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Sustainability indicators in a globalised poultry sector: production, consumption, trade openness, and GDP across 126 countries

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ABSTRACT

The sustainability of the meat industry relies on consistent demand and the desire for meat. In recent years, chicken was produced around 104.2 million metric tons and expected to increase by 2% in the upcoming years with a record of 109.6 million tons worldwide. Also, global chicken meat export will increase by 3% with a record of around 14.7 million tons. Therefore, this research focuses on investigating the causal relationships that have a significant impact on chicken production, considering independent variables as chicken consumption, trade openness, and GDP. This study is conducted across several income groups, encompassing 126 countries, for a 30-year period from 1993 to 2022. To strengthen the study, the demand theory and international trade theory were utilised. This study employs multiple methodologies, including panel Granger analysis, cross-country Granger causality analysis to identify the direction of causality, and thereafter the Wavelet coherence analysis to determine the time variance and the nature of the coherence between the variables. According to the study, the results have revealed unidirectional relationships between production and trade openness, chicken meat consumption, and GDP. Accordingly, policy suggestions are provided for farmers, policymakers, relevant organisations, and legislators to make an impact on the chicken meat industry by enhancing production, optimising operations, and maintaining high quality to improve nutritional value. All the implementation suggestions are given to support the Sustainable Development Goals, established by the United Nations.

Introduction

The desire for meat is unsatisfied, and in such a world, people consider healthier options. In this regard, chicken is one of the highest-quality types of meat, being the most consumed poultry meat (Ning et al., 2025; Qi et al., 2025) and the second most consumed meat worldwide (Wang et al., 2023). Chicken meat is low in fat (Gkarane et al., 2020), cholesterol (Jaturasitha et al., 2008), and calories, providing high nutritional values for consumers (Debbarma et al., 2024). Due to the high demand for chicken meat worldwide (Araújo dos Santos et al., 2023; Bhalerao et al., 2014; United States Department of Agriculture, 2025), the poultry industry is experiencing significant growth. To meet this substantial demand (Selle et al., 2021), producers need to ensure consistent production. Consequently, chicken meat production (CMP) constitutes a vital part of the sustainable meat industry.

Economic instability is a prevalent global phenomenon, prompting people to carefully assess the perceived value of goods and services before making purchasing decisions. When people buy meat, they feel both affordability and healthier options, such as chicken (Asante-Addo & Weible, 2020). Chicken meat consumption (CMC) is based on various factors (Cappone et al., 2025), and it has a significant impact on production.

In the international borders, trade openness (TO) plays a key role (Radin et al., 2017). It serves as the gateway to global markets for chicken meat producers, enabling them to expand their distribution and develop the meat industry. This makes it a considerable factor that affects chicken meat production. With exports and imports being high, and considering the purchasing power of consumers, the meat industry makes a significant contribution to a country's gross domestic product (GDP). There may be a relationship between chicken meat production and GDP, as the ability to purchase plays a crucial role in the sustainability of chicken meat production.

Therefore, this study aims to identify the causal relationships between chicken meat production, chicken meat consumption, trade

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openness, and GDP. To achieve this goal, this study makes several significant contributions to the existing body of literature.

First, this study encompasses a broader geographical scope by conducting research across various income groups, including high-income (HI), upper-middle-income (UMI), lower-middle-income (LMI), and low-income (LI) countries, spanning 126 countries worldwide over 30 years from 1993 to 2022.

Second, this study employs dual methodologies. In the first methodology involves panel Granger analysis and cross-country Granger analysis, which provides a broader perspective on the relationship between the variables within countries. In the second methodology, Wavelet coherence analysis was employed to identify the directional causalities and nature of the coherence between the variables.

Third, this study presents attractive and innovative visualisations of descriptive statistics, Wavelet coherence analysis, and Granger causality analysis results in a simplified manner, facilitating an understanding of the causal direction of chicken meat production and the relevant variables.

Finally, this study presents novel findings that contribute to the sustainable chicken meat industry and offer policy implications for farmers, policymakers, organisations, and legislators related to enhancing production and economic sustainability, which also supports the Sustainable Development Goals (SDGs) established by the United Nations.

This study primarily caters to specific SDGs established by the United Nations, which include SDG 2: Zero Hunger, SDG 3: Good Health and Well-being, SDG 4: Quality Education, SDG 8: Decent Work and Economic Growth, SDG 9: Industry, Innovation, and Infrastructure, SDG 10: Reduced Inequalities, SDG 12: Responsible Consumption and Production, SDG 17: Partnerships for the Goals.

The remaining sections of this paper will outline the theoretical framework, provide a critical review of the existing literature, describe the data and methodologies, present the results, and include a discussion of the relevant findings. A conclusion, policy implications, limitations, and suggestions for future research will follow this.

Literature review and theoretical perspective

This section provides a comprehensive literature review of existing studies to examine the interconnection of variables, incorporating a theoretical perspective through the conceptualisation of the variables in the study. Also, an expanded version of the review has been included in the Appendix 1.

Critical literature review

Global meat production and consumption are growing at an exponential rate, with the poultry sector being the most significant contributor to the agricultural industry (Choudhury et al., 2025). It is a path to sustainable food production (Mendes et al., 2024).

In this connection, chicken meat is considered to be the most consumed poultry meat type in the world (Ning et al., 2025; Qi et al., 2025), also the second most consumed meat type in the world (Wang et al., 2023), and predicted that the worldwide meat production will be led by poultry production (Food and Agriculture Organization, 2024), due to its high nutritional value (Mishra et al., 2023), efficient source of protein (Sparrow et al., 2024), and its affordability (Abeyesinghe et al., 2025; Debbarma et al., 2024; Gkarane et al., 2020; Mir et al., 2017).

When people consume chicken, they are concerned about the quality of the chicken, and there have been many studies on their dietary treatment that affect the quality of the meat (Abu Jafor Siddik et al., 2025; Altmann et al., 2020; Campbell et al., 2025; Cortinas Hernández et al., 2005; Cullere et al., 2019; López-Ferrer et al., 2001) with appropriate stored (Cooreman-Algoed et al., 2022). Also, health reasons, taste, nutritional value, and price are essential consumer concerns (Chiras et al., 2023; Szeląg-Sikora et al., 2024).

Using antibiotics improves health and safety (Nduku et al., 2025), however, the resistance to antibiotics has been addressed by consuming organic chicken (Abd El-Hack et al., 2025). In the United States, there is a shift toward outdoor access production to improve quality (Campbell et al., 2025). Although global poultry consumption is increasing, various countries have distinct preferences regarding chicken products (Tsiboe et al., 2024).

As for demand increases, many studies related to chicken meat consumption have been done for many countries, such as China (Cui et al., 2022; Feng et al., 2022) which is the second largest producer in the globe (Giusti et al., 2022; Li, 2025), Japan (Kito, 2025), Mexico (Godínez-Oviedo et al., 2022), Thailand (Lengkidworraphiphat et al., 2021) and South Africa (Katiyo et al., 2020) and many more. Since chicken consumption and production appear to be linked globally, it is worthwhile to investigate the relationship between chicken production and consumption.

The meat industry makes a significant contribution to a country's GDP. On that note, poultry is an important source of protein, and poultry production is also a substantial source of income (Idowu et al., 2021) for UMI, LMI, and LI countries (Shioda et al., 2024) on the same.

In low and middle-income countries, one of the most common production systems is backyard chickens (Chauhan et al., 2024; Di-Pillo et al., 2019; Ibrahim et al., 2025; Muñoz-Gómez et al., 2025; Muñoz-Gómez & Torgerson, 2024), which is practised by 80% of rural populations worldwide (Conan et al., 2012; Ibrahim et al., 2025). Biosecurity measures are essential when it comes to poultry farming in low and middle-income countries (Nielsen et al., 2025).

Additionally, in the United States, as chicken production exports increase, so does the economy (Wen et al., 2019). Furthermore, including Mozambique (Shioda et al., 2024), Indonesia (Sumantri et al., 2020), and Vietnam (Truong et al., 2021),the chicken sector is a significant source of income for families, as it has a positive economic impact on society (Ngongolo et al., 2021). Therefore, chicken production will have a significant role in income sources in developed and developing countries. As there appears to be a connection between Chicken meat production and GDP, it is worth investigating.

Significant growth in the meat industry can be attributed to increased openness. On that note, satisfying the global demand for poultry meat will depend on the ability to supply it from countries that focus on growing poultry production (Arp et al., 2024). Consequently, billions of chickens are being shipped globally to meet this demand (Radin et al., 2017). In the following decades, chicken meat imports in developing countries are expected to increase by 3.4% per year (Harb et al., 2018). Furthermore, in countries like China as a leading exporter of chicken meat (Aranda et al., 2019; de Jesus Xavier & dos Reis, 2022), Thailand is also one of the top ten poultry producers among exporters (Klaharn et al., 2024), Europe, high demand for imported chicken has led to a rapid increase in imports; however, various concerns have been raised in studies (Abgottspon et al., 2014; Dhanji et al., 2010; Katrin et al., 2016).

On the other hand, in Senegal (Boimah & Weible, 2021) and Russia, several trade restrictions and bans on chicken imports from the U.S. (United States), Canada, Australia, the Europe, and Norway have been implemented over the past few years (Soon & Thompson, 2020).

Some trade bans were imposed on the U.S. exports at the time of disease outbreaks (Padilla et al., 2025; Thompson et al., 2020), because poultry products are a source of spreading diseases (Tykalowski and Koncicki, 2024), and the same prevails in China as well (Zhou et al., 2019). Then, in the United Kingdom, to differentiate the imported products, including chicken, they have introduced a country of origin food labelling system (Balcombe et al., 2016), and there have been discussions with the U.S. on a Free Trade Agreement that will allow the importation of chicken (Millstone et al., 2019). Due to the high demand, Ghana also imports chicken meat from the United States, Brazil, and the European Union (Apike et al., 2024; Johnson, 2011). However, consumers prefer imported chicken meat because it is 25% less costly than

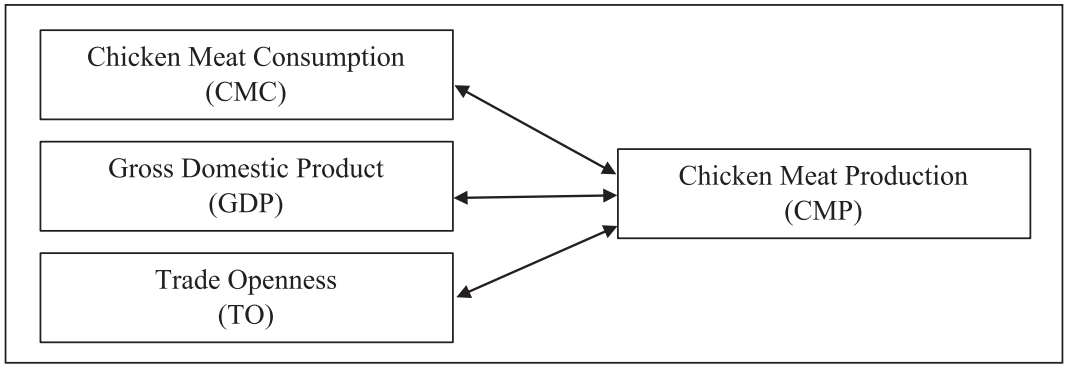


Fig. 1. Theoretical framework. .
Source: Authors' Illustration

domestic production (Ragasa et al., 2020) and provides preferred cuts of meat (Banson et al., 2015; Kwadzo et al., 2013).

Over the past decade, non-tariff measures have had a significant impact on the meat trade (Ridley et al., 2024), including the effects of temperature and precipitation abnormalities (Rezitis et al., 2024). There appears to be a clear connection between chicken meat production and trade openness that warrants investigation at a global level.

The knowledge gap has been identified after a critical literature review of previous studies. Earlier research has been conducted using single variables and focused on individual countries or multiple countries within each income group. There have been limited studies on the association between trade openness and GDP, despite the extensive discussion of chicken meat production and consumption throughout the literature. The limited use of sophisticated methodologies to identify causal relationships between variables have been identified. Therefore, by combining multiple variables, including countries, income groups, and methodologies, this study aims to produce novel results that are highly valuable for building a sustainable meat industry.

Theoretical framework

Theoretical concepts utilised in this study include demand theory and international trade theory, which support and solidify the theories aligned with CMP and other variables. Theoretical concepts will be discussed under this section, and the conceptual framework is constructed for the variables in Fig. 1.

Demand theory was utilised in this study (Böhm & Haller, 2017; Koutsoyiannis, 1979), as the demand for chicken meat is increasing due to excessive consumption. This theory explains the desire to consume goods to satisfy needs. The demand is based on various factors, such as price, quality (Escobedo del Bosque et al., 2022), taste (Jayasena et al., 2013), health benefits, nutritional value (Marangoni et al., 2015), and the safety of the meat consumed. This theory will solidify this study by supporting chicken production through consistent consumption of chicken.

International trade theory explains how goods and services are exchanged in global markets and across borders (Leamer & Levinsohn, 1995). This refers to international transactions among countries, organisations, or companies (Chen, 2022; Ezenwa et al., 2021). In most countries, a chicken meat production shortage is faced in the domestic market due to regional impacts. Therefore, trade opens the door for infrastructure expansion and helps improve regional well-being and employment, while reducing production costs by utilising efficient resources. This enhances regional chicken meat production and allows for improved economic growth within the country.

Data and methodology

This section of the study presents a detailed description of the data considered, along with the methodologies used to analyse and generate the results, as well as the process.

Table 1
Data sources and variables.

Variable	Measurement	Source
Chicken Meat Production (CMP)	Kg per capita	(Food and Agriculture Organization Statistics, 2025b)
Chicken Meat Consumption (CMC)	Kg per capita	(Food and Agriculture Organization Statistics, 2025a)
Gross Domestic Product (GDP)	GDP per capita (USD)	(World Bank, 2025a)
Trade Openness (TO)	Percentage of GDP	(World Bank, 2025b)

Source: Authors' Compilation.

