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Original Research Article

Empirical Analysis on Import Diversification of Major Livestock Commodities in Malaysia

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Abstract: The long-standing underperforming self-sufficiency status of major ruminant commodities in Malaysia signifies that the livestock sub-sector is confronting crucial import dependency status, particularly beef and mutton. Self-sufficiency has indicated stagnating and deteriorating trends stemming from a massive gap between domestic production and the demand for meat products. Various efforts and strategies are implemented to expand local beef and mutton production, yet the performance remains insignificant. This crucial situation further urges the government to regulate import quotas for the two main meat commodities, aiming to provide a meat supply based on current needs at the industry or consumer level and further facilitate market equilibrium for meat products. Nevertheless, the import tendency has concentrated on a few dominant global markets. Previous studies suggested that trade diversification is crucial for creating a more sustainable economy and food security. Therefore, this study identifies the status of trade diversification of primary livestock commodities and measures the association between trade diversification and economic performance in Malaysia. Time series databases (2000–2020) were utilized and analyzed using quantitative methods to estimate the import diversification index (ID) using the Herfindahl-Hirschman Index (HHI), which is further used as an endogenous variable to develop the import diversification empirical model, while the exogenous variables include gross domestic product per capita, food security, and total factor productivity. The Import Diversification Index confirms that the beef import market demonstrates a low diversified or highly concentrated market, whereas mutton showed more diversified import markets. The results showed that national gross per capita income and food security status are the two variables that significantly influence the country's concentrated import markets for beef and mutton import diversification status. This study also found that per capita national income, self-sufficiency, and total factor productivity significantly affect the degree of trade diversification for beef and mutton imports in Malaysia. Despite being massively dependent on meat (beef and mutton) imports, none of the specific studies has attempted to measure the trade diversification circumstance in Malaysia. The findings of this study help strategize the

diversification of import markets, particularly for primary ruminant livestock commodities, in line with Malaysia's national food security direction and policy agenda.

Keywords: Trade diversification; beef; mutton; food security, Malaysia

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1. Introduction

The national ruminant industry in Malaysia remains far behind compared to other livestock industries, with long-standing underperforming self-sufficiency status of ruminant commodities in Malaysia that signifies livestock confronting crucial import dependency status while causing domestic supply distortion to continue depending on import supplies to satisfy the growing demand over the years, particularly beef and mutton. Self-sufficiency has indicated stagnating and deteriorating trends stemming from a massive gap between domestic production and the demand for meat products. For many years, beef and mutton's self-sufficiency ratio (SSR) has been reflected in domestic production's static and even deteriorated performance. Both SSR of beef and mutton recorded a relatively low with an average of 25% and 12%, respectively, from 2010 to 2020 (Figure 1), which implied that the import dependency ratio (IDR) for beef was 75% and mutton 88% during the same period (Ministry of Agriculture and Food Security, Malaysia, 2020).

