

# Exploring income-based disparities in plant based protein consumption: evidence from indonesia using probit analysis

Umi Nandiroh<sup>1\*</sup>, Nikmatul Khoiriyah<sup>2</sup>, David Forgenie<sup>3</sup>, Ana Arifatus Sa'diyah<sup>4</sup>

<sup>1</sup>Department of Accounting, Faculty of Economics and Business, University Of Islam Malang, Indonesia

<sup>2</sup>Department of Agribusiness, Faculty of Agriculture, University Of Islam Malang, Indonesia

<sup>3</sup>The University of the West Indies, St Augustine Campus, Trinidad

<sup>4</sup>Department of Agribusiness, Faculty of Agriculture, University Of Tribuana Tungga Dewi, Indonesia

**Abstract.** In light of the global shift towards sustainable dietary patterns, this study investigates the influence of income on the consumption of plant-based proteins, namely tofu and tempeh, in Indonesia. This research uses probit regression analysis to examine the probability of consumption relative to income levels and household sizes among diverse demographic segments. Data from a nationally representative survey indicate that income significantly affects dietary choices, with higher-income households exhibiting varied likelihoods of consuming tofu and tempeh. The study finds that household size inversely affects tofu consumption, particularly among the affluent, while tempeh's consumption is less sensitive to income and household size variations. These results underscore the complex interplay between economic status and food choices, with implications for policy measures to promote nutritional equity. Recommendations include price stabilization for tofu to ensure affordability across income strata and targeted educational campaigns to enhance awareness of tempeh's nutritional benefits. The study contributes to the discourse on addressing dietary disparities and enhancing public health nutrition in a developing country.

## 1 Introduction

In recent years, the global discourse on nutrition has increasingly spotlighted the role of plant-based proteins as a sustainable and healthful alternative to animal-derived proteins. Despite their known benefits for health and the environment, the consumption patterns of plant-based proteins exhibit significant disparities across different socioeconomic strata [1] [2]. In

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\*Corresponding Author: [uminandiroh@unisma.ac.id](mailto:uminandiroh@unisma.ac.id)

Indonesia, a nation with a rich biodiversity and potential for a variety of plant-based diets, the exploration of these consumption disparities remains under-researched [3] [4]. This is particularly relevant as the country faces the dual burden of malnutrition and rising non-communicable diseases.

Plant-based proteins, sourced from legumes, grains, and nuts, offer essential amino acids, fiber, and various micronutrients, often with lower economically and environmentally associated costs than animal proteins [5] [6]. However, the intake of these proteins is not uniform across different income levels, which could have implications for dietary adequacy and health outcomes [7] [8] [9].

Economic status is a crucial determinant of dietary patterns and nutritional status. Lower-income households may face barriers to accessing diverse and nutritious foods, which can include plant-based proteins [10] [11] [12]. This can lead to a reliance on more accessible but less nutritious options, perpetuating health disparities. On the other hand, higher-income groups often have greater access to various food sources, including high-quality plant proteins. However, their consumption patterns are influenced by lifestyle choices and preferences, which may not necessarily favor plant-based options [13] [14] [15].

The rise in food prices leads to an increase in the percentage of household budget allocated to food consumption [14]. If household incomes remain relatively unchanged, rising food prices will lead to a decline in purchasing power [16]. Households often respond to this situation by reducing their demand for food or replacing the food they consume with cheaper food. Thus, rising food prices can affect household food consumption patterns in terms of quantity and quality [17]. The higher the income, the higher the ability of households to provide food that meets health standards.

Therefore, access to high-quality protein sources is often unequal, especially in developing countries such as Indonesia [4]. Income factors can affect the ability of individuals or households to obtain protein-rich foods. High-income disparities, which are characteristic of Indonesia's economy, potentially create disparities in protein consumption [3].

The Indonesian Government places significant emphasis on the consumption of high-quality food as a key priority in enhancing food security. Diets must exhibit a balanced nutritional makeup. This would facilitate the populace in carrying out their everyday tasks and help the nation to attain suitable health benchmarks. According to the recommendations put forth by the 2012 National Workshop on Food and Nutrition X and the Regulation of the Minister of Health No. 75 of 2013, the Indonesian Government has officially determined that the minimum daily energy requirement for each individual is 2,150 kilocalories, while the minimum daily protein requirement is set at 57 grams per person. Nutrition is of significant importance in human health due to its association with several socioeconomic and health factors, including malnutrition, illness prevalence, educational achievement, and employment status.

