broiler sector, along with other segments of the agri-food industry, faced challenges during the COVID-19 pandemic, which resulted in disruptions in supply chains and shifts in consumer behaviour. Despite these challenges, the broiler industry exhibited resilience and successfully adapted to the emerging market conditions (Mizik, 2021).

In 2022 Hungary experienced a decline in the total output of live animals and animal products compared to the previous year. Russia's war in Ukraine adversely impacted the flow of agricultural commodities, leading to a temporary surge in feed and energy prices among other factors, both in the EU and worldwide (Nasir *et al.*, 2022). Veterinary emergencies, including avian influenza outbreaks, coupled with unfavourable economic conditions such as the weakening of the Hungarian forint and increasing interest rates (OECD, 2023) imposed an additional burden on producers, substantially raising production costs. The poultry flock decreased by 10%; within that, the hen flock declined by over 9% to 29.1 million, while the number of cattle, pigs, and other animals decreased by 8%, 6%, and 5%, respectively (HCSO, 2023).

The welfare of broilers in the EU: key considerations

There is ongoing discourse surrounding animal welfare, covering various facets of livestock production. Animal welfare measures aim to be effectively applied within poultry production considering established health, physiological, behavioural, and zootechnical indicators (EFSA, 2005). Additionally, there is a pressing need to enhance monitoring programmes for broiler chickens, with visual inspection playing a crucial role (EFSA, 2012).

The European Animal Welfare Protocol primarily focuses on optimising production. Adhering to this protocol ensures product safety, leading to increased consumer acceptance. Moreover, this approach positively impacts producers' economic returns, driving advancements in the economic production standards of the poultry industry and aiming to enhance environmental sustainability (Beal *et al.,* 2023).

Fast-growing broiler chickens are commonly produced worldwide, including in non-EU countries. Research indicates that these birds suffer from health issues, leading to diminished well-being compared to medium-sized chickens. However, it is crucial to consider various factors influencing these outcomes, such as commercial chicken lines, management practices, and animal density (Averós *et al.*, 2022). Studies have shown that the best well-being is observed in slower-growing breeds reared at lower densities (Rayner *et al.*, 2020).

Nineteen welfare consequences affecting broilers on farms were identified linked to genetic selection exerting effects over time (EFSA, 2010). Additionally, cardiac issues in birds are vital concerns (Zhang *et al.*, 2018; Olkowski, 2007; Olkowski and Classen, 1998). Within this context, a crucial step in poultry farming is recognising the risks associated with welfare violations and emphasising the implementation of measures to prevent the deterioration of bird health, low-quality production, and adverse economic impacts on producers. European welfare strategies are anticipated to be applied on EU farms to improve various conditions related to housing, feeding, transportation, and the overall well-being of chickens (Moyano Estrada *et al.*, 2015).

As previous experience suggests, implementing these strategies could enhance feed efficiency by minimising competition for food among the birds. Consequently, there might be a reduction in production costs that would benefit the broiler industry (Zampiga *et al.*, 2021).

A research study on poultry density revealed that higher poultry density may lead to animal health issues such as highly pathogenic avian influenza (HPAI). However, it is also important to examine the economic repercussions of such circumstances (Pavade *et al*., 2011).

Methodology

The tool utilised in our analysis is AGMEMOD (Agricultural Member States Modelling), a multi-country, multi-market, dynamic and partial equilibrium econometric model designed to analyse the impact of policy changes or other factors on agri-food markets within the European Union at both national and Union levels. Since its creation in 2001, AGMEMOD has undergone continuous improvements and updates through collaboration among research institutes, universities, and government agencies. It has also been extended to include third countries such as Russia, Ukraine, and Turkey.

The country-specific models reflect the intricacies of agriculture in each member state while allowing for their combination into an EU-wide model. AGEMEMOD serves as a valuable tool for modelling the effects of policy changes across various countries. The structure of the AGMEMOD model is shown in Figure 1.

