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Impact of Religion on Global Meat Consumption

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Abstract

Due to economic development and dietary changes, human meat consumption continued to increase. In addition, demand for meat generally tends to rise along with the improvement of consumers' income level. Recently, there have been significant criticisms due to the negative impact of the livestock industry on the environment and human health. Nevertheless, meat still plays an important role as a source of protein, and the livestock industry holds an important source of income in rural areas. In particular, in developing countries, the potential of the livestock industry to consume balanced impacts of residents and fight poverty is very great.

Meat consumption is affected by various factors. Many previous studies have already conducted a factor analysis of meat consumption, focusing on economic and social factors. In this study, the effect of cultural factors that received relatively less attention on meat consumption was analyzed. In particular, the influence of religion, a representative cultural factor, on meat consumption was analyzed by income level and livestock species. The data used for analysis was panel data from 106 countries between 2010 and 2019, analyzed using a one-way error component fixed effect model. As dependent variables, the total annual meat consumption per person and meat consumption by livestock species were used, and the annual ratio was used as religious variables by classifying religions in the country into five groups.

As a result of analyzing the factors affecting total meat consumption in all countries, price and income had a positive (+) effect on meat consumption. Some different results were derived for each income group of the country. There were many significant economic factor variables in low-income countries, and there were many significant social variables in high-income countries. Christianity and Buddhism were found to have a positive (+) correlation with total meat consumption, and Islam had a negative (-) correlation.

As a result of analyzing by the same income group, the effect of religion on

meat consumption by livestock species showed different patterns. For example, in low-income countries, Islam has a positive (+) correlation with beef consumption and a negative (-) correlation with chicken consumption. In the high-income group of countries, Buddhism and Hinduism were found to have opposite correlations with beef and pork consumption.

As a result of analyzing the same livestock species, religion had a different effect on meat according to the national income level. Christianity had a positive (+) correlation with total meat consumption in high-income countries, and low-income countries had a negative (-) correlation.

This study is meaningful in that it empirically verified that the effect of religion on meat consumption varies by livestock species and income level, and also affects total meat intake. In general, it has been widely known that some religions restrict the intake of certain meat, but it has also been shown to affect total meat intake, including this, hindering balanced diet and nutritional intake. Therefore, in order to overcome religious restrictions on meat consumption, it is necessary to explore alternative livestock and increase productivity. Furthermore, it is necessary to mitigate the negative impact of religion on meat consumption in developing countries and to develop and disseminate other protein sources for balanced nutrition. This is also helpful in strengthening food security at the national level and achieving Sustainable Development Goals.

Key words: Meat consumption, Religion, Influencing factors, Income level, One-way error component model, Fixed effect model

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List of Abbreviations

AI	Avian Influenza
EDCF	Economic Development Cooperation Fund
FAO	Food and Agriculture Organization
FBS	Food Balance Sheet
FE	Fixed effect
FMD	Foot and Mouth Disease
ILO	International Labour Organization
KOICA	Korea International Cooperation Agency
KOF	Konjunkturforschungsstelle
MAFRA	Ministry of Agriculture, Food and Rural Affairs
POLS	Pooled Ordinary Least Square
PPI	Producer Price Index
RE	Random effect
WAHIS	World Animal Health Information System
WB	World Bank
WOAH	World Organisation for Animal Health
WRD	World Religion Database

1. Introduction

1.1. Background

With the increase in population and income, the portion of meat has also increased in people's diets, particularly in developed countries. Studies have consistently reported that this over-intake of red meat is related to an increased incidence of diseases, such as cancer, cardiovascular diseases, and Type 2 diabetes (Aune et al., 2009; Pan et al., 2012; Sinha et al., 2009). Studies also show that the livestock industry, which produces meat, generates up to 280 times more carbon emissions per calorie than grains and accounts for more than 25% of the total land area worldwide. It also causes other problems, such as water shortage and land degradation (Ilea, 2009; Stehfest et al., 2009; Steinfeld et al., 2006; Tilman & Clark, 2014).

The forecast that the global population will reach 10 billion by 2050 has led researchers to recognize that the "Western diet," which contains a high percentage of meat, is no longer environmentally sustainable. Thus, they have suggested adopting a diet considering that the livestock industry affects the environment. These studies have in common that they highlight the importance of reducing meat consumption and shifting to a fiber-rich diet (Pradhan et al., 2013; Willett et al., 2019).

Many studies have explored meat consumption across the world. However, traditional quantitative assessments of meat consumption have mainly focused on income and prices (FİDAN, 2005; Huang & Lin, 2000; Schroeder et al., 1996). Most studies have analyzed meat consumption using surveys on consumers, households, regions, and countries (Arısoy & Bayramoğlu, 2015; Burton et al., 1993; Vukasovič, 2009). They have also analyzed the price elasticity of meat and consumer's purchase intentions and behaviors, focusing on livestock diseases, such as Avian Influenza

(AI), and Foot-and-Mouth Disease (FMD), in a specific region for a short period or the events affecting supply and demand, such as free trade agreements (FTA) (Figuié & Fournier, 2008; Park et al., 1996; Kim and Im, 2020). It has been found that both product characteristics and social factors, such as urbanization, globalization, and women's labor participation, and cultural factors, such as ethics, beliefs, and religion, influence meat consumption (Disdier, 2016; Hayley et al., 2015; Jusmaliani & Nasution, 2013; Miguel et al., 2020; Milford et al., 2019; Placzek, 2021; Seto & Ramankutty, 2016).

However, the livestock industry is indispensable for rural households and the national economy. In addition, meat is a source of proteins and micronutrients, which show high conversion rates, and an adequate meat intake is essential for human growth and development (Heys et al., 2010; Krasevec et al., 2017; Krebs et al., 2011; Upton, 2004). Many countries, particularly in sub-Saharan Africa, suffer from malnutrition, and fiber-rich diets do not provide enough nutrients for children to grow (Herrero et al., 2013). Since it is difficult to have the benefits of meat in a meat-deficient diet, an adequate meat intake is necessary.

Consequently, various Official Development Assistance (ODA) projects in livestock field are being implemented to enhance livestock productivity in developing countries and provide a balanced diet. Moreover, animal husbandry is closely connected to food security and nutrition security. In addition, meat producing livestock industry holds the potential to make a substantial impact on achieving the Sustainable Development Goals (SDGs), which are designed to promote sustainable human development. Specifically, it will likely play a key role in achieving SDG2.1, which strives to end hunger and ensure access by all people, and SDG2.2, which aims to end all forms of malnutrition.

Table 1. Korea's ODA project focusing on livestock

Title	Type	Period	Doner	Country(Area)	Description
Poultry Processing Project	Livestock	2008-2015	EDCF	Angola (Malange)	Establishment of the broiler production environment, creation of high value-added business
Improving farm income through agriculture and livestock in circulation	Livestock	2017-2020	KOICA	Kenya (Kabanyoro)	Enhance livestock and feed crop productivity and quality.
Improving Productivity of Dairy Farmer by Supporting Dairy Technology and Infrastructure in Uganda	Livestock	2019-2022	MAFRA	Uganda (Gayaza, Entebbe)	Improving the productivity of dairy farmers by supporting dairy technology and infrastructure in Uganda
Laos Vientiane Region Farm Income Increase Poultry Project	Livestock	2020-2022	KOICA	Laos (Vientiane)	Securing Initial funds for family-based poultry farm 4. Development of advanced poultry technology 5. Providing poultry skills training
Income generation project through dairy value-chain development in Kajiado, Kenya	Agriculture development	2018-2021	KOICA	Kenya (Kajiado)	Provision of breed improvement and proper disease treatment for cattle, found operation of milk collecting based on business community organization.
Strengthening the Poultry Value Chain in Sulawesi, Indonesia	Rural development	2019-2023	KOICA	Indonesia (Sulawesi)	Enhance chicken farm and forage productivity.
Local cow stockbreeding project for the economic independence of the poor in Kabarnet, Kenya (Phase 3)	Rural development	2018-2020	KOICA	Kenya (Kabarnet)	Improving productivity and promoting economic independence through the supply of excellent genetic resources and training of human resources.
Mongolian Veterinary Capacity Building Project in Veterinary Medical Practice	Animal disease	2019-2023	MAFRA	Ulaanbaatar (Mongolia)	Construct a veterinary medical center, and skill training
Building resilient communities through improved food and nutrition security in Amhara region of Ethiopia (Phase 2)	Training	2020-2021	KOICA	Ethiopia (Amhara)	Provision of improved crops and livestock to increase agricultural and livestock productivity, livestock health service and feed seed support, technical training

Source: ODA Korea, Climate Technology Information System

1.2. Research purpose

As discussed in the previous section, meat consumption has two conflicting characteristics. Although it is useful as an efficient energy source, it poses the risk of harming the environment and health. In other words, the pros and cons of meat consumption are highly contradictory. Meat is a source of energy necessary for human and national growth, particularly in developing countries, and its consumption is closely related to a country's economic factors, such as income and price. However, it is also true that external environmental factors, such as social and cultural factors, which tend to vary between countries, have a complex impact on meat consumption.

Meat consumption is essential to eradicate hunger and maintain stable nutrition. It differs across countries and time depending on the economic and social environment. Hence, this study uses national observations from 2010 to 2019 to categorize the determinants of meat consumption in a country into economic, social, and cultural factors. It also quantitatively analyzes the impact of each of these factors on meat consumption.

Religion, a cultural factor, has long impacted eating habits. Islam and Judaism specify in their scriptures the animal species their followers are allowed to eat. Beef consumption is a taboo in Hinduism, which considers the cow a symbol of the supreme god.

More specifically, this study investigates whether religion, a determinant of eating habits, influences meat consumption in the world and the species of livestock consumed. It intends to enhance the understanding of the increasing demand for meat and have empirical evidence to make policy suggestions.

2. Literature Review

Meat consumption is considered enjoyable and symbolizes wealth (Dobersek et al., 2021; Lee et al., 2022). It has a social, economic, and environmental impact across the intake of nutrition (Popkin, 2006). Thus, studies have explored many of its determinants. It varies among consumers depending on product characteristics and socio-economic, ethical, and religious beliefs and traditions (Font-i-Furnols & Guerrero, 2014). Milford et al. (2019) divided the factors affecting meat consumption into economic factors, natural endowment, social factors, and globalization. A meta-study that analyzed consumer behaviors to reduce meat consumption showed that the factors affecting meat consumption behaviors could be classified into personal factors, socio-cultural factors, and external incentives (Stoll-Kleemann & Schmidt, 2017).