Data

This research study has utilised a panel dataset that includes 126 countries, which are divided according to their income levels. A dataset for a 30-year time frame was employed. The dataset used in this study is provided in Appendix 2.

As presented in Table 1, the measurements of all variables have been converted to per capita values. Data related to CMP and CMC were obtained from the Food and Agriculture Organisation database, while data for the GDP and TO were extracted from the World Bank. The data collection and analysis process, utilising methodologies, is presented in Fig. 2.

Methodology

The causal relationship between chicken meat production and the independent variables, which include chicken meat consumption, GDP, and trade openness, has been analysed using several methodologies.

A panel Granger causality analysis and cross-country Granger analysis was utilised to identify the causal relationship between the variables. Then, the Wavelet coherence analysis was employed to determine the direction of causality, as well as the nature of the coherence at time-varying frequencies.

Panel Granger causality analysis

Granger causality analysis is a comprehensive statistical method used by researchers across various disciplines. Including the global supply chain (Ren et al., 2024), Finance (Feng et al., 2023), Telecommunication (Dutta, 2001), Climate science (Zolghadr-Asli et al., 2021), Political science (Groshek, 2011) and many more.

Before conducting the panel Granger causality analysis, the Cross-Sectional Dependency test (CSD) (Pesaran, 2004) is utilised to identify

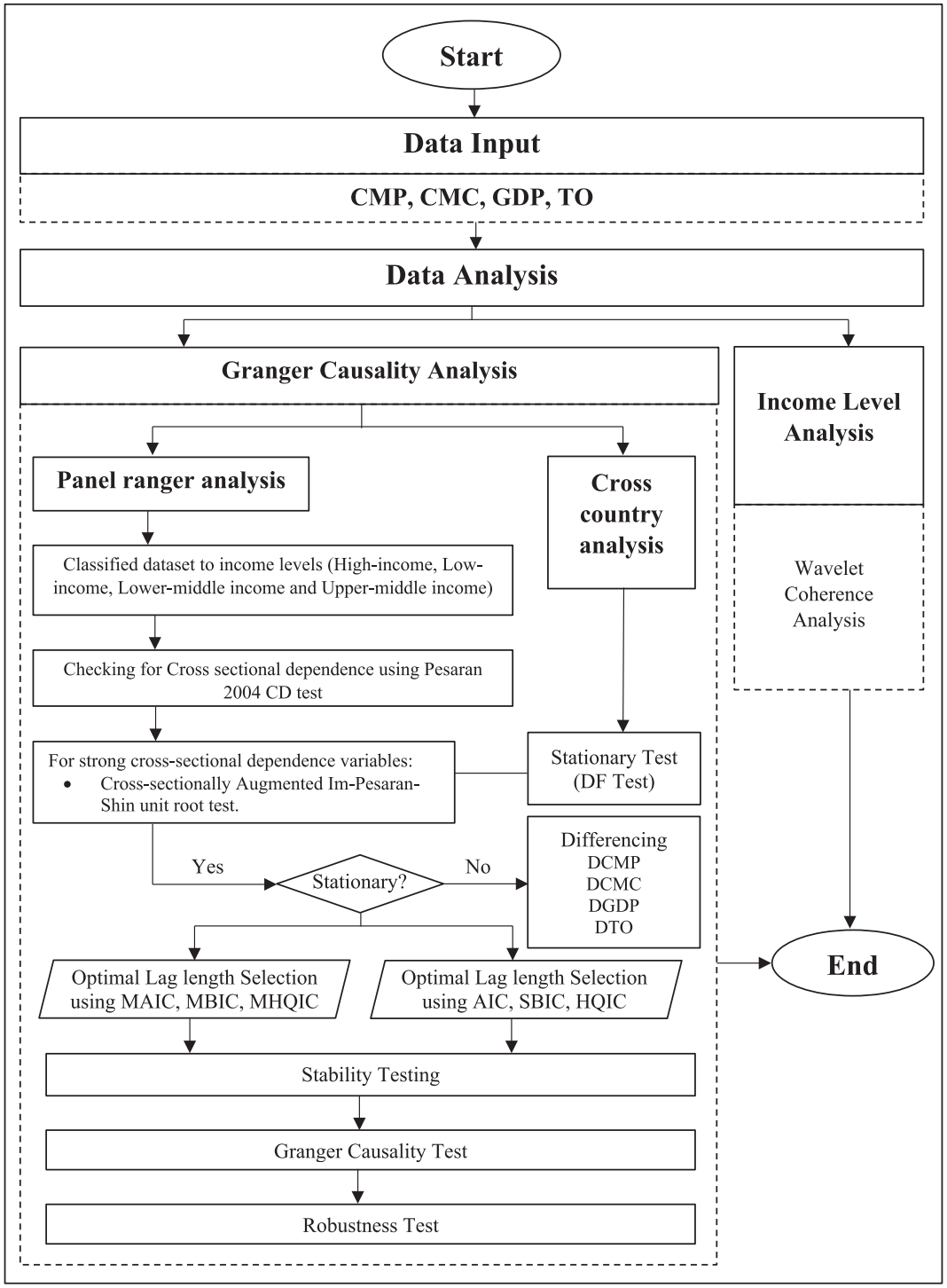


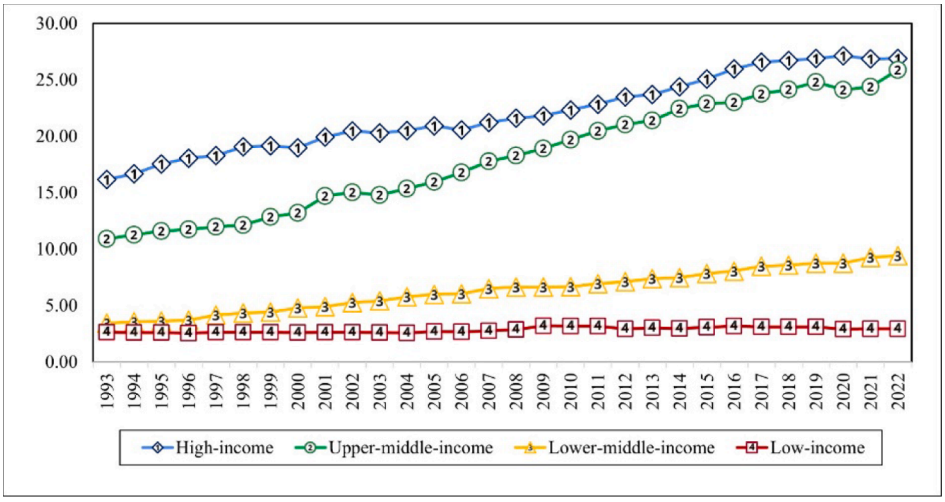
Fig. 2. Methodology Flow Diagram. .
Source: Authors' Illustration

the existence of cross-sectional dependencies in the panel (Ertur & Musolesi, 2017). Therefore, to check stationarity of the strong cross-sectional dependence variables, employ the second-generation root test, which is the Cross-sectionally Augmented Im-Pesaran-Shin unit root test (CIPS) (Pesaran, 2007), which is widely used in macro-level variables to check stationarity (Athalage et al., 2025; Kaya et al., 2025). After determining the existence of a unit root in all variables, they are converted to differences until stationarity is achieved.

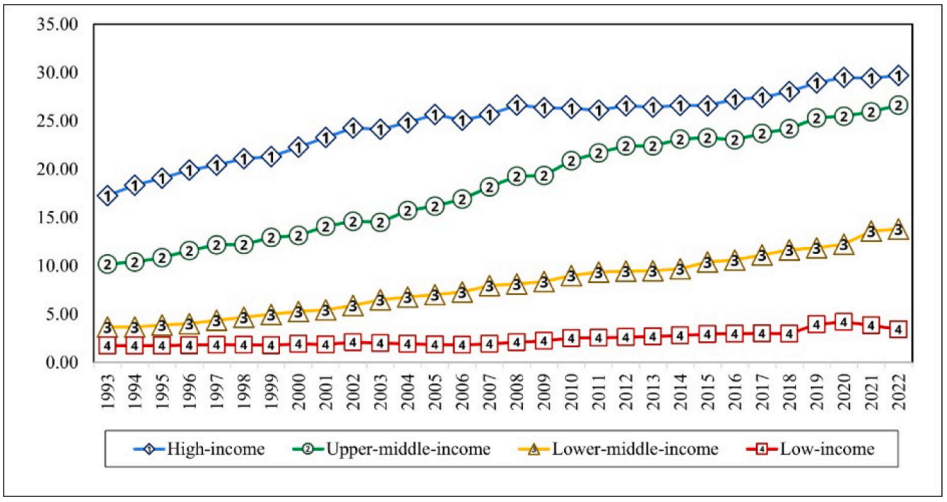
Afterward, to identify the lag interval for each income group, the team utilised the Panel Vector Autoregression model (PVAR) within each income group to determine the optimal lag length by using the Moment selection Akaike Information Criteria (MAIC) (Akaike, 1969), the Moment selection Bayesian Information Criterion (MBIC) (Schwarz, 1978), and the Moment selection Hannan and Quinn Information Criterion (MQIC) (Hannan & Quinn, 1979) selection criteria, and the stability condition. Once all conditions were satisfied, the panel Granger causality analysis was employed.

This methodology can be used to analyse time series data, identify causal relationships between variables, and predict the interactions of these variables. Equation (1) was formulated to utilise the Granger

(A) Average of Chicken Meat Production



(B) Average of Chicken Meat Consumption



(C) Average of Trade Openness

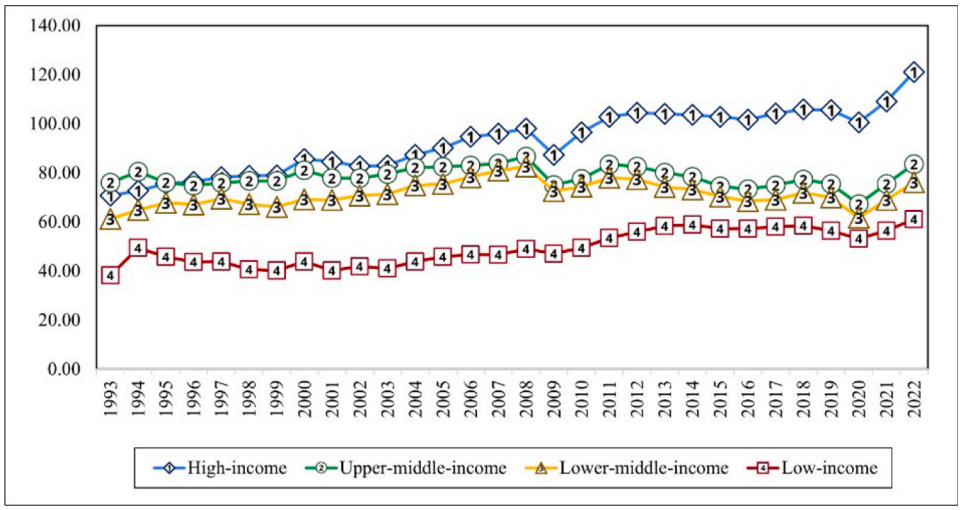


Fig. 3. The average values of CMP, CMC and TO across different income levels from 1993 to 2022. .
Source: Authors' illustration

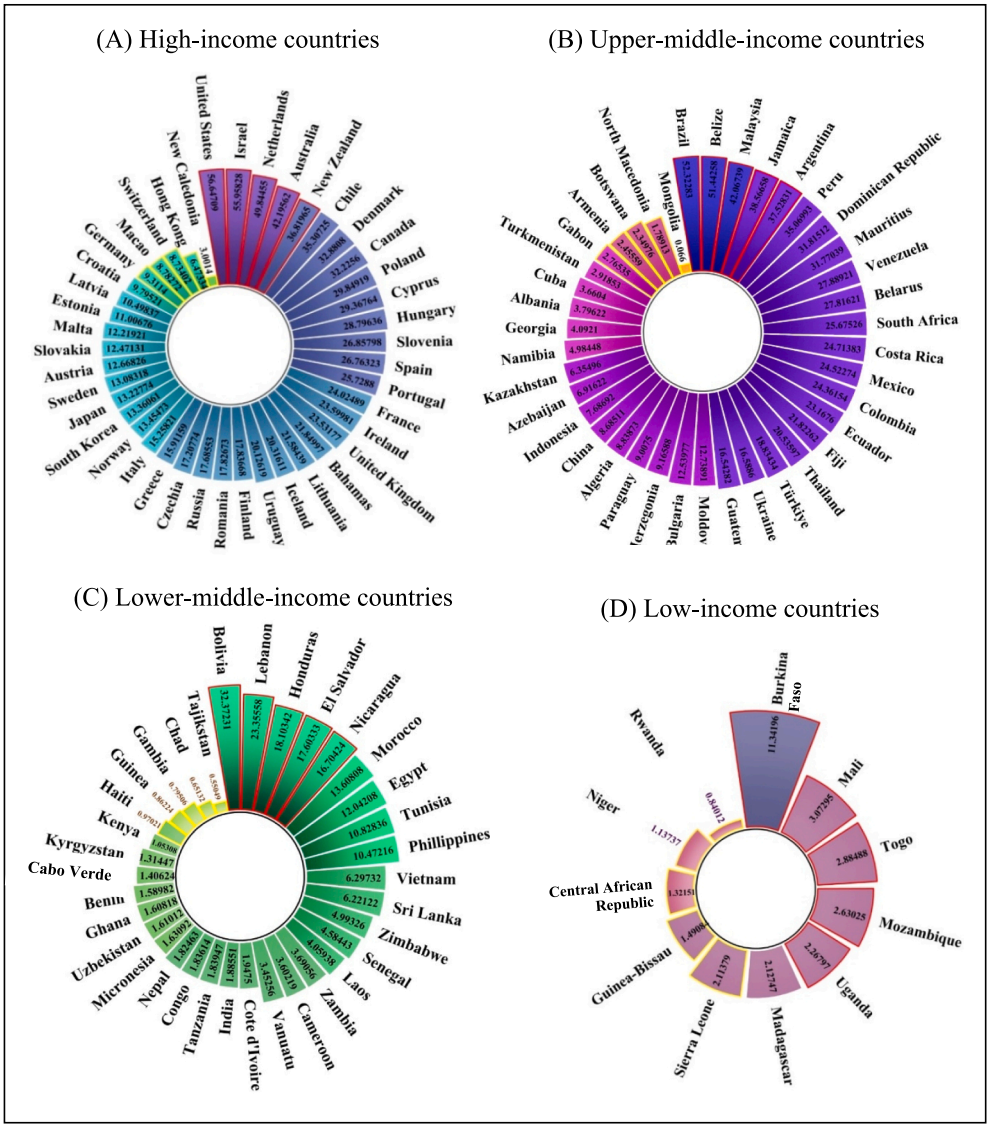


Fig. 4. The average values of chicken meat production across different income levels, classified by countries. .
Source: Authors' illustration

equation for the relevant variables in the study.

$$Y_{i,t} = \sum_{k=1}^{\rho} \beta_i Y_{i,t-k} + \sum_{k=0}^{\rho} \theta_k X_{i,t-k} + u_{i,t} \tag{1}$$

In the equation, X and Y are independent and dependent variables, respectively. Income categories (high, low, upper-middle, lower-middle) represent i and t, which denote the period in years. K delineates the frequency of lags, and ρ shows the number of lags. The regression coefficient of the equation is denoted by β, and θ represents the constant value of the regression, where k may vary from 1 to N (the population size). u demonstrate the error term.

