

Connecting Global Markets and Farm Household Income in the Central Highlands of Vietnam: The Case of World Coffee Price Fluctuations

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ABSTRACT: Vietnam is the world's second-largest coffee exporter and the leading producer of Robusta coffee, with over 90% of its production coming from smallholder farmers in the Central Highlands. Despite the sector's significant contribution to the national economy, coffee-farming households face various challenges in maintaining and increasing income, including global price fluctuations, rising input costs, and aging plantations. This study aims to examine the factors influencing the average annual income of coffee-farming households in Vietnam's Central Highlands, using a quantitative approach based on a household survey dataset. The multiple linear regression results reveal that global coffee price, production cost, coffee yield, and access to credit are statistically significant determinants of income. While cultivated area and education level show positive relationships with income, their effects are not statistically significant at the 5% level. These findings confirm the applicability of the Agricultural Household Model (Singh et al., 1986) and Price Transmission Theory (Meyer & von Cramon-Taubadel, 2004) in the Vietnamese context. The study offers practical implications for policymakers, particularly in designing support programs for input cost reduction, credit access, yield improvement, and technical training, aiming to enhance the resilience and profitability of smallholder coffee farmers.

KEYWORDS: Central Highlands; coffee income; global coffee price; price fluctuation; smallholder farmers.

I. INTRODUCTION

Vietnam has emerged as a global powerhouse in the coffee industry, currently holding the position of the world's second-largest coffee exporter and the leading producer of Robusta coffee, accounting for approximately 40% of the global Robusta supply (Vietnam.vn, 2025). The coffee sector is not only a critical pillar of Vietnam's agricultural economy but also a major source of livelihood for millions of smallholder farmers, especially in the Central Highlands provinces of Dak Lak, Lam Dong, Gia Lai, and Dak Nong. These regions benefit from favorable agro-climatic conditions and contribute over 90% of the country's total coffee cultivation area (Ministry of Agriculture and Environment, 2025). However, despite its scale and importance, the sector faces mounting challenges. Global coffee price volatility, rising production costs, environmental risks such as prolonged droughts, and tightening international trade regulations, including the European Union's Deforestation Regulation (EUDR), impose significant pressures on the sustainability and profitability of coffee farming in Vietnam (Theinvestor, 2025; National Statistics Office, 2025). These complex dynamics underscore the urgent need to deepen our understanding of the factors shaping the income of coffee-farming households to ensure long-term resilience and inclusive growth in this sector.

The income of coffee farmers in Vietnam is strongly influenced by both external and internal factors. On the one hand, the international coffee market plays a decisive role in determining farm-gate prices, as Vietnam exports over 90% of its coffee production. The Price Transmission Theory (Meyer & von Cramon-Taubadel, 2004) posits that fluctuations in world commodity prices are partially or fully passed through to domestic producer prices, impacting household income directly. However, the degree to which this transmission occurs in Vietnam's coffee sector, and how it interacts with local production and household characteristics, remains insufficiently studied. On the other hand, internal factors such as cultivated land size, yield levels, access to credit, and education of household heads potentially mediate the effects of market changes on income but have often been examined in isolation rather than within a comprehensive framework (Hong, 2016; Nguyen et al., 2023). This fragmented approach limits the ability of policy-makers and development practitioners to design effective interventions that address the multifaceted nature of income generation among coffee producers. Identifying and quantifying the key determinants of coffee-

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farming household income in the Central Highlands is therefore critical, especially given the sector's exposure to economic shocks and environmental uncertainties. Current literature reveals gaps in integrated empirical analyses that combine market price effects with production, financial, and socio-demographic factors in the Vietnamese context. Moreover, as the government seeks to transition the sector toward higher value-added production and sustainable practices, understanding these income drivers can inform better-targeted policies such as financial support programs, extension services, climate adaptation measures, and market risk management tools. Enhancing the income and resilience of smallholders will contribute not only to poverty reduction but also to maintaining Vietnam's competitive position in the global coffee market.