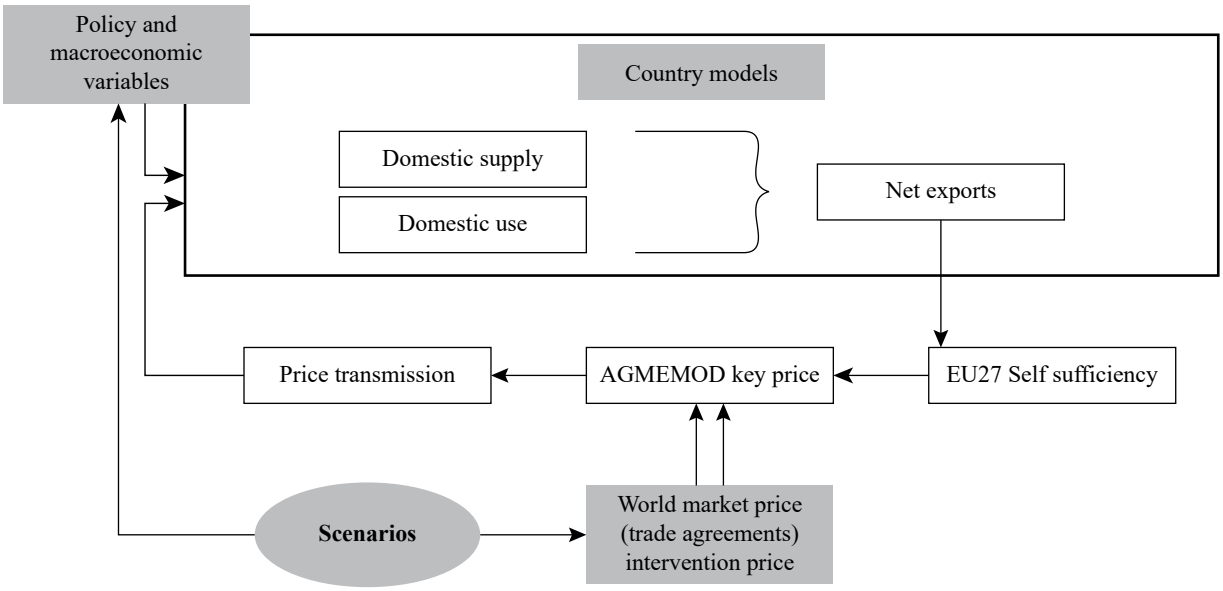

Figure 1: AGMEMOD model structure.
Source: Own elaboration based on The AGMEMOD Book, Chantreuil *et al*. (2012)

This structure of the country models is based on the GOLD model (Hanrahan, 2001). Its standardised template-based approach allows for the incorporation of diverse agricultural systems across the countries considered, ensuring analytical consistency across the commodity models. The primary objective of AGEMEMOD is to improve the accuracy of analytical findings used for decision-making related to agricultural policies (Chantreuil *et al.*, 2012).

The total annual production of broiler meat considered for our scenario analysis is published by AKI. We also utilised two quantitative studies conducted by this Institution for the years 2019 and 2021. These surveys collected essential data on Hungarian poultry production parameters and the nutritional composition of chicken feed for 24 enterprises in 2019 and 23 in 2021, representing 61.7% and 71.7% of total annual chicken meat production, respectively. Given the representativeness of the sample, the surveys were useful for assessing the impact of reducing the growth rate and stocking density in broiler production.

The reduction in production resulting from the adoption of animal welfare measures was computed based on specific guidelines. Farmers are recommended to lower the growth rate and stocking density of their chickens; however, selling chickens below a certain weight is not feasible or economically viable. One potential solution involves extending the rearing period, consequently reducing the number of broiler batches per year and, therefore overall production. The exact calculations and methodology are kept confidential as they refer to farm-specific data provided by Hungarian enterprises.

To better reflect real-world conditions, we incorporated a ten-year adjustment period into the model, spanning from 2023 to 2032. Within this timeframe, it is assumed that only a minority of companies will initially implement the broiler welfare recommendations, while the vast majority will undertake these changes in the last three years leading up to 2032. The mathematical formula used to build the model is:

$$u = \frac{pl_{(t_{10})}}{e^{(t_{10}-t_0)}}$$
$$pl_{(t_n)} = ue^{(t_n-t_0)} \quad (1)$$

Where:
u = multiplier
pl = production loss in the year t
t = time
e = exponential constant (approximately 2.71828)

This mathematical formula, utilised to model EFSA's recommendations, generated the annual percentage of chicken meat production loss over 10 years. This outcome was integrated into the broiler chicken production equation within AGMEMOD, generating an annual production loss measured in tonnes from 2023 to 2032.

To analyse the Hungarian price dynamics concerning chicken meat, pork, and maize, following Szabo *et al.* (2023) and Leeuwen *et al.* (2022), we incorporated EU reference prices converted to Hungarian forints in the AGMEMOD equations. These prices include the German pork price, the Polish chicken meat price, and the French maize price.

Factors such as chicken meat consumption and pork consumption depend on the growth of the Hungarian population and the per capita consumption. Regarding the international trade of broiler chicken, imports and exports are primarily influenced by prices, production, and consumption of chicken meat, similarly to Potori *et al.* (2023).

The present research was conducted for the Hungarian broiler sector, utilising official and validated data while strictly maintaining the confidentiality of non-public information. The main sources of information included Eurostat, the Hungarian Central Statistical Office and the Institute of Agricultural Economics (AKI) of Hungary.