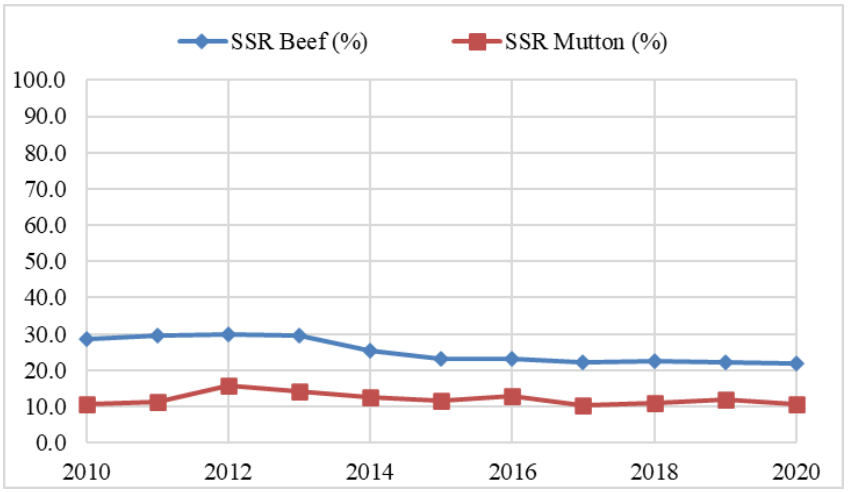
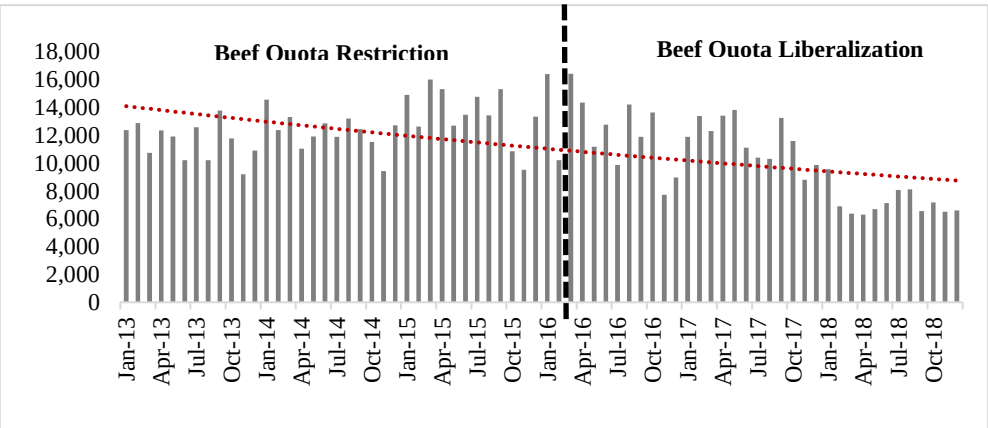


Figure 1. Self-Sufficiency Ratio (SSR) of Beef and Mutton in Malaysia, 2010–2020. (Source: Agro-Food Statistics, MAFS [2021])

Various efforts and strategies are implemented to expand local beef and mutton production, yet the performance remains insignificant. The most recent policy agenda involved the revision of the existing import quotas for livestock commodities to promote supply while protecting against domestic shortages. This crucial situation has urged the government to remove import quota restrictions by implementing trade liberalization starting in 2016 for major agro-food commodities, including beef and mutton. The main objective of liberalization is to increase the meat supply to serve both food processing industries and individual consumers sufficiently. Subsequently, the market is expected to reach an equilibrium, thus stabilizing the market prices. During the first three years (from 2016 to 2018) of the liberalization, imports of beef and mutton did not increase. Instead, the import volume declined after a few years of liberalization (Figure 2), mainly due to trade restrictions imposed by the dominant exporting countries, India and Australia (Roslina *et al.*, 2021). This similar study found that removing trade restrictions does not guarantee an increasing supply within the short term with other market forces and trade restrictions imposed by major exporting countries — India and Australia. India banned beef imports due to shrinkage in domestic production resulting from livestock outbreaks. At the same time, Australia has enforced the ESCAS — Exporter Supply Chain Assurance System Audit Guidance policy since 2015 by restricting livestock commodity exports concerning animal welfare. As Malaysia mainly depends on beef and mutton imports with a high concentration in Australia and India, the primary meat supply is distorted, becoming 'fragile' and hence insecure. Bista (2019) found that the impacts of import diversification and economic growth tend to be higher in developing countries.