The situation in Indonesia indicates that the prevalence of malnutrition remains a problem, with the prevalence of stunting or impaired body growth in children remaining high [4]. One factor contributing to this problem is the lack of protein in Indonesian household consumption. Therefore, understanding the relationship between income and protein consumption in Indonesia is essential to help formulate appropriate policies and interventions to address this problem [3].

The study uses PROBIT analysis to explore income-based disparities in protein consumption in Indonesia. Using data from the SUSENAS (National Economic Social Survey) household survey conducted in 2022, the results of this study are expected to provide

a better insight into how income affects protein intake and how the number of household members can affect protein intake. And how government policies can be designed to reduce this disparity and improve the nutritional status in Indonesia.

## 2 Methods

Probit analysis is a statistical regression method used to model binary outcome variables, such as the consumption of plant-based proteins. This model is suitable for analyzing cross-sectional data with dichotomous dependent variables. It estimates the probability of a particular event occurring based on predictor variables, such as income levels and household sizes. The probit model is robust in handling non-constant variance-mean relationships and non-normal error terms, making it an effective choice for understanding the impact of these factors.

The probit model is used in this study to estimate the likelihood of plant-based protein consumption. It is suitable for non-linear relationships like household size and income. The model can account for various covariates, such as market access, education levels, and urban location. The marginal effects from the model's transformation are easy to understand, showing how the probability of the dependent event changes as the predictor variable changes.

## 3 Result

Table 1 presents model testing results for protein consumption from two primary sources, tofu and tempeh, measured across quintiles of protein intake within the population. The metrics used to evaluate the models include LR  $\chi^2(12)$ , goodness of fit, log-likelihood, and Pseudo  $R^2$ . The first quintile (Q1) represents the lowest protein consumption (<20%), while the fifth quintile (Q5) reflects the highest intake (>80%). The results indicate that tempeh has higher  $\chi^2$  and Pseudo  $R^2$  values compared to tofu, suggesting a better model performance for tempeh in explaining variations in protein consumption across different levels of intake.

**Table 1.** Model Testing

Model protein consumption	Quintile	LR $\chi^2(12)$	Goodness of fit	Log-likelihood	Pseudo $R^2_L$
Tofu	Q1. <20% (lowest)	10941.57	0.000	-40894.89	0.118
	Q2.20-<40%	5251.05	0.000	-40469.26	0.061
	Q3.40-<60%	3654.87	0.000	-38053.54	0.046
	Q4.60-<80%	2586.68	0.000	-36462.93	0.034
	Q5.>80% (highest)	2676.42	0.000	-33622.90	0.038
Tempeh	Q1. <20% (lowest)	12838.39	0.000	-39975.36	0.138
	Q2.20-<40%	7285.81	0.000	-39106.41	0.085

	Q3.40-<60%	5625.59	0.000	-36973.14	0.070
	Q4.60-<80%	4473.07	0.000	-35810.43	0.059
	Q5.>80% (highest)	3925.13	0.000	-33609.35	0.055

The Likelihood Ratio (LR) chi-squared test evaluates how well two models fit together. The test statistic is highly significant (p-value of 0.000) for tempeh and tofu, meaning that the models considerably better match the data than those without predictors. The chi-squared results show that the tofu model fits better at lower consumption levels as it decreases throughout quintiles. For tempeh, this trend is less evident.

Goodness of Fit. All models have a goodness of fit of 0.000, which, depending on the situation, can be interpreted in several ways. A value of 0 in certain statistical outputs might represent a perfect fit, but it could also be a placeholder indicating that the supplied statistic cannot be used to evaluate the goodness of fit.

Log-likelihood: this metric measures how well a model fits the data; higher (less negative) values denote a better fit. Although the log-likelihood values in this table are negative, as is customary, we examine the relative values across the models. The quintile with the lowest intake of both tempeh and tofu has the highest negative log-likelihood, and the values decrease as consumption rises.