Results

After modelling the effects of implementing a reduction in broiler stocking density by up to 11 kg/m^2 and a decrease in growth rate by up to 50 g/day, considering a ten-year adaptation period, the production of chicken meat showed a substantial decline of 72.4% compared to the baseline by 2032 (Figure 2). This means a reduction from 345.1 to 103.7 thousand tonnes (Figure 3) impacting imports, exports, consumption, and prices of chicken meat. Consequently, the economic sustainability of the sector over the next decade

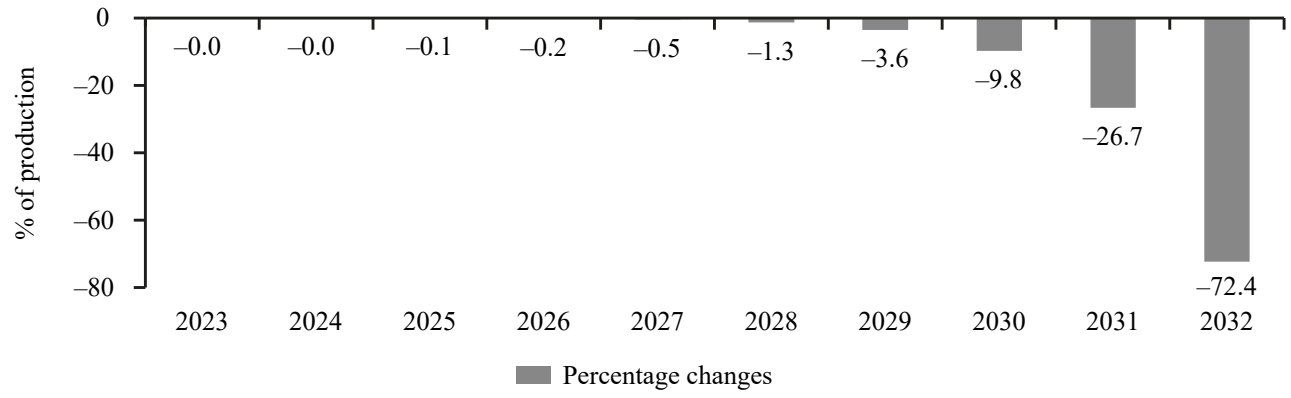

Figure 2: Scenario and baseline variations of broiler production under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

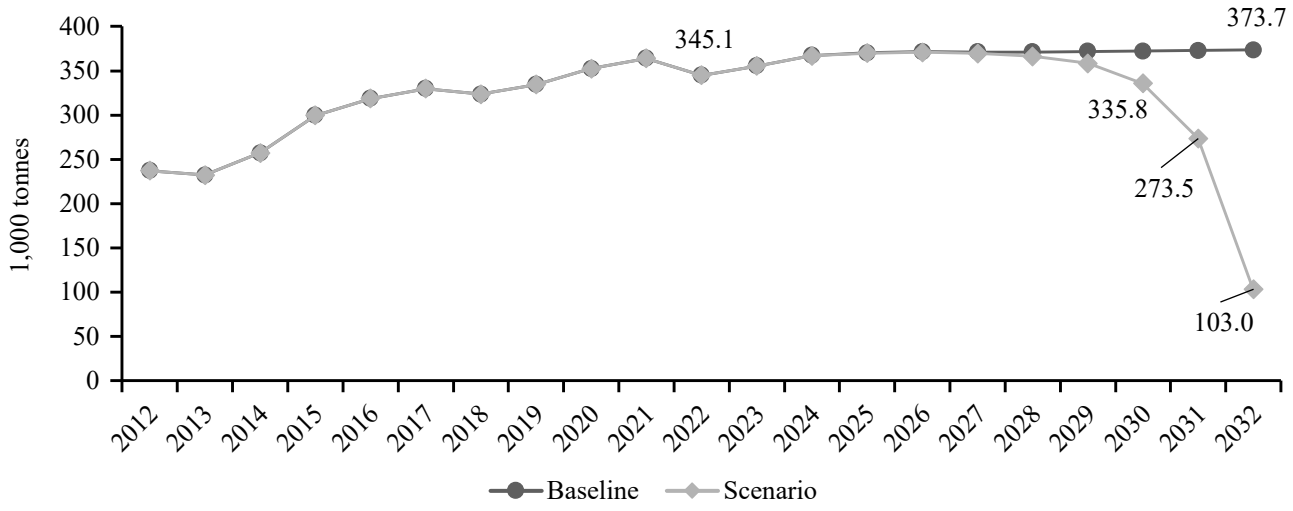

Figure 3: Broiler production comparison under a combined measure
Source: Own elaboration based on AGMEMOD simulations