2.1. Economic and social factors

Economic factors are some of the most well-known factors affecting meat consumption. Cole and McCoskey (2013) found that meat consumption patterns vary based on income. Vranken et al. (2014) argued that meat consumption might decrease above a certain income level. Sahinli and Fidan (2012) found that grains and meat are substitutes, while Hayat et al. (2016) suggested that vegetables, beans, and bread could be meat alternatives.

Social factors have led to differences in countries' meat consumption which cannot be explained by economic factors alone. One of the most important social factors is urbanization. Regmi and Dyck (2001) argued that large urban populations are exposed more to western food consumption patterns through the media and thus consume more western diets. Schmidhuber and Shetty (2005) found that an

increasing percentage of women participating in the labor market led to more women eating out and consuming convenience food.

Filippini and Srinivasan (2019) argued that globalization might increase meat consumption by reducing people's commitment to religious norms. Similarly, Bottalico et al. (2016) found that globalization has changed food distribution and shifted people toward a western diet.

Trade development has resulted in increased income, which, in turn, has led to increased meat consumption (Schroeder et al., 1996). To secure food safety, livestock must have adequate animal welfare and cold chain systems (Čepinskis & Masteika, 2010). This advanced trade system can meet halal food requirements and safely supply meat to end consumers (Bruil, 2010). Sanitary and protective trade barriers also hugely impact the global meat trade (Dyck & Nelson, 2003). Generally, developing countries feel the burden of quarantine and customs clearance in meat import and export and bear more costs than developed countries (Henson & Loader, 2001).

Foreign direct investment has positively affected the meat industry in the country that has received it. Launching products that meet the needs of a growing middle class or increase production output can also have a positive impact (Gupta, 2012; Mihalache-O'keef & Li, 2011).

Pimentel and Pimentel (2007) analyzed different countries and confirmed that meat consumption was higher in countries with higher land availability. Moreover, 80% of the farmland worldwide is used for livestock farming, and the higher the percentage of farmland in a country, the easier it is to produce large-scale livestock products and fodder crops (Weindl et al., 2017).

Animal diseases have also affected meat consumption. Some studies found that adverse media reports on mad cow disease and residual hormones in livestock products impacted meat consumption (Burton & Young, 1996; Verbeke & Ward, 2001).

2.2. Cultural factors

In developing countries, culture plays a vital role in determining food patterns (Lahsaeizadeh, 2001). Highly educated individuals tend to reduce meat consumption or choose alternatives (Jallinoja et al., 2016; Rimal, 2002). Furthermore, age changes dietary patterns since meat consumption decreases as age increases (Landi et al., 2019; Yen et al., 2008). Personal values also affect meat consumption. For instance, consumers who believe in universalism, a high value of self-transcendence, motivate other consumers to protect themselves, thus negatively impacting meat consumption (Hayley et al., 2015; Ruby et al., 2013).

Consumers increasingly choosing a vegetarian diet also has a negative impact on meat consumption. Vegetarianism is defined differently by different people, and some of the most common reasons vegetarians refuse meat consumption are love for animals, health, the environment, and religion (Rosenfeld, 2018).

While religion has dramatically impacted life, its role in consumers' food choices remains somewhat ambiguous (Delener, 1994). However, in most cases, religion is a strong factor limiting meat choices (Shatenstein & Ghadirian, 1998). Bonne and Verbeke (2006) have confirmed that muslim consumers eat halal meat to follow and express the religious teachings of Islam. While religion is a powerful motivation to consume certain meats, consumption barriers, such as price and safety, can prevent people from eating them (Bonne et al., 2007). Furthermore, a certification system is required for the production and slaughter of meat because of some religions; these systems require additional cost and labor and affect followers' meat consumption (Heiman et al., 2019).

Table 2 summarizes previous studies, and Table 3 selects variables for this study based on literature reviews.

Table 2. Summary of literature review

No.	Authors	Title	Factor influencing meat consumption			
			Economic	Social	Cultural	Other
1	Godfray et al., 2018	Meat consumption, health, and the environment	Price			Preference, intrinsic desire
2	Cole & McCoskey, 2013	Does global meat consumption follow an environmental Kuznets curve?	Income	Urbanization, Land per capita		
3	Vranken et al., 2014	Curbing global meat consumption: Emerging evidence of a second nutrition transition	Income		Hofstede index, Religion	Landlock
4	Sahinli & Fidan, 2012	Estimation of food demand in Turkey: Method of an almost ideal demand system	The price of 6 items includes meat			
5	Hayat, Hussain, & Yousaf, 2016	Food Demand in Pakistan: Analysis and Projections	Meat price, Substitute price, Expenditure			Number of household members, age
6	Regmi & Dyck, 2001	Effects of Urbanization on Global Food Demand	GNP per capita	Urbanization		
7	Schmidhuber & Shetty, 2005	The nutrition transition to 2030. Why developing countries are likely to bear the major burden	Population	Urbanization, Globalization		
8	Filippini & Srinivasan, 2019	Impact of religious participation, social interactions and globalization on meat consumption: Evidence from India			Religion	Household Characteristic
9	Bottalico et al., 2016	Erosion of the Mediterranean Diet in Apulia Region, South-eastern Italy: Exploring Socio-cultural and Economic Dynamics		Female Labor participate		Household expenditure
10	Schroeder et al., 1996	Income growth and international meat consumption	Meat price, Substitute price, Population			
11	Čepinskis & Masteika, 2010	Role of logistics in the development of Lithuanian meat sector	Transportation			
12	Bruil, 2010	Halal logistics and the impact of consumer perceptions	Trade system			

13	Dyck & Nelson, 2003	Structure of the global markets for meat	Trade barrier			
14	Henson&Loader, 2001	Barriers to Agricultural Exports from Developing Countries: The Role of Sanitary and Phytosanitary Requirements	Logistics environment			
15	Pimentel & Pimentel, 2007	Food, Energy, and Society		Arable Land		
16	Weindl et al., 2017	Livestock and human use of land: Productivity trends and dietary choices as drivers of future land and carbon dynamics		Arable Land		
17	York & Gossard., 2004	Cross-national meat and fish consumption: exploring the effects of modernization and ecological context	GDP	Urbanization. Land per capita		Temperature, Area, Water per capita
18	Burton & Young, 1996	The impact of BSE on the demand for beef and other meats in Great Britain	Meat price	Animal Disease		
19	Verbeke & Ward, 2001	A fresh meat almost ideal demand system incorporating negative TV press and advertising impact.	Meat price	Animal Disease		
20	Shatenstein&Ghadirian, 1998	Influences on diet, health behaviours and their outcome in select ethnocultural and religious groups.			Culture, Religion	Age, Gender, Personal status
21	Bonne & Verbeke, 2006	Muslim consumer's motivations towards meat consumption in Belgium : qualitative exploratory insights from means-end chain analysis				Anthropological background, Diet
22	Bonne et al., 2007	Determinants of halal meat consumption in France		Religion	Education	Age, Region, Family, Origin, Generation

Source: Author summarized

Table 3. Variable selection from the literature review

Variable Group	Authors	Factor used	Effect on Meat consumption
Economic	Cole & McCoskey, 2013	Income	Different consumption patterns depend on the income
Economic	Vranken et al., 2014	Income	In Some income levels, meat consumption can stagnate or even decline
Economic	Godfray et al., 2018	Meat price	Meat prices are lower than ever in history
Economic	Hayat, Hussain, & Yousaf, 2016	Substitutes	In Pakistan, vegetables, beans, and bread can be meat substitutes.
Economic	Sahinli & Fidan, 2012	Substitutes	Grain and meat are substitute relationships.
Social	Regmi & Dyck, 2001	Urbanization	Urbanization westernizes food consumption patterns.
Social	Schmidhuber & Shetty, 2005	Female Labor Paricipate	As women move away from home, their intake of outside food and convenience food increases.
Social	Filippini & Srinivasan, 2019	Globalization	Globalization can increase meat consumption by reducing the willingness to comply with religious norms.
Social	Bottalico et al., 2016	Globalization	Globalization changes food distribution patterns, triggering a shift to a Western diet.
Social	Schroeder et al., 1996	Trade	The FTA agreement increased meat consumption in Mexico.
Social	Henson&Loader, 2001	Trade	Quarantine and customs incur additional costs for meat transportation.
Social	Pimentel & Pimentel, 2007	Arable Land	Countries with higher land availability have higher meat consumption.
Social	York & Gossard, 2004	Land per capita	Nations with more land per capita consume more meat per capita.
Social	Burton & Young, 1996	Animal disease	BSE affects consumers' meat spending.
Social	Verbeke & Ward, 2001	Animal disease	Adverse reports of unfavorable factors related to the stability of livestock products affect meat consumption.
Culture	Shatenstein&Ghadirian, 1998	Religion	In most cases, Religion is a limiting factor in meat consumption.
Culture	Bonne & Verbeke, 2006	Religion	Consuming halal meat to keep religious teachings.
Culture	Bonne et al., 2007	Religion	Personal attitude, pressure from others, etc. affect halal meat selection.

Source: Author summarized

3. Data and Procedure

3.1. Hypothesis

This study proposes three main hypotheses based on a review of the literature as follows:

It is widely acknowledged that certain religions can affect particular meat consumption. However, it remains to be fully determined if the religion can influence total meat consumption. Additionally, it is hypothesized that various religions may affect meat consumption variously. In light of this, a hypothesis test was conducted as part of this study.

Hypothesis 1.

H_0: Religion doesn't affects meat consumption.

H_1: Religion affects meat consumption.

If a particular religion restricts certain meat, other type of meat may become more prevalent and can be promoted. Simultaneously, it should be noted that religion may promote meat consumption regardless of the type of meat (Milford et al., 2019; Vranken et al., 2014). Therefore, this study aims to examine religion's influence on meat consumption, differentiated by the type of livestock, through hypothesis testing.

Hypothesis 2.

H_0: Religion gives similar effects on meat consumption by meat type.

H_1: Religion gives different effects on meat consumption by meat type.

Generally, meat consumption tends to increase as income increases. Notwithstanding, consumption stagnates or decreases when reaching a certain

income level (Cole & McCoskey, 2013). This indicates that meat consumption is responsive to changes in income. Hence, this research classifies the income level to verify religion's effect on meat consumption by hypothesis testing.

Hypothesis 3.

H_0: Religion gives similar effects on meat consumption by income level.

H_1: Religion gives different effects on meat consumption by income level.