Against this backdrop, the present study aims to fill the research gap by systematically examining the influences of world coffee prices, production costs, cultivated area, coffee productivity (yield), access to credit, and educational attainment of household heads on the average annual income of coffee-farming households in Vietnam's Central Highlands. Drawing on the Household Economic Behavior Framework (Singh et al., 1986) and the Price Transmission Theory (Meyer & von Cramon-Taubadel, 2004), this research endeavors to provide robust empirical evidence on the relative importance and interplay of these factors. The findings are expected to contribute valuable insights for stakeholders in designing evidence-based strategies to improve the livelihoods of coffee farmers, promote sustainable production, and mitigate the sector's vulnerability to global market and environmental risks. The research paper is structured in five parts: (1) introduction; (2) theoretical framework and hypothesis development; (3) research methodology; (4) research results and discussion; and (5) conclusions, implications and directions for further research.

II. CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

World Coffee Price Fluctuation

Price fluctuation, also referred to as price volatility, is defined as the degree of variation in the price of a commodity over a specific period of time. It represents the instability or unpredictability of prices, typically measured through statistical indicators such as standard deviation or coefficient of variation (Deaton, 1999, as cited in Singhal et al., 2025). In the context of agricultural commodities, price fluctuation is a natural phenomenon caused by seasonal changes, supply shocks, market expectations, and international trade dynamics. For globally traded crops like coffee, price fluctuation refers to how international coffee prices (such as Robusta and Arabica) change over time. These changes are particularly impactful in developing countries, where farmers often act as price takers, accepting the world price without the ability to negotiate or hedge (Singhal et al., 2025). In Vietnam, which ranks among the top global coffee exporters, world coffee price movements are a key determinant of farmer income.

For the nature and characteristics of World Coffee Price Fluctuations, The global coffee market is characterized by significant price volatility. This is primarily due to the interaction of unpredictable weather patterns, shifting global demand, speculative trading, exchange rate fluctuations, and trade policies. For example, droughts or frosts in Brazil or Vietnam, which are two of the largest producers, can dramatically reduce global supply and cause sharp price spikes (FAO, 2024). Additionally, coffee is one of the most traded agricultural commodities in futures markets, where speculation can exacerbate short-term price swings (Singhal et al., 2025). Another defining feature of coffee price volatility is the lag in production response. Coffee trees typically take 3–4 years to mature, and once established, plantations cannot be easily adjusted to short-term market signals. This inflexibility amplifies the effects of price changes, since producers cannot rapidly increase or reduce supply in response to market conditions (Singhal et al., 2025). Price changes in global markets are usually transmitted to domestic producers through export channels. However, the degree and speed of transmission can vary depending on local market structures, government policies, and transaction costs. In Vietnam, fluctuations in world coffee prices are generally reflected in farm-gate prices, although with some lag and distortion due to exchange rates and intermediary margins (Hong, 2020). Several studies have observed that coffee prices tend to follow medium-term cycles. For instance, Vietnam's coffee export prices have shown patterns of 5–7 year cycles of increases and declines, influenced by global production and demand shifts (Hong, 2020). Moreover, producers may react more strongly to negative price shocks than to positive ones, due to the asymmetric nature of financial losses.

However, there are significant issues arising from coffee price fluctuation. Price volatility is a major source of income instability for coffee farmers. As prices fluctuate, farmers' revenues become uncertain, making it difficult to plan expenditures, invest in farm improvements, or save. In developing countries, where smallholders rely heavily on coffee income, this volatility often translates into economic insecurity (Nhung et al., 2025; Singhal et al., 2025). Volatile prices discourage farmers from making long-term investments, such as adopting new technologies or replanting aging coffee trees. When returns are uncertain, risk-averse behavior often leads to underinvestment in productivity-enhancing inputs. This in turn creates a vicious cycle of low yields and vulnerability to price changes (Singhal et al., 2025). In response to declining or unpredictable prices, coffee-producing