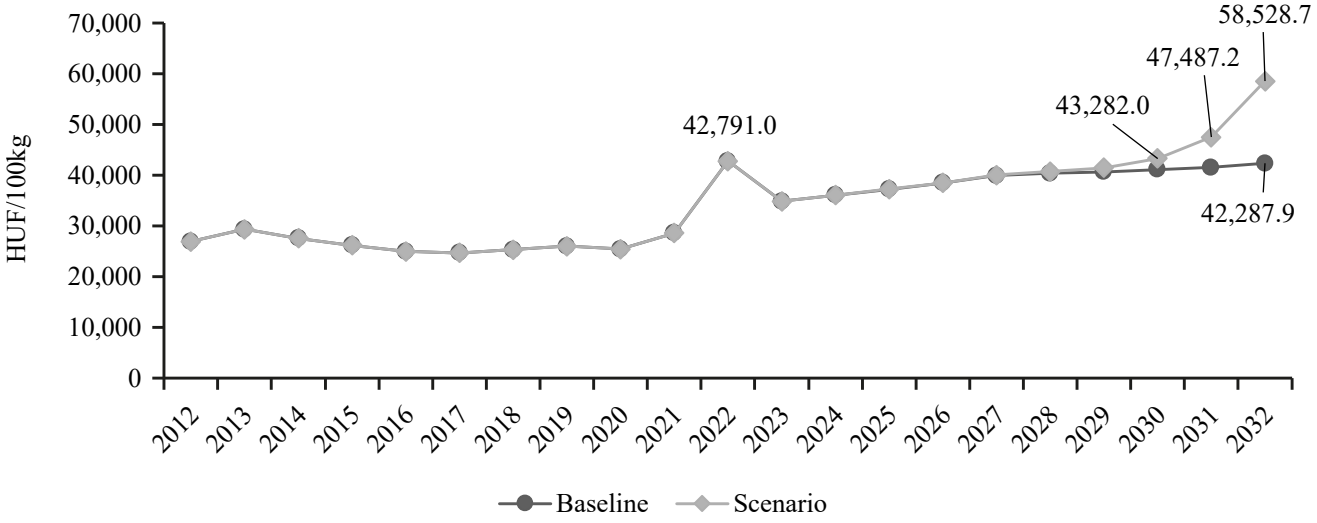

Figure 4: Chicken meat price comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

appears doubtful, and most producers may struggle to comply with these suggestions.

In this scenario, prices gradually increased from 42 791 to 58 529 HUF/100 kg (Figure 4) reflecting a +38.41% difference from the baseline by 2032. Consumer behaviour followed a similar trajectory to production with a 6.94% decrease in consumption (Figure 5), significantly affecting imports in Hungary, which could drop by 5% relative to the baseline (Figure 6).

This decrease in consumption can be attributed to the sensitivity of Hungarian consumers to price changes given the country's relatively low average wages in Europe. Although higher prices may incentivise imports in Hungary, other European countries could also experience production losses, potentially limiting their ability to export. Third countries such as Brazil could potentially step in as broiler exporters. However, the Hungarian consumer's preference for affordable options, due to higher prices from third-country imports, could likely drive them towards pork as the next substitute.

With a rise in chicken prices and a decrease in production, chicken meat exports gradually declined, particularly from 2029, with a –4% difference from the baseline, making it increasingly unfeasible to export chicken meat by 2032, when most broiler-producing companies decide to comply with EFSA's broiler welfare recommendations (Figure 7).

Conducting a comprehensive cross-sectoral analysis, the pork sector was also impacted. There is an anticipated increase in pork consumption by 12.83% in 2032 (Figure 8) due to a decline in broiler consumption. However, the price of pork could rise by 9.9% (Figure 9) as chicken ceases to be a strong competitor. Regarding the crop sector, the price of maize, a primary component of chicken feed, experienced significant effects due to these broiler welfare recommendations. The reduced demand for maize as chicken feed could lead to a gradual 25.6% decrease in prices by 2032 compared to the baseline (Figure 10).

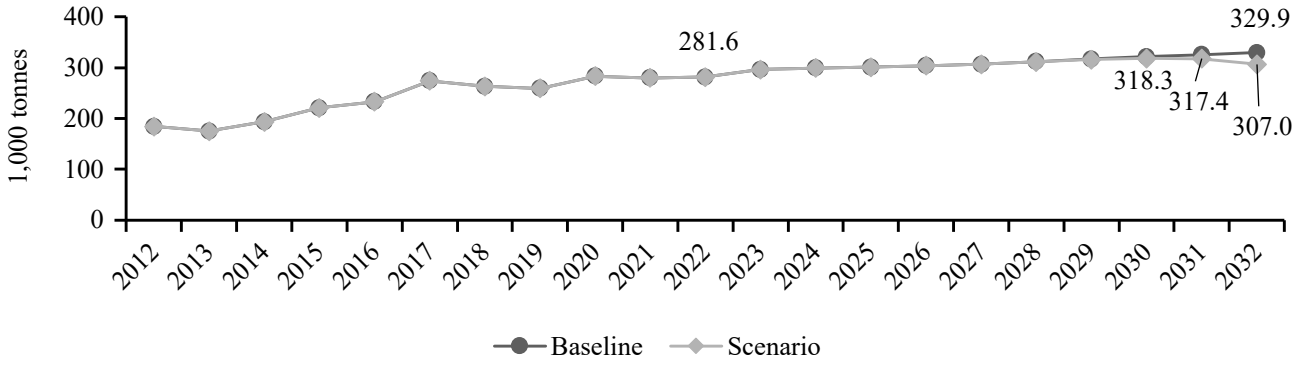

Figure 5: Broiler consumption comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations.