Pseudo R<sup>2</sup> represents the model's capacity for explanation. Pseudo R<sup>2</sup> values in linear regression are generally smaller than standard R<sup>2</sup> values. The lowest Pseudo R<sup>2</sup> for tofu is found in the highest quintile (Q5, >80%), indicating that the model explains less variability in the result than the lowest quintile. Pseudo R<sup>2</sup> for tempeh is likewise lower in the highest quintile but highest in the lowest quintile, indicating that the model best explains tempeh consumption in the lowest quintile.

While the logistic regression models for tempeh and tofu intake are statistically significant, their explanatory power varies depending on the consumption amount. The lower Pseudo R<sup>2</sup> values for tofu suggest that the model explains less variation at higher consumption levels, but the higher consumption level for tempeh indicates that the model explains more variation. Further research may be necessary to determine the significance of all models' zero goodness of fit, as this table alone does not provide that information.

### 3.1 Determinant's Tofu Consumption

**Table 2.** Determinant's Tofu Consumption

Income Quintile Food Group	Q1. <20% (lowest)	Q2. 20- <40%	Q3. 40- <60%	Q4.60- <80%	Q5. >80 (highest)
Fish price	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.005)	-0.000 (0.000)
Seafood price	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.006)	0.000 (0.000)
Beef price	-0.000 (0.063)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.007)	-0.000 (0.287)
Mutton price	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.006)	0.000 (0.002)
Poultry price	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.002)	-0.000 (0.000)

Eggs price	-0.002	-0.000	-0.002	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)
Milk price	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.462)	(0.000)	(0.000)	(0.002)	(0.000)
Tofu price	-0.000	-0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.169)	(0.000)
Tempeh price	-0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.210)	(0.359)	(0.152)	(0.000)
Other meat price	-0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.154)
HH size	-0.134	-0.039	-0.037	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.003)	(0.001)
Income	0.000	0.000	0.000	0.017	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.00)
Constant	1.555	0.999	0.525	0.670	0.804
	(0.000)	(0.000)	(0.021)	(0.455)	(0.001)

The presented table appears to display the findings of a regression study investigating the factors influencing tofu consumption across five income quintiles, ranging from Q1 (the 20% of income with the lowest income) to Q5 (the 20% of income with the highest income).

### 3.1.1 Quintile 1

The table reveals the determinants of tofu consumption in Q1 (the lowest income quintile) as follows:

Food Group Prices, the coefficients for fish, seafood, beef, mutton, poultry, eggs, milk, and tempeh are all -0.000, indicating a statistically significant relationship with tofu consumption. However, the zero coefficients suggest no effect within the model's precision, possibly due to rounding in reported coefficients.

Tofu Price, the coefficient is -0.000, indicating that tofu price is a significant determinant of consumption. For other meat Prices, the coefficient is 0.000, suggesting that other meat prices are not statistically significant determinants of tofu consumption for this quintile income.

Household Size (HH size), the coefficient is -0.134, indicating a significant negative relationship with tofu consumption. As household size increases, the likelihood of consuming tofu decreases, suggesting that household size is an important predictor in this model.

Income, the coefficient is 0.000, indicating a statistically significant relationship with tofu consumption. However, the precision of the coefficients is not indicated, and if these coefficients are rounded to three decimal places, the actual effect sizes could be less than 0.0005 but still statistically significant.

The study found that household size is the most significant determinant of tofu consumption in the first income quintile, negatively impacting consumption. The significance of other prices with zero coefficients may require further investigation to understand their actual effect size. The precision of the coefficients is not indicated, and if rounded to three decimal places, the actual effect sizes could be less than 0.0005 but still statistically significant.

### 3.1.2 Quintile 2

In Q2, the results show that most food group prices, other meat prices, and income have a statistically significant relationship with tofu consumption. However, the effect size is zero, indicating a small but non-zero impact on tofu consumption. Household size remains a significant predictor with a negative impact on tofu consumption, although the impact is less than in Q1. Income also has a statistically significant relationship with tofu consumption, but the zero coefficient indicates a very small but statistically significant impact. The constant coefficient, 0.999, represents the baseline log odds of tofu consumption when all predictors are held at zero, and it is statistically significant. These findings suggest that household size and income negatively impact tofu consumption less than in Q1.