This technique has the benefit of predicting future values of the dependent variable by utilising the independent variables and provides information on the strength of the relationship between the variables. A novel visualisation called the Lucius Jesper Chloe heatmap (LJC) (Dissanayake et al., 2025) was utilised in this study to illustrate the panel Granger analysis results.

Wavelet coherence analysis

A sophisticated methodology, such as the Wavelet coherence analysis, was utilised to gain insights into the direction of the causal relationship between the variables, and then to identify the nature of the coherence at different frequencies. This method was used by many researchers in various disciplines such as climate (Dastour et al., 2022; Lan et al., 2025), energy (Long & Cao, 2024; Putra et al., 2025), Environment (Bilgili et al., 2016; Caldera et al., 2024; Pan et al., 2024), and many more.

Wavelet coherence equation for the variables that are relevant to study depicted in Equation (2), where the scale and the translation are represented by a and b, respectively, and the Morlet Wavelet function is shown by $\psi^{a,b}$.

$$\psi^{a,b}(x) = |a|^{-\frac{1}{2}} \psi\left(\frac{x-b}{a}\right) \tag{2}$$

This methodology has numerous benefits, including identifying relationships between variables and understanding their nature. Time-varying results can be obtained for short-term, medium-term, and long-term applications. Wavelet graphs were generated using R software to illustrate the coherence of the variables.

Cross-country Granger causality analysis

Cross-country Granger causality analysis was utilised in this study to

gain a broader perspective on the variables at the country level. This methodology used wider studies (Galappaththi et al., 2023; Palliyaguru et al., 2024), which related to various sectors. Before conducting this analysis, stationarity was checked using the Dickey-Fuller (DF) unit root test (Dickey & Fuller, 1979), a method suitable for verifying stationarity in time series data. Afterwards, we use a Vector Autoregression (VAR) model to check the stability of the model and determine the optimal lag length to obtain more reliable data.

Afterwards, by using Akaike's Information Criterion (AIC) (Akaike, 1998; Maradana et al., 2019), Schwarz's Bayesian Criterion (SBIC) (Schwarz, 1978) and the Hannan and Quinn Information Criterion (HQIC) (Hannan & Quinn, 1979), the minimum criteria are selected as the optimal lag length. Once all prerequisite tests have been performed, the cross-country Granger causality analysis is employed.

$$Y_{i,t} = \sum_{k=1}^{\rho} \varpi_i Y_{i,t-k} + \sum_{k=0}^{\rho} \pi_k X_{i,t-k} + u_{i,t} \quad (3)$$

A general statistical equation is used to identify causal flows between CMP, CMC, GDP, and TO, as shown in Equation (3). Independent and dependent variables are expressed by X and Y respectively. Country depicts i and time span is shown from t. The number of lags and frequency of lags are symbolised by ρ and k, respectively. Coefficient regression shows that ϖ and π are the constant values of the regression, where k may take any value within the range from 1 to the total number of observations in the population. The ε is an error term.

By utilising cross-country Granger causality analysis, it is possible to identify causal associations between variables with unidirectional and bidirectional impacts within each country, using time series data, which helps to forecast future values. Additionally, by grouping similar causal flows from existing countries together, policymakers may gain fresh insights. Therefore, it's more suitable to employ this methodology to obtain accurate results in this study, which contains a time series dataset comprising 20 nations over a 30-year period.

Results and discussion

This section presents the results and discussion of the descriptive analysis, the panel Granger analysis, the wavelet coherence analysis, and the cross-country Granger analysis for the different income groups, comprising 126 countries.

Descriptive statistics

The descriptive statistics obtained for each income group, analysing 126 countries, are included in Appendix 3. According to Fig. 3, line charts have been drawn using the average values from 1993 to 2022 to illustrate the time trend of each income group within each variable (CMP, CMC, and TO).

According to Fig. 3A, which illustrates the time trend of the average CMP, Fig. 3B shows the trend of the average values of the CMC, and Fig. 3C illustrates the trend of the average values of the TO across each income group. The HI has the upper hand in each graph, followed by the UMI, LMI, and LI, respectively.

Radial bar charts were generated for each income group, classified by the countries within each group, as shown in Fig. 4. The average values of CMP were used to determine the size of the bars, and the countries are listed in order from highest to lowest. It is generated to identify the top 5 countries and the bottom five countries to conduct the cross-country Granger analysis.

The HI countries were illustrated in Fig. 4A. The top 5 countries selected for the analysis were the USA, Israel, the Netherlands, Australia, and New Zealand, while the bottom five countries were New Caledonia, Hong Kong, Switzerland, Macao, and Germany.

The UMI countries were illustrated in Fig. 4B. The top 5 countries selected for the analysis were Brazil, Belize, Malaysia, Jamaica, and Argentina, while the bottom five countries were chosen as Mongolia, North Macedonia, Botswana, Armenia, and Gabon.

The LMI countries were illustrated in Fig. 4C. The top 5 countries we selected for the analysis were Bolivia, Lebanon, Honduras, El Salvador, and Nicaragua, while the bottom five countries were chosen as Tajikistan, Chad, Gambia, Guinea, Haiti, and Kenya.

The LI countries were illustrated in Fig. 4D. The top five countries selected for the analysis were Burkina Faso, Mali, Togo, Mozambique, and Uganda. In comparison, the bottom five countries were Rwanda, Niger, the Central African Republic, Guinea-Bissau, and Sierra Leone.

Table 2
Interpretations for LJC heatmaps.

	Interpretations / Descriptions		
Axis	X Axis	↔	Entity names
	Y Axis	↕	Variable names (Name on the top – first variable, name on the bottom – second variable).
Arrows	Downward arrows	↓	Unidirectional Granger causality from the first variable to second variable.
	Upward arrows	↑	Unidirectional Granger causality from the second variable to the first variable.
	Bidirectional arrows	↕	Bidirectional Granger causality between variables.
	Bidirectional arrows cut in the middle	⇕	No Granger causality between the variables.
	Arrow length		The longer the arrow, the higher the number of lags used in the model.
Circles	Top circle		Granger causality from the first variable to second variable.
	Bottom circle		Granger causality from the second variable to the first variable.
	Warm colours		Results are statistically significant. (Red - 1% significance, Orange - 5% significance, Yellow - 10% significance)
	Cold colours		The results are not statistically significant. (Significance more than 10%)
	Circle size		The higher the circle size, the higher the z-bar tilde statistic value.

Source: Authors' compilation.

Panel Granger causality analysis

Panel Granger causality analysis was conducted for the variables CMC, TO, and GDP to find the relationship with CMP. Before the analysis, the CSD test identified all variables with strong cross-sectional dependence, and the results have been presented in Appendix 4. Therefore, to find the stationarity of all variables, the CIPS stationarity test was utilised in this study. As shown in Appendix 5, the maximum of the first difference for all variables achieves stationarity. Afterwards, as shown in Appendix 6, a PVAR model stability test was conducted using the stability test, which revealed that all eigenvalues lie within the unit root circle; hence, the model is stable and can be used for further analysis. After the prerequisite tests were completed, utilise the panel Granger causality analysis, and the results were illustrated using a novel visualisation called LJC heatmaps. A guideline for interpreting LJC heatmaps is provided in Table 2. The detailed version of the analysis results is included in Appendix 7.

Long-term causality direction patterns can be identified in Fig. 5, where the horizontal heatmaps are separated into various sections according to the respective stages of the stationarity and stability of the variables used in the analysis to generate the results.

CMP and CMC in Fig. 5A, the first section is stationary and stable

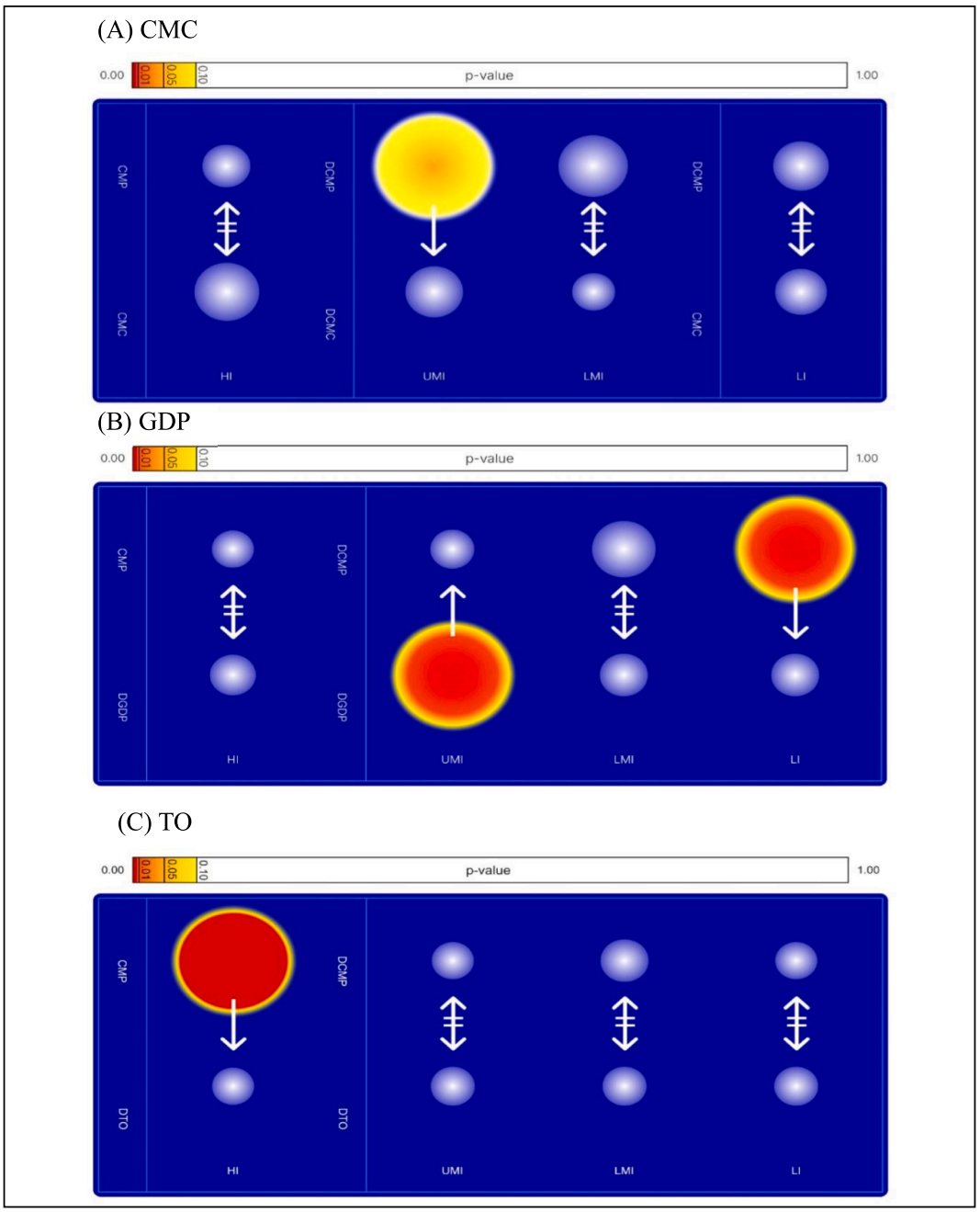


Fig. 5. LJC heatmap for panel Granger results; classified by variables.).
Source: Authors' compilation using the LJC heatmap website (Chloe, 2025

without differentiation, and HI belongs to that section. The second section includes differentiations for both variables, and that section also covers. In the Last section, only the CMP is included, with differentiation where the LI is also included. Regarding the results, the yellow-coloured circle and downward arrow indicate that only UMI exhibits unilateral causality from CMP to CMC, while the other income groups are statistically insignificant.

Then, in Fig. 5B, the first section distinguishes between GDP and CMP, including HI, and the second section differentiates between the two variables, encompassing UMI, LMI, and LI. As for the results, the light red circle and the upward arrow indicate that only one-way causalities can be observed from GDP to CMP across UMI, and another from CMP to GDP across LI, as indicated by the downward arrow. The other two income groups are statistically insignificant.

In Fig. 5C, the first section includes differentiations for the TO, where HI falls. It has a unidirectional causal impact from CMP to TO across HI, as indicated by the dark red circle and the downward arrow. The second section includes differentiations for both variables; however, neither is statistically significant across the other three income levels.