3.2. Data

The following data were used to analyze the factors affecting meat demand. The annual total meat consumption per capita and the annual meat consumption per capita based on the livestock species were extracted from the Food Balance Sheets[①] (FBS) of the Food and Agriculture Organization (FAO) to represent a country's meat consumption.

Countries listed in the FBS between 2010 and 2019 were to be analyzed in this study. However, data were missing for some countries, or the mean meat consumption was in the bottom 0.5%, and thus they were excluded to improve the accuracy of the analysis. Consequently, only 106 countries in the FBS were selected out of 186 countries. The following description explains how data were collected for this study.

By considering the country's agriculture and trade data as the actual consumption, the FBS is used to make policy decisions. Although the FBS may not directly measure per capita consumption, require some adjustment for food waste, and result in underestimation, they are the only available data through which a country's food consumption can be compared with that of other countries. The FAO provides annual data on more than 180 countries. Depending on how it is compiled[②], it presents an old version of data (FBSH, 1961-2013) and a new version (FBS, 2010-2019). This study uses the new version of the data.

Panel data were constructed for panel regression analysis, and the FBS and international statistical data provided by international organizations, such as the World Bank (WB), were used for the independent variables.

① FAO. FAOSTAT Database. Food Balance Sheets, www.fao.org/faostat/en/#data/FBS

② Imbalances due to feed, inventory, and non-food items were corrected, and demographic statistics from 2015 or before, which were used previously, were integrated into 2019 demographic data.

The dependent variable of meat consumption per capita was measured using the FBS mentioned above. The total meat consumption per capita, which is the sum of the consumption of five livestock species, and the meat consumption per capita by livestock species were used as the dependent variables.

Next, the FAO Producer Price Index (PPI)[③] was used to ascertain the price of meat, grains, and vegetables, which were the independent variables. Although the WB publishes consumption prices by item in the International Comparison Program, it publishes data every six years. Meanwhile, the PPI is calculated using the average of the three years from 2014 to 2016 as 100. It is calculated annually and reflects trends in countries' food prices. The mean PPI of beef, pork, and the chicken was used as total meat price.

Next, to measure income, the real Gross National Income (GNI) per capita at purchasing power parity[④] was divided by 1,000 to avoid distortion from unit differences. Furthermore, the four income groups classified by the WB—low, lower-middle, upper-middle, and high-income groups—were used to categorize countries into income groups.

As social factors, this study used the social dimension of the KOF Globalization Index[⑤], the labor force participation rate of women aged over 15 from the International Labor Organization (ILO)[⑥], the urbanization population rate, the rate of arable land, and the logistics performance index published by WB.

Regarding animal diseases, disease statistics reported by the World Organization for Animal Health (WOAH)[⑦] were converted into dummy variables and used in this study. AI and FMD are listed in former disease List A[⑧]. Whenever

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③ FAO. FAOSTAT Database. Producer Prices, www.fao.org/faostat/en/#data/PP
④ WB. World Bank Open Data. GDP per capita, PPP (current international $), https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD
⑤ ETH Zurich KOF. https://kof.ethz.ch/
⑥ WB. World Bank Open Data. Labor force participation rate, female (% of female population ages 15+) (modeled ILO estimate) data.worldbank.org/indicator/SL.TLF.CACT.FE.ZS
⑦ WOAH. World Animal Health Information System. wahis.woah.org/#/home
⑧ Contagious disease that can spread rapidly across borders, cause severe socioeconomic or public health issues, significantly affect global trade of animals and animal products.

an outbreak occurs, it must be reported to the WOAH. AI is a disease transmitted through not only wild animals but also global trade. Cases in which more than 1,000 birds were slaughtered or killed in a country in a year were filtered for this study. FMD is a disease that can affect domestic consumption and global trade, and some countries slaughter or cull infected animals to maintain their status as being FMD (Kim et al., 2011). The dummy variables equaled zero when the disease did not break out and one when it broke out.

The percentage of each religion was a key variable in this study. Based on their doctrine, 18 religions in the World Religion Database (WRD)[⑨] were classified into Christianity, Islam, Buddhism, Hinduism, and other religions. This database is published by Boston University, and it provides five-year data by collecting and correcting databases of religions around the world. Changes in the country's percentage of religions by year were split equally.

⑨ World Religion Database. https://www.worldreligiondatabase.org/

Table 4. Description of the variables

Variable			Description	Source
Dependent		Total meat consumption	Total meat/capita/year (kg)	FAO
		Beef consumption	Beef/meat/capita/year (kg)	FAO
		Pork consumption	Pork/capita/year (kg)	FAO
		Chicken consumption	Chicken/capita/year (kg)	FAO
Independent	Economic	Cereal PPI	Total Cereal Producer Price Index (2014-2016=100)	FAO
		Vegetable PPI	Total Vegetable Producer Price Index (2014-2016=100)	FAO
		Meat PPI	Total Meat Producer Price Index (2014-2016=100)	FAO
		Beef PPI	Beef Producer Price Index (2014-2016=100)	FAO
		Chicken PPI	Chicken Producer Price Index (2014-2016=100)	FAO
		Pork PPI	Pork Producer Price Index (2014-2016=100)	FAO
		GNIPPP1000	Gross National Income (GNI) per capita at purchasing power parity (Current USD)	WB
		Income group	Worldbank Income Group (1~4)	WB
	Social	KOF Social Globalization Index	Social Globalization Index	KOF
		Female Labor Participate	Female labor force participation rate (%)	ILO
		Urbanized population	Urban population (%)	WB
		Arable Land	Arable land (%)	WB
		Logistics Performance Index	Global Logistics Performance Index	WB
		Avian Influenza	Avian Influenza outbreak (dummy)	WOAH
		Foot and Mouth Disease	Foot and Mouth disease outbreak (dummy)	WOAH
	Religion	Christianity	Rate of Christians in the country (%)	WRD
		Islam	Rate of Muslims in the country(%)	WRD
		Buddhism	Rate of Buddhists in the country(%)	WRD
		Hinduism	Rate of Hindi in the country (%)	WRD
		Other	Rate of Other religion believers and non-religions in the country (%)	WRD

3.3. Method

Analyses of the demand for a goods are broadly divided into two categories. The first category includes the method which recognizes demand as a matter of maximizing utility and estimates the demand system that satisfies the basic assumptions of the demand function, such as the Rotterdam model, the linear expenditure model, and the Almost Ideal Demand System model.

The second category includes the traditional linear model, which has the quantity demand as the dependent variable, considers factor affecting the quantity demand as independent variables, and estimates the coefficient of each variable. It includes the log-log model, the log-linear model, and the log-inverse-log model. Valin et al. (2014) argued that demand analysis must consider not only income and price elasticity but also other explanatory variables. Therefore, the traditional linear model was used in this paper, and the panel data analysis was also selected as the analysis method.

A typical demand function looks like this:

$$Q_d = f(P, D_s) \tag{3.1}$$

where Q_d is the quantity demanded and P is the price of the goods. D_s is a demand shifter that can shift the demand, including income or the price of substitute goods.

Adding the determinants of demand as explanatory variables into the traditional demand function, this study investigates how these factors affect meat consumption and whether their effect is statistically significant. It uses the following demand function for meat consumption.

$$Q_{dtm} = f(P_{tm}, P_{ms}, Y, R_c, A_c, D_{tms}) \quad (3.2)$$

where Q_{dtm} is the country's total meat demand, P_{tm} is the total meat price, P_{ms} is the price of meat substitutes, Y is the income, R_c is the percentage of religions in the country, A_c is the current status of animal diseases in the country, and D_{tms} represents other factors affecting meat demand.

The following is the meat demand function based on the species of livestock.

$$Q_{dm} = f(P_m, P_{ms}, Y, R_c, A_c, D_{ms}) \quad (3.3)$$

where Q_{dm} is the demand for meat in the country based on the species of livestock, P_m is the price of meat based on the species of livestock, P_{ms} is the price of meat substitutes, Y is the income, R_c is the percentage of religions in the country, A_c is the current status of animal diseases in the country, and D_{ms} represents other factors affecting meat demand.

This study analyzes the factors affecting meat consumption. A panel regression analysis is conducted with meat consumption as the dependent variable. Economic and social variables determined from previous studies and religion, representing cultural factors, are the independent variables.

A regression analysis based on panel data combines cross-sectional data (samples observed at a specific time point) and time series data (samples collected continuously across the period). It has many advantages compared to an analysis that uses only time series or cross-sectional data (Min & Choi, 2009). Panel data control for individual heterogeneity and reduces the risk of multicollinearity and omitted-variable bias, making it practical for empirical analyses.

The error term is categorized as the variable that differs between regions but does not change over time, the variable that changes over time but does not differ between regions, and the stochastic disturbance term that differs between regions

and changes over time. The following equation expresses it as a typical linear model (Ashenfelter et al., 2003).

$$Y_{it} = \alpha + X_{it}\beta + \epsilon_{it} \quad (3.4)$$

where i (region) = 1, 2… N, and t (year) = 1,2… T. Y_{it} is the dependent variable at the time t of i region, and X_{it} is the explanatory variable at time t of region i. The following represents the error term of the panel model ϵ_{it}.

$$\epsilon_{it} = \mu_i + \lambda_t + \nu_{it} \quad (3.5)$$

μ_i = Unobservable individual effect

λ_t = Unobservable time effect

ν_{it} = Remainder stochastic disturbance term

The panel data model is divided into a one-way error component regression model or a two-way error component regression model, depending on how the error term is considered. This research implements a one-way error component model, which presupposes that a certain unobservable individual effect potentially exists in cross-sectional data.

It is divided into a fixed-effects model (FE) or a random-effects model (RE), depending on the error term assumption. The fixed-effects model has the disadvantage that it sacrifices the degree of freedom, but it recognizes the correlation between the effect of regional characteristics and the independent variable. Meanwhile, the random-effects model assumes that the effect of regional characteristics has nothing to do with the independent variable (Choi, 2008).

The Hausman test is used to distinguish which models are more appropriate. The underlying hypothesis of this test is that “the estimate of the random effects model is appropriate.” Therefore, if this hypothesis is rejected, the fixed-effects model is selected.