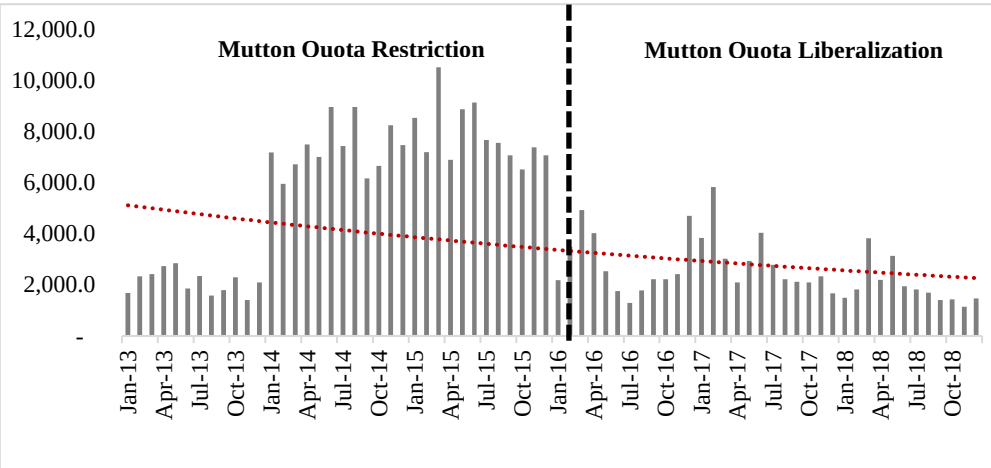


Figure 2. Import trends of beef and mutton during quota restrictions and liberalization, Jan. 2013 – Dis. 2018
Source: Department of Veterinary Service, Malaysia (2018)

Currently, Malaysia mainly depends on beef and mutton from Australia, which is dominated by 90% (beef) and 93% (mutton) in 2020, while the remaining supply markets include New Zealand, India and the United States. The recent data revealed a more diversified market from new importing countries for beef and mutton, albeit with very marginal shares (Table 1).

Table 1. Import shares of Beef and Mutton in Malaysia, 2017–2020

	Beef (%)					**Mutton (%)**			
	2017	**2018**	**2019**	**2020**		**2017**	**2018**	**2019**	**2020**
Australia	93.5	91.3	84.3	90.0	**Australia**	86.7	88.1	89.1	93.1
New Zealand	2.8	3.7	5.3	1.6	**New Zealand**	13.3	11.1	10.7	6.9
India	1.6	0.4	3.3	1.4	**India**	-	0.8	0.09	-
USA	0.5	2.6	3.2	0.9	**United Kingdom**	-	-	0.01	
Pakistan	1.5	-	-	-	**Germany**	-	-	-	0.01
Japan	-	2.0	2.1	5.4					
China	-	-	-	0.6					

Source: Authors' calculation using UN COMTRADE databases (2021)

Subsequently, this study aims to identify and measure the magnitude of import diversification by focusing on beef and mutton as protein source substitutes for this region and to evaluate the relationships between market diversification, economic indicators and food security. Time series databases were utilized and analyzed using quantitative methods to estimate the import diversification index (ID) using the Herfindahl-Hirschman Index

(HHI), which is further used as an endogenous variable for the import diversification empirical model with the exogenous variables as gross domestic product per capita, food security, and total factor productivity. Economic growth and national income are widely used to measure the degree of trade diversification (Vivoda & Manicom, 2011; Vivoda, 2009; World Bank, 2021). The ID index confirms that the beef import market demonstrates low diversification or a highly concentrated market, while mutton showed more diversified import markets. The empirical model projects that national gross per capita income and food security status are the two variables significantly influencing the country's concentrated import markets for beef and mutton import diversification status. This study indicates that per capita national income, self-sufficiency, and total factor productivity significantly affect the degree of trade diversification for beef and mutton imports in Malaysia. These findings help strategize the diversification of import markets, particularly for primary ruminant livestock commodities. In line with the National Food Security Policy Action Plan (DSMN, 2021–2025) to diversify the imported food supply in addressing the policy that has outlined strategies and initiatives to ensure consistent food supply while preparing for any unpredicted food crises (MAFS, 2021), this study is expected to draw policy strategies on primary livestock commodities in light of trade diversification.

2. Literature Review

The empirical literature on trade diversification has widely concentrated on export diversification. At the same time, imports gained lesser attention than the former, focusing on the impacts, linkages and drivers of the diversification comprising the size of the economy (proxy by total population), market access (proxy by preferential trade agreement), human capital, transportation and infrastructure quality, productivity, self-sufficiency, gross domestic product (GDP), and food security to the country economy (Amurgo-Pacheco & Pierola, 2008; Cadot *et al.*, 2011; Dutt *et al.*, 2009; Klinger & Lederman, 2006; Parteka & Tamberi, 2008). Most studies postulated positive impacts of trade diversification. Krugman (1979) and Grossman and Helpman (1991) have argued and explained that a wide range of imported commodities contributed to additional gains from trade for both firms and consumers. Specific studies on linkages between import diversification and economic indicators revealed the positive impacts on the economic parameters worldwide. Table 2 displays how trade diversification reflects economic growth, improves food security, and encourages productivity, especially those commodities with marginal self-sufficiency levels. In contrast, a highly concentrated market in a trade structure could negatively affect food security while stimulating uncompetitive markets globally.