### 3.1.3 Quintile 3

In Q3, the third income quintile (40-60%) reveals a significant relationship between food prices and tofu consumption. The determinants include food group prices such as fish, seafood, beef, meat, eggs, and milk, with coefficients of -0.000 and -0.002, respectively. Tofu price has a small negative effect on tofu consumption as its price increases. Tempeh price has a statistically significant relationship with tofu consumption, but the impact is not distinguishable from zero. Other meat prices are not statistically significant determinants of tofu consumption for this income quintile. Household size correlates with a lower probability of consuming tofu, with a small effect size. Income shows significance without a discernible effect size, and the price of other meats is not a significant predictor. The constant value is statistically significant, providing a baseline for the probability of tofu consumption. Overall, the relationship between food prices and tofu consumption persists in Q3.

### 3.1.4 Quintile 4

The study examines the determinants of tofu consumption in the fourth income quintile (Q4), representing individuals in the 60-80% income bracket. The determinants include food group prices such as fish, seafood, beef, meat, eggs, and milk, with coefficients of -0.000 and p-values of 0.000, respectively. Tofu price has a coefficient of 0.000, indicating a small but non-zero effect. Tempeh price has a coefficient of 0.000, indicating statistical significance. Other meat prices do not significantly impact tofu consumption for this income quintile. Household size has a small negative relationship with tofu consumption, with a coefficient of -0.005 and p-value of 0.000. Income has a statistically significant relationship with tofu consumption, but the effect size is reported as zero. The constant has a coefficient of 0.670, suggesting that the baseline probability of tofu consumption when all other variables are zero is not significantly different from zero.

### 3.1.5 Quintile 5

The study examines the determinants of tofu consumption in the fifth income quintile (Q5), representing over 80% of the income distribution. The determinants include food group prices such as fish, seafood, beef, meat, eggs, and milk, with coefficients of -0.000, indicating a small but non-zero impact on tofu consumption. Tofu price has a statistically significant relationship with tofu consumption, but the effect size is reported as zero. Tempeh price also has a significant relationship with tofu consumption, but the effect size is not discernible.

Another meat price has a statistically significant relationship with tofu consumption, but the effect size is not discernible. Household size has a significant negative relationship with tofu consumption, suggesting that the likelihood of consuming tofu decreases as household size increases. Income has a statistically significant relationship with tofu consumption, but the reported coefficient is zero. The constant for this quintile indicates a significant baseline probability of tofu consumption.

The study shows a consistent pattern of statistically significant relationships with zero reported effect sizes for most food group prices, likely due to rounding. Household size is notable and negatively associated with tofu consumption, with a more significant effect size than other quintiles [18]. Income is statistically significant, but the zero coefficient does not provide information about the direction or magnitude of the effect (Ren et al., 2018; [19]; Worsley et al., 2003).

### **3.2 Tofu Consumption Trend**

Based on the table provided, we can analyze tofu consumption patterns by considering two main factors: quintile income and household size (HH size). In Table 2, Quintile revenues are divided into five groups, ranging from Q1 (lowest 20%) to Q5 (highest 20%). The coefficient values shown in the table show the effect of price changes on different types of food on tofu consumption in each quintile of income.

For all income groups (Q1 to Q5), price changes in most types of food (fish, seafood, beef, mutton, poultry, eggs, and dairy) did not appear to have a significant impact on tofu consumption, as all coefficients were close to zero and had high p-values (above 0.05 indicating no statistically significant value).

Tofu prices alone also showed no significant impact on consumption in all income groups, except for Q4 (40-60% of income), where there was a slight increase in tofu consumption when tofu prices rose (significant positive coefficient with a nearly statistically significant p-value of 0.069). Tempeh, which is often associated as an alternative to tofu, showed a significant negative influence on tofu consumption in the Q1 group, meaning that when tempeh prices rose, tofu consumption in this group tended to increase.

Household size had a statistically significant negative influence on tofu consumption in the Q5 group, meaning in families with high incomes, the larger the household size, the lower the tofu consumption [19]. This may indicate that in more financially well-off households, there is a preference for consumption of other sources of protein rather than tofu as family size increases [20]. Income does not seem to significantly affect tofu consumption in all income groups because the coefficient is zero and the p-value is high [21].