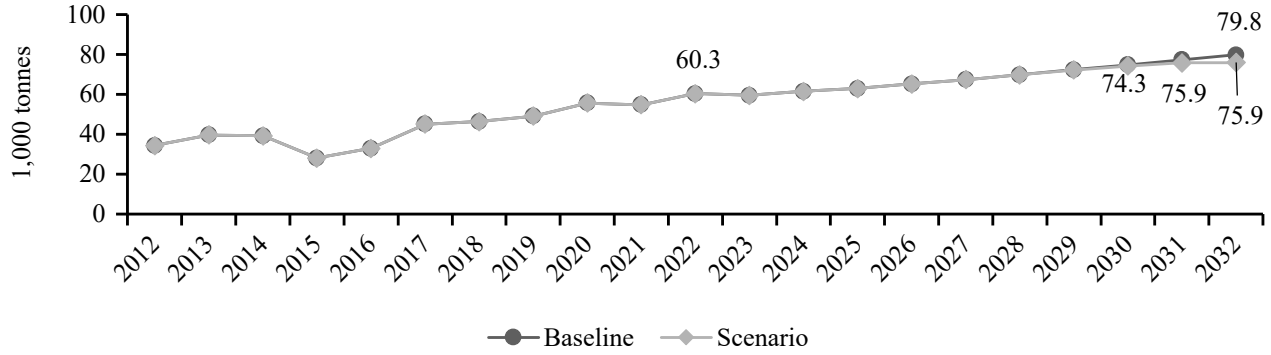

Figure 6: Broiler imports comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

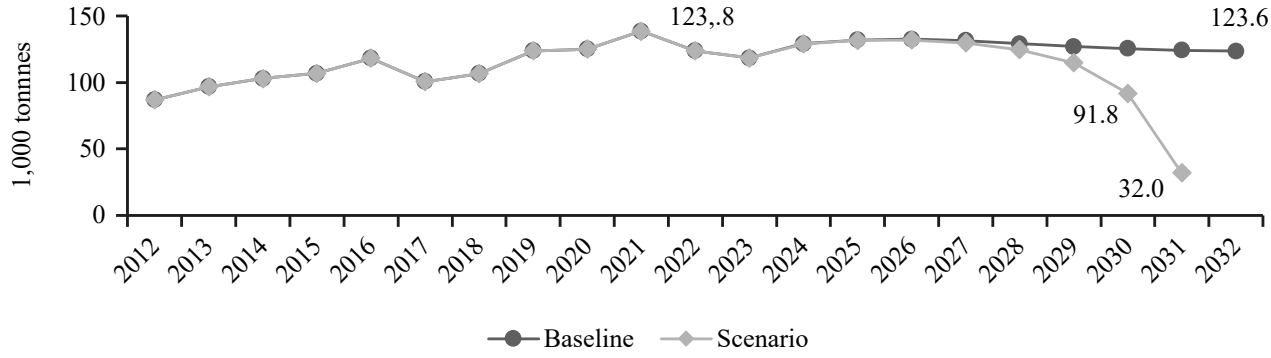

Figure 7: Broiler exports comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

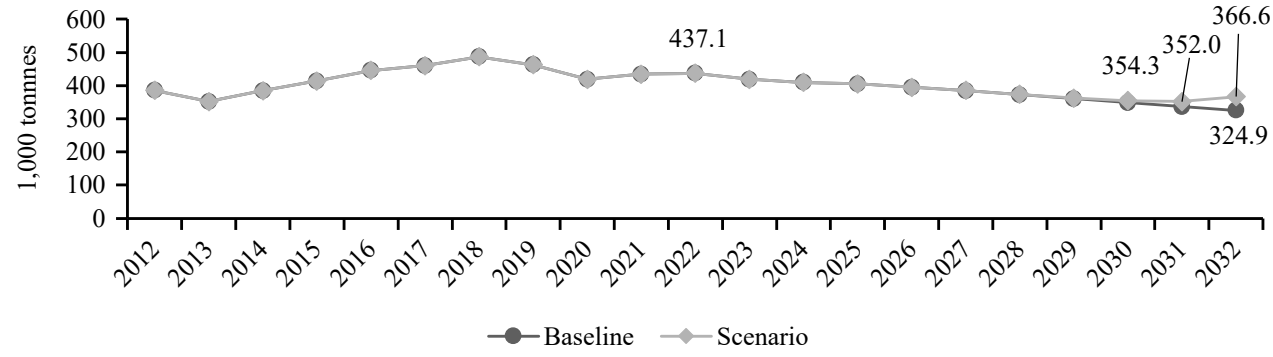

Figure 8: Pork consumption comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