Table 2. Impacts of trade Diversification on economic and political indicators

Impacts	Major Findings	Source
Economic Growth	Diversification in products and destinations positively impacts trade growth, but diversification of destinations has a more substantial effect.	Campi *et al.* (2021)

Impacts	Major Findings	Source
	Studies predict a monotonic trend between income and diversification and suggest a higher country economy (per capita income) leads to a more diversified import market of a particular commodity.	Jaimovich (2012); Jean and Wacziarg (2003)
	Diversification revealed significant impacts on economic growth, yet some evidence that the degree of concentration declines with development at early stages, and increases.	Hausmann *et al.* (2005); Koren and Tenreyro (2007)
Food Security	Countries with low self-sufficiency rates (SSR) but imposing trade openness could increase food security through diversification.	Hubbard and Hubbard (2013)
	Import diversification is predicted to have some positive impacts on sustainable domestic supply.	Defra *et al.* (2006)
Productivity	Imported sources could influence productivity due to imperfect substitution between imported and domestic inputs.	Halpern *et al.* (2015)
	Imported and cost-effective input sources could increase productivity through supply diversification.	Amiti and Konings (2007)

3. Materials and Method

A quantitative approach using secondary data has been used. At the same time, the leading indicators for import diversification are total factor productivity (TFP), capital stock, exchange rates and trade performance (Mejia *et al.*, 2016).

3.1. Data Calibration

This study utilizes a time series of secondary databases from multiple sources and is analyzed quantitatively. The main parameters include total factor productivity (TFP), capital stocks, currency exchange and trade performance (Mejia *et al.*, 2016). The central databases consist of both international and domestic databases, mainly the Global Food Security Index (GFSI), the Food and Agricultural Organization (FAO), the national livestock statistics (retrieved from the Department of Veterinary Services, Malaysia (DVS), and the TFP (livestock) derived from the Agricultural Science and Technology Indicators (ASTI). The time-series data from 2000 to 2020 involving trade, domestic production, and market prices referring to the 6-digit HS-Code for beef and mutton. Prior to analysis, diagnostic tests were applied to validate the data. The primary tests included stationary, multicollinearity, autocorrelation, and heteroscedasticity. Further, the data was analyzed using the Least Square Estimation Method (OLS) for each beef and mutton commodities empirical model.

3.2. Modelling Framework

This study applied multivariate regression analysis to estimate the association between import diversification, food security and economic growth. Several approaches have been used to measure import diversification, including the Gini, Herfindahl-Hirschman Index (HHI) and Theil indices (citation); however, the HHI method was chosen because it measures

a wide variety of imports while not only focusing on new import lines (Mejia *et al.*, 2016; Cadot *et al.*, 2011). The HHI can be estimated as follows:

$$HHI = \frac{\sum_{i=1}^{n}(S_i)^2 - \frac{1}{n}}{1 - \frac{1}{n}}; \qquad where: S_i = \frac{x_i}{\sum_{i=1}^{n} x_i} \tag{1}$$

Si is the share of imports for commodity i, Xi is the total amount of imports for i, and n is the number of imports (from all destination sources). This index is evaluated between zero (0) and one (1). A value close to one represents a high concentration level or a low level of diversification; conversely, a value close to zero indicates a high level of diversification.

Before analyzing, we identify the associations between endogenous, import diversification indexes, and exogenous variables — Per capita Gross Domestic Product (GDPpc), Total Factor Productivity (TFP), and self-sufficiency level (SSL) for beef and mutton. As displayed in Figure 3, the import diversification of beef commodities is constantly high as the index of HHI is approaching one (1) over the years