Fixed-effect model can be expressed as follows.

$$\mathrm{Y}_{it} = (\alpha + \mu_i) + \beta X_{it} + \epsilon_{it} \quad (3.6)$$

Subtracting between model 3.7 consisting of the average for each panel group, from Equation 3.6.

$$\overline{\mathrm{Y}_i} = \alpha + \beta\overline{X_i} + \mu_i + \overline{\epsilon_i} \quad (3.7)$$

The following within estimation model can be obtained equation 3.8, follow:

$$\left(\mathrm{Y}_{it} - \overline{\mathrm{Y}_i}\right) = \beta\left(X_{it} - \overline{X_i}\right) + (\epsilon_{it} - \overline{\epsilon_i}) \quad (3.8)$$

This study estimates the effect of religion on meat consumption using the within method. The model of the study analysis total meat consumption as a dependent variable is as follow:

$$\begin{aligned} Y_{it} = {} & \alpha + \beta_1 MeatPPI + \beta_2 CerealPPI + \beta_3 VegetablePPI + \\ & \beta_4 GNIPPP1000 + \beta_5 LPI + \beta_6 KOFSoGI + \beta_7 FLP + \beta_8 UP + \\ & \beta_9 AL + \beta_{10} AI + \beta_{11} FMD + \beta_{12} Religion + \epsilon_{it} \end{aligned} \quad (3.9)$$

Where i=country; Y_{it} is an amount of annual total meat consumption; MeatPPI is PPI of total meat in years; Cereal PPI is PPI of Cereal in years; VegetablePPI is PPI of Vegetable in years; GNIPPP1000 is GNI per capita at purchase power parity in years; LPI is Logistics Performance Index in years; KOFSoGI is Social dimension of KOF Globalization index in years; FLP is rate of female labor force participate over age 15; UP is rate of urbanized population; AL is rate of Arable land in years; AI is dummy variable of Avian influenza outbreak in which outbreak is 1, and otherwise 0; FMD is dummy variable of Foot-and-Mouth Disease in which outbreak is 1, and otherwise 0; Religion is the rate of each religion

in country in years. β is the unknown parameters to be estimated, and ϵ_{it} is random error term.

The model of the study analysis meat consumption by livestock type as dependent variable is as follows:

$$Y_{it} = \alpha + \beta_1 BeefPPI + \beta_2 PorkPPI + \beta_3 ChickenPPI + \beta_4 CerealPPI + \beta_5 VegetablePPI + \beta_6 GNIPPP1000 + \beta_7 LPI + \beta_8 KOFSoGI + \beta_9 FLP + \beta_{10} UP + \beta_{11} AL + \beta_{12} AI + \beta_{13} FMD + \beta_{14} Religion + \epsilon_{it} \quad (3.10)$$

Where i=country; Y_{it} is an amount of annual meat consumption er capita by livestock type; BeefPPI is PPI of beef in years; PorkPPI is PPI of pork in years; ChickenPPI is PPI of chicken in years; Cereal PPI is PPI of Cereal in years; VegetablePPI is PPI of Vegetable in years; GNIPPP1000 is GNI per capita at purchase power parity in years; LPI is Logistics Performance Index in years; KOFSoGI is Social dimension of KOF Globalization index in years; FLP is the rate of female labor force participate over age 15; UP is the rate of urbanized population; AL is rate of Arable land in years; AI is dummy variable of Avian influenza outbreak in which outbreak is 1, and otherwise 0; FMD is dummy variable of Foot-and-Mouth Disease in which outbreak is 1, and otherwise 0; Religion is the rate of each religion in country in years. β is the unknown parameters to be estimated, and ϵ_{it} is random error term.

STATA SE 17.0 was used for analysis in this study.

4. Empirical Results

4.1. Descriptive statistics

During the analysis period, the world's mean annual total meat consumption per capita was 50.97kg. It was estimated as 12.11 kg for beef, 15.70 kg for pork, and 19.18 kg for chicken. Among the economic factors, the average PPI of cereal and vegetable was 101.32 and 99.65, respectively. The average PPI of meat was 99.39. By the livestock species, it was 98.81 for beef, 100.26 for chicken, and 99.18 for pork. GNI per capita at purchasing power parity was $19,520, with the mean of 2.83 among income groups. In the income group variable, 1 indicates a low-income country, while 4 represents a high-income country.

The social dimension of the Globalisation Index published by KOF Zurich was used as a social factor. This index consists of economic, social, and cultural dimensions, but only the social dimension was used in this study. The mean social globalization index was 65.25. The mean labor force participation rate of women aged 15 and older was 51.51%, suggesting that about half of these women leave home and participate in the labor market. The mean urbanization population rate was 60.78. The mean agricultural land rate was 17.06%.

AI and FMD were 0.22 and 0.24, respectively. In more than 20% of the countries, there had been an outbreak of a contagious animal disease at least once during the analysis period. Regarding the percentage of religions in the country, Christianity had the highest mean percentage of 54.55%, and Hinduism had the lowest mean percentage of 2.01%. The mean percentage of Islam was 23.67%, and that of other religions was 14.01%.

Table 5. Summary statistics

Variable			Obs	Mean	Std. dev.	Min	Max
Dependent		Total meat consumption	1060	50.97	28.63	3.76	128.44
		Beef consumption	1060	12.11	9.33	0.19	55.43
		Pork consumption	1050	15.70	15.78	0.00	67.22
		Chicken consumption	1060	19.18	14.21	0.40	76.89
Independent	Economic	Cereal PPI	1060	101.32	22.62	16.26	300.65
		Vegetable PPI	1060	99.65	22.95	16.33	362.57
		Meat PPI	1060	99.39	18.43	24.04	290.64
		Beef_PPI	1060	98.81	23.19	22.26	433.86
		Chicken_PPI	1000	100.26	22.29	21.10	360.03
		Pork_PPI	1060	99.18	19.85	27.32	372.06
		GNIPPP1000	1060	19.52	16.61	0.93	72.43
		Income group	1060	2.83	1.02	1.00	4.00
	Social	KOF Social Globalization Index	1060	65.25	16.75	24.91	91.59
		Female Labor Participate	1060	51.51	14.46	12.93	84.09
		Urbanized population	1060	60.78	20.89	15.54	98.04
		Arable Land	1060	17.06	13.83	0.79	62.48
		Logistics Performance Index	1060	3.00	0.54	2.03	4.23
		Avian Influenza	1060	0.22	0.41	0.00	1.00
		Foot and Mouth Disease	1060	0.24	0.43	0.00	1.00
	Religion	Christianity	1060	54.55	36.81	0.09	98.56
		Islam	1060	23.67	34.79	0.01	99.77
		Buddhism	1060	5.76	17.95	0.00	87.24
		Hinduism	1060	2.01	9.83	0.00	73.38
		Other	1060	14.01	15.17	0.14	78.03

Source: Author's calculation based on constructed panel data

Table 6 classifies religions worldwide into five groups and categorizes meat consumption by income and livestock species. If the country's particular religion rate in the year is more than 50%, the country is classified as a particular religion. If there is no religion more than 50%, the country is classified based on 40%. If two religions exceed 40% of the population, the country's religion is classified as the most congregated religion.

In low-income countries classified based on religion, beef consumption per capita was the highest in Muslim countries (8.34 kg) and the lowest in Hindu countries (4.54 kg). Meanwhile, pork was consumed the most in Buddhist countries.

Muslim and Hindu countries consumed less than kilo a year per capita. The chicken was highly consumed in Christian and Buddhist countries. Countries in which other religions are followed include Korea, the Czech Republic, China and Israel. All of these countries were classified as high-income countries. Hence, there was no low-income country panel in this category.

Meat consumption per capita based on the livestock species in high-income countries differed significantly from that in low-income countries. Pork and chicken consumption per capita exceeded 25 kg in Christian countries, showing different consumption patterns than those in low-income Christian countries. Even in Muslim countries, chicken consumption was twice as high as beef consumption, suggesting that meat consumption patterns in high-income countries differ from those in low-income Muslim countries. Beef, mutton and goat meat consumption decreased in Buddhist countries, while pork and chicken consumption increased. Finally, pork and chicken consumption per capita was about 30 kg in countries where other religions are followed, showing a big difference from the consumption in high-income countries with other religions.

Table 6. Meat consumption by income, religion, species

Unit: kg

		Christianity	Islam	Buddhism	Hinduism	Other religion
Low-income	Beef	6.45	8.34	7.65	4.54	
	Pork	5.83	0.75	11.93	0.53	
	Chicken	11.69	5.81	9.28	2.08	
	Mutton& Goat	1.03	4.52	8.08	1.47	
	Meat, other	1.33	1.32	1.67	0.00	
	Total	26.33	20.73	38.62	8.62	
High-income	Beef	16.65	11.07	5.78		13.70
	Pork	26.58	2.46	15.40		29.61
	Chicken	26.77	20.74	14.68		30.09
	Mutton& Goat	2.07	6.92	2.13		1.44
	Meat, other	1.05	0.73	0.59		1.18
	Total	73.12	41.92	38.58		76.02

Source: Author's calculation based on FAO FBS.

4.2. Total meat consumption analysis

Table 7 shows the results of an analysis of the economic and social factors affecting meat consumption. Each analysis method differs slightly depending on the processing method of the error term, and the three analysis methods were compared to observe the change in the estimated coefficient according to the difference in the analysis method.

Table 7. Meat consumption analysis by different panel analysis

	POLS	RE	FE
Economic factor			
Meat_PPI	-0.01	0.01	0.02
	(-0.20)	(1.21)	(1.93)
Cereal_PPI	0.04	0.01	0.02
	(1.26)	(1.81)	(1.94)
Vegetable_PPI	-0.03	-0.02*	-0.01
	(-1.05)	(-2.13)	(-1.61)
GNIPPP1000	0.27***	0.16**	0.16***
	(4.03)	(3.28)	(3.31)
Social Factor			
FLP	0.27***	0.12	0.09
	(7.27)	(1.73)	(1.00)
UP	0.30***	0.24**	-0.17
	(7.62)	(2.99)	(-1.34)
AL	-0.17***	-0.15	0.01
	(-4.33)	(-1.43)	(0.05)
LPI	-0.59	0.08	-0.59
	(-0.31)	(0.08)	(-0.59)
KOFSoGI	0.85***	0.66***	0.56***
	(12.63)	(8.39)	(6.32)
0. AI		(Baseline)	
1. AI	1.46	-0.57	-0.33
	(1.09)	(-1.25)	(-0.72)
0. FMD		(Baseline)	
1. FMD	-3.03*	0.04	0.29
	(-2.21)	(0.07)	(0.55)
_cons	-36.34***	-14.48*	16.83
	(-5.97)	(-2.07)	(1.84)
N	1060	1060	1060
r2	0.69		0.1
r2_a	0.68		-0.01
F	207.25		9.14

Note: * p<0.05, ** p<0.01, *** p<0.001

This analysis found the income variable (GNIPPP1000) and the social globalization variable (KOFSoGI) to be statistically significant positive (+) estimated coefficients, which was in line with the results of previous studies.