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households often adjust their labor strategies. Research from Vietnam shows that when prices fall, adults in farm households increase off-farm wage work, while children are more likely to be pulled into farm labor to compensate (WIDER UNU, 2021). Recent studies have emphasized the non-financial effects of price volatility. Income uncertainty caused by commodity price swings can increase psychological stress and lower the subjective well-being of farmers. In Vietnam and other producing countries, higher coffee price volatility has been associated with elevated levels of depression and anxiety among farmers (Singhal et al., 2025; The Conversation, 2024). Extreme weather events such as drought and floods driven by climate change are increasingly contributing to supply shocks, which in turn cause global price volatility. In 2024, for example, global Robusta prices surged by nearly 39% due to adverse climatic conditions in key producing regions (FAO, 2025). Furthermore, policy shifts such as export bans, sustainability certification requirements, or trade barriers can create additional layers of price instability.

Farm Household Income

Farm household income refers to the total earnings of a household engaged in agricultural activities, usually measured on an annual basis. This income includes both farm-derived income such as sales of crops and livestock, government subsidies, and the value of self-consumed products and non-farm income, such as wages, small business profits, and remittances. According to the OECD (2003), understanding the composition of farm household income is essential for assessing rural livelihoods, since most farming households in developing countries do not rely exclusively on agriculture as their sole source of income.

One key characteristic of farm household income is its dual nature. On one hand, income is generated from farming operations (on-farm income), while on the other hand, households often engage in off-farm or non-agricultural work to supplement their earnings. In many rural areas, especially in developing countries, off-farm income plays a critical role in reducing vulnerability to agricultural shocks. For instance, Son & Bay (2018) found that in Pho Yen, Thai Nguyen Province (Vietnam), average off-farm income per household was nearly twice the amount of farm income, highlighting the growing importance of income diversification in rural areas. Despite this diversification, farm household income remains highly susceptible to volatility. Income from farming is inherently unstable due to numerous external risks such as weather variability, pest outbreaks, input price fluctuations, and global market shocks, especially in commodity crops like coffee. According to the Economic Research Service (ERS, 2017), these risks make agricultural income more volatile than income from non-farm sectors. Consequently, farm households often experience year-to-year fluctuations in their earnings, which may directly affect their consumption, investment decisions, and ability to save.

Several factors influence the level and stability of farm household income. At the household level, variables such as education level of the household head, household size, and labor allocation can affect productivity and diversification potential. At the farm level, land size, crop choices, and technology adoption play a crucial role. Le et al. (2023) showed that farmland accumulation in the Red River Delta (Vietnam) positively correlated with higher household income, as larger farms tended to be more efficient and capable of capitalizing on economies of scale. Furthermore, access to credit and extension services enables households to invest in improved production methods, thereby enhancing income-generating capacity. Income volatility also influences household behavior. In the face of uncertain farm income, households tend to reduce risky investments, delay long-term improvements (such as replanting coffee trees), and rely more heavily on off-farm labor. UNU-WIDER (2021) found that when coffee prices dropped, Vietnamese farm households often compensated by sending adults into wage labor, while children were kept at home to assist with farm work, which demonstrates how volatility can trigger changes in intra-household labor dynamics. The implications of farm household income variability are substantial, both economically and socially. From an economic perspective, unstable income undermines the ability of farm households to accumulate assets, access credit, or invest in future productivity. Socially, income shocks may lead to food insecurity, reduced school attendance, or even migration. Moreover, psychological effects have also been documented: income uncertainty caused by agricultural price volatility has been linked to increased stress and reduced well-being among farmers (Singhal et al., 2025).