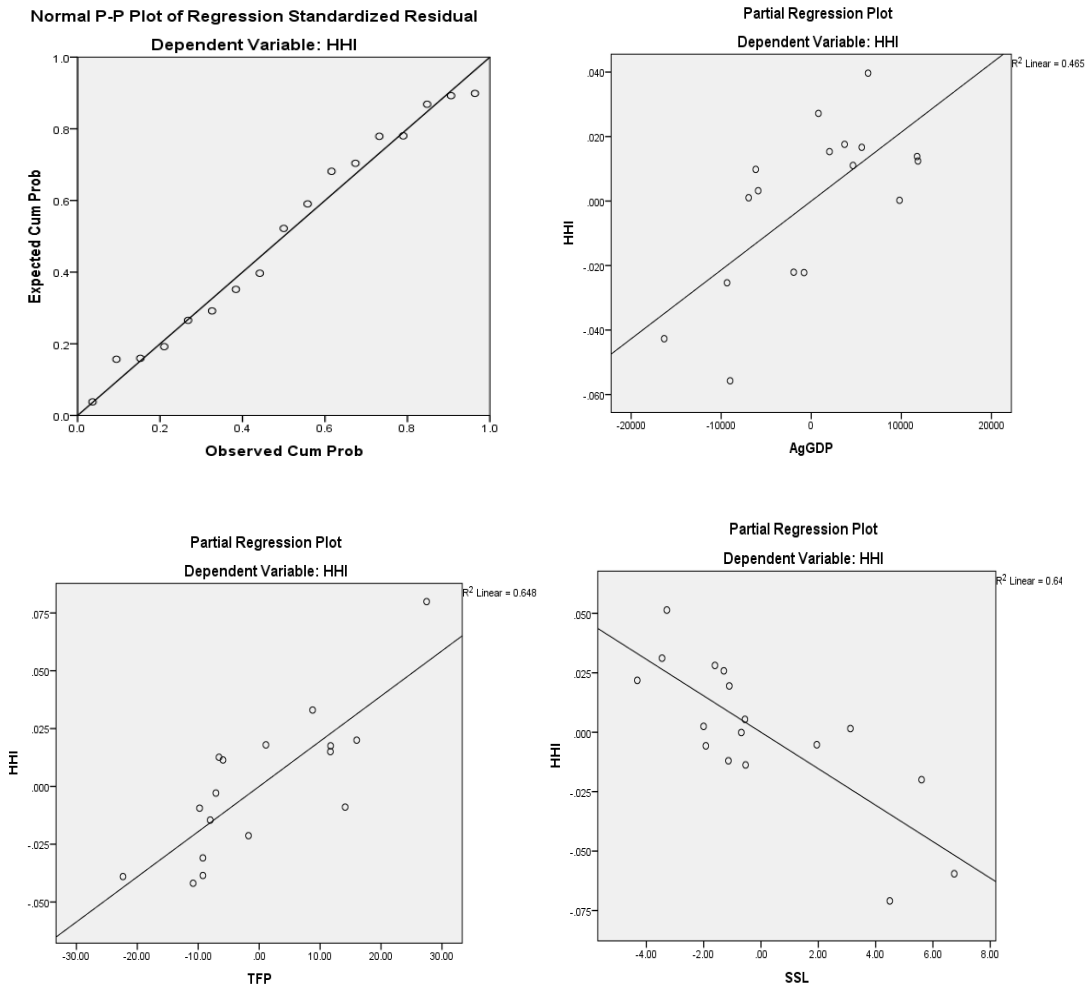


Figure 3. Import diversification of beef commodities in Malaysia

For regression analysis, Mejia *et al.* (2016) stated that no specific model can explain the diversification of imports. Nevertheless, this study using the model from Mityakov *et al*. (2013) and Jaimovich (2012) found that the level of import diversification is related to the national Gross Domestic Product (GDP). The model can be expressed as follows:

$$ID_{it} = \alpha + F(GDPpc_{it}) + \varepsilon_{it} \quad (2)$$

IDit is the import diversification index for country i in year t, and *GDPpcit* is the Gross Domestic Product Per Capita of country i in year t. The expected relationship between the import diversification index and GDP Per Capita is negative, which means the higher the country's GDP Per Capita, the higher the level of import diversification. The selection of exogenous variables based on past studies, which consist of self-sufficiency rate, a proxy of food security status (*FSec*) and total factor productivity (*TFPt*) of the livestock sector in the model (3) as follows:

$$ID_{it} = \alpha ID_{it-1} + \beta GDPpc_{it} + \gamma FSec_{it} + \delta TFPt_{it} + \varepsilon_{it} \quad (3)$$

