



Determinants of household cigarette and alcohol consumption in Indonesia: An Islamic economics perspective using Had Kifayah framework with interpretable machine learning and econometric approaches

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ABSTRACT

The present study is focused on analyzing the determinants of household cigarette and alcohol consumption in Indonesia through an Islamic economics perspective using the Had Kifayah (minimum sufficiency threshold) framework. The incorporation of nationally representative household microdata from SUSENAS March 2024 enabled the classification of households into Mustahik (zakat-eligible) and Muzaki (zakat-paying) groups based on provincial Islamic sufficiency thresholds. In addition, a Double-Hurdle framework alongside interpretable machine learning (XGBoost with SHAP values) was also adopted. The results showed near-universal smoking prevalence, with Mustahik households allocating a larger budget share to cigarettes despite respective lower absolute expenditure. The income elasticities for cigarettes were higher among Mustahik households. Meanwhile, the alcohol income elasticity exceeded unity, which resulted in the classification of alcohol as a luxury good. The XGBoost framework outperformed probit specifications. Furthermore, SHAP analysis identified urbanization, education, and food expenditure share as the leading predictors of participation. These results collectively supported progressive excise taxation combined with targeted zakat distribution mechanisms consistent with *maqasid al-shariah*.

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1 Introduction

The consumption of cigarette and alcohol in Indonesia is known to connect public health, economic, and religious challenges. Indonesia is among the countries with the highest smoking rates globally, with over 60% of adult males classified as active smokers (WHO 2023). Household tobacco expenditure frequently showed spending on food, education, and healthcare among low-income populations (Semba *et al.* 2007; Block & Webb 2009; Ahsan *et al.* 2022). The juristic status of cigarette smoking remains contested, while alcohol is clearly prohibited (*haram*) under Islamic jurisprudence. Some studies classified alcohol as prohibited (*haram*), others as discouraged (*makruh*), and many contemporary authorities addressed respective rulings regarding its established harm to health. However, the consumption of both commodities persists across all socioeconomic strata in this Muslim-majority nation (Al-Qardawi 2000).

Conventional studies depended on the poverty line established by Statistics Indonesia (BPS), which focused mainly on caloric sufficiency and basic non-food needs. This framework did not capture the multidimensional welfare standards articulated in Islamic economics. The Had Kifayah framework's minimum sufficiency threshold offered a more comprehensive welfare classification comprising seven dimensions of basic needs, namely food, clothing, shelter, worship, education, health, and transportation (BAZNAS 2024; PUSKAS BAZNAS 2018). Households were classified as Mustahik (zakat-eligible) when income earned was below the minimum sufficiency threshold, or Muzaki (zakat-paying) when it met or exceeded the threshold. This classification is in line with the multidimensional poverty measurement proposed by Alkire & Foster (2011). However, it was distinguished by the inclusion of spiritual dimensions and normative grounding in *maqasid al-shariah* (Auda 2008). Beik & Pratama (2016) showed that multidimensional Islamic welfare measures captured dimensions neglected by income-based classifications. Azman *et al.* (2017) also focused on a systematic methodology for computing Had Kifayah thresholds in line with *maqasid al-shariah*.

In this context, approximately 39.7% of Indonesian households were below the Had Kifayah threshold. The outcome was larger than 9.03%

of households identified as poor by BPS standards in March 2024. This made the framework particularly relevant for examining the consumption of commodities considered harmful to individual welfare and social wellbeing by Islamic jurisprudence (Kamali 2008).

The econometric challenge in modeling cigarette and alcohol consumption centered on the preponderance of zero observations. Furthermore, the Double-Hurdle framework (Cragg 1971; Jones 1989) addressed the challenge by decomposing consumption into participation (whether to consume) and intensity (how much), recognizing that these decisions may be governed by different behavioral mechanisms. The participation process reflected social norms, addiction formation, and religious adherence, while intensity suggested budgetary constraints and price sensitivity (Becker & Murphy 1988; Gruber & Köszegi 2001). The econometrics of tobacco demand has a rich history. Cragg (1971) proposed the Double-Hurdle framework, allowing different mechanisms to govern participation and intensity decisions, an approach particularly appropriate for addictive commodities (Jones 1989). In the Indonesian context, Adioetomo *et al.* (2005) reported that lower-income households showed higher cigarette price sensitivity. Ahsan *et al.* (2022) quantified the displacement of nutritional spending among poor households. International evidence consistently showed that tobacco demand was price-inelastic but with higher sensitivity among lower-income groups (Chaloupka *et al.* 2019; Ross & Chaloupka 2003). To complement parametric frameworks, Mullainathan & Spiess (2017) reported that machine learning excelled at prediction while traditional econometrics remained essential for estimation. SHAP values (Lundberg & Lee 2017), based on the cooperative game theory proposed by Shapley (1953), provided theoretically grounded feature importance decomposition.