The F-test is used to select the model between Pooled Ordinary Least Square (POLS) and Fixed Effect Model, while the Breusch and Pagan Lagrangian Multiplier test is used to select between POLS and Random Effect Model. In addition, the Hausman test is widely used for selecting between Fixed Effect Model and Random Effect Model.

The analysis results show that using Fixed Effect Model in the F-test and Random Effect Model in the BP-LM test can lead to more efficient estimators than POLS. In addition, the Hausman test showed Chi2 = 38.27 with a significance probability of 0.00. Therefore, the factors affecting meat consumption are analyzed using the Fixed Effect Model in this paper.

First, Table 8 shows the effect of religion on meat consumption by inputting the proportion variable of each religious adherent one by one into the model. As a result, Meat_PPI, namely, the meat price, was found to be a positive (+) estimated coefficient for meat consumption. In addition, income (GNIPPP1000) and social globalization (KOFSoGI) variables, were found to be positive (+) estimated coefficients.

In terms of religion, Christianity and Buddhism were found to be positive (+) estimated coefficients. On the other hand, Islam and other religions were found to be negative (−) estimated coefficients. These results show that the proportion of people of each religion in the country affects meat consumption in various ways.

Table 8. Total meat consumption analysis

	Total	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Meat_PPI	0.02	0.02*	0.02*	0.02*	0.02	0.02*
	(1.93)	(1.98)	(2.03)	(2.38)	(1.93)	(2.01)
Cereal_PPI	0.02	0.01	0.01	0.01	0.02*	0.01
	(1.94)	(1.57)	(1.80)	(1.39)	(1.97)	(1.51)
Vegetable_PPI	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(-1.61)	(-1.55)	(-1.22)	(-1.53)	(-1.64)	(-1.80)
GNIPPP1000	0.16***	0.31***	0.22***	0.13**	0.17***	0.27***
	(3.31)	(6.04)	(4.44)	(2.72)	(3.45)	(5.42)
Social Factor						
LPI	-0.59	-0.21	-0.33	-0.79	-0.64	-0.38
	(-0.59)	(-0.21)	(-0.33)	(-0.80)	(-0.63)	(-0.39)
KOFSoGI	0.56***	0.48***	0.58***	0.54***	0.55***	0.46***
	(6.32)	(5.59)	(6.69)	(6.33)	(6.20)	(5.27)
FLP	0.09	0.05	0	0.1	0.09	0.11
	(1.00)	(0.57)	(0.02)	(1.11)	(0.99)	(1.28)
UP	-0.17	-0.2	-0.12	-0.19	-0.18	-0.24
	(-1.34)	(-1.60)	(-0.95)	(-1.55)	(-1.42)	(-1.90)
AL	0.01	-0.07	0.09	0.05	0.02	-0.13
	(0.05)	(-0.35)	(0.41)	(0.26)	(0.10)	(-0.63)
0. AI			(Baseline)			
1. AI	-0.33	-0.45	-0.26	-0.29	-0.33	-0.5
	(-0.72)	(-1.02)	(-0.57)	(-0.67)	(-0.73)	(-1.14)
0. FMD			(Baseline)			
1. FMD	0.29	0.35	0.07	0.25	0.3	0.51
	(0.55)	(0.68)	(0.13)	(0.48)	(0.55)	(0.98)
Religion Factor						
Christianity		1.37***				
		(7.62)				
Islam			-2.08***			
			(-4.91)			
Buddhism				7.32***		
				(6.68)		
Hinduism					-3.1	
					(-1.05)	
Other						-1.50***
						(-7.36)
_cons	16.83	-51.62***	62.33***	-23.15*	24.11*	47.38***
	(1.84)	(-4.08)	(4.81)	(-2.15)	(2.10)	(4.82)
N	1060	1060	1060	1060	1060	1060
r2	0.10	0.15	0.12	0.14	0.10	0.15
r2_a	-0.01	0.04	0.01	0.03	-0.01	0.04
F	9.14	13.72	10.59	12.48	8.47	13.36

Note: * p<0.05, ** p<0.01, *** p<0.001

Next, the analysis results in which countries were divided into Low-Income Countries (consisting of low and lower-middle countries) and High-Income Countries (consisting of upper-middle and high-income countries), according to the WB's annual country classification criteria, are as follows. Of 1,060 panels, 404 were classified as Low-Income Countries, while 656 were classified as High-Income Countries.

An analysis in Table 9, Low-Income Countries, found that annual total meat consumption per capita increased by 0.03kg in most models when the price of grain increased by one unit. On the other hand, annual total meat consumption per capita decreased by 0.03 kg when the price of vegetables increased by one unit. Income was statistically significant only in the model in which the proportion variable Christian inputted and not in the other models. Social globalization was found to be a positive (+) estimated coefficient in all analyses.

In terms of religion, Christianity and Islam were found to be negative (−) coefficients, while Buddhism was found to be positive (+) coefficients.

Table 9. Total meat consumption analysis in low-income countries

	Total	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Meat_PPI	0.02	0.01	0.02	0.03*	0.02	0.02
	(1.34)	(1.14)	(1.45)	(2.58)	(1.30)	(1.33)
Cereal_PPI	0.03**	0.03**	0.03*	0.02	0.03**	0.03**
	(2.77)	(3.24)	(2.49)	(1.77)	(2.74)	(2.74)
Vegetable_PPI	-0.03**	-0.03**	-0.03**	-0.03**	-0.03**	-0.03**
	(-2.95)	(-3.10)	(-2.71)	(-2.77)	(-2.84)	(-2.94)
GNIPPP1000	0.39	0.48*	0.34	-0.06	0.39	0.39
	(1.61)	(1.99)	(1.44)	(-0.27)	(1.64)	(1.59)
Social Factor						
LPI	-0.4	-0.41	-0.21	-0.72	-0.33	-0.4
	(-0.35)	(-0.37)	(-0.18)	(-0.71)	(-0.29)	(-0.35)
KOFSoGI	0.39***	0.40***	0.41***	0.43***	0.39***	0.39***
	(4.01)	(4.13)	(4.26)	(4.92)	(4.05)	(3.97)
FLP	0.01	0.04	-0.05	0.02	0.02	0.01
	(0.06)	(0.40)	(-0.43)	(0.22)	(0.15)	(0.06)
UP	0.08	0.09	0.16	0.18	0.09	0.08
	(0.51)	(0.56)	(0.99)	(1.25)	(0.58)	(0.50)
AL	-0.14	-0.19	-0.16	-0.1	-0.16	-0.14
	(-0.43)	(-0.59)	(-0.49)	(-0.34)	(-0.48)	(-0.42)
0. AI	(Baseline)					
1. AI	-0.84	-0.72	-0.81	-0.76	-0.85	-0.84
	(-1.35)	(-1.16)	(-1.31)	(-1.35)	(-1.37)	(-1.35)
0. FMD	(Baseline)					
1. FMD	0.62	0.55	0.62	0.55	0.61	0.62
	(1.18)	(1.04)	(1.17)	(1.14)	(1.14)	(1.17)
Religion Factor						
Christianity		-1.39*				
		(-2.56)				
Islam			-1.01*			
			(-2.06)			
Buddhism				7.85***		
				(9.10)		
Hinduism					2.38	
					(0.70)	
Other						0
						(-0.00)
_cons	2.41	57.63*	34.35	-78.04***	-8.68	2.42

	(0.24)	(2.42)	(1.85)	(-6.12)	(-0.46)	(0.20)
N	404	404	404	404	404	404
r2	0.19	0.21	0.2	0.35	0.19	0.19
r2_a	0.06	0.08	0.07	0.24	0.06	0.06
F	7.48	7.51	7.27	15.37	6.88	6.83

Note: * p<0.05, ** p<0.01, *** p<0.001

Table 10, an analysis of total meat consumption in High-Income Countries using 656 panels, yielded different results. First, an increase in income positively affected meat consumption in all models, and social globalization and women's labor participation also acted as factors that increased meat consumption. However, an increase in urbanized population had a negative (−) effect on meat consumption.

Christianity was found to be a positive estimated coefficient (+) in terms of religion, differing from the results shown for Low-Income Countries. Islam was found to be the same negative estimate coefficient as in Low-Income Countries. Therefore, the effect of religion on meat consumption differed depending on the income level.

Table 10. Total meat consumption in high-income countries

	Total	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Meat_PPI	0.01	0.01	0.01	0.01	0.01	0.01
	(0.41)	(0.72)	(0.84)	(0.51)	(0.37)	(0.59)
Cereal_PPI	0.02	0.01	0.01	0.02	0.02	0.01
	(1.33)	(1.02)	(1.19)	(1.29)	(1.39)	(1.04)
Vegetable_PPI	0	0	0	0	0	0
	(-0.04)	(-0.10)	(0.18)	(-0.11)	(-0.00)	(-0.26)
GNIPPP1000	0.13*	0.31***	0.25***	0.13*	0.16**	0.26***
	(2.29)	(5.12)	(4.06)	(2.16)	(2.61)	(4.36)
Social Factor						
LPI	-1.27	-0.41	-1.1	-1.31	-1.2	-0.48
	(-0.77)	(-0.26)	(-0.68)	(-0.79)	(-0.73)	(-0.30)
KOFSoGI	0.74***	0.57***	0.70***	0.73***	0.73***	0.58***
	(4.72)	(3.81)	(4.59)	(4.67)	(4.66)	(3.81)
FLP	0.27*	0.19	0.16	0.27	0.28*	0.23
	(1.97)	(1.42)	(1.19)	(1.96)	(2.05)	(1.74)
UP	-0.52*	-0.51**	-0.52**	-0.55**	-0.54**	-0.52**
	(-2.56)	(-2.62)	(-2.61)	(-2.66)	(-2.64)	(-2.63)
AL	0	-0.17	0.19	0.01	0.02	-0.27
	(-0.01)	(-0.61)	(0.66)	(0.02)	(0.07)	(-0.97)
0. AI			(Baseline)			
1. AI	-0.09	-0.21	0.06	-0.06	-0.15	-0.27
	(-0.14)	(-0.36)	(0.11)	(-0.09)	(-0.24)	(-0.45)
0. FMD			(Baseline)			
1. FMD	0.41	0.51	-0.71	0.42	0.39	1.06
	(0.40)	(0.52)	(-0.69)	(0.41)	(0.38)	(1.07)
Religion Factor						
Christianity		1.51***				
		(7.28)				
Islam			-3.38***			
			(-4.90)			
Buddhism				3.41		
				(0.92)		
Hinduism					-8.28	
					(-1.80)	
Other						-1.59***
						(-6.58)
_cons	34.08*	-50.00**	93.85***	25.06	40.00*	70.85***
	(2.12)	(-2.59)	(4.70)	(1.33)	(2.44)	(4.29)
N	656	656	656	656	656	656
r2	0.08	0.16	0.12	0.08	0.09	0.14
r2_a	-0.05	0.04	-0.01	-0.05	-0.05	0.02
F	4.53	8.95	6.32	4.22	4.44	8.06

Note: * p<0.05, ** p<0.01, *** p<0.001

4.3. Meat consumption analysis by livestock

Income and social globalization positively affected total meat consumption at all income levels. In addition, it was found that even the same religion showed different results depending on income level.