Optimal lag lengths are indicated as consistent according to the same length of arrows in each graph. This visualisation provides a clear perspective of the panel Granger causality analysis results. Finally, as shown in Appendix 8, a robustness check was conducted to validate the panel Granger results using alternative lags. The majority of the results confirmed the same findings as the panel Granger results, thereby validating the findings.

Wavelet coherence analysis

Wavelet Coherence analysis was utilised across various income

Table 3
Interpretation of wavelet coherence.

Direction of arrows/ The Scale of Time Range	Description
→	Positive Correlation
←	Negative Correlation
↖ or ↗ and ↙ or ↘ and	The second variable (CMC, GDP, TO) causes the first variable (CMP).
	First variable (CMP) causing Second variable (CMC, GDP, TO).
↖ ↗ or ↙ ↘	Bidirectional casual flow between the first variable (CMP) and the second variable (CMC, GDP, TO).
0 - 16	Short Term
16 - 64	Medium Term
64 - 256	Long Term

Source: Authors' compilation.

groups, including high-income, upper-middle-income, lower-middle-income, and low-income countries. The primary variable is CMP, and the secondary variables are CMC, GDP, and TO. In Wavelet graphs, a grey-shaped cone is used for analysis, representing the interconnection between variables and the nature of coherence. The 5% significance level can be indicated from the black line, which is determined by the Monte Carlo simulations. In the graph, the red/orange area indicates the existence of correlation, and the blue area indicates the absence of correlation.

The scale range of 0 to 256 indicates various terms. The interval of 0 to 16 implies short term, then 16 to 64 implies medium term, and 64 to 256 implies long term (Wijesuriya et al., 2025; Yeboah et al., 2025). Additional interpretation guidelines for the graphs are provided in Table 3.

Wavelet coherence analysis for high-income countries

The causal relationships between CMP and other variables across high-income countries are illustrated in Fig. 6.

Mostly bidirectional causal relationships can be observed between CMP and CMC in the short and medium term, from 1993 to 2022, as shown in Fig. 6A. Then, unidirectional causal flows can be observed from CMP to CMC from 2003 to 2022, but no causality from 1993 to 2002 in the long term. All terms have a positive nature of coherence with a high frequency.

According to Fig. 6B, a two-way causality between CMP and GDP is present in the short term from 1993 to 2022, and a one-way causality from CMP to GDP is present from 2003 to 2022. However, from 1993 to 2002, no causality was present in the medium term. No causality is present from 1993 to 2022 in the long term. Most terms have a positive nature of coherence with a high frequency. As for Fig. 6C, bidirectional causality from 1993 to 2002 and unidirectional causality from TO to CMP are present from 2003 to 2022 in the short term, with a positive coherence. Then, a negative coherence with unidirectional flow from CMP to TO is present from 1993 to 2012, but no causality from 2013 to 2022 in the long term. No casualties are present in the medium term.

Wavelet coherence analysis for upper-middle-income countries

The causal relationships between CMP and other variables across Upper-Middle-Income countries are illustrated in Fig. 7.

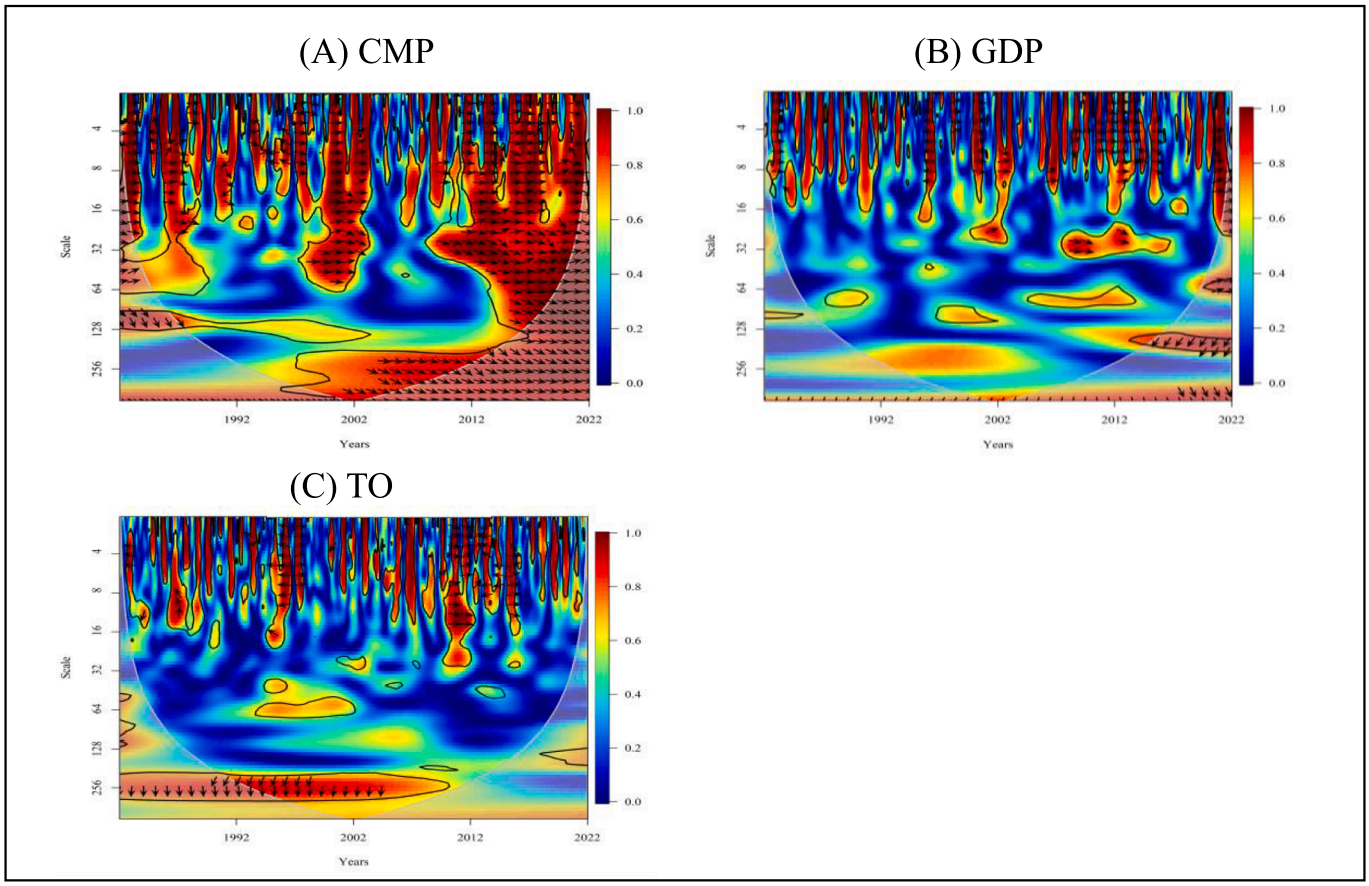


Fig. 6. Wavelet coherence diagram for high-income group.).
Source: Authors' compilation using (Posit RStudio, 2025

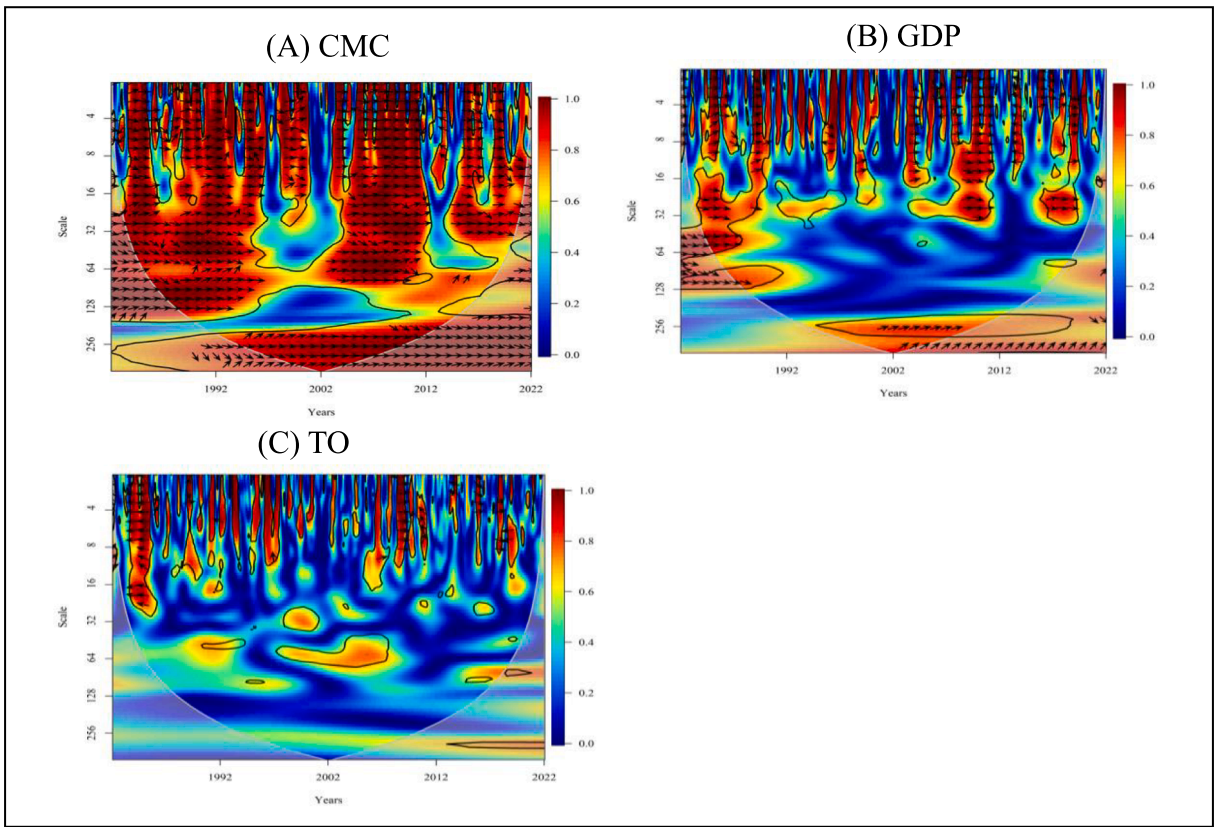


Fig. 7. Wavelet coherence diagram for upper-middle-income group.).
Source: Authors' compilation using (Posit RStudio, 2025

Mostly bidirectional causal relationships are present between CMP and CMC throughout all terms from 1993 to 2022, as shown in Fig. 7A, with a positive coherence nature at high frequencies.

In Fig. 7B, two-way causality is present between CMP and GDP throughout the short term and from 2003 to 2022 in the medium term with a positive coherence, but no causality from 1993 to 2002 in the medium term and throughout the long term.

According to Fig. 7C, A negative coherence with unidirectional causality is observed from TO to CMP from 1993 to 2002; however, from 2003 to 2022, bidirectional causality is present between CMP and TO with a mixed coherence. On the other hand, no causality is observed in the medium-term and long-term periods.

Wavelet coherence analysis for lower-middle-income countries

The causal relationships between CMP and other variables across Lower-Middle-Income countries are illustrated in Fig. 8.

Mostly bidirectional causalities are present between CMP and CMC in all the terms shown in Fig. 8A, with a positive coherence at a high frequency from 1993 to 2022.

According to Fig. 8B, a predominantly two-way causality is identified between CMP and GDP in both the short and medium terms from 1993 to 2022. However, unidirectional causality is present from GDP to CMP, with a positive coherence from 2003; however, there is no causality from 1993 to 2002 in the long term. In Fig. 8C, mostly bidirectional causality between CMP and TO is present throughout the short term, with a positive coherence. Unidirectional causalities were observed from 1993 to 2012, and bidirectional causality was observed from 2013 to 2022 in the medium term. Throughout the long term, no causality is present.

Wavelet coherence analysis for low-income countries

The causal relationships between CMP and other variables across Low-Income countries are illustrated in Fig. 9.

CMP and CMC in Fig. 9A indicate that a bidirectional causal relationship exists between the variables from 1993 to 2022, both in the short-term and medium-term. However, in the medium term, from 2013 to 2022, there is no causality, which is also observed throughout the long term.

According to Fig. 9B, bidirectional causality exists between CMP and GDP from 2002 to 2022, but not in the short term from 1993 to 2002. No causality is present between the medium term and the long term. In Fig. 9C, a negative coherence is observed, indicating unidirectional causality from CMP to TO from 1993 to 2002. In contrast, from 2003 to 2022, a positive coherence is present, suggesting bidirectional causality between CMP and TO in the short term. Throughout the medium term, a positive coherence with unidirectional flow is present from CMP to TO. However, no causality was found in the long term.

Cross-country Granger causality analysis

The Dickey-Fuller unit root test, conducted before running the Granger causality analysis, shows that all variables achieve stationarity at the maximum of the first difference (DCMP, DCMC, DGDP, and DTO), as presented in Appendix 9. Afterwards, by using the VAR model, we verified that the model is stable and then conducted further analysis. Then, using AIC, S, BIC, and HQIC lag selection criteria, we identified the length and proceeded with the Granger causality analysis. The country-wise Granger results are presented in Appendix 10, and a graphical illustration is shown in Fig. 10.