4. Result and Discussion

4.1. Import Diversification Index (IDI)

IDI measures the degree of diversification of beef and mutton imports in Malaysia. An index value of 0.8, close to one (1), describes a less diversified market, while a value close to zero (0) indicates a more diversified market. The HHI confirmed that beef showed low diversification, indicating highly concentrated markets. Conversely, Mutton denotes a higher degree of diversification with index values of 0.6 (2020), implying a more fragmented import market (Figure 4).

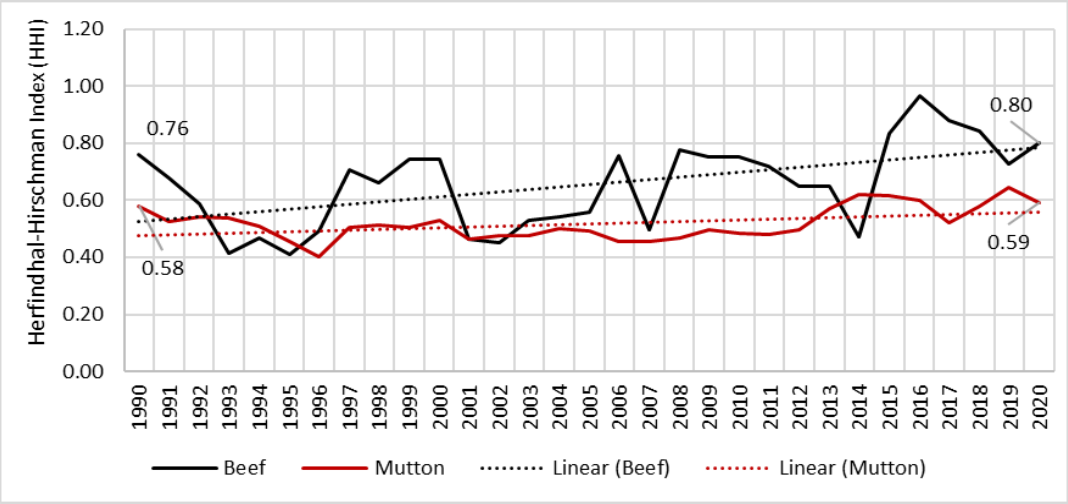


Figure 4. Import diversification index for beef and mutton in Malaysia, 1990–2020. (Source: Authors calculation using *UN Comtrade* (2022) databases; *HS0201-Meat of bovine animals; fresh or chilled dan HS0204: Meat of sheep or goat; fresh, chilled or frozen*)

Further, a multivariate regression analysis was applied to predict the association between the degree of diversification and the country's economy. Before the analysis, diagnostic tests were carried out to confirm data reliability using the necessary tests, including unit root, multicollinearity, autocorrelation and heteroscedasticity.

4.2. Unit Root Test

Test τ (Tau) Augmented Dicky-Fuller (ADF) was used to test the hypothesis:

H_0: δ=0 (Non-stationary)

H_1: δ<0 (Stationary)

All negative and significant coefficient values at the 'first difference' validate the null hypothesis of the rejected unit root. Therefore, all variables are stationary (Table 3).

Table 3. Results of *Unit root test (Augmented Dickey-Fuller*)

	Beef				**Mutton**			
	Levels		*First differences*		*Levels*		*First differences*	
Variable	*Constant*	*Constant with trend*	*Constant*	*Constant with trend*	*Constant*	*Constant with trend*	*Constant*	*Constant with trend*
	-2.92*	-3.62**	-6.31***	-6.19***	-1.28	-2.71	-4.19***	-4.06**
IDI	(.06)	(.05)	(.00)	(.00)	(.62)	(.24)	(.00)	(.03)
	-1.31	-1.14	-3.85***	-4.00**	-1.31	-1.14	-3.85***	-4.00**
GDPpc	(.60)	(.90)	(.00)	(.03)	(.60)	(.89)	(.01)	(.03)
	-2.05	-3.26	-5.26***	-7.06***	-3.37**	-3.21	-5.75***	-5.79***
FSec	(0.26)	(0.11)	(.00)	(0.00)	(0.03)	(0.11)	(0.00)	(0.00)
	-1.17	-1.86	-4.50***	-4.53***	-1.17	-1.86	-4.50***	-4.53***
TFP	(0.67)	(0.64)	(.00)	(0.01)	(0.67)	(0.64)	(0.00)	(0.01)