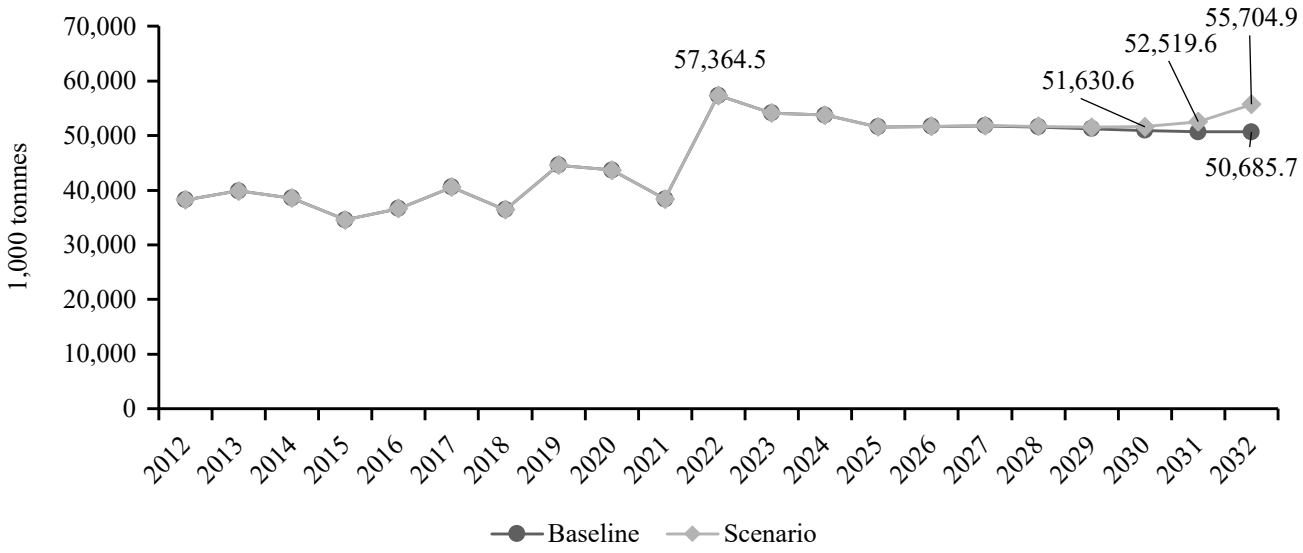

Figure 9: Pork price comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

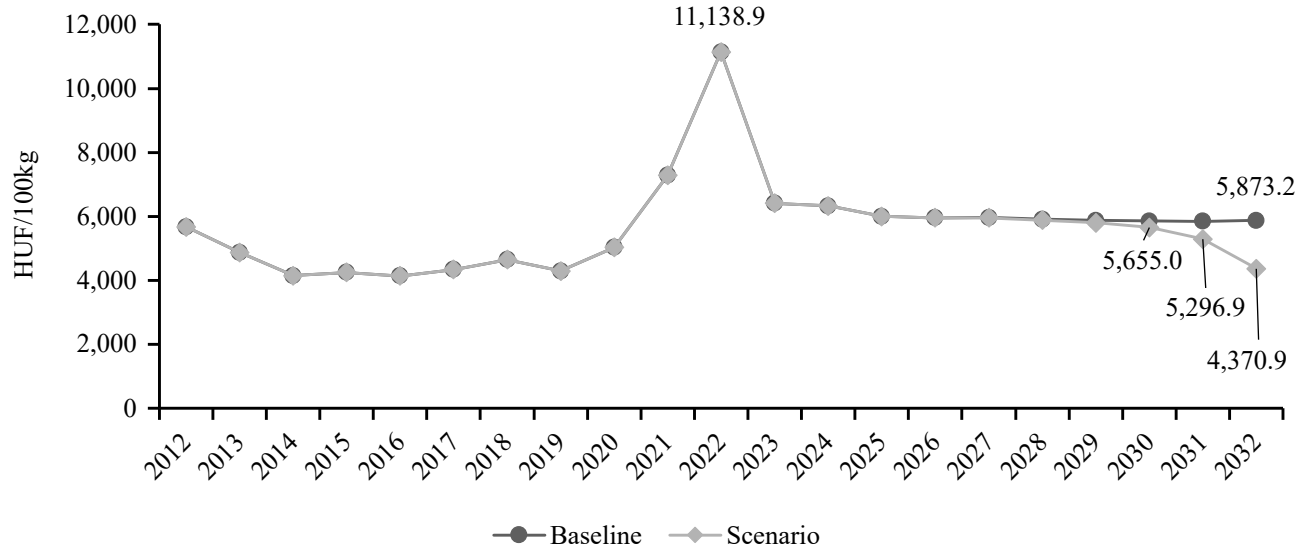

Figure 10: Maize price comparison under a combined measure.
Source: Own elaboration based on AGMEMOD simulations

A potential solution for meeting the EFSA's new animal welfare goals, while also maintaining the profitability of the broiler industry and thereby ensuring the competitiveness of farmers, is to implement these recommendations separately. On one hand, introducing solely the 50 g/day growth rate recommendation could lead to an 18 % decrease in production (Figure 11). On the other hand, adopting only the 11 kg/m^2 density suggestion could result in a 66 % loss in production.