Total meat consumption is the sum of beef, pork, chicken, mutton and goat, and other meat, while meat prices are also limited to the arithmetic mean of the producer price indices of cattle, pigs, and chickens. Therefore, to examine the factors affecting meat consumption in detail, factors affecting meat consumption by livestock species were analyzed using the consumption of beef, pork, and chicken, which are the most consumed species in the world, as dependent variables. Unlike in the previous analysis, the producer price indices for each type of meat were used as price variables to reflect the price change for each item.

First, the factors affecting beef consumption in Low-Income Countries were analyzed in table 10. An increase in the beef price and the grain price were found to have positive (+) effects on the dependent variable, while an increase in the chicken price and the vegetable price had negative (−) effects on annual beef consumption per capita. The effect of income on beef consumption was not statistically significant.

In some models, an increase in the share of the population living in cities negatively impacted beef consumption. In addition, large-scale animal diseases had a negative impact on beef consumption in Low-Income Countries.

In terms of religion, Christianity was found to be a negative (−) estimated coefficient, while Islam and Buddhism were found to be positive (+) estimated coefficients, having positive effects on beef consumption.

Table 11. Beef consumption analysis in low-income countries

	No religion	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Beef_PPI	0.02***	0.02***	0.02***	0.02***	0.02***	0.02***
	(5.54)	(4.94)	(5.29)	(5.53)	(5.53)	(5.86)
Pork_PPI	0	0	0	0	0	0
	(0.61)	(0.77)	(0.75)	(-0.38)	(0.60)	(0.29)
Chicken_PPI	-0.04***	-0.04***	-0.04***	-0.03***	-0.04***	-0.04***
	(-7.47)	(-7.43)	(-7.59)	(-5.43)	(-7.45)	(-7.09)
Cereal_PPI	0.01***	0.02***	0.02***	0.01**	0.01***	0.01**
	(3.54)	(3.97)	(3.91)	(2.71)	(3.54)	(3.08)
Vegetable_PPI	-0.01*	-0.01*	-0.01*	-0.01*	-0.01*	-0.01*
	(-1.99)	(-2.06)	(-2.26)	(-2.15)	(-1.99)	(-2.23)
GNIPPP1000	0.15	0.19*	0.17	0.06	0.15	0.1
	(1.61)	(2.02)	(1.88)	(0.63)	(1.60)	(1.05)
Social Factor						
LPI	0.17	0.12	-0.02	0.07	0.17	-0.01
	(0.39)	(0.27)	(-0.06)	(0.16)	(0.38)	(-0.02)
KOFSoGI	0.03	0.04	0.02	0.05	0.03	0.02
	(0.92)	(1.00)	(0.54)	(1.34)	(0.90)	(0.54)
FLP	-0.02	0	0.01	-0.02	-0.02	0
	(-0.54)	(-0.11)	(0.27)	(-0.47)	(-0.55)	(-0.01)
UP	-0.08	-0.07	-0.12	-0.08	-0.08	-0.13*
	(-1.32)	(-1.22)	(-1.86)	(-1.33)	(-1.32)	(-2.09)
AL	-0.01	-0.02	0.01	0.03	-0.01	0.04
	(-0.07)	(-0.18)	(0.09)	(0.27)	(-0.06)	(0.32)
0.AI			(Baseline)			
1.AI	-0.41	-0.36	-0.43	-0.35	-0.41	-0.47*
	(-1.70)	(-1.49)	(-1.77)	(-1.50)	(-1.70)	(-1.98)
0.FMD			(Baseline)			
1.FMD	-0.15	-0.18	-0.12	-0.17	-0.15	-0.08
	(-0.74)	(-0.87)	(-0.57)	(-0.87)	(-0.73)	(-0.41)
Religion Factor						
Christianity		-0.51*				
		(-2.46)				
Islam			0.54**			
			(2.78)			
Buddhism				2.14***		
				(6.03)		
Hinduism					-0.11	
					(-0.08)	
Other						-0.67***
						(-3.49)
_cons	10.35**	31.75***	-4.75	-13.13*	10.83	19.95***
	(2.62)	(3.33)	(-0.71)	(-2.43)	(1.52)	(4.19)
N	373	373	373	373	373	373
r2	0.23	0.24	0.25	0.31	0.23	0.26
r2_a	0.1	0.11	0.11	0.19	0.09	0.13
F	7.18	7.21	7.36	10.01	6.65	7.77

Note: * p<0.05, ** p<0.01, *** p<0.001

Table 12 shows the results of an analysis of factors affecting beef consumption in High-Income Countries. Changes in the price of meat and nutritious alternatives did not significantly impact meat consumption. In addition, urbanization and income were negative (−) estimated coefficients in some models.

The bird flu, causing more than 1,000 deaths in single locations, had a negative effect on beef consumption, but foot-and-mouth disease was not found to be a statistically significant estimated coefficient on meat consumption.

Beef consumption declined as the proportion of Muslims, Buddhists, Hindus, and adherents of other religions increased in High-Income Countries. This means that compared to the analysis of Low-Income Countries, the direction of the estimated coefficients for Islam and Buddhism has changed, and a statistically significant estimated coefficient for Hinduism has been derived.

Table 12. Beef consumption analysis in high-income countries

	No religion	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Beef_PPI	0	0	0	0	0	0
	(-0.00)	(-0.14)	(0.18)	(-0.22)	(-0.19)	(-0.33)
Pork_PPI	0	0	0	0	0	0
	(0.39)	(0.36)	(0.52)	(0.51)	(0.66)	(0.16)
Chicken_PPI	0	0	0	0	0	0
	(-0.13)	(0.27)	(-0.18)	(-0.46)	(-0.51)	(0.47)
Cereal_PPI	0	0	0	0	0	0
	(-0.53)	(-1.00)	(-0.61)	(-0.39)	(-0.36)	(-1.00)
Vegetable_PPI	0	0	0	0	0	-0.01
	(-0.76)	(-0.86)	(-0.62)	(-0.47)	(-0.45)	(-1.10)
GNIPPP1000	-0.05*	0.02	-0.04	-0.05*	-0.02	0
	(-2.34)	(0.64)	(-1.47)	(-2.06)	(-0.96)	(0.10)
Social Factor						
LPI	-0.52	-0.22	-0.48	-0.49	-0.41	-0.23
	(-0.83)	(-0.36)	(-0.77)	(-0.79)	(-0.69)	(-0.38)
KOFSoGI	0.16*	0.09	0.15*	0.17**	0.14*	0.09
	(2.58)	(1.49)	(2.49)	(2.73)	(2.35)	(1.44)
FLP	-0.05	-0.08	-0.07	-0.05	-0.04	-0.07
	(-0.94)	(-1.67)	(-1.27)	(-0.92)	(-0.76)	(-1.37)
UP	-0.21**	-0.21**	-0.22**	-0.19*	-0.24**	-0.21**
	(-2.72)	(-2.76)	(-2.77)	(-2.42)	(-3.20)	(-2.72)
AL	-0.06	-0.11	-0.03	-0.07	-0.03	-0.15
	(-0.57)	(-1.08)	(-0.31)	(-0.67)	(-0.30)	(-1.45)
0.AI			(Baseline)			
1.AI	-0.49*	-0.55*	-0.46*	-0.52*	-0.58*	-0.58*
	(-2.09)	(-2.43)	(-1.98)	(-2.21)	(-2.57)	(-2.55)
0.FMD			(Baseline)			
1.FMD	0.06	0.12	-0.13	0.07	0.05	0.34
	(0.15)	(0.30)	(-0.30)	(0.17)	(0.14)	(0.86)
Religion Factor						
Christianity		0.53***				

		(6.82)				
Islam			-0.53*			
			(-2.04)			
Buddhism				-3.53*		
				(-2.55)		
Hinduism					-11.67***	
					(-7.14)	
Other						-0.61***
						(-6.66)
_cons	26.51***	-3.47	34.38***	36.50***	35.72***	41.58***
	(4.04)	(-0.45)	(4.52)	(4.79)	(5.57)	(6.19)
N	627	627	627	627	627	627
r2	0.08	0.15	0.09	0.09	0.16	0.15
r2_a	-0.06	0.03	-0.05	-0.05	0.03	0.02
F	3.6	6.95	3.66	3.85	7.29	6.78

Note: * p<0.05, ** p<0.01, *** p<0.001

Next, the effect on pork consumption by income level in the country was analyzed. The results are shown in Table 13. In all models for Low-Income Countries, a one-unit increase in the beef price led to an increase in pork consumption, indicating that more pork was consumed when the price of beef increased. Pork and chicken price variables were not statistically significant. Social globalization had a positive impact on pork consumption.

However, income and the rate of arable land within the country were found to be negative (−) estimated coefficients regarding pork consumption.

In terms of religion, Islam, in which pork is forbidden, was found to be a negative (−) estimated coefficient, indicating that religious doctrine has an effect.