Note: ***, **, * denote the statistical sig. At the 1%, 5% and 10% levels, respectively. The numbers in parentheses indicate the p-values

Variance inflation factor (VIF) analysis is used to detect multicollinearity of the regression model in both the correlation and magnitude between indigenous variables. A VIF value of less than 10 (VIF<10) confirmed the existing multicollinearity issue in the model (Table 4).

Table 4. Results of *variance inflation factor (VIF)*

Variable	**Beef**		**Mutton**	
	VIF	1/VIF	VIF	1/VIF
GDPpc	1.18	.850	1.27	.789
FSec	1.25	.801	1.34	.746
TFP	1.35	.742	1.54	.648
Mean VIF	**1.26**		**1.38**	

Source: Authors' estimation (2023)

The Breusch-Godfrey Serial Correlation LM Test is used to identify autocorrelation issues that commonly occur in time series data. The Chi-Square's P-values are .278 and .138 (greater than .05) for beef and mutton, respectively, confirming that the regression model has no autocorrelation issues (Table 5).

Table 5. *Breusch-Godfrey serial correlation LM Test*

Parameters	**Beef**			**Mutton**		
F-statistic	1.040	Prob.F (2,15)	0.377	1.613	Prob. F (4,13)	0.230
Obs*R-squared	2.559	Prob.Chi-Sq. (2)	0.278	6.965	Prob. Chi-Sq. (4)	0.138

The heteroscedasticity test was conducted to diagnose uniform or non-different residual distribution (homoscedasticity) using Breusch-Pagan-Godfrey. The Chi-Square denoted .601 and .715 (greater than .05) confirmed the absence of heteroscedasticity in the model (Table 6).

Table 6. Heteroscedasticity test using *Breusch-Pagan-Godfrey*

Parameters	**Beef**			**Mutton**		
F-statistic	.358	Prob. F (3,17)	.783	2.292	Prob. F (3,17)	.114
Obs.*R-squared	1.250	Prob. Chi-Sq. (3)	.740	6.049	Prob. Chi-Sq. (3)	.109
Scaled explained SS	1.862	Prob. Chi-Sq. (3)	.601	1.357	Prob. Chi-Sq. (3)	.715

The primary analysis is the quantitative model to identify the association between economic variables and import diversification. The main variables associated with import diversification were gross domestic product per capita, food security and productivity at the domestic level (Mejia *et al.*, 2016). Therefore, the import diversification index (ID), which is projected using the Herfindahl-Hirschman Index (HHI) according to the estimate in [1], is used as an endogenous variable. In contrast, the exogenous variables consist of economic parameters — gross domestic product per capita (GDPpc), food security (FSec), which is measured based on the self-sufficiency status for beef and mutton and the total factor productivity (TFPt) of the livestock sector, obtained from agricultural science and technology indicators (ASTI) (Stads *et al.*, 2020). The data distribution of each variable is displayed in Table 7.

Table 7. Data distribution of major variables

Variable	**Obs.**	**Beef**				**Mutton**			
		Mean	**Std. Dev**	**Min.**	**Max.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
ID	21	0.698	0.142	0.45	0.96	0.524	0.061	0.45	0.646
GDPpc	21	8197.5	2777.11	3913.4	11432.82	8197.5	2777.11	3913.4	11432.82
FSec	21	25.47	3.787	17.95	30.12	11.402	3.73	5.93	20.45
$\boldsymbol{TFP_t}$	21	86.24	44.64	0.000	140.23	86.26	44.64	0.00	140.23

Note: Std. Dev., min., and max. are referred to as standard deviation, minimum and maximum, respectively.