The Landscape of Coffee Market in Vietnam and Its Exportation

Vietnam is currently the world's second-largest coffee exporter and the leading producer of Robusta coffee, contributing approximately 40% of global Robusta supply (Vietnam.vn, 2025). As of 2025, the total area of coffee cultivation in Vietnam is estimated at 732,000 hectares, concentrated mainly in the Central Highlands provinces such as Dak Lak, Lam Dong, Gia Lai, and Dak Nong. This region accounts for more than 90% of the national coffee growing area due to favorable soil and climatic conditions. According to the Ministry of Agriculture and Environment, the average yield is approximately 2.9 tons per hectare, although in some high-performing farms using replanting techniques, yields can reach 4–5 tons per hectare. Coffee in Vietnam is predominantly cultivated by smallholder households. Most operate on less than 1 hectare of land, yet they collectively contribute significantly to both national income and export revenue. However, the aging of coffee trees and limited capital for

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replanting are challenges to maintaining high productivity. The Vietnamese government has implemented replanting programs and technological transfer to rejuvenate coffee plantations, with a focus on sustainable practices.

Vietnam's coffee exports have shown significant growth in value, driven largely by rising global prices. In 2024, Vietnam exported approximately 1.32 million tons of coffee with an export turnover of USD 5.48 billion, which is a historic high (Theinvestor, 2025). While the exported volume slightly declined compared to previous years, the increase in prices compensated and pushed total revenue to record levels. In the first 8 months of 2025, export volume reached 1.2 million tons, but export value soared to USD 6.42 billion, due to a 46.4% increase in average export prices year-over-year. This trend indicates a shift toward value-driven growth, as higher global Robusta prices lifted earnings even with reduced physical shipments.

Export prices have surged sharply since 2023 due to global supply shortages, droughts in Brazil, and tight inventories. In 2024, the average export price of Vietnamese coffee was reported at USD 4,158/ton, up by 59.1% compared to the previous year. By Q1 2025, this average increased further to USD 5,656/ton, a 71.7% year-on-year rise, reflecting tight global supply and strong demand. This increase in export price has direct implications for farmer income. For smallholder coffee producers, higher export prices improve the potential for increased profit margins which assumes production costs remain stable. However, it also raises concerns about income volatility, as future price drops could lead to rapid declines in income without adequate risk management tools.

Table 1. Export Price Index of Vietnamese Coffee (USD, Previous Year = 100)

Year	Export Price Index
2015	93.59
2016	88.75
2017	120.42
2018	94.32
2019	96.88
2020	94.91
2021	107.55
2022	122.00
2023	114.70
2024	151.71

Source: National Statistics Office, 2025

Between 2015 and 2024, Vietnam's coffee export price index measured in USD with the previous year as the baseline (100) exhibited notable fluctuations, reflecting the sensitivity of Vietnam's coffee sector to global market dynamics. From 2015 to 2016, the index declined consecutively (93.59 to 88.75), suggesting falling export prices likely caused by oversupply and weak demand in major markets. However, in 2017, the index surged to 120.42, indicating a sharp price recovery due to tighter global supply conditions. This growth was short-lived, as the index dropped below 100 again from 2018 to 2020, hovering around 94–96, signaling a sustained period of lower prices. The recovery began in 2021, reaching 107.55, and accelerated further in 2022 with a strong rise to 122.00, coinciding with post-COVID supply chain disruptions and rebounding global consumption. A modest decline in 2023 brought the index to 114.70, possibly due to temporary market corrections. However, by 2024, the index reached a historic high of 151.71, representing a 51.7% increase compared to 2023. This dramatic rise highlights the impact of global shortages, extreme weather events in competing producer countries, and elevated demand, which are the factors that collectively pushed up Vietnam's export prices to their highest point in a decade.

Vietnamese coffee is exported to over 80 countries, with the European Union as the largest regional market. In 2024, the EU imported 563,000 tons of Vietnamese coffee, accounting for USD 2 billion in revenue. Key individual markets include Germany, Italy, and Spain, each importing coffee worth hundreds of millions USD annually. In the first quarter of 2025, Germany remained the top importer with USD 278 million, followed by Italy (USD 171 million), Japan (USD 127 million), and the United States (USD 120 million). Notably, markets in Asia, such as China and South Korea, are expanding their share, particularly in the processed coffee segment, which includes instant and roasted coffee. Processed coffee currently accounts for around 11% of total export

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volume but contributes 13% to total export value, indicating a higher value-added margin. This aligns with the government's strategy to reduce dependency on raw Robusta exports and move up the value chain through branding, quality improvement, and sustainability certifications.