In this study, cross-country Granger causality results suggest that there are unidirectional causalities from chicken meat consumption to chicken meat production in high-income countries, specifically Germany, the Netherlands, and New Caledonia. Additionally, the relationship between chicken meat production and GDP is evident in Hong

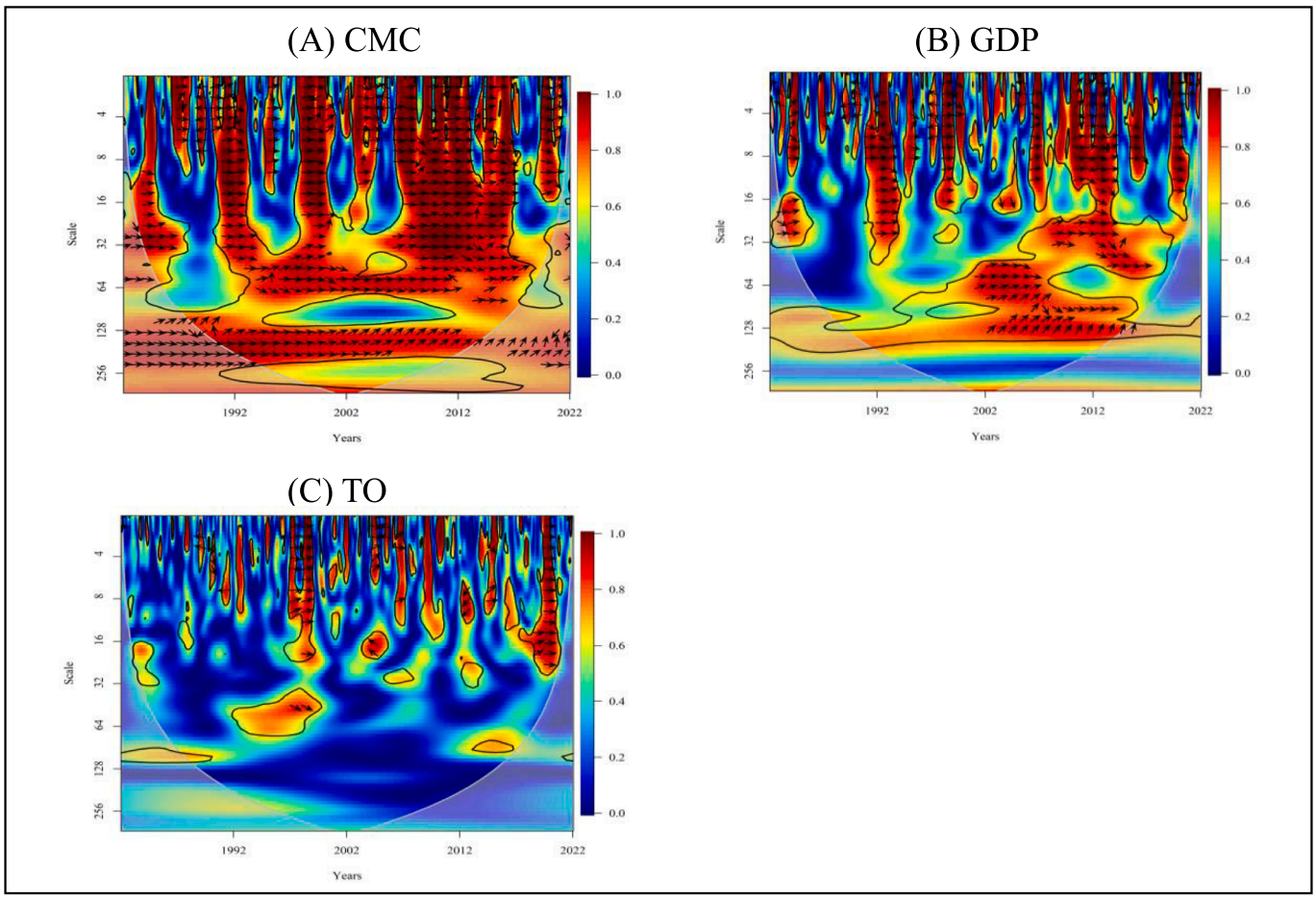


Fig. 8. Wavelet Coherence diagram for lower-middle-income group.).
Source: Authors' compilation using (Posit RStudio, 2025

Kong, Switzerland, and the United States, which is characterised by a unilateral trend. The same can be observed in the production of chicken meat and trade openness between New Caledonia and Switzerland. Additionally, Germany, the Netherlands, and Israel exhibit a one-way causal relationship between trade openness and chicken meat production. Results suggest that the United States, Brazil, and China are the largest chicken producers, which are major contributors to economic growth by increasing national income and trade (Wen et al., 2019). Australia's past studies suggest no causal relationship between chicken meat production and economic development (Tang, 2013). However, Australia, Macao, and New Zealand are statistically insignificant in terms of the association between chicken meat production and all variables.

In low-income countries, the results suggest that there is unidirectional causality from chicken meat production to consumption in nations such as Mali, Rwanda, and Uganda. Additionally, Mali exhibits a one-way causal flow from chicken meat production to GDP, whereas Niger, Rwanda, and Uganda display a unidirectional causal flow from GDP to chicken meat production. Past studies have revealed that Rwanda lacks grazing farms to produce livestock, and the poultry industry contributes 6% to its GDP (Mbuza et al., 2017); Therefore, investing more in local farms will increase domestic production, and exports will increase the national GDP. Uganda's poultry industry contributes 9% to its GDP, but rural poultry does not significantly impact GDP (Henry, 2009). Therefore, Uganda should focus more on enhancing development on its local farms, and Nigeria also provides a significant contribution from its chicken meat production (Moussa et al., 2019). Unlike other countries, Burkina Faso, Mozambique, and Togo did not have statistically significant casualties in chicken meat production across all variables.

In upper-middle-income countries, Granger results suggest that Gabon has a unidirectional causal relationship from chicken meat production to its consumption and GDP. Belize exhibits a one-way causal relationship between chicken meat consumption and its output. Argentina exhibits a similar pattern, with a unilateral and casual relationship between chicken meat production and GDP and trade openness, as observed in past studies (Yankelevich & Mcgrath, 2024). Jamaica exhibits a unidirectional relationship between its GDP and chicken meat production. The same unidirectional causal flow from GDP and trade openness to chicken production is evident in Malaysia. However, nations like Botswana, Brazil, Mongolia, and North Macedonia do not have a statistically significant relationship between chicken meat production and all other variables.

Results from lower-middle-income nations, such as Nicaragua, indicate unidirectional causality from chicken meat production to its consumption. Past studies suggest that domestic markets increase their chicken production due to the availability of duty-free chicken within the country (Mangino & Mangino, 2022). Furthermore, Guinea exhibits a unilateral relationship between chicken consumption and its production. Additionally, countries such as Bolivia, Honduras, and Tajikistan exhibit a one-way causal relationship between chicken production and their GDP.

Additionally, there is unidirectional causality from Gambia and Guinea, with chicken production influencing trade openness. The Central African Republic and Guinea-Bissau exhibit a one-way causal relationship between trade openness and chicken meat production. This

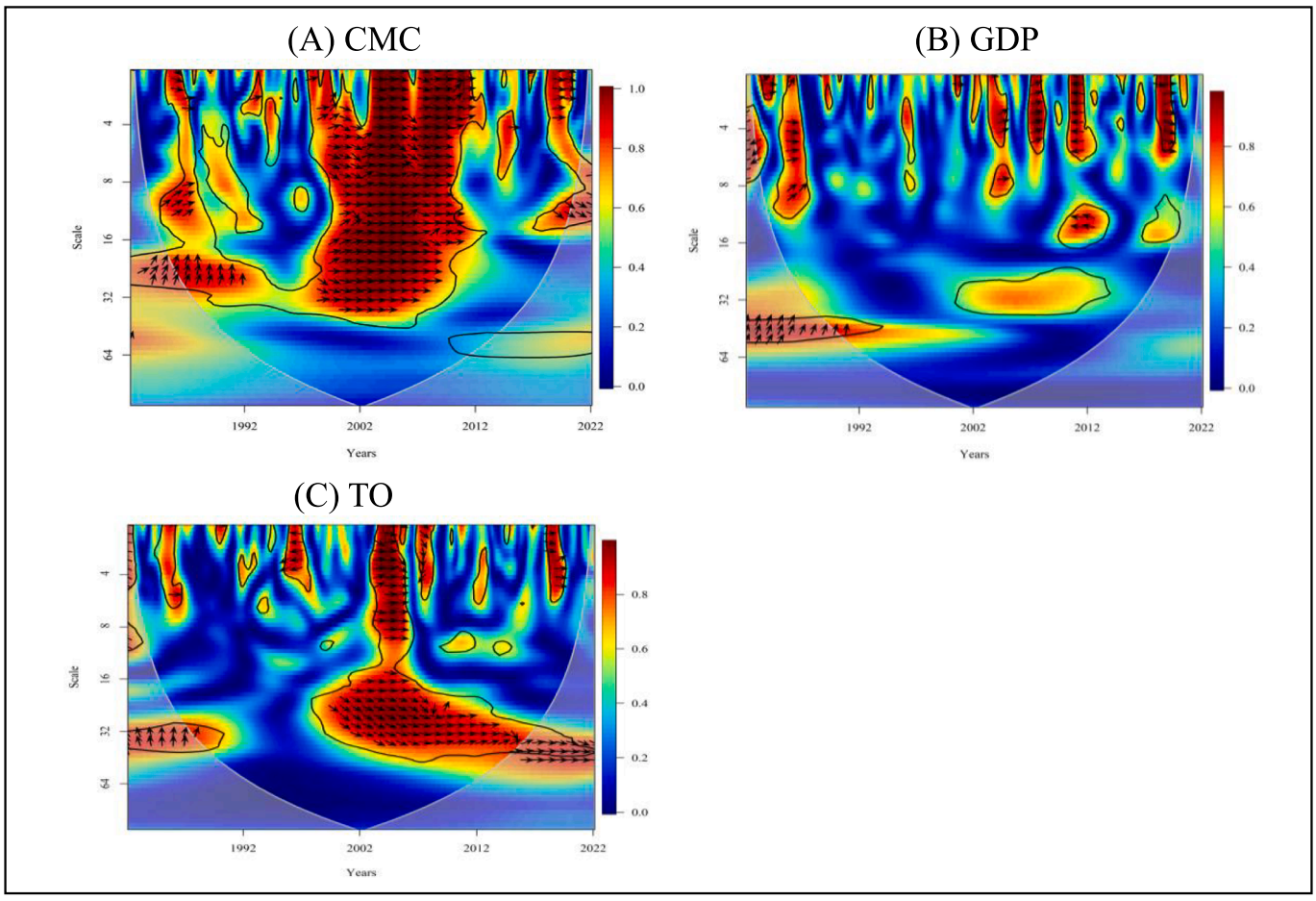


Fig. 9. Wavelet Coherence diagram for the low-income group.).
Source: Authors' compilation using (Posit RStudio, 2025

implies that in 2000, the aim to increase domestic chicken production in South Africa led to an increase in duty rates for importing chicken meat from the United States (Cochrane et al., 2016). However, nations like Chad, El Salvador, Haiti, and Lebanon do not have statistically significant causality between chicken meat production and all other variables.

Conclusion

In summary, this study aimed to determine the relationships between CMP and the independent variables, specifically CMC, GDP, and TO. To achieve this objective, six continents comprising 126 countries were analysed over 30 years, from 1993 to 2022. Demand theory and international trade theory provide the base for these variables. For the analysis, comprehensive methodologies were employed, including panel Granger causality analysis, Wavelet coherence analysis, and cross-country Granger causality analysis, to investigate the relationships between variables across different time scales and at the country level. A critical literature review was done to evaluate how the relevant variables have been utilised in past studies. The knowledge gap has been identified as these variables have been assessed individually in individual countries. Therefore, this study bridges that gap by investigating these variables together across different income groups in a single study across 30 years and provides results with novel visualisations. The results will reveal the directional relationships among the variables, and a country-wise analysis has been conducted to provide policy implications for farmers, policymakers, relevant organisations, and legislators, aiming to make an impact on the chicken meat industry by enhancing production, optimising operations, and maintaining high quality for nutritional value. All implementations aim to promote the sustainability of the meat industry, which also supports the United Nations' Sustainable Development Goals.

Policy recommendations

The causal relationships between the variables were investigated through a comprehensive analysis, and some relevant policy pathways were identified for parties interested in improving the Chicken meat industry across countries in different income groups. Relevant policy implications are aligned with the SDGs established by the United Nations.