Table 8 shows the correlation coefficient value between endogenous (ID) and exogenous variables (GDPpc, FSec, TFPt) for beef and mutton. A significant positive

relationship between GDPpc and TFPt showed that the higher the gross domestic product (per capita) and productivity (livestock), the more trade diversified (i.e. the diversification import index approaches zero). The food security status (FSec) indicated a positive relationship, implying that the more diversified trade contributed to a more sustainable food supply for beef, yet the coefficient value is insignificant.

Table 8. Results of bivariate correlation between variables

Variable	Beef				Mutton			
	ID	***GDPpc***	***FSec***	***TFP***	***ID***	***GDPpc***	***FSec***	***TFP***
ID	1.000				1.000			
GDPpc	0.472**	1.000			.448*	1.000		
FSec	0.305	0.635**	1.000		0.100	0.430	1.000	
TFP_t	0.618**	0.368	-0.369	1.000	0.462	0.368	-0.058	1.000

Note: **, * Correlation is significant at the 0.05 and 0.1 levels (2-tailed)

The empirical model of import diversification is a critical analysis to determine the impact of diversification on the national economy. Table 9 displays the results of the import diversification model in equations (2) and (3) for beef and mutton, respectively. The coefficient values for all variables are significant except TFPt for beef commodity, while for mutton, the only significant coefficient value is GDPpc. A positive coefficient value for beef predicts a positive association between the impact on GDPpc and TFPt with import diversification. However, the value of TFPt is not significant due to data availability. Consistent with past studies, Jaimovich (2012) postulated positive associations between import diversification and per capita income, while Bista (2019) discovered the effects of covariates of economic growth by introducing import diversification into the growth model.

In contrast, the negative coefficient explains the negative association between food security and import concentration. For mutton, import diversification has a significant and positive impact on GDPpc, while other variables are insignificant. The higher productivity of the livestock sub-sector contributes to more diversified beef imports. This finding is consistent with the endowment theory and the Heckscher-Ohlin trade model, which explains that countries with higher productivity in capital and labour are more likely to diversify import sources. The coefficient of mutton demonstrates a positive and significant GDPpc, explaining that a higher national per capita income contributes to a more equilibrium market (i.e. demand and supply).

Table 9. Results of multivariate regression analysis

Parameters	Coefficient *(s.e)*	
	Beef	**Mutton**
AgGDP	2.136E-6*** (0.000)	1.54E-05***
FSec	-0.008*** (0.002)	-0.0031 (0.0033)
TFP_t	0.002 (0.000)	-0.0001 (0.0002)

Parameters	Coefficient *(s.e)*	
	Beef	**Mutton**
Adj. R-squared	0.764	0.4653

Predictors: (Constant), AgGDP, TFP, SSL; b. Dependent Variable: HHI; ***, ** sig. at 1%,5%, respectively, Figures in parentheses refer to standard errors (s.e)

5. Conclusions

This study analyzes the import diversification of primary livestock commodities – beef and mutton — in Malaysia to identify the impact and the association between trade diversification and the country's economic indicators. Secondary data involving import volume, gross domestic product per capita, self-sufficiency level (used as a proxy for food security), and productivity are the main parameters to estimate the import diversification index. The Herfindahl-Hirschman Index (HHI), a widely used approach, was used to measure the index and as an endogenous variable for the import diversification model. In contrast, the exogenous variables included per capita gross domestic product, food security and livestock productivity. The ID index confirmed that beef import revealed a less diversified market (i.e. highly concentrated) than mutton, performing a more diversified and fragmented import market. The empirical model projects that national gross per capita income and food security status have significantly influenced the country's concentrated import markets for beef and mutton commodities. This study suggests that per capita national income, self-sufficiency, and total factor productivity significantly affect diversification magnitude. In addition, the findings also showed that the country was more inclined to diversify meat imports, especially beef, if the level of productivity factors in the livestock sector is higher. Yet, the coefficient value is not significant and is expected mainly due to the limited data availability on TFP. Further studies will focus on the microeconomic parameters of imported commodity sources that dominate meat commodity exports in the national market, such as geographical factors, transportation costs, logistics infrastructure, stability and fragility of supply, and political and diplomatic relations between countries. This study could serve as a reference to determine the direction and diversification strategies of Malaysia's major meat commodity imports.

Author Contribution: All authors contributed in this research.

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