Table 13. Pork consumption analysis in low-income countries

	No religion	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Beef_PPI	0.01***	0.01***	0.02***	0.01***	0.01***	0.01***
	(4.18)	(4.09)	(4.80)	(4.10)	(4.13)	(4.00)
Pork_PPI	0	0	0	0	0	0
	(-0.30)	(-0.30)	(-0.56)	(-0.55)	(-0.24)	(0.05)
Chicken_PPI	0	0	0	0	0	-0.01
	(-0.66)	(-0.67)	(-0.60)	(-0.12)	(-0.71)	(-1.16)
Cereal_PPI	0.01*	0.01*	0.01	0.01*	0.01*	0.01**
	(2.34)	(2.28)	(1.76)	(2.06)	(2.29)	(2.90)
Vegetable_PPI	-0.01	-0.01	0	-0.01	-0.01	0
	(-1.60)	(-1.59)	(-1.20)	(-1.62)	(-1.47)	(-1.40)
GNIPPP1000	-0.17*	-0.17*	-0.21**	-0.19*	-0.17*	-0.13
	(-2.26)	(-2.24)	(-2.80)	(-2.50)	(-2.25)	(-1.67)
Social Factor						
LPI	-0.35	-0.35	-0.06	-0.37	-0.29	-0.19
	(-0.95)	(-0.95)	(-0.18)	(-1.02)	(-0.80)	(-0.52)
KOFSoGI	0.17***	0.17***	0.19***	0.17***	0.17***	0.18***

	(5.45)	(5.44)	(6.27)	(5.55)	(5.58)	(5.95)
FLP	0.06	0.06	0.01	0.06	0.06	0.04
	(1.67)	(1.63)	(0.24)	(1.70)	(1.76)	(1.10)
UP	0.09	0.09	0.14**	0.09	0.09	0.13**
	(1.77)	(1.76)	(2.79)	(1.79)	(1.85)	(2.62)
AL	-0.17	-0.17	-0.20*	-0.16	-0.19	-0.22*
	(-1.65)	(-1.64)	(-1.99)	(-1.56)	(-1.78)	(-2.10)
0.AI			(Baseline)			
1.AI	-0.26	-0.26	-0.24	-0.25	-0.25	-0.21
	(-1.29)	(-1.29)	(-1.24)	(-1.22)	(-1.26)	(-1.04)
0.FMD			(Baseline)			
1.FMD	0.1	0.1	0.04	0.09	0.09	0.03
	(0.56)	(0.56)	(0.26)	(0.54)	(0.50)	(0.20)
Religion Factor						
Christianity		0.01				
		(0.07)				
Islam			-0.78***			
			(-4.96)			
Buddhism				0.47		
				(1.52)		
Hinduism					1.36	
					(1.26)	
Other						0.61***
						(3.81)
_cons	-6.84*	-7.35	15.02**	-12.02*	-13.05*	-15.53***
	(-2.08)	(-0.92)	(2.76)	(-2.54)	(-2.21)	(-3.93)
N	373	373	373	373	373	373
r2	0.24	0.24	0.3	0.25	0.25	0.28
r2_a	0.11	0.11	0.18	0.12	0.12	0.15
F	7.84	7.26	9.58	7.48	7.41	8.63

Note: * p<0.05, ** p<0.01, *** p<0.001

Table 14 shows the factors affecting pork consumption in High-Income Countries. An increase in beef price contributed to an increase in pork consumption. When the price of chicken increased, the price of pork decreased.

Social globalization and women's labor participation were found to be positive (+) estimated coefficients. On the other hand, urbanization and an increase in the ratio of arable land showed a negative (−) effect on pork consumption. As for religion, all models showed statistical significance in different directions.

Table 14. Pork consumption analysis in high-income countries

	No religion	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Beef_PPI	0.03***	0.03***	0.04***	0.04***	0.03***	0.03***
	(3.71)	(3.70)	(4.46)	(4.10)	(3.80)	(3.55)
Pork_PPI	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(-1.04)	(-1.10)	(-0.62)	(-1.25)	(-1.13)	(-1.22)
Chicken_PPI	-0.03**	-0.02**	-0.03***	-0.02*	-0.02**	-0.02**
	(-3.06)	(-2.80)	(-3.35)	(-2.56)	(-2.94)	(-2.69)
Cereal_PPI	0.01	0.01	0.01	0.01	0.01	0.01

	(1.48)	(1.14)	(1.25)	(1.28)	(1.41)	(1.19)
Vegetable_PPI	0.01	0.01	0.01	0	0.01	0.01
	(0.97)	(0.94)	(1.47)	(0.53)	(0.86)	(0.77)
GNIPPP1000	0	0.09*	0.09*	-0.02	-0.02	0.06
	(-0.03)	(2.36)	(2.45)	(-0.48)	(-0.54)	(1.61)
Social Factor						
LPI	-0.91	-0.52	-0.71	-0.97	-0.96	-0.6
	(-0.97)	(-0.57)	(-0.80)	(-1.06)	(-1.04)	(-0.65)
KOFSoGI	0.31***	0.22*	0.28**	0.29**	0.32***	0.23*
	(3.40)	(2.48)	(3.19)	(3.23)	(3.54)	(2.57)
FLP	0.27***	0.23**	0.18*	0.27***	0.27***	0.25**
	(3.49)	(2.99)	(2.41)	(3.50)	(3.42)	(3.27)
UP	-0.38**	-0.37**	-0.39***	-0.43***	-0.36**	-0.37**
	(-3.24)	(-3.28)	(-3.52)	(-3.74)	(-3.13)	(-3.23)
AL	-0.41*	-0.47**	-0.27	-0.39*	-0.43**	-0.51**
	(-2.54)	(-3.02)	(-1.73)	(-2.43)	(-2.66)	(-3.16)
0.AI			(Baseline)			
1.AI	0.51	0.43	0.63	0.57	0.55	0.41
	(1.45)	(1.27)	(1.87)	(1.65)	(1.59)	(1.21)
0.FMD			(Baseline)			
1.FMD	0.24	0.31	-0.68	0.22	0.25	0.53
	(0.40)	(0.52)	(-1.15)	(0.38)	(0.41)	(0.89)
Religion Factor						
Christianity		0.67***				
		(5.72)				
Islam			-2.60***			
			(-6.94)			
Buddhism				8.23***		
				(4.04)		
Hinduism					6.42*	
					(2.54)	
Other						-0.63***
						(-4.60)
_cons	21.50*	-16.32	59.88***	-1.81	16.42	37.30***
	(2.20)	(-1.41)	(5.51)	(-0.16)	(1.66)	(3.66)
N	627	627	627	627	627	627
r2	0.11	0.16	0.18	0.13	0.12	0.14
r2_a	-0.02	0.03	0.06	0	-0.01	0.01
F	4.98	7.23	8.47	5.92	5.13	6.31

Note: * p<0.05, ** p<0.01, *** p<0.001

Finally, the global consumption of chicken is increasing at the fastest rate because there are no restrictions on the consumption of chicken despite some guidelines over slaughtering methods. Table 15 shows the results of an analysis of the factors affecting the consumption of chicken, which is not forbidden by any religion.

Chicken consumption tended to increase as the producer price index of beef and pork increased. Grain price was also a positive (+) estimated coefficient. Social globalization and the proportion of the urbanized population positively affected chicken consumption. Regarding religion, Islam was found to be a negative (−) estimated coefficient. On the other hand, other religions were found to be positive (+) estimated coefficients.

Table 15. Chicken consumption analysis in low-income countries

	No religion	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Beef_PPI	0.01*	0.01*	0.02**	0.01*	0.01*	0.01*
	(2.32)	(2.03)	(2.79)	(2.32)	(2.30)	(2.05)
Pork_PPI	0.01*	0.01*	0.01	0.01*	0.01*	0.01*
	(2.00)	(2.07)	(1.84)	(1.97)	(2.02)	(2.57)
Chicken_PPI	0	0	0	0	0	-0.01
	(-0.60)	(-0.55)	(-0.54)	(-0.57)	(-0.61)	(-1.30)
Cereal_PPI	0.01	0.01	0	0.01	0.01	0.01*
	(1.27)	(1.46)	(0.74)	(1.26)	(1.25)	(2.06)
Vegetable_PPI	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(-1.82)	(-1.85)	(-1.47)	(-1.82)	(-1.76)	(-1.58)
GNIPPP1000	-0.1	-0.07	-0.15	-0.1	-0.1	0.01
	(-0.75)	(-0.54)	(-1.16)	(-0.74)	(-0.75)	(0.09)
Social Factor						
LPI	-0.11	-0.14	0.31	-0.11	-0.07	0.27
	(-0.17)	(-0.23)	(0.50)	(-0.17)	(-0.11)	(0.45)
KOFSoGI	0.16**	0.16**	0.19***	0.16**	0.16**	0.19***
	(3.02)	(3.05)	(3.64)	(3.00)	(3.05)	(3.72)
FLP	-0.02	0	-0.09	-0.02	-0.01	-0.06
	(-0.28)	(-0.08)	(-1.48)	(-0.28)	(-0.24)	(-1.11)
UP	0.31***	0.31***	0.38***	0.31***	0.31***	0.41***
	(3.53)	(3.58)	(4.39)	(3.52)	(3.55)	(4.79)
AL	-0.21	-0.22	-0.25	-0.21	-0.22	-0.31
	(-1.16)	(-1.21)	(-1.43)	(-1.16)	(-1.20)	(-1.81)
0.AI			(Baseline)			
1.AI	-0.58	-0.54	-0.55	-0.58	-0.57	-0.45
	(-1.68)	(-1.58)	(-1.64)	(-1.68)	(-1.67)	(-1.37)
0.FMD			(Baseline)			
1.FMD	0.51	0.49	0.43	0.51	0.5	0.36
	(1.74)	(1.67)	(1.51)	(1.73)	(1.71)	(1.28)
Religion Factor						
Christianity		-0.34				
		(-1.15)				
Islam			-1.14***			

			(-4.22)			
Buddhism				-0.02		
				(-0.03)		
Hinduism					0.92	
					-0.5	
Other						1.43***
						(5.36)
_cons	-7.84	6.33	24.02*	-7.67	-12.06	-28.16***
	(-1.41)	(0.47)	(2.58)	(-0.95)	(-1.20)	(-4.29)
N	373	373	373	373	373	373
r2	0.22	0.22	0.26	0.22	0.22	0.28
r2_a	0.09	0.09	0.13	0.08	0.08	0.16
F	6.86	6.47	7.98	6.35	6.38	8.98

Note: * p<0.05, ** p<0.01, *** p<0.001

Finally, Table 15 shows the results of an analysis of the factors affecting chicken consumption in High-Income Countries. Beef price, income, and social globalization had positive effects, whereas pork price was found to be a negative (−) estimated coefficient, and religion did not have a statistically significant effect in all models.