Policy recommendations for high-income countries

High-income countries should focus on forecasting demand by building a system that analyses retail data and provides information by connecting it to producers. Additionally, with the expansion of the supply chain, product diversification should be employed to increase demand. Additionally, improve infrastructure in rural areas to support local producers and transition to eco-friendly technology. These policies will support SDG 9: Industry, Innovation, and Infrastructure, as well as SDG 12: Responsible Consumption and Production. Educating consumers on the health benefits will not only improve their health and well-being but also increase demand, supporting SDG 2: Zero Hunger and SDG 3: Good Health and Well-being. Supporting exports and imports by negotiating trade agreements, issuing quality certificates for goods, and utilising skilled workers to enhance productivity, aligning

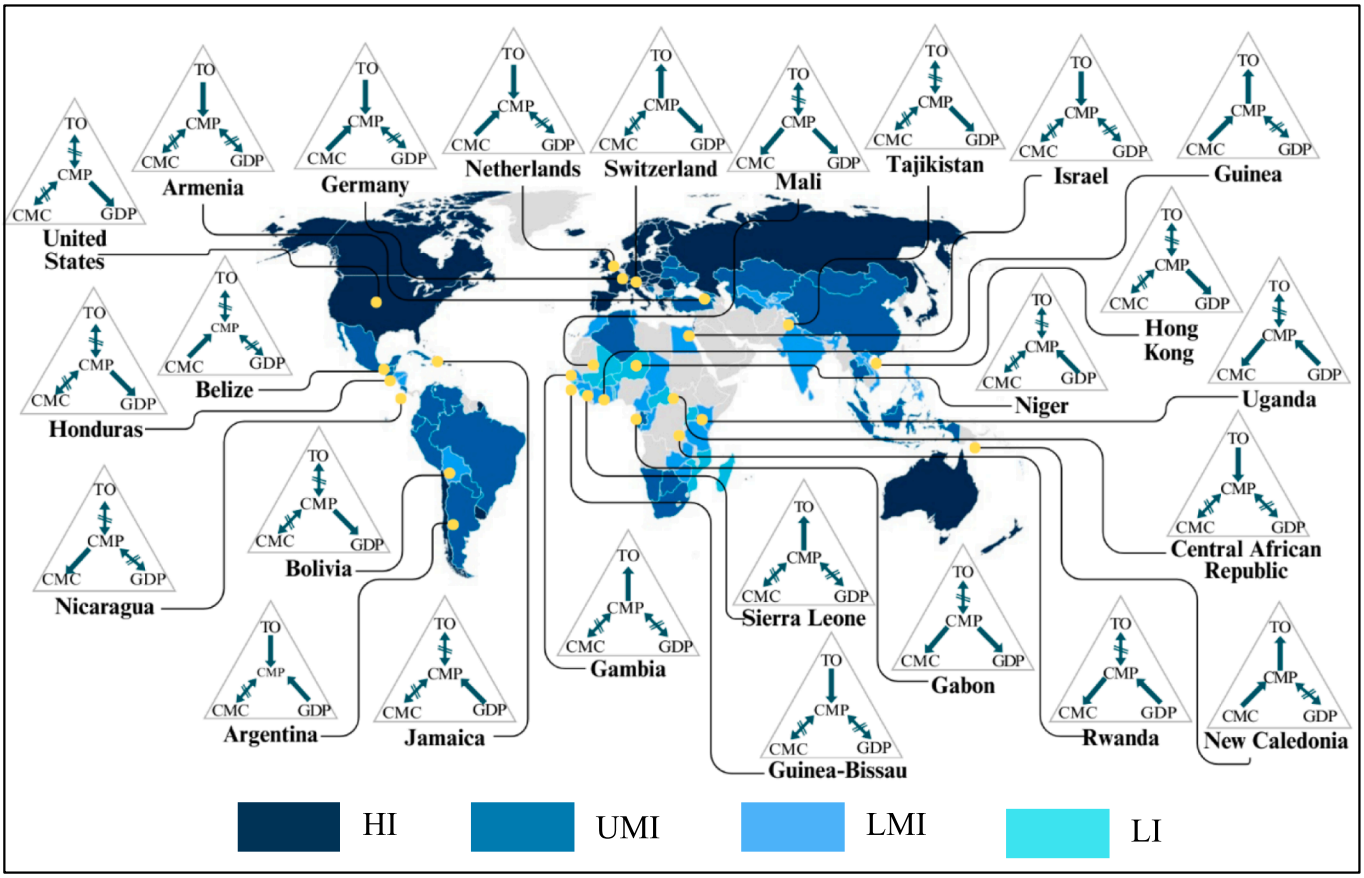


Fig. 10. Cross-country Granger causality results. Note: High-income (HI), upper-middle-income (UMI), lower-middle-income (LMI), and low-income (LI) countries are shaded from dark to light colours on the world map. The inside of the triangles reflects the direction of causality between chicken meat production (CMP), gross domestic product (GDP) and trade openness (TO) of each country. .
Source: Authors' illustrations-based Granger analysis results

with SDG 8: Decent Work and Economic Growth and SDG 17: Partnerships for the Goals.

Policy recommendations for upper-middle-income countries

Upper-middle-income countries should focus on increasing productivity by providing farmers with the right tools, modern technology, and updated knowledge, then by feeding livestock with proper nutrients for sustainable production, and investing in the cold chain. Provide incentives for local producers, also increase employment in rural areas, and then pave the pathway for exports by investing in trade certifications and facilities. These efforts will support the achievement of SDG 2: Zero Hunger, SDG 8: Decent Work and Economic Growth, SDG 9: Industry, Innovation, and Infrastructure, SDG 12: Responsible Consumption and Production, and SDG 17: Partnerships for the Goals. Conduct public campaigns to raise awareness of the health benefits and reduce overconsumption, while supporting SDG 3: Good Health and Well-being.

Policy recommendations for lower-middle-income countries

Lower-middle-income countries should prioritise strengthening the infrastructure for chicken meat production by making investments to enhance the sector. Improve the quality of trade certifications and make export agreements to gain access to international markets. Motivate domestic chicken consumption by making people aware of its health benefits, and it will also encourage domestic producers to enhance their production. These policies will support SDG 2: Zero Hunger, SDG 8: Decent Work and Economic Growth, SDG 9: Industry, Innovation, and Infrastructure, and SDG 17: Partnerships for the Goals. Provide training for farmers on using modern technologies to enhance chicken production, which aligns with SDG 4: Quality Education.

Policy recommendations for low-income countries

Low-income countries should focus on gaining basic market knowledge and managing production effectively and encourage producers to enter the cold chain to reduce waste. Governments should stabilise the market by maintaining a consistent demand, and producers should make their products more affordable by adjusting their product sizes. Practise basic feed management and manure management for sustainable production. Make room for budget transportation by allowing shared chillers and improving quality certification for chicken meat products. These will align towards SDG 2: Zero Hunger, SDG 8: Decent Work and Economic Growth, SDG 9: Industry, Innovation, and Infrastructure, SDG 10: Reduced Inequalities, SDG 12: Responsible Consumption and Production, and SDG 17: Partnerships for the Goals.

Limitations and future research

This research study has been conducted using a panel dataset spanning 30 years (1993–2022); therefore, the study is limited to this period due to the unavailability of data before this time. Even though all income groups have been considered, only 126 countries have been utilised under the income groups. The methodologies have their unique limitations; for instance, the panel Granger analysis is unavailable for identifying relationships between variables at the country level, and Wavelet graphs are challenging to interpret due to their complex, time-varying results. The results can be misinterpreted due to a smaller

sample size. Although a cross-country Granger analysis was conducted, it did not cover the entire globe.

Furthermore, Other possible methodologies can be used for future research, and this study has paved the way for opportunities by outlining its limitations. More comprehensive methods can be employed and utilise a larger dataset for more insightful results about the variables. The possibility of adding more variables to the study exists, as well as conducting the study on a continental level. Despite the limitations, this study offers meaningful insights from a critical investigation of CMP and other variables, including CMC, GDP, and TO. It will contribute to the sustainability of the meat industry and future research.

CRediT authorship contribution statement

Yasodara Silva: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Nisal Perera:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Data curation, Conceptualization. **Kalana Mendis:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation. **Himaya Susan:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Data curation. **Ruwan Jayathilaka:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resglo.2026.100340.

References

Abd El-Hack, M. E., Aldhalmi, A. K., Abu-Hiamed, H. A., Almarkhan, W. D., Alharbi, N. A., Alhassani, W., & Swelum, A. A. (2025). Antibiotic alternatives to produce organic poultry meat as a safe food source and the impact of its consumption on human health. *Ann. Anim. Sci., 25*(3), 815–828. https://doi.org/10.2478/aoas-2024-0090

Abeyesinghe, S. M., Stanley, I., Nicol, C. J., & Cardwell, J. M. (2025). Stakeholder views on shifting UK chicken meat production to slower-growing broilers. *Front. Anim. Sci., 6*. https://doi.org/10.3389/fanim.2025.1534108

Abgottspon, H., Stephan, R., Bagutti, C., Brodmann, P., Hächler, H., & Zurfluh, K. (2014). Characteristics of extended-spectrum cephalosporin-resistant escherichia coli isolated from swiss and imported poultry meat. *J. Food Prot., 77*(1), 112–115. https://doi.org/10.4315/0362-028X.JFP-13-120

Siddik, A. J., Aliar Rahman, M., Chowdhury, R., Khan, Md., & Islam, S. (2025). Feeding trial on the effects of high-protein, low-energy diets on lean meat production in broiler. *Veterinary Integrative Sci., 24*(1), 1–10. https://doi.org/10.12982/VIS.2026.003

Akaike, H. (1969). Fitting autoregressive models for prediction. *Ann. Institute Statistical Mathem., 21*(1), 243–247. https://doi.org/10.1007/BF02532251

Akaike, H., 1998. Information theory and an extension of the maximum likelihood principle. In E. Parzen, K. Tanabe, & G. Kitagawa (Eds.), *Selected Papers of Hirotugu Akaike* (pp. 199-213). New York, NY. 10.1007/978-1-4612-1694-0_15.

Altmann, B. A., Wigger, R., Ciulu, M., & Mörlein, D. (2020). The effect of insect or microalga alternative protein feeds on broiler meat quality. *J. Sci. Food Agric., 100*(11), 4292–4302. https://doi.org/10.1002/jsfa.10473

Apike, I. A., Osei Mensah, J., Aidoo, R., Wongnaa, C. A., & Boakye Appiah, G. (2024). Structure of imported chicken market and willingness of distributors to accept domestically produced and processed chicken: Evidence from Ghana. *Cogent Food Agric., 10*(1), Article 2296121. https://doi.org/10.1080/23311932.2023.2296121

Aranda, M., Sgavioli, S., Domingues, C., Santos, E., Nääs, I., Moura, J., & Garcia, R. (2019). Analysis of barriers to brazilian chicken meat imports. *Brazilian Journal of Poultry Science, 21*(2). https://doi.org/10.1590/1806-9061-2018-0863

Araújo dos Santos, R., Silva da Costa, J., Maranduba, H. L., Almeida Neto, J. A., & Rodrigues, L. B. (2023). Reducing the environmental impacts of Brazilian chicken meat production using different waste recovery strategies. *J. Environ. Manage., 341*, Article 118021. https://doi.org/10.1016/j.jenvman.2023.118021

Arp, T., Delmore, R., & Dikeman, M., 2024. Meat import and export for different countries. In *Encyclopedia of Meat Sciences (Third Edition)* (pp. 740-749). Elsevier. 10.1016/B978-0-323-85125-1.00193-9.

Asante-Addo, C., & Weible, D. (2020). Imported versus domestic chicken consumption in Ghana: Do attitudes and perceptions matter? *J. Int. Food Agribusiness Market., 32*(5), 503–526. https://doi.org/10.1080/08974438.2020.1751767

Athalage, D., Wijesuriya, P., Sandanayaka, I., Rathnayake, D., & Jayathilaka, R. (2025). The interplay between globalisation and economic growth: a multi-regional analysis. *Discover Sustainab., 6*(1), 525. https://doi.org/10.1007/s43621-025-01403-6

Balcombe, K., Bradley, D., Fraser, I., & Hussein, M. (2016). Consumer preferences regarding country of origin for multiple meat products. *Food Policy, 64*, 49–62. https://doi.org/10.1016/j.foodpol.2016.09.008

Banson, K. E., Muthusamy, G., & Kondo, E. (2015). The import substituted poultry industry; Evidence from Ghana. *Int. J. Agric. Forestry, 5*(2), 166–175. https://doi.org/10.5923/j.ijaf.20150502.11

Tykalowski, B., & Koncicki, A. (2024). National and international trade in poultry and poultry products in light of the valid legal regulations. *Medycyna Waterynaryjna, 80*(8), 365–369. https://doi.org/10.21521/mw.6920

Bhalerao, S., Hegde, M., Katyare, S., & Kadam, S. (2014). Promotion of omega-3 chicken meat production: An Indian perspective. *Worlds Poult. Sci. J., 70*(2), 365–374. https://doi.org/10.1017/S0043933914000373

Bilgili, F., Öztürk, İ., Koçak, E., Bulut, Ü., Pamuk, Y., Muğaloğlu, E., & Bağlıtaş, H. H. (2016). The influence of biomass energy consumption on CO2 emissions: A wavelet coherence approach. *Environ. Sci. Pollut. Res., 23*(19), 19043–19061. https://doi.org/10.1007/s11356-016-7094-2

Böhm, V., & Haller, H. (2017). Demand theory. In *The New Palgrave Dictionary of Economics* (pp. 1–14). Palgrave Macmillan UK.

Boimah, M., & Weible, D. (2021). Assessing protectionism and its impact from consumers' perspective: The case of Senegal's poultry import ban. *World Food Policy, 7*(1), 26–40. https://doi.org/10.1002/wfp2.12025

Caldera, Y., Ranthilake, T., Gunawardana, H., Senevirathna, D., Jayathilaka, R., Rathnayake, N., & Peter, S. (2024). Understanding the interplay of GDP, renewable, and non-renewable energy on carbon emissions: Global wavelet coherence and Granger causality analysis. *PLoS One, 19*(9). https://doi.org/10.1371/journal.pone.0308780

Campbell, Y. L., Walker, L. L., Bartz, B. M., Eckberg, J. O., & Pullin, A. N. (2025). Outdoor access versus conventional broiler chicken production: Updated review of animal welfare, food safety, and meat quality. *Poult. Sci., 104*(4), Article 104906. https://doi.org/10.1016/j.psj.2025.104906

Cappone, E. E., Zambotto, V., Mota-Gutierrez, J., Soglia, D., Daniele, G. M., Cianciabella, M., & Schiavone, A. (2025). Native Italian poultry products: The factors influencing consumer perceptions. *Ital. J. Anim. Sci., 24*(1), 347–360. https://doi.org/10.1080/1828051X.2025.2453549

Chauhan, D. S., Jugran, H. P., Negi, G. C. S., & Bisht, D. S. (2024). Income generation potential of backyard poultry in rural areas of Central Himalaya. *Worlds Poult. Sci. J., 80*(4), 1225–1239. https://doi.org/10.1080/00439339.2024.2364880

Chen, Z. (2022). Research on international trade theory and the status quo of world international trade. *Am. J. Ind. Bus. Manag., 12*(6). https://doi.org/10.4236/ajibm.2022.126057

Chiras, D., Stamatopoulou, M., Paraskevis, N., Moustakidis, S., Tzimitra-Kalogianni, I., & Kokkotis, C. (2023). Explainable machine learning models for identification of food-related lifestyle factors in chicken meat consumption case in Northern Greece. *BioMedInformatics, 3*(3), 817–828.

Chloe, L.J., 2025. *LJC heatmaps*. https://www.ljcheatmap.com/.