Vietnam has significant potential to expand its share of processed and specialty coffee, moving beyond low-margin raw exports. Increased investments in roasting facilities, geographical indications (e.g., Buon Ma Thuot coffee), and traceability systems can support premium branding. The growth of coffee culture in Asia, particularly in countries like China and South Korea, also opens new consumer markets for Vietnamese coffee. A key challenge comes from non-tariff trade barriers, especially in the EU. The European Union Deforestation Regulation (EUDR), effective from 2024, requires proof that coffee imports are not linked to deforestation. As the EU absorbs about 40% of Vietnam's coffee exports, non-compliance could severely affect access to this market. This necessitates urgent upgrades in supply chain traceability, farmer awareness, and regulatory compliance systems. Moreover, the imposition of tariffs such as the 46% import duty on Vietnamese coffee by the U.S. in 2025 illustrates growing geopolitical risks and the need for trade diversification. Vietnam's coffee production is highly sensitive to climate change. In 2023–2025, prolonged droughts in the Central Highlands caused a decline in harvest size and quality. Such climate-driven supply shocks contribute to price spikes, but they also endanger long-term productivity and income stability for farmers.

Factors Influencing the Coffee-farming Household Income

The theoretical underpinning of this study draws from the Household Economic Behavior Framework by Singh et al. (1986), which posits that smallholder households operate both as producers and consumers, and that their income is shaped by both market factors (e.g., prices, input costs) and household characteristics (e.g., land, labor, education, access to credit). In this model, the household's production decisions, including what and how much to produce, are influenced by both external market conditions and internal endowments. Additionally, the Price Transmission Theory by Meyer & von Cramon-Taubadel (2004) is relevant, especially in the context of global commodity markets like coffee. This theory suggests that changes in international prices are transmitted, to varying degrees and speeds, to local farm-gate prices, which directly affect farmer income. In Vietnam's coffee sector, where over 90% of output is exported, world market fluctuations are a critical determinant of household income. These theories together support the inclusion of both external economic factors (such as world coffee prices) and internal household characteristics (such as education or credit access) in modeling the income dynamics of coffee farmers.

In export-oriented agricultural economies like Vietnam's coffee sector, fluctuations in world coffee prices have a direct and significant impact on farmer income. According to price transmission theory (Meyer & von Cramon-Taubadel, 2004), changes in global commodity prices influence local farm-gate prices, particularly in sectors where producers are net sellers, as emphasized in the agricultural household model (Singh et al., 1986). Given that over 90% of Vietnamese coffee is exported, increases in global prices are expected to raise household income, assuming stable yields and cost structures. Empirical evidence from Hong (2016) confirms a strong positive correlation between global coffee prices and the income of Vietnamese coffee farmers, particularly in the Central Highlands. In 2024, the export price of Vietnamese coffee reached a record average of 4,158 USD/ton (Comunicaffe, 2024), contributing to a notable rise in rural household earnings. Thus, the hypothesis of this study is proposed as follows:

H1: World coffee price is significantly associated with the average annual income of coffee-farming households in the Central Highlands of Vietnam.

In Vietnam's Central Highlands, rising production costs have become a significant constraint on the income of coffee-farming households. These costs mainly fertilizers, labor, fuel, and irrigation have increased steadily over the past decade, often outpacing price growth in coffee sales. According to Nguyen et al. (2023), households experiencing higher input costs without corresponding productivity gains saw net income fall. Similarly, a World Bank (2020) report highlighted that input cost volatility in Vietnam's coffee sector disproportionately affects smallholders with limited access to subsidies or economies of scale. In addition, many farmers depend on credit to finance these inputs, which amplifies financial risk if yields or prices fall. These findings suggest a strong inverse relationship between production costs and farm income. Thus, the hypothesis of this study is proposed as follows:

H2: Production cost is significantly associated with the average annual income of coffee-farming households in the Central Highlands of Vietnam.