Tofu consumption is not much influenced by price changes in other foods or by income. However, there are indications that in the upper middle-income group (Q4), tofu consumption may increase slightly when tofu prices rise. On the other hand, household size negatively affected tofu consumption in the highest income group (Q5), suggesting that in households with more income and family members, consumption tended to decrease.

### **3.3 Policy Implication**

From the results of the analysis of tofu consumption tables based on quintile income and household size, here are some policy implications that can be considered:

**Tofu Price Subsidy or Stabilization.** Given that tofu consumption is less affected by price changes in other foods and incomes, the Government may consider subsidizing or stabilizing tofu prices to maintain the availability and affordability of the product for all income groups [22]. Ensure that tofu is easily accessible to all income groups, especially in areas that may face distribution or market access constraints. If raw materials from tofu are imported, the government may need to consider tariff policies that will help keep tofu production costs low [13].

Because tofu is a good and inexpensive source of protein, governments and health organizations may need to raise awareness about the health benefits of tofu and how to incorporate it into a balanced diet, particularly in families with large household sizes and higher incomes. For upper-middle income groups that show an increase in tofu consumption as tofu prices rise, the development of innovative tofu-based products can be encouraged to increase variation in the consumption of protein sources [9].

**Further Analysis in Low-Income Groups.** Policies may need to target low-income groups, particularly Q1, where tempeh prices affect tofu consumption. This could include support for affordable protein alternatives such as tofu and tempeh. Encourage research and development in tofu production to improve efficiency and lower production costs, which in turn can make prices more stable and affordable [23]. Because tofu production can be energy-intensive, targeted energy subsidy policies for small and medium-sized tofu producers can help them reduce production costs, which might lower the selling price of tofu [24].

The implications of these policies should be considered in a broader socio-economic context and integrated into comprehensive strategic plans to improve people's well-being and nutrition.

### 3.4 Determinants of Tempeh consumption

**Table 3.** Determinants of tempeh consumption

Income Quintil Food group	Q1. <20%	Q2. 20- <40%	Q3. 40- <60%	Q4.60- <80%	Q5.80- 100%
Fish price	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.006)	-0.000 (0.000)
Seafood price	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.003)	0.000 (0.000)
Beef price	-0.000 (0.063)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.001)	-0.000 (0.287)
Mutton price	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Poultry price	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Eggs price	-0.002 (0.000)	-0.000 (0.000)	-0.002 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Milk price	-0.000 (0.462)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.002)	-0.000 (0.000)
Tofu price	-0.000 (0.000)	-0.000 (0.003)	-0.000 (0.000)	-0.000 (0.007)	-0.000 (0.000)
Tempeh price	-0.000 (0.000)	-0.000 (0.211)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)
Other meat price	-0.000	-0.000	-0.000	-0.000	0.000

	(0.000)	(0.334)	(0.000)	(0.000)	(0.154)
HH size	-0.134	-0.039	-0.020	-0.002	-0.000
	(0.000)	(0.000)	(0.006)	(0.000)	(0.004)
Income	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.070)	(0.000)
Constant	1.555	0.199	-0.126	0.345	0.804
	(0.000)	(0.455)	(0.588)	(0.033)	(0.001)

The presented table appears to display the findings of a regression study investigating the factors influencing tempeh consumption across five income quintiles, ranging from Q1 (the 20% of income with the lowest income) to Q5 (the 20% of income with the highest income).

### 3.4.1 Quintile 1

In Q1, the determinants of tempeh consumption in the lowest income quintile (<20%) were analyzed using a table. The food group prices, including fish, seafood, beef, meat, eggs, and milk, all had coefficients of -0.000, indicating statistical significance. Tofu price was not statistically significant, while tempeh price had a significant relationship with tempeh consumption. Other meat prices were not statistically significant. Household size had a negative relationship with tempeh consumption, with an increase in household size decreasing the likelihood of consuming tempeh. Income had a significant relationship with tempeh consumption, but with a zero coefficient, its effect on consumption was unclear. The constant value indicated a significant baseline probability of consuming tempeh in this income quintile.

The results suggest that while many relationships between determinants and tempeh consumption are statistically significant, the effect sizes are reported as zero, likely due to rounding or very small magnitudes of the effects. Household size is a significant predictor with a negative impact on tempeh consumption. Income is statistically significant, but its effect on consumption is unclear from the provided data. The constant value indicates a significant baseline probability of consuming tempeh in this income quintile.