Choudhury, T. R., Jahan, F., Alam, M. N. E., Lutfa, L. N., Chowdhury, T. I., Rahman, M. S., & Tareq, S. M. (2025). An evaluation of potential sources of toxic metals in the poultry industry in Bangladesh: dietary exposure and toxicological implications. *J. Food Prot., 88*(8), Article 100565. https://doi.org/10.1016/j.jfp.2025.100565

Cochrane, N., Hansen, J., & Seeley, R. (2016). *Poultry production and trade in the Republic of South Africa: A look at alternative trade policy scenarios* (United States Department of Agriculture, Issue. https://ers.usda.gov/sites/default/files/_laserfiche/outlooks/81067/AES-96.pdf?v=57819#:~:text=The%20tariff%20was%20raised%20from,applies%20to%20this%20tariff%20line.&text=*New%20tariffs%20took%20effect%20October,and%20USDA%2C%20Foreign%20Agricultural%20Service.&text=Imports%20have%20continued%20to%20grow,%2DEU%20trade%20agree%2D%20ment.

Conan, A., Goutard, F. L., Sorn, S., & Vong, S. (2012). Biosecurity measures for backyard poultry in developing countries: A systematic review. *BMC Vet. Res., 8*(1), 240. https://doi.org/10.1186/1746-6148-8-240

Cooreman-Algoed, M., Boone, L., Taelman, S. E., Van Hemelryck, S., Brunson, A., & Dewulf, J. (2022). Impact of consumer behaviour on the environmental sustainability profile of food production and consumption chains – a case study on chicken meat. *Resour. Conserv. Recycl., 178*, Article 106089. https://doi.org/10.1016/j.resconrec.2021.106089

Cortinas Hernández, L., Barroeta, A. C., Villaverde Haro, C., Galobart i Cots, J., Guardiola Ibarz, F., & Baucells Sánchez, M. D. (2005). Influence of the dietary polyunsaturation

level on chicken meat quality: lipid oxidation. *Poult. Sci., 84*(1), 48–55. https://doi.org/10.1093/ps/84.1.48
Cui, B., Wang, L.-D.-L., Chen, X., Xu, M. Y., Ke, J., & Tian, Y. (2022). Chicken meat taste preferences, perceived risk of human infection with avian influenza virus, and self-reported chicken meat consumption in China. *Prev. Vet. Med., 203*, Article 105658. https://doi.org/10.1016/j.prevetmed.2022.105658
Cullere, M., Woods, M. J., van Emmenes, L., Pieterse, E., Hoffman, L. C., & Dalle Zotte, A. (2019). Hermetia illucens larvae reared on different substrates in broiler quail diets: effect on physicochemical and sensory quality of the quail meat. *Animals, 9*(8), 525. https://doi.org/10.3390/ani9080525
Dastour, H., Ghaderpour, E., Zaghloul, M. S., Farjad, B., Gupta, A., Eum, H., & Hassan, Q. K. (2022). Wavelet-based spatiotemporal analyses of climate and vegetation for the Athabasca river basin in Canada. *Int. J. Appl. Earth Obs. Geoinf., 114*, Article 103044. https://doi.org/10.1016/j.jag.2022.103044
de Jesus Xavier, D. L., & dos Reis, J. G. M. (2022). Effects of importer country's GDP in Brazilian agriculture exports: chicken meat, coffee, maize, soybean and soybean cake. In D. Y. Kim, G. von Cieminski, & D. Romero, *Advances in Production Management Systems. Smart Manufacturing and Logistics Systems: Turning Ideas into Action* Cham.
Debbarma, S., Baruah, M. S., Debbarma, A., & Sneha, E. N. P. (2024). Chicken meat: A nuritious choice for a healtheir future. *3*, 10-13. https://www.researchgate.net/publication/383863144_CHICKEN_MEAT_A_NUTRITIOUS_CHOICE_FOR_A_HEALTHIER_FUTURE.
Dhanji, H., Murphy, N. M., Doumith, M., Durmus, S., Surman Lee, S., Hope, R., & Livermore, D. M. (2010). Cephalosporin resistance mechanisms in *Escherichia coli* isolated from raw chicken imported into the UK. *J. Antimicrob. Chemother., 65*(12), 2534–2537. https://doi.org/10.1093/jac/dkq376
Di-Pillo, F., Anríquez, G., Alarcón, P., Jimenez-Bluhm, P., Galdames, P., Nieto, V., & Hamilton-West, C. (2019). Backyard poultry production in Chile: Animal health management and contribution to food access in an upper middle-income country. *Prev. Vet. Med., 164*, 41–48. https://doi.org/10.1016/j.prevetmed.2019.01.008
Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *J. Am. Stat. Assoc., 74*(366a), 427–431. https://doi.org/10.1080/01621459.1979.10482531
Dissanayake, P., Chloe, L., Azmi, Y., Landersz, S., & Jayathilaka, R. (2025). Brain drain or economic gain? Untangling the global migration-growth puzzle through causality and time-frequency lenses. *Res. Globaliz.tion, 11*, Article 100305. https://doi.org/10.1016/j.resglo.2025.100305
Dutta, A. (2001). Telecommunications and economic activity: an analysis of granger causality. *J. Manag. Inf. Syst., 17*(4), 71–95. https://doi.org/10.1080/07421222.2001.11045658
Ertur, C., & Musolesi, A. (2017). Weak and strong cross-sectional dependence: A panel data analysis of international technology diffusion. *J. Appl. Economet., 32*(3), 477–503. https://doi.org/10.1002/jae.2538
Escobedo del Bosque, C. I., Grahl, S., Nolte, T., & Mörlein, D. (2022). Meat quality parameters, sensory properties and consumer acceptance of chicken meat from dual-purpose crossbreeds fed with regional faba beans. *Foods, 11*(8), 1074.
Ezenwa, C. A., Iheanacho, J. I., & Okafor, H. I. (2021). Theories of international trade In. https://doi.org/https://www.researchgate.net/publication/389043595_THEORIES_OF_INTERNATIONAL_TRADE.
Feng, Y., Xiao, Z., Zhou, J., & Ni, G. (2023). Asymmetrically examining the impact of green finance and renewable energy consumption on environmental degradation and renewable energy investment: The impact of the COVID-19 outbreak on the chinese economy. *Energy Rep., 9*, 5458–5472. https://doi.org/10.1016/j.egyr.2023.04.361
Feng, Y., Yan, W., Zuo, M., & Zhang, Q. (2022). Consortium blockchains based traceability system for chicken product supply chain. *MATEC Web Conf., 355*. https://doi.org/10.1051/matecconf/202235502037
Food and Agriculture Organization. (2024). *Food Outlook – Biannual report on global food markets*. https://doi.org/10.4060/cd1158en.
Food and Agriculture Organization Statistics. (2025a). https://doi.org/https://www.fao.org/faostat/en/#home.
Food and Agriculture Organization Statistics. (2025b). *Crops and livestock products*. Food and Agriculture Organization of the United Nations. https://www.fao.org/faostat/en/#data/QCL.
Galappaththi, K., Jayathilaka, R., Rajamanthri, L., Jayawardhana, T., Nuththara, S., Nimnadi, T., & Karadanaarachchi, R. (2023). Economy and elderly population, complementary or contradictory: a cross-continental wavelet coherence and cross-country Granger causality study. *PLoS One, 18*(1), Article e0278716. https://doi.org/10.1371/journal.pone.0278716
Giusti, G., Marques, T. L., Figueirêdo, M. C. B., & Silva, D. A. L. (2022). Integrating water footprint in the eco-efficiency assessment of Brazilian chilled chicken. *Sustainable Prod. Consump., 33*, 331–342. https://doi.org/10.1016/j.spc.2022.07.009
Gkarane, V., Ciulu, M., Altmann, B. A., Schmitt, A. O., & Mörlein, D. (2020). The effect of algae or insect supplementation as alternative protein sources on the volatile profile of chicken meat. *Foods, 9*(9), 1235. https://doi.org/10.3390/foods9091235
Godínez-Oviedo, A., Sampedro, F., Bowman, J. P., Garcés-Vega, F. J., & Hernández-Iturriaga, M. (2022). Genotypic and phenotypic quantitative microbial risk assessment model of human salmonellosis related to the consumption of chicken meat in the central region of Mexico. *Food Res. Int., 162*, Article 111901. https://doi.org/10.1016/j.foodres.2022.111901
Groshek, J. (2011). Media, instability, and democracy: examining the granger-causal relationships of 122 countries from 1946 to 2003. *J. Commun., 61*(6), 1161–1182. https://doi.org/10.1111/j.1460-2466.2011.01594.x
Hannan, E. J., & Quinn, B. G. (1979). The determination of the order of an autoregression. *J. Roy. Stat. Soc.: Ser. B (Methodol.), 41*(2), 190–195. https://doi.org/10.1111/j.2517-6161.1979.tb01072.x
Harb, A., Habib, I., Mezal, E. H., Kareem, H. S., Laird, T., O'Dea, M., & Abraham, S. (2018). Occurrence, antimicrobial resistance and whole-genome sequencing analysis of Salmonella isolates from chicken carcasses imported into Iraq from four different countries. *Int. J. Food Microbiol., 284*, 84–90. https://doi.org/10.1016/j.ijfoodmicro.2018.07.007
Henry, B. S. (2009). Poultry genetic resources and small poultry production systems in Uganda. *Food and Agricutural Organization*. https://www.fao.org/4/al689e/al689e00.pdf.
Ibrahim, N., Chantziaras, I., Chakma, S., Islam, S. S., Amalraj, A., Caekebeke, N., & Dewulf, J. (2025). Biocheck.UGent: A risk-based tool to assess the status of biosecurity in backyard poultry in low- and middle-income countries. *Prev. Vet. Med., 241*, Article 106540. https://doi.org/10.1016/j.prevetmed.2025.106540
Idowu, P. A., Zishiri, O., Nephawe, K. A., & Mtileni, B. (2021). Current status and intervention of South Africa chicken production – a review. *Worlds Poult. Sci. J., 77*(1), 115–133. https://doi.org/10.1080/00439339.2020.1866965
Jatarasitha, S., Srikanchai, T., Kreuzer, M., & Wicke, M. (2008). Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (black-boned and thai native) and imported extensive breeds (bresse and rhode island red). *Poult. Sci., 87*(1), 160–169. https://doi.org/10.3382/ps.2006-00398
Jayasena, D. D., Ahn, D. U., Nam, K. C., & Jo, C. (2013). Flavour chemistry of chicken meat: A review. *Animal Biosecinece, 26*(5), 732–742. https://doi.org/10.5713/ajas.2012.12619
Johnson, M. C. (2011). Lobbying for trade barriers: A comparison of poultry producers' success in Cameroon, Senegal and Ghana. *J. Mod. Afr. Stud., 49*(4), 575–599. https://www.cambridge.org/core/product/D32A5BE8C805F614BF65070717B40CB6.
Katiyo, W., Coorey, R., Buys, E. M., & de Kock, H. L. (2020). Consumers' perceptions of intrinsic and extrinsic attributes as indicators of safety and quality of chicken meat: Actionable information for public health authorities and the chicken industry. *J. Food Sci., 85*(6), 1845–1855. https://doi.org/10.1111/1750-3841.15125
Katrin, Z., Taurai, T., Laurent, P., Patrice, N., & Roger, S. (2016). Draft genome sequence of escherichia coli S51, a chicken isolate harboring a chromosomally encoded mcr-1 Gene. *Genome Announc., 4*(4). https://doi.org/10.1128/genomea.00796-16
Kaya, F., Mia, B., Aktar, M. A., Hossain, M. S., Hassan, M. M., Rahaman, M. A., & Voumik, L. C. (2025). Impact of environmental taxes, hydroelectricity consumption, economic globalization, and gross domestic product (GDP) on the load capacity factor in the selected European Union (EU) member countries. *Reg. Sustainability, 6*(2), Article 100210. https://doi.org/10.1016/j.regsus.2025.100210
Kito, Y. (2025). What drives risky eating behavior: Applying an extended theory of planned behavior to raw or undercooked chicken consumption in Japan. *Food Res. Int., 219*, Article 116971. https://doi.org/10.1016/j.foodres.2025.116971
Klaharn, K., Ngampak, R., Chudam, Y., Salvador, R., Jainonthee, C., & Punyapornwithaya, V. (2024). Analyzing and forecasting poultry meat production and export volumes in Thailand: A time series approach. *Cogent Food Agric., 10*(1), Article 2378173. https://doi.org/10.1080/23311932.2024.2378173
Koutsoyiannis, A. (1979). Theory of Demand. In *Modern Microeconomics*. Macmillan Education UK. 10.1007/978-1-349-16077-8_2.
Kwadzo, G., Dadzie, F., Osei-Asare, Y., & Kuwornu, J. (2013). Consumer preference for broiler meat in Ghana: A conjoint analysis approach. *Internnational Journal of Marketing Studies, 5*. https://doi.org/10.5539/ijms.v5n2p66
Lan, Y., Gao, H., Zhou, P., Zhang, H., & Li, H. (2025). The impact of climate risks on global energy production and consumption: New evidence from causality-in-quantile and wavelet analysis. *Energy, 319*, Article 134850. https://doi.org/10.1016/j.energy.2025.134850
Leamer, E. E., & Levinsohn, J. (1995). Chapter 26 International trade theory: The evidence. In *Handbook of International Economics* (Vol. 3, pp. 1339-1394). 10.1016/S1573-4404(05)80006-1.
Lengkidworraphiphat, P., Wongpoomchai, R., Bunmee, T., Chariyakornkul, A., Chaiwang, N., & Jaturasitha, S. (2021). Taste-active and nutritional components of Thai native chicken meat: A perspective of consumer satisfaction. *41*(2), 237-246. https://doi.org/10.5851/kosfa.2020.e94.
Li, Y.-W. (2025). Spatiotemporal investigation into water, land, energy, and carbon footprints of broiler and correlations among them in China. *Discover Sustainab., 6*(1), 794. https://doi.org/10.1007/s43621-025-01760-2
Long, H., & Cao, Y. (2024). A wavelet analysis of the relationship between carbon emissions rights and crude oil prices in China. *Resour. Policy, 91*, Article 104712. https://doi.org/10.1016/j.resourpol.2024.104712
López-Ferrer, S., Baucells, M. D., Barroeta, A. C., & Grashorn, M. A. (2001). n-3 enrichment of chicken meat. 1. use of very Long-Chain Fatty Acids in Chicken Diets and their Influence on Meat Quality: Fish Oil. *Poult. Sci., 80*(6), 741–752. https://doi.org/10.1093/ps/80.6.741
Mangino, E., & Mangino, E. (2022). Nicaragua expands duty free chicken meat import quotas *Food and Agricutural Organization*. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Nicaragua%20Expands%20Duty%20Free%20Chicken%20Meat%20Import%20Quotas_Managua_Nicaragua_NU2022-0002.pdf.
Maradana, R. P., Pradhan, R. P., Dash, S., Zaki, D. B., Gaurav, K., Jayakumar, M., & Sarangi, A. K. (2019). Innovation and economic growth in European Economic Area countries: The granger causality approach. *IIMB Manag. Rev., 31*(3), 268–282. https://doi.org/10.1016/j.iimb.2019.03.002
Marangoni, F., Corsello, G., Cricelli, C., Ferrara, N., Ghiselli, A., Lucchin, L., & Poli, A. (2015). Role of poultry meat in a balanced diet aimed at maintaining health and wellbeing: An italian consensus document. *Nutr. Res., 59*. https://doi.org/10.3402/fnr.v59.27606