Implementing the growth rate limiting recommendation individually led to a less severe scenario for farmers, with only a moderate decrease in production levels, making it feasible to maintain market equilibrium. The chicken meat price experienced a moderate increase of 10% by 2032 compared to the baseline (Figure 12). Consequently, consumers could not be substantially impacted, resulting in a gradual decrease in consumption of 1.75% by 2032 in the new scenario compared to the baseline.

Anticipating these price increases, farmers could be incentivised to prioritise selling broiler products in the domestic market over international markets. Consequently, exports are expected to decrease gradually by 51% by 2032 compared to the baseline (Figure 13). Concerning the self-sufficiency ratio, it is projected to reach 0.9 by 2032 (Figure 14). The 10-year transition period could provide the industry with an opportunity to innovate through new technologies and enable farmers to reinvest their profits into upgrading infrastructure. This strategic shift is crucial for recovering production levels after the transition period, positioning the industry to be more profitable in the future and more resilient to economic downturns.

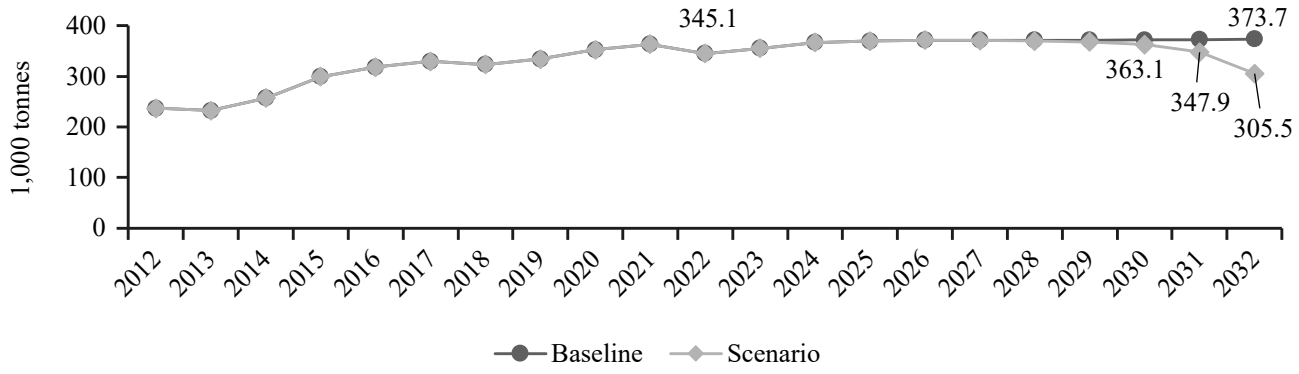

Figure 11: Broiler production comparison under a growth reduction rate scenario.
Source: Own elaboration based on AGMEMOD simulations.

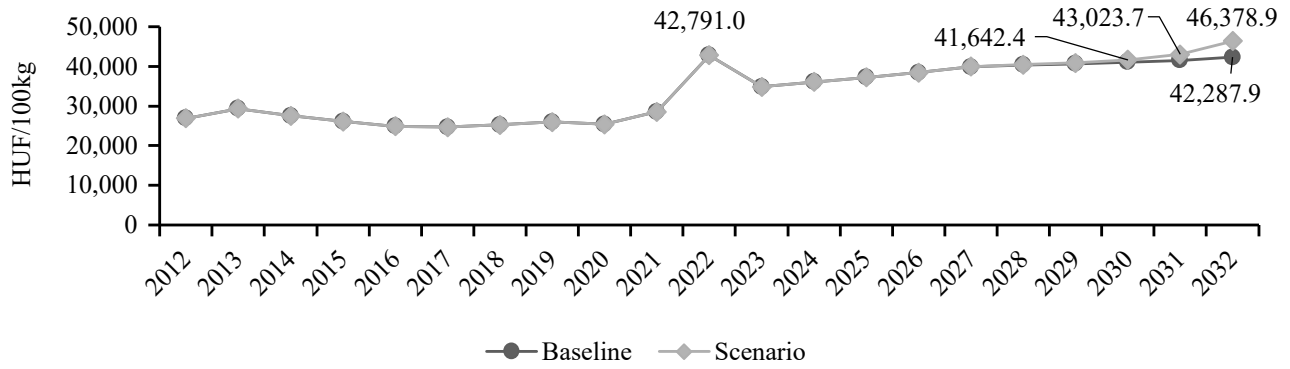

Figure 12: Chicken meat price comparison under a growth reduction rate scenario.
Source: Own elaboration based on AGMEMOD simulations