Based on the description above, the present study focused on addressing the following three questions (1) What are the consumption patterns and behavioral determinants of cigarette and alcohol use among Mustahik and Muzaki households? (2) How do price and income elasticities differ between these groups? (3) What are the policy implications for excise taxation and zakat distribution? Furthermore, the use of National Socioeconomic Survey (SUSENAS) conducted in March 2024 which cover

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343,468 households, enabled the study to make certain contributions. These were achieved by applying the Had Kifayah framework as a welfare classification device. The process adopted methodological triangulation combining Double-Hurdle with XGBoost-SHAP to provide policy-relevant elasticity estimates for both commodities.

2 Materials and Methods

2.1 Data and Sample

Microdata from the National Socioeconomic Survey (SUSENAS) March 2024, conducted by BPS (BPS-Statistics Indonesia 2024), were used in this study. The dataset comprised 343,468 households with complete information on consumption expenditure, demographic characteristics, and geographic location across all 38 Indonesian provinces. SUSENAS provided comprehensive household expenditure records through its consumption module (KOR42 and KOR43), including item-level data for food commodities. Cigarette and alcohol expenditures were identified from commodity groups 159 (tobacco products, item codes 160–167) and 192 (alcoholic beverages, item codes 193–197), respectively. Additionally, non-zero expenditure values were converted to monthly equivalents.

2.2 Variable Construction

Participation is coded as binary 1 if the household reports positive expenditure. The dependent variable for intensity is log monthly expenditure, with unit values serving as price proxies. Province-specific Had Kifayah thresholds from BAZNAS (BAZNAS 2024), ranging from IDR 920,000 to IDR 1,650,000 per capita per month, classified households into Mustahik ($n = 136,295$, 39.7%) and Muzaki ($n = 207,173$, 60.3%). The variables included age, sex, marital status, education of household head, household size, presence of children under 15, urban/rural location, log total expenditure (income proxy), and food expenditure share. In addition, all models included province fixed effects

2.3 Econometric Framework: Double-Hurdle Framework

The first hurdle modeled the probability that household i participated in the consumption of commodity c through a probit specification, $\Pr(Y_{ic} = 1 | \mathbf{X}_i) = \Phi(\mathbf{X}_i' \beta_c)$, where Y_{ic} is a binary participation indicator, $\mathbf{X}_i$ depicts the vector of household characteristics described in Section 2.2, β_c represents the corresponding coefficient vector, and $\Phi(\cdot)$ denotes the standard normal cumulative distribution function. Conditional on positive consumption, the second hurdle modeled log expenditure intensity through OLS, $\ln(E_{ic} | Y_{ic} = 1) = \mathbf{Z}_i' \gamma_c + \varepsilon_{ic}$, where E_{ic} refers to the monthly expenditure on commodity c , $\mathbf{Z}_i$ is the vector of covariates, including log price and log income, γ_c denotes the corresponding coefficient vector, and ε_{ic} represents the error term. The log-price and log-income coefficients in γ_c were interpreted directly as elasticities and treated as the parameters of primary interest. Both hurdles were estimated for the full sample, Mustahik, and Muzaki subsamples, producing six probit and OLS models, respectively. In addition, heteroskedasticity-robust standard errors were used throughout the analysis.

2.4 Machine Learning Framework: XGBoost with SHAP

Chen & Guestrin (2016) developed XGBoost, which was used during the classification and regression stages. Hyperparameters were optimized through five-fold cross-validation ($\text{max_depth} = 5$, $\text{learning_rate} = 0.05$, $\text{min_child_weight} = 5$), and $\text{subsample} = 0.8$. SHAP values decomposed each prediction into additive feature contributions (Lundberg & Lee 2017), with mean absolute SHAP values ranking feature importance and beeswarm plots showing effect directions across the distribution.