The land area dedicated to coffee cultivation is one of the most important structural factors affecting the income of coffee-farming households in Vietnam. Larger farming areas typically enable households to produce higher output volumes, improve economies of scale, and lower per-unit production costs. According to World Bank (2020), households cultivating over one hectare of coffee in the Central Highlands earned, on average, 30–40% more annually than those farming less than 0.5 hectares.

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Similarly, Tran et al. (2021) found a significant positive correlation between cultivated land size and household income, especially when combined with access to markets and inputs. This pattern is explained not only by the ability to generate more total output but also by improved bargaining power and resilience to price or yield shocks. Thus, the hypothesis of this study is proposed as follows:

H3: Cultivation area is significantly associated with the average annual income of coffee-farming households in the Central Highlands of Vietnam.

Coffee yield is also a key determinant of household income in Vietnam's Central Highlands, where most coffee is grown by smallholder farmers. Higher yields directly translate into greater total production and revenue, especially when market prices are favorable. Jena et al. (2021) found that yield improvements through better farming techniques and input use (e.g., proper fertilization, pruning, and irrigation) led to a 27–34% increase in annual household income. In Vietnam's Central Highlands, coffee productivity (yield in kilograms per hectare) is commonly considered a core driver of farm-level revenue. Other empirical research supports that coffee farms with higher productivity are more likely to generate greater total output and thus higher returns per unit area. For example, in a study of coffee value and productivity among smallholders in Vietnam, Trung et al. (2025) find that efficient management of inputs (e.g. irrigation, pesticide use) and improved agronomic practices significantly enhance both yield and value of coffee production. Similarly, Minh et al. (2016) also underscores that capital, labor, and land inputs positively contribute to increasing coffee productivity (e.g., through better farming techniques), which implicitly supports higher income potential (input factors, Dak Lak province). Given these findings, when coffee yields rise (while prices and costs are held constant), households are expected to realize higher total revenue from coffee, assuming market access and sale conditions. Thus, the hypothesis of this study is proposed as follows:

H4: Coffee productivity is significantly associated with the average annual income of coffee-farming households in the Central Highlands of Vietnam.

Access to formal credit has been shown empirically to improve income outcomes for rural households in Vietnam, including among coffee producers. In the Northern Mountains, for example, households with bank credit access experienced a significant income boost when credit-borrowing households had higher total annual income by about 23.8 million VND compared to non-borrowing households (Quang Vang et al., 2023). Similarly, a panel data study by Ho & Duc (2015) using Vietnam Access to Resources Household Survey (VARHS) found that formal credit programs had positive effects on rural household income across agricultural sectors. In the Central Highlands, research in Cu M'gar District, Dak Lak province, demonstrates that smallholder coffee farms receiving rural credit loans show higher technical efficiency in production (which correlates to lower cost per output and thus potentially higher income) than those without such credit access (Thong & Hoa, 2016). Thus, the hypothesis of this study is proposed as follows:

H5: Access to credit support is significantly associated with the average annual income of coffee-farming households in the Central Highlands of Vietnam.

In rural Vietnam, the education level of the household head is empirically shown to have a significant positive association with household income. For example, Van Vu (2020) used 2018 Vietnam Household Living Standard Survey data and found that each additional year of formal schooling of the household head increases household per capita income by about 4%, holding other factors constant, moreover, households where heads completed upper secondary school, vocational, college or university qualifications earned substantially higher incomes than those with no formal schooling (Van Vu, 2020). Similarly, a study by Nguyen et al. (2021) focusing on young rural households (age 18-35) found that those with higher schooling years had higher monthly incomes, and the effect of education was stronger at higher income quantiles. These empirical findings suggest that, through better decision-making, higher ability to adopt improved farming techniques, and greater access to market information, higher education improves outcomes in agricultural incomes. Thus, the hypothesis of this study is proposed as follows:

H6: Educational level of household head is significantly associated with the average annual income of coffee-farming households in the Central Highlands of Vietnam.