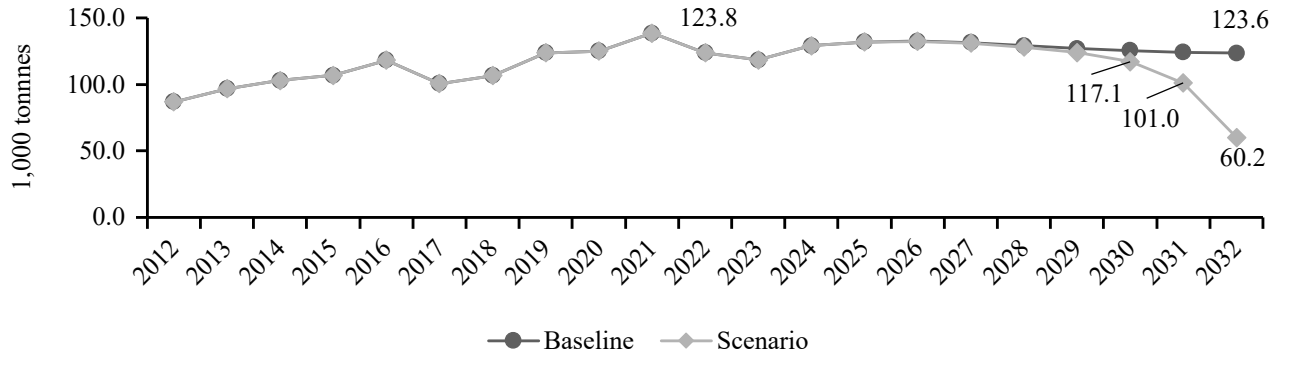

Figure 13: Broiler exports comparison under a growth reduction rate scenario.
Source: Own elaboration based on AGMEMOD simulations

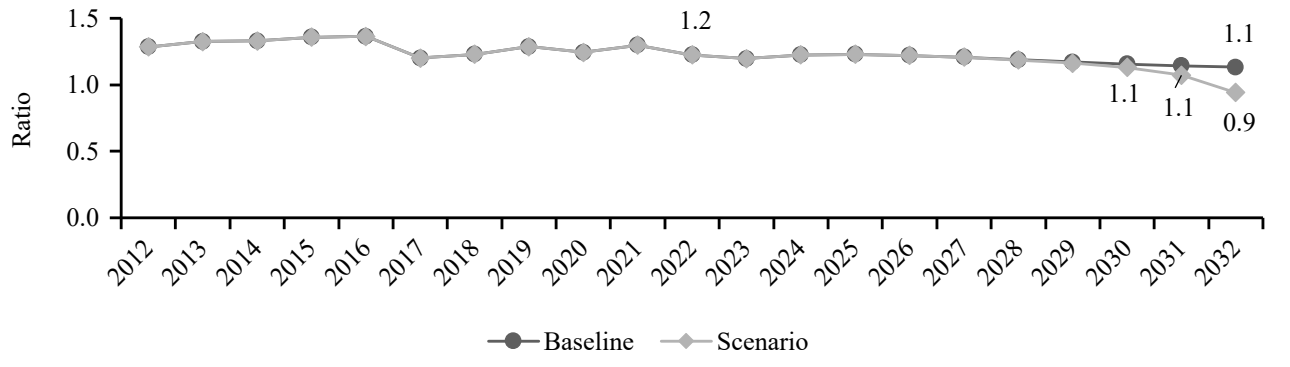

Figure 14: Self-sufficiency ratio of broiler chicken, comparison under a growth reduction rate scenario.
Source: Own elaboration based on AGMEMOD simulations

According to the latest report by AVEC (2023), implementing the EFSA's broiler welfare recommendations analysed in this paper – specifically, those concerning stocking density and growth rate – could result in a 70% reduction in chicken meat production across Europe. This projection aligns closely with our findings for Hungary, as our research calculates a 72% loss of national broiler chicken production, taking official databases into account. The medium-term agricultural outlook report of the European Commission (2022) provides an overview of the European agricultural market up to 2032, offering insights into the main agronomic indicators in Hungary. It reveals a trend of increasing chicken production and per capita consumption, driven by shifts in consumer behaviour and perceptions of chicken meat's health benefits over other meats, such as pork.

Conclusions

It is concluded that simultaneously applying a reduction in growth rate and stocking density are not economically viable. This approach could result in a shortage of chicken meat in the market, affecting key industries related to chicken production, including the pork and maize sectors. A potential resolution could involve implementing these changes independently, starting with a reduction in growth rate by 50 grams per day over the next ten years. This strategy is projected to cause an 18% drop in production, coupled with a manageable 10% increase in market prices by 2032 compared to the baseline. Consequently, the impact on consumers could be minimal, with a slight consumption reduction of just 1.75% in this new scenario compared to the baseline.

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