3 Results

3.1 Descriptive Statistics

Table 1 shows the summary statistics obtained by the Had Kifayah classification. Several patterns merited attention first, smoking prevalence was near-universal at 94.2%. This was consistent with Indonesia's status as a major tobacco-consuming nation (WHO 2023). Muzaki households showed slightly higher prevalence (95.0% vs. 93.0%), reflecting the positive association between income and smoking initiation in low- and middle-income countries (Liu *et al.* 2006). Second, while absolute cigarette expenditure was higher among Muzaki (IDR 201,077 vs. 130,590), the budget share was greater among Mustahik (4.2% vs. 3.3%). This showed lower absolute spending but higher relative burden, consistent with the crowding-out hypothesis (Ahsan *et al.* 2022; Block & Webb 2009). Third, alcohol prevalence at 62.9% is significantly high, depicting the SUSENAS classification of traditional fermented beverages and non-standard products. Mustahik households showed higher alcohol prevalence (66.1% vs. 60.7%). Fourth, these households were larger (8.3 vs. 6.2 members), more rural (66.4% vs. 52.2%), male-headed (87.7% vs. 82.3%), and had children under 15 (69.7% vs. 44.0%), characteristics associated with greater economic vulnerability.

Table 1: Descriptive statistics of household expenditure, consumption prevalence, and demographic characteristics by Had Kifayah classification

Variable	Total Sample	Mustahik	Muzaki
N (Sample size)	343,468	136,295	207,173
Total Exp. (IDR/mo)	5,183,644	3,154,880	6,518,327
Food Share (%)	56.1	61.4	52.5
Smoking Prevalence (%)	94.2	93.0	95.0
Cig. Exp. (IDR/mo, consumers)	173,471	130,590	201,077
Cig. Budget Share (% , consumers)	3.6	4.2	3.3
Alcohol Prevalence (%)	62.9	66.1	60.7
HH Size	7.1	8.3	6.2
Head Age (years)	50.2	49.2	50.8
Male Head (%)	84.4	87.7	82.3
Urban (%)	42.1	33.6	47.8
Has Children <15 (%)	54.2	69.7	44.0

3.2 Econometric Results

Table 2 shows a summary of the main probit and OLS estimates. For cigarette participation, log income exerted a strong positive effect (0.300–0.355). This suggested that higher-income households were projected to contain smokers. The negative coefficient on male household head appeared counterintuitive but reflected multivariate conditioning. Given the same income and household size, female-headed households contained adult male members who smoked. Education was positively associated with smoking participation, reflecting an income-education correlation at the extensive margin. Urban location increased smoking probability (0.066–0.072), with the Mustahik indicator being negative and significant (−0.042), suggesting slightly lower participation conditional on other controls. Based on alcohol participation, the sex of the household head was the dominant factor, with male-headed households showing significantly higher consumption probability (0.930–1.171). Education and log income were positive and significant, while urbanization reduced alcohol participation (−0.270 to −0.384). This is consistent with the greater availability and social acceptability of traditional fermented beverages in rural areas. Marriage also reduced alcohol participation (−0.315 to −0.327), potentially reflecting household formation effects on drinking behavior.

The positive cigarette price elasticity is an artifact of unit value endogeneity, such as households spending more on cigarettes purchasing premium brands with higher per-stick prices (Deaton 1997). This unit value bias was well-documented in demand estimation using household survey data. The correction through instrumental variables using regional mean prices produced negative elasticities consistent with theory, but centered beyond the scope of the current cross-sectional analysis. Income elasticities were substantially higher for Mustahik across both commodities (cigarettes: 0.870 vs. 0.549; alcohol: 1.240 vs. 0.752). Both cigarette values fell in the normal-good range ($0 < \varepsilon < 1$), while the alcohol income elasticity for Mustahik exceeded unity (1.240), placing alcohol in the luxury-good range for this group. The welfare-group gap was the salient result, with income elasticities roughly 50% larger for Mustahik than for Muzaki in both commodities. In addition, the implications of these magnitudes for zakat distribution are reviewed in Section 4.

3.3 Machine Learning Results

XGBoost outperformed probit for both commodities, with a higher AUC for cigarette participation (0.747 vs. 0.705) and an alcohol-participation AUC of 0.787. This suggested non-linear patterns in consumption determinants. The performance gap is visible in the cigarette-participation ROC curves shown in Figure 1. The XGBoost curve dominated the probit curve across the full range of false-positive rates. SHAP-based feature importance showed urbanization (mean $|\text{SHAP}| = 0.320$), education (0.294), and food expenditure share (0.220) as top predictors for cigarette participation, diverging from the probit framework where log income dominates. Zakat status ranked fourth (0.203), validating the importance of the welfare dimension. Furthermore, log income ranked seventh (0.112) in SHAP rankings, suggesting that once non-linear effects were accommodated, the income's marginal predictive contribution diminished relative to compositional and geographic factors.