Table 16. Chicken consumption analysis in high-income countries

	No religion	Christianity	Islam	Buddhism	Hinduism	Other
Economic factor						
Beef_PPI	0.03***	0.03***	0.03***	0.03***	0.03***	0.03***
	(3.48)	(3.48)	(3.47)	(3.54)	(3.52)	(3.46)
Pork_PPI	-0.02*	-0.02*	-0.02*	-0.02*	-0.02*	-0.02*
	(-2.14)	(-2.14)	(-2.13)	(-2.18)	(-2.19)	(-2.15)
Chicken_PPI	0.01	0.01	0.01	0.01	0.01	0.01
	(0.83)	(0.84)	(0.83)	(0.93)	(0.89)	(0.85)
Cereal_PPI	0.01	0.01	0.01	0.01	0.01	0.01
	(1.46)	(1.45)	(1.45)	(1.41)	(1.43)	(1.44)
Vegetable_PPI	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(-0.84)	(-0.84)	(-0.83)	(-0.93)	(-0.90)	(-0.85)
GNIPPP1000	0.15***	0.15***	0.15***	0.15***	0.14***	0.16***
	(4.57)	(4.21)	(4.30)	(4.45)	(4.23)	(4.36)
Social Factor						
LPI	0.86	0.87	0.86	0.84	0.83	0.87
	(0.95)	(0.96)	(0.95)	(0.93)	(0.92)	(0.96)
KOFSoGI	0.38***	0.38***	0.38***	0.37***	0.38***	0.37***
	(4.34)	(4.25)	(4.33)	(4.29)	(4.40)	(4.22)
FLP	0.14	0.14	0.14	0.14	0.14	0.14
	(1.91)	(1.88)	(1.87)	(1.90)	(1.87)	(1.89)
UP	-0.03	-0.03	-0.03	-0.04	-0.03	-0.03
	(-0.29)	(-0.29)	(-0.29)	(-0.38)	(-0.22)	(-0.28)
AL	0.18	0.18	0.18	0.19	0.17	0.18
	(1.17)	(1.16)	(1.17)	(1.20)	(1.12)	(1.13)
0.AI	(Baseline)					
1.AI	0.15	0.14	0.15	0.16	0.17	0.14
	(0.43)	(0.43)	(0.44)	(0.47)	(0.50)	(0.42)
0.FMD	(Baseline)					
1.FMD	0.22	0.22	0.21	0.22	0.22	0.24
	(0.38)	(0.38)	(0.35)	(0.37)	(0.38)	(0.40)
Religion Factor						

Christianity		0.02				
		-0.14				
Islam			-0.03			
			(-0.08)			
Buddhism				1.68		
				-0.84		
Hinduism					3.08	
					-1.26	
Other						-0.03
						(-0.25)
_cons	-20.90*	-21.84	-20.45	-25.65*	-23.33*	-20.07*
	(-2.22)	(-1.90)	(-1.87)	(-2.33)	(-2.43)	(-2.00)
N	627	627	627	627	627	627
r2	0.22	0.22	0.22	0.23	0.23	0.22
r2_a	0.11	0.11	0.11	0.11	0.11	0.11
F	12.14	11.25	11.25	11.32	11.4	11.26

Note: * p<0.05, ** p<0.01, *** p<0.001

5. Discussion

This paper empirically investigates key factors that influence meat consumption by the types of livestock and by nations. Specifically, in this study, the religion which has incessantly influenced human behavior, is included as a key variable, and the effect of income level is also elucidated.

The research model selects the total meat consumption and the meat consumption by the livestock types as dependent variables, while independent variables are classified as economic, social, and cultural factors based on previous research. Additionally, religion is conjugated as a variable that represents cultural aspects. Herein, a one-way error component fixed effect model is selected to analyze a panel constructed by international statistical data from 2010 to 2019 from 106 countries.

Regarding the analysis of the total meat consumption by countries in all income levels, it has been revealed that price and income have a positive correlation coefficient. Economic factors significantly affect low-income countries, whereas social factors affect high-income countries. It was shown that religion influences meat consumption throughout this research. For instance, Christianity and Buddhism positively impact total meat consumption, while Islam has negative impacts. Total meat consumption is negatively affected since eating pork is forbidden by Islam. Consequently, it can be seen that the effect on meat consumption can vary depending on the type of religion. Therefore, an alternative hypothesis to Hypothesis 1 is adopted.

In the intervening period, it is notable that the effect of religion on meat consumption by livestock types differs in the same income group. For instance, in low-income countries, Islam's beef consumption is enhanced whereas chicken consumption is reduced. Similarly, for high-income countries, the correlation coefficient for beef and chicken consumption was shown to have different directions

in Buddhism and Hinduism. In this regard, Hypothesis 2 is adopted given that religion affects meat consumption by livestock types while having the coefficients with opposite trends.

As a result, the impact of religion on meat consumption can differ based on income, even within the same type of meat. For example, Christianity has differing effects on total meat and beef consumption in low and high-income countries, with a positive impact on all types of meat consumption in high-income countries and a negative impact in low-income countries. Similarly, the influence of Islam and Buddhism on beef consumption also varies by income. However, only a part of Hypothesis 3 is adopted, as the analysis finds no significant difference and yields the same results regardless of income level.

The significance of this study lies in several aspects. Firstly, it is widely recognized that certain religions can limit the consumption of a specific type of livestock due to their doctrine or tradition. For example, this study provides empirical evidence that Islam negatively impacts pork consumption. However, it should be noted that religion affects not just the consumption of a single type of meat but also the total meat consumption.

Additionally, this study has revealed that the variable of social globalization is significant in most of the analysis results, apart from religion. As globalization advances, meat consumption is expected to rise, with the "Western diet," which typically contains high quantities of meat, becoming more widespread. This also implies an increase in the demand for forage crops to support growing meat consumption. Consequently, this study indirectly highlights the need to enhance food security, which has become a global concern.

6. Conclusion

While various economic, social, and cultural factors affect meat consumption, Religion has been found to impact meat consumption among cultural factors. It affects not only specific meats but also total meat consumption, and the influence varies depending on each country's religion and income level. The results of this research have the following implications.

This study confirmed that religion impacts not only the consumption of certain meat, but also the overall meat consumption, which can affect an individual's nutrition and dietary balance. To address these constraints, alternative meat options should be made available. To do this, it is crucial to increase the supply of meat from different livestock species through the development of the livestock industry.

The impact of religion on meat consumption varies based on each country's income level. In high-income countries, Christianity has a positive impact on total meat consumption, while it has a negative impact in low-income countries.

Due to relatively high cost of beef compare to other meats, consumer in low-income countries may face low accessibility to beef. To address this issue and increase meat supply, measures such as small-scale poultry farming, which allow farmers to raise the meat and consume it themselves while also making income from sales, are being promoted as ODA projects in developing countries.

The difference in religion's influence on meat consumption by country and livestock species is believed to be related to residents' meat preferences. Thus, the distribution of alternative livestock species and industrial development may not be uniform. It is necessary to consider residents' meat preferences and eating habits when developing alternative foods, such as fish and vegetable protein, to replace meat and mitigate the negative impact of religion on meat consumption.

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Abstract in Korean

경제 발전과 식생활 변화로 인류의 육류 소비량은 지속적으로 증가하였다. 또한, 소비자의 소득수준 향상과 함께 육류에 대한 수요도 일반적으로 증가하는 경향을 보인다. 최근에는 축산업의 환경과 건강에 대한 부정적인 영향으로 비판적인 여론도 적지 않다. 그럼에도 불구하고 육류는 단백질 공급원으로 여전히 중요한 역할을 하고 있고, 농촌에서는 축산업이 매우 중요한 소득원 역할을 하고 있다. 특히, 개발도상국에서는 주민의 균형적인 영향 섭취와 빈곤 퇴치를 위한 축산업의 잠재력은 매우 크다.

육류 소비는 다양한 요인의 영향을 받는다. 이미 많은 선행연구에서 경제적, 사회적 요인을 중심으로 육류 소비의 요인분석을 실시하였다. 본 연구에서는 상대적으로 덜 주목받았던 문화적 요인의 육류 소비에 미친 영향을 분석하였다. 특히, 대표적인 문화적 요인인 종교가 육류의 소비에 미치는 영향을 소득수준별, 축종별로 나누어 분석하였다. 2010~2019 년의 106 개국 패널자료를 구축하고 일원 오차 성분모형을 적용하여 분석하였다. 종속변수로는 1 인당 연간 총 육류 소비량과 축종별 육류 소비량을 사용하였고, 국가 내 종교를 5 개 그룹으로 분류하여 연도별 비율을 종교변수로 이용하였다.

전체 국가의 총 육류 소비량에 영향을 미치는 요인을 분석한 결과, 가격과 소득은 육류 소비량에 긍정적인 영향을 미쳤다. 국가의 소득그룹별로 다소 상이한 결과가 도출되었다. 저소득 국가에서는 유의미한 경제적 요인 변수가 많았고, 고소득 국가에서는 유의미한 사회적 변수가 많았다. 기독교와 불교는 총 육류 소비와 정(+)의 상관관계를 갖고, 이슬람교는 부(-)의 상관관계를 갖는 것으로 나타났다.

동일한 소득그룹별로 분석한 결과, 종교가 축종별 육류 소비량에 미치는 영향은 다른 양상을 보였다. 예를 들어, 저소득 국가그룹에서 이슬람교는 소고기 소비와 정(+)의 상관관계를 갖고, 닭고기 소비와는 부(-)의 상관관계를 갖는다. 고소득 국가그룹에서는 불교와 힌두교는 소고기와 돼지고기 소비와 각기 정반대의 상관관계를 갖는 것으로 나타났다.

동일한 축종을 대상으로 분석한 결과, 국가 소득수준에 따라 종교가 육류에 상이한 영향을 미쳤다. 기독교는 고소득 국가의 총 육류 소비와 정(+)의 상관관계를 가졌고, 저소득 국가는 부(-)의 상관관계를 갖는다.

본 연구는 종교가 육류 소비량에 미치는 영향이 축종별, 소득수준별로 상이하며 총 육류 섭취에도 영향을 미친다는 사실을 실증적으로 검증했다는 것에 그 의의가 있다. 일반적으로 일부 종교가 특정 육류의 섭취를 제한한다는 사실은 널리 알려졌지만, 이를 포함한 총 육류 섭취에도 영향을 미쳐 균형 있는 식습관과 영양 섭취를 저해하는 것으로 나타났다. 따라서 육류 소비에 있어 종교의 제약을 극복하기 위해 대체 축종을 보급하고 생산성과 수익을 늘리는 방안을 모색해야 한다. 더 나아가 개발도상국에서 육류 소비에 있어 종교의 부정적인 영향을 완화하고 균형적인 영양 섭취를 위해 기타 단백질 공급원을 개발하여 보급할 필요가 있다. 이는 국가 차원의 식량안보 강화 및 국제사회의 지속가능발전목표(SDGs) 달성에도 도움이 된다.

주요어: 육류 소비, 종교, 영향요인, 소득 수준, 일원 오차 성분 모형, 고정 효과 모형

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