Mbuza, F., Manishimwe, R., Mahoro, J., Simbankabo, T., & Nishimwe, K. (2017). Characterization of broiler poultry production system in Rwanda. *Trop. Anim. Health Prod., 49*(1), 71–77. https://doi.org/10.1007/s11250-016-1160-0

Mendes, C. M. I., Dematte Filho, L. C., & Gameiro, A. H. (2024). Incorporating sustainability in the food supply chain: The development of a private standard of nature farming poultry production in Brazil. *Research in Globalization, 8*, Article 100185. https://doi.org/10.1016/j.resglo.2023.100185

Millstone, E., Lang, T., & Marsden, T. (2019). Food brexit and chlorinated chicken: A microcosm of wider food problems. *Polit. Q., 90*(4), 645–653. https://doi.org/10.1111/1467-923X.12780

Mir, N. A., Rafiq, A., Kumar, F., Singh, V., & Shukla, V. (2017). Determinants of broiler chicken meat quality and factors affecting them: A review. *J. Food Sci. Technol., 54*(10), 2997–3009. https://doi.org/10.1007/s13197-017-2789-z

Moussa, H. O., Keambou, T. C., Hima, K., Issa, S., Motsa'a, S. J., & Bakasso, Y. (2019). Indigenous chicken production in Niger. *Vet. Anim. Sci., 7*, Article 100040. https://doi.org/10.1016/j.vas.2018.11.001

Muñoz-Gómez, V., Shaw, A. P. M., Abdykerimov, K., Abo-Shehada, M., Bulbuli, F., Charypkhan, D., & Torgerson, P. R. (2025). Economic impact of chicken diseases and other causes of morbidity or mortality in backyard farms in low-income and middle-income countries: A systematic review and meta-analysis. *BMC Vet. Res., 21*(1), 151. https://doi.org/10.1186/s12917-025-04549-7

Muñoz-Gómez, V., & Torgerson, P. R. (2024). Global and regional prediction of heterakidosis population prevalence in extensive backyard chickens in low-income and middle-income countries. *Vet. Parasitol., 332*, Article 110329. https://doi.org/10.1016/j.vetpar.2024.110329

Nduku, X., Stempa, T., Lungu, N. S., Ndobeni, T. N., & Mlambo, V. (2025). Prospects for antibiotic-free poultry production in South Africa: An analysis of the enablers and stumbling blocks. *One Health, 21*, Article 101144. https://doi.org/10.1016/j.onehlt.2025.101144

Ngongolo, K., Omary, K., & Andrew, C. (2021). Social-economic impact of chicken production on resource-constrained communities in Dodoma. *Tanzania. Poultry Science, 100*(3), Article 100921. https://doi.org/10.1016/j.psj.2020.12.019

Nielsen, S. S., Kemunto, N. P., Muloi, D. M., Bojesen, A. M., Knight-Jones, T., Ayebare, D., & Moodley, A. (2025). Flexible assessment of biosecurity in small- and medium scale poultry farms in low and middle income countries. *Acta Vet. Scand., 76*(1), 9. https://doi.org/10.1186/s13028-025-00796-8

Ning, H., Yang, A., Zhou, W., Li, S., Tang, Y., Ma, W., & Liu, P. (2025). Key volatile off-flavor compounds identification in chicken meat and deodorizing effects of polyphenol and spice extracts. *Food Chem.: X, 29*, Article 102659. https://doi.org/10.1016/j.fochx.2025.102659

Padilla, S. L., Baker, Q. J., & MacLachlan, M. J. (2025). The impact of HPAI trade restrictions on U.S. poultry exports in 2022–23. *Appl. Econ. Perspect. Policy, 47*(3), 933–948. https://doi.org/10.1002/aepp.13504

Palliyaguru, D., Senarathne, B., Jayathilaka, R., Rajamanthri, L., & Wickramarachchi, C. (2024). Cheers to anxiety: Granger causality insights on alcohol consumption patterns across 13 South American countries. *BMC Public Health, 24*(1), 2664. https://doi.org/10.1186/s12889-024-20146-z

Pan, J., Yin, C., & Zhou, Y. (2024). The spillover effects among crude oil future markets under high-frequency data environment: Trivariate VAR-BEKK-GARCH model based on wavelet multiresolution analysis. *Procedia Comput. Sci., 442*, 758–765. https://doi.org/10.1016/j.procs.2024.08.191

Pesaran, M. H. (2004). General diagnostic tests for cross section dependence in panels. http://dx.doi.org/10.2139/ssrn.572504.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *J. Appl. Economet., 22*(2), 265–312. https://doi.org/10.1002/jae.951

Posit RStudio. (2025). *Download RStudio Desktop*. https://posit.co/download/rstudio-desktop/.

Putra, M. G., Deendarlianto, P., Ariesta, E. P., Oktaviandi, R., Setiawan, P. H., & Juarsa, M. (2025). Investigation of natural circulation flow instability based on thermal effect during steady-state condition using wavelet and chaotic analysis. *Nucl. Eng. Des., 443*, Article 114299. https://doi.org/10.1016/j.nucengdes.2025.114299

Qi, H., Wang, H., Ma, Z., Wang, T., He, Q., Yu, H., & Li, H. (2025). Comparative analysis of meat quality and flavor compounds in hot fresh, chilled, and frozen Qingyuan partridge chicken. *Appl. Food Res., 5*(2), Article 101216. https://doi.org/10.1016/j.afres.2025.101216

Radin, J. M., Shaffer, R. A., Lindsay, S. P., Araneta, M. R. G., Raman, R., & Fowler, J. H. (2017). International chicken trade and increased risk for introducing or reintroducing highly pathogenic avian influenza a (H5N1) to uninfected countries. *Infectious Disease Modelling, 2*(4), 412–418. https://doi.org/10.1016/j.idm.2017.09.001

Ragasa, C., Andam, K. S., Asante, S. B., & Amewu, S. (2020). Can local products compete against imports in West Africa? Supply- and demand-side perspectives on chicken, rice, and tilapia in Ghana. *Glob. Food Sec., 26*, Article 100448. https://doi.org/10.1016/j.gfs.2020.100448

Ren, X., Fu, C., Jin, C., & Li, Y. (2024). Dynamic causality between global supply chain pressures and China's resource industries: A time-varying Granger analysis. *Int. Rev. Financ. Anal., 95*, Article 103377. https://doi.org/10.1016/j.irfa.2024.103377

Rezitis, A. N., Zangelidis, L., & Karytsas, S. (2024). Investigating factors affecting trade flows in pork and poultry global markets using gravity models. *Agrekon, 63*(4), 303–318. https://doi.org/10.1080/03031853.2024.2434470

Ridley, W. C., Luckstead, J., & Devadoss, S. (2024). Impacts of tariffs and NTMs on beef, pork and poultry trade. *J. Agric. Econ., 75*(2), 546–572. https://doi.org/10.1111/1477-9552.12574

Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics, 6*(2), 461–464. https://doi.org/10.1214/aos/1176344136

Selle, P. H., Hughes, R. J., Godwin, I. D., Khoddami, A., Chrystal, P. V., & Liu, S. Y. (2021). Addressing the shortfalls of sorghum as a feed grain for chicken-meat production. *Worlds Poult. Sci. J., 77*(1), 29–41. https://doi.org/10.1080/00439339.2020.1866966

Shioda, K., Smith, F., Mucache, H. N., Marri, A. R., Chew, J., Levy, K., & Freeman, M. C. (2024). Purchase, consumption, and ownership of chickens and chicken products among households in Maputo, Mozambique: A cross-sectional study. *One Health, 19*, Article 100943. https://doi.org/10.1016/j.onehlt.2024.100943

Soon, B. M., & Thompson, W. (2020). Non-tariff barrier on chicken imports into Russia: Impact on production, trade and prices. *J. Policy Model, 42*(3), 583–596. https://doi.org/10.1016/j.jpolmod.2019.11.002

Sparrow, R., Degeling, C., & Mayes, C. (2024). "Lights out" poultry production and pandemic influenza. *Agric. Hum. Values, 41*(4), 1385–1391. https://doi.org/10.1007/s10460-024-10589-w

Sumantri, C., Khaerunnisa, I., & Gunawan, A. (2020). The genetic quality improvement of native and local chickens to increase production and meat quality in order to build the Indonesian chicken industry. *IOP Conf. Ser.: Earth Environ. Sci, 492*(1), Article 012099. https://doi.org/10.1088/1755-1315/492/1/012099

Szeląg-Sikora, A., Oleksy-Gębczyk, A., Kowalska-Jarnot, K., Sikora, J., & Stuglik, J. (2024). Development of poultry meat production and consumption levels in the Light of environmental sustainability goals. In E. Lorencowicz, B. Huyghebaert, & J. Uziak, *Farm Machinery and Processes Management in Sustainable Agriculture* Cham.

Tang, C. F. (2013). The linkage between stock price and economic growth in Australia: A chicken-and-egg paradox? *Economic Research-Ekonomska Istraživanja, 26*(2), 99–116. https://doi.org/10.1080/1331677X.2013.11517609

Thompson, J. M., Pendell, D. L., Hagerman, A. D., & Johnson, K. K. (2020). International trade implications of highly pathogenic poultry disease events. *Agricultural and Resource Economics Review, 49*(3), 517–537. https://www.cambridge.org/core/product/93D8DF20E1E3EBC2ED182F2ECE995440.

Truong, D. B., Cuong, N. V., Doan, P. H., Dung, N. T. T., Kiet, B. T., Rushton, J., & Carrique-Mas, J. (2021). Small-scale commercial chicken production: A risky business for farmers in the mekong delta of Vietnam. *Prev. Vet. Med., 195*, Article 105470. https://doi.org/10.1016/j.prevetmed.2021.105470

Tsiboe, F., Appiah-Twumasi, M., Xia, T., & Amanor-Boadu, V. (2024). Consumption patterns of fresh and frozen chicken: A Ghanaian food policy perspective. *Agribusiness*. https://doi.org/10.1002/agr.21972

United States Department of Agriculture. (2025). *Livestock and Poultry: World Markets and Trade* https://apps.fas.usda.gov/psdonline/circulars/livestock_poultry.pdf.

Wang, J., Chen, J., Sun, Y., He, J., Zhou, C., Xia, Q., & Du, L. (2023). Ultraviolet-radiation technology for preservation of meat and meat products: Recent advances and future trends. *Food Control, 148*, Article 109684. https://doi.org/10.1016/j.foodcont.2023.109684

Wen, X., Li, L., Sun, S., He, Q., & Tsai, F.-S. (2019). The contribution of chicken products' export to economic growth: Evidence from China, the United States, and Brazil sustainability. *Sustainability, 11*(19), 5253. https://doi.org/10.3390/su11195253

Wijesuriya, P., Athalage, D., Rathnayake, D., Sandanayaka, I., & Jayathilaka, R. (2025). Globalisation and growth nexus: Evidence from Africa through Granger Causality and Wavelet Coherence. *Sustainable Futures, 9*, Article 100833. https://doi.org/10.1016/j.sftr.2025.100833

World Bank. (2025a). GDP (current US$). https://doi.org/https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

World Bank. (2025b). Trade (% of GDP). https://doi.org/https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS.

Yankelevich, A., & Mcgrath, C. (2024). Poultry and products annual. *Food and Agricutural Organization*. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Poultry%20and%20Products%20Annual_Buenos%20Aires_Argentina_AR2024-0014.

Yeboah, S. D., Baboo, A. M., Fumey, M. P., Ansah, M. A., & Oduro, L. (2025). Role of agricultural finance and investment in reducing rural poverty in Ghana: Insights from wavelet coherence analysis. *Discover Sustainability, 6*(1), 996. https://doi.org/10.1007/s43621-025-01308-4

Zhou, L., Li, L., & Lei, L. (2019). Avian influenza, non-tariff measures and the poultry exports of China. *Aust. J. Agric. Resour. Econ., 63*(1), 72–94. https://doi.org/10.1111/1467-8489.12285

Zolghadr-Asli, B., Enayati, M., Pourghasemi, H. R., Naghdyzadegan Jahromi, M., & Tiefenbacher, J. P. (2021). Application of Granger-causality to study the climate change impacts on depletion patterns of inland water bodies. *Hydrol. Sci. J., 66*(12), 1767–1776. https://doi.org/10.1080/02626667.2021.1944633