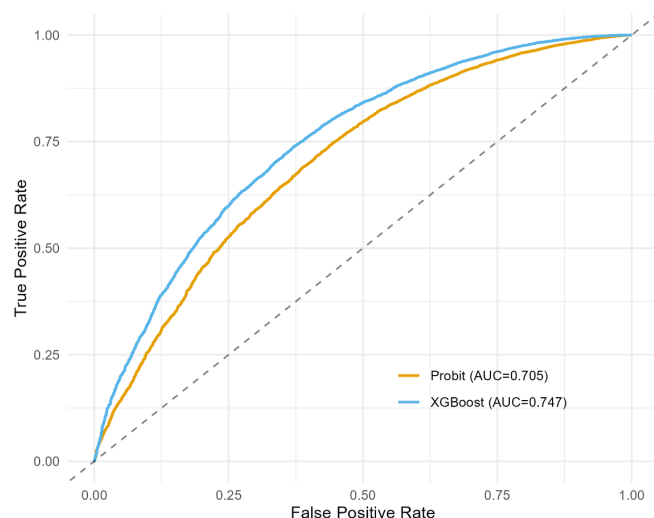
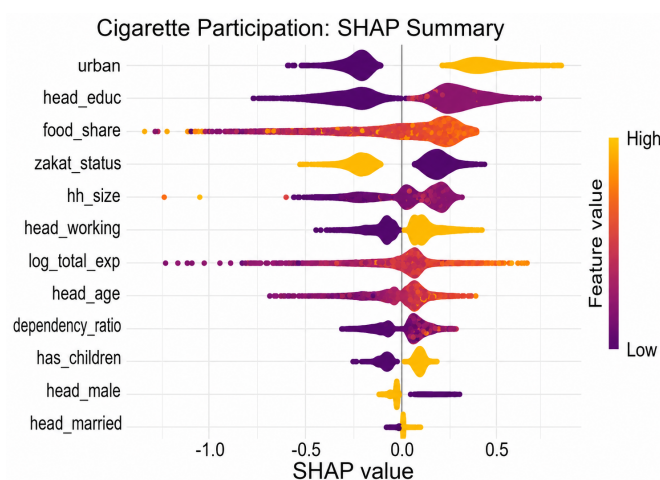
Table 2: Descriptive statistics of household expenditure, consumption prevalence, and demographic characteristics by Had Kifayah classification

Sample	Commodity	Price Elasticity	Income Elasticity
Full Sample	Cigarette	0.187***	0.621***
Mustahik	Cigarette	0.147***	0.870***
Muzaki	Cigarette	0.215***	0.549***
Full Sample	Alcohol	−0.187***	0.896***
Mustahik	Alcohol	−0.248***	1.240***
Muzaki	Alcohol	−0.095***	0.752***

Note: *** $p < 0.01$. Robust standard errors. Province fixed effects included.

Table 3: Top 6 SHAP feature importance for cigarette and alcohol participation

Rank	Cigarette Feature	SHAP	Alcohol Feature	SHAP
1	Urban	0.320	Food Share	0.725
2	Education	0.294	Male Head	0.375
3	Food Share	0.220	Log Income	0.318
4	Zakat Status	0.203	HH Size	0.121
5	HH Size	0.159	Dependency Ratio	0.110
6	Head Working	0.117	Head Working	0.108

**Figure 1:** ROC curves for cigarette participation: XGBoost (AUC = 0.747) versus Probit (AUC = 0.705)**Figure 2:** SHAP summary (beeswarm) for cigarette participation, showing the direction and magnitude of each feature's contribution across the distribution

For alcohol participation, food expenditure shares dominated SHAP rankings (0.725), followed by male household headship (0.375) and log income (0.318). SHAP dependence plots showed non-linear income effects. These included the contribution of income increasing steeply at lower levels before plateauing, as captured by XGBoost but constrained to linearity in probit. Both approaches were in line with the importance of zakat status and household size, providing mutual validation of the numerous determinants (Mullainathan & Spiess 2017).

The SHAP decomposition clarified which household characteristics drove the predictions and in which direction, beyond aggregate fit. Figure 2 shows the SHAP summary for cigarette participation, where each point denotes a household and its horizontal position gives that feature's contribution to the predicted log-odds of smoking. Urbanization and education showed the widest spread, confirming the dominant role identified in Table 3. Meanwhile, the coloring showed that higher food-expenditure shares were associated with lower predicted participation.