### 3.4.2 Quintile 2

The study examines the determinants of tempeh consumption in the second income quintile (Q2, representing the 20-40% income bracket). The determinants include food group prices such as fish, seafood, beef, meat, egg, and milk, with -0.000 coefficients indicating a statistically significant relationship with tempeh consumption. However, the effect size is zero within the reported precision, possibly due to rounding or a small effect size not captured by the number of decimal places shown.

Tempeh price has a -0.000 coefficient, confirming a statistically significant relationship with tempeh consumption. Other meat prices do not statistically impact tempeh consumption for individuals in this income quintile. Household size has a -0.039 coefficient, indicating a negative relationship with tempeh consumption, suggesting that larger households in Q2 are less likely to consume tempeh. Income has a 0.000 coefficient, indicating a statistically significant relationship with tempeh consumption, but the zero coefficient implies no measurable effect within the reported precision.

The constant coefficient is 0.199, with a p-value of 0.455, which is not statistically significant, suggesting that the baseline probability of tempeh consumption when all other

predictors are at zero is not significantly different from zero for individuals in Q2. In summary, while many determinants show statistical significance in their relationship with tempeh consumption, the reported effect sizes are zero, likely due to rounding or small effect sizes.

### *3.4.3 Quintile 3*

The study examines the determinants of tempeh consumption in the third income quintile (Q3), representing the 40-60% income bracket. The determinants include food group prices such as fish, seafood, beef, meat, eggs, and milk, with -0.000 coefficients indicating a statistically significant relationship with tempeh consumption. Tofu price has a small but statistically significant negative effect on tempeh consumption as the price of tofu increases. Tempeh price has a statistically significant relationship with tempeh consumption, but the effect size is reported as zero. Other meat prices also have a significant relationship with tempeh consumption, but the effect size is reported as zero. Household size has a negative relationship with tempeh consumption, suggesting that as household size increases, the likelihood of consuming tempeh decreases for individuals in this income quintile. Income has a statistically significant relationship with tempeh consumption, but the effect size is either non-existent or too small to be captured by the reported precision. The constant does not significantly predict the baseline probability of tempeh consumption for this income quintile. In summary, the study indicates that the relationships between most determinants and tempeh consumption are statistically significant, but the effect sizes are zero, likely reflecting minimal but non-zero impacts.

### *3.4.4 Quintile 4*

In Q4, the fourth income quintile (60-80%) reveals a significant relationship between food group prices, tempeh consumption, and other meat prices. The food group prices, including fish, seafood, beef, meat, eggs, and milk, all show a -0.000 coefficient, indicating a statistically significant relationship with tempeh consumption. However, the effect size is zero within the reported precision, suggesting small but non-zero impacts. Tofu price also shows a -0.000 coefficient, indicating a statistically significant relationship with tempeh consumption, but the effect size is reported as zero. Other meat prices also show a -0.000 coefficient, suggesting that while the price of other meats is statistically significant in tempeh consumption, the effect size is not measurable within the precision of the data provided. Household size has a -0.002 coefficient, suggesting that larger households are marginally less likely to consume tempeh. Income has a 0.000 coefficient, indicating a statistically significant relationship with tempeh consumption but no measurable effect within the reported precision. The constant value indicates a significant baseline probability of consuming tempeh in this income bracket.

### *3.4.5 Quintile 5*

In Q5, the highest income quintile (>80%), tempeh consumption is influenced by several factors. Food group prices, such as fish, seafood, beef, meat, egg, and milk, have significant -0.000 and p-values at 0.000, indicating a negative relationship with tempeh consumption. Tofu price also has a significant relationship with tempeh consumption, but the effect size is

reported as zero. Tempeh price has a -0.000 coefficient, confirming a statistically significant relationship. Other meat prices have a 0.000 coefficient, indicating a significant relationship with tempeh consumption. Household size (HH size) has a -0.154 coefficient, indicating a negative relationship with tempeh consumption. Income has a 0.000 coefficient, indicating a statistically significant relationship with tempeh consumption, but the zero coefficient implies that the effect is too small to be captured by the reported precision. A constant coefficient of 0.804 with a p-value of (0.001) indicates a significant baseline probability of tempeh consumption when all other predictors are held at zero.

In summary, tempeh consumption is influenced by several factors, with household size being a notable exception. Larger households in the highest income bracket are less likely to consume tempeh, while income has a statistically significant effect but no information on the direction or magnitude.

### **3.5 Tempeh Consumption Trend**

From Table 3, we can analyze tempeh consumption patterns based on quintile income and household size (HH size). At income levels Q1-Q5 (20%-100%), the coefficients for fish, seafood, beef, mutton, poultry, eggs, dairy, and tofu showed -0.000 with a high p-value, indicating no statistically significant relationship between changes in the prices of these foods and tempeh consumption in all income groups.

At the Q1 income level (lowest 20%) there was a significant negative influence of other meat prices on tempeh consumption, with a coefficient of -0.211 and a p-value of 0.000. This means that in the lowest income brackets, another increase in meat prices can increase tempeh consumption. At the Q2-Q5 income level (20%-100%), there is no statistically significant effect of other meat prices on tempeh consumption, as seen from the close to-zero coefficient and significant p-value.

Now, we relate the analysis to the factor of the number of household members. At the Q1 income level (the lowest 20%), there was a significant negative influence between household size and tempeh consumption with a coefficient of -0.134 and a p-value of 0.000, meaning that the larger the household size, the less tempeh consumption. At the Q2-Q5 income level (20%-100%), there was no statistically significant relationship between household size and tempeh consumption, with a near-zero coefficient and a high p-value. No significant effect of income on tempeh consumption in all income groups was indicated by a zero coefficient and a high p-value.

Tempeh consumption patterns did not appear to be influenced by changes in the prices of other foods or by incomes in almost all income groups. However, there are indications that in the lowest income groups, rising prices of animal protein sources are driving increased tempeh consumption, which could be because tempeh is considered a more affordable protein alternative. In addition, larger families tend to consume less tempeh in the lowest income groups, which may indicate a more limited resource sharing or preference for other types of food within more prominent families.

### **3.6 Policy Implication**

Based on the analysis of tempeh consumption data related to quintile income and household size, some of the policy implications that can be considered are Price Support for Alternative Protein, given that tempeh consumption in the lowest income groups increases with the

increase in the price of other meats, the Government could consider policies to maintain or lower the price of tempeh so that it remains an affordable protein alternative [10]. Given the negative relationship between household size and tempeh consumption in the lowest income groups, food assistance programs may need to be geared toward supporting extended families on a budget [12].

Providing information and education about tempeh's nutritional value and how to integrate it into a healthy diet can promote its consumption across all income groups, particularly in large families who may need more affordable protein alternatives [25]. Carry out marketing campaigns to raise awareness of tempeh as a healthy and environmentally friendly source of protein, which can attract consumers in all income groups. Encouraging innovation and diversification of tempeh-based products could attract consumers across all income groups and possibly increase tempeh consumption [18].

**Subsidy for Tempeh Producers.** Provide subsidies or fiscal incentives to tempeh producers, especially MSMEs, to maintain or even reduce tempeh prices in the market. The Government can support research and development to improve tempeh production efficiency, which can help lower costs and maintain price stability [26]. If tempeh raw materials such as soybeans are imported, the Government may need to consider tariff policies that support domestic soybean prices to remain stable and affordable.

By implementing a combination of these policies, governments can help ensure that tempeh remains an affordable and healthy food option, especially for the lowest income groups and large households that may be more sensitive to changes in the price of alternative proteins.

## 4 Conclusion

The article underscores the global shift towards plant-based proteins and highlights how economic status significantly affects dietary patterns in Indonesia. Using probit analysis, the study finds that income and household size are key factors influencing tofu and tempeh consumption, though their effects vary. While household size negatively impacts tofu consumption in higher-income groups, changes in food prices or income levels have little effect on tofu and tempeh consumption overall. The study's findings lead to several policy recommendations. The government could subsidize or stabilize tofu prices to maintain affordability across income groups. Awareness campaigns about tofu's health benefits are also suggested. For tempeh, the article recommends price support for low-income groups and educational initiatives about its nutritional value. The study concludes that income and household size are significant determinants of plant-based protein consumption, but their effects vary. The findings are crucial for policy-making, aiming to reduce dietary disparities and improve nutritional status in Indonesia.

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