4 Discussion

The high-income elasticity of cigarettes among Mustahik (0.870) in terms of unity suggested that income gains from zakat transfers significantly increased cigarette consumption. However, for alcohol, Mustahik income elasticity exceeded unity (1.240), showing that increases in zakat-funded income triggered alcohol spending proportionally compared

to total spending. Both patterns represented the manifestations of *israf* (extravagance) and *tabdhir* (wasteful spending), thereby contradicting the *maqasid al-shariah* objectives which outlined zakat distribution (Kahf 2014; Chapra 2000). This led to the formulation of five essential objectives, by the *maqasid al-shariah* framework, namely preservation of faith, life, intellect, lineage, and wealth (Kamali 2008), compromised by cigarette and alcohol consumption. In addition, the results supported three recommendations made by zakat institutions. These included (i) conditional transfers with restrictions on tobacco and alcohol purchases, (ii) in-kind distribution modalities (food packages, education subsidies) rather than unrestricted cash (Wahab & Rahman 2023), and (iii) financial literacy programs outlining Islamic consumption ethics as part of zakat recipient support services (Beik & Pratama 2016).

The discovery that Mustahik allocated a larger budget share to cigarettes (4.2% vs. 3.3%) confirmed the crowding-out patterns. This is in line with the study by Semba *et al.* (2007), who associated paternal smoking with child malnutrition risk. Furthermore, Block & Webb (2009) also reviewed tobacco's displacement of food expenditure in developing countries. These results extended this literature by showing that the crowding-out effect is more pronounced when welfare is measured through Islamic sufficiency thresholds rather than conventional poverty lines, as the Had Kifayah framework captured a broader set of vulnerable households (39.7% vs. 9.03% under BPS standards).

In this context, the differential elasticity estimates supported progressive excise taxation. Mustahik allocated a larger budget share to cigarettes (4.2% vs. 3.3%), therefore uniform excise bore a heavier relative burden on lower-welfare households. The estimated price elasticities further suggested that Mustahik would reduce cigarette consumption less than Muzaki for a given tax increase. This reflected the lower price sensitivity, and as a result, excise alone neither fell hardest on the most responsive group nor spared the most burdened. The tension was best resolved not by the tax schedule itself but by allocating revenue to social protection and cessation support targeted at Mustahik households (Chaloupka *et al.* 2019; Prasetyo & Setyawan 2022). For alcohol, Mustahik's higher price sensitivity (-0.248 vs. -0.095) showed excise increases would disproportionately reduce consumption among lower-welfare households, desirable from both public health and Islamic economics perspectives.

The XGBoost framework showed clear predictive improvements over probit, validating non-linear patterns. Machine learning does not replace econometric estimates, because probit and OLS tended to provide interpretable elasticities essential for policy design. Meanwhile, SHAP offered validation and non-linearity insights. This methodological triangulation exemplified the complementary relationship proposed by Mullainathan & Spiess (2017). The divergence between probit (income-dominated) and SHAP rankings (urbanization- and education-dominated) reflected the fundamental difference between marginal effect and predictive contribution, both were valid perspectives for understanding consumption behavior.

Several limitations were recognized, for example, the cross-sectional design precluded dynamic causal analysis. Unit value endogeneity prevented the clean identification of cigarette price effects, with instrumental variables or regional price data proposed to improve future studies. The SUSENAS alcohol categories should comprise traditional beverages differing from standard classifications. The Had Kifayah thresholds depended on BAZNAS normative standards that tended to vary across Islamic jurisprudence schools. Future studies could address these through panel data analysis of excise tax reforms, instrumental variable estimation, and comparative investigations across Muslim-majority countries.

5 Conclusion

In conclusion, this study showed that Had Kifayah framework provided a substantively significant welfare classification for consumption analysis, identifying a broader set of vulnerable households than conventional poverty lines. The combination of the Double-Hurdle framework with XGBoost-SHAP interpretability offered complementary insights. For example, the parametric framework produced policy-relevant elasticities while machine learning showed non-linear patterns and validated determinant rankings. The main policy takeaway is dual, progressive excise taxation was supported by differential price sensitivities, but revenue allocated to social protection played an essential role. Meanwhile, zakat distribution mechanisms should incorporate conditionality or in-kind modalities to prevent income transfers from increasing haram consumption, a recommendation grounded in both empirical evidence and *maqasid al-shariah*.

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Conflict of Interest

The authors declare no conflict of interest.

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