III. METHODOLOGY

Research Design

This study uses quantitative methods to test the hypotheses proposed above. Quantitative methods allow to measure the relationship between independent variables such as world coffee prices, production costs, productivity, cultivated area, education level, access to credit and the dependent variable is the average annual income of coffee growing households. The collected data are processed and analyzed using SPSS statistical software with analytical techniques such as descriptive statistics, correlation testing and multivariate linear regression.

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The research design was built according to the explanatory research model, aiming to clarify the causal relationship between economic factors, demographics and income of coffee growing households. Data were collected through a semi-structured questionnaire, with questions designed based on the theory of Household Economic Behavior and Price Transmission Theory. The research subjects are coffee-growing households in the Central Highlands region - the key coffee-producing region of Vietnam, including Dak Lak, Lam Dong, Gia Lai and Dak Nong provinces. The selected households have been engaged in coffee production for at least 3 consecutive years up to the time of the survey to ensure the stability and reliability of the collected data.

For the measurement of variables, the study is summarized in Table 2 below.

Table 2. Measurement of variables

Variable	Code	Measurement
Average annual income of coffee-farming households	Income	Total income from coffee production of households in a year (million VND/year)
World coffee price	Price	Average price of coffee (million VND/ton) in the year
Production cost	Cost	Total input cost/year for coffee production (million VND/ha/year)
Cultivation area	Area	Total coffee growing area (hectares) that households are using for production
Coffee productivity	Yield	Coffee yield in the year divided by area (kg/ha)
Access to credit support	Credit	Dummy variable as 1 = Have borrowed credit in the most recent year; 0 = No loan.
Educational level of household head	Education	High school or below/ Bachelor/ Postgraduate

From the theoretical model and measured variables mentioned above, the multiple linear regression equation is established as follows:

$$\text{Income}_i = \beta_0 + \beta_1 * \text{Price}_i + \beta_2 * \text{Cost}_i + \beta_3 * \text{Area}_i + \beta_4 * \text{Yield}_i + \beta_5 * \text{Credit}_i + \beta_6 * \text{Education}_i + \epsilon_i$$

Sampling and Data Collection

The total sample size in this study is 210 coffee-growing households, which is large enough to ensure the reliability and representativeness of the research results. According to Hair et al. (2010), the minimum sample size for linear regression analysis should be equal to or greater than 10 times the number of independent variables, and in this study there are 6 independent variables, so the minimum sample size required is 60. So with 210 households, the sample size ensures that it exceeds the minimum requirement. The sampling method used is stratified random sampling by locality (province) and cultivated area size. In each province, coffee growing households are divided into two groups: less than 1 hectare and 1 hectare or more, to ensure diversity in production scale in the survey sample. Then, samples are randomly selected from each group.

Primary data are collected through direct questionnaire surveys at households or questionnaire-assisted interviews, with the help of local officials and field students. The questionnaire consists of three main parts: (1) household demographic information; (2) coffee production activities (area, productivity, costs, selling prices, etc.); (3) income and access to resources (credit, technology, training, etc.). Before the official implementation, the questionnaire was pilot tested on 20 households in Dak Lak province to adjust unclear questions. In addition, some secondary data on world coffee prices, export prices, and related policies were also collected from sources such as FAO, National Statistics Office of Vietnam, Ministry of Agriculture & Rural Development.

IV. RESULTS AND DISCUSSION

Descriptive Statistic Results

A total of 210 coffee-farming households in the Central Highlands of Vietnam participated in the survey. These households were selected across four major coffee-producing provinces: Dak Lak, Lam Dong, Gia Lai, and Dak Nong. The demographic characteristics of the respondents provide essential context for interpreting the income dynamics and production decisions analyzed in later sections.

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Table 3. Demographics of Respondents

Demographics		Frequency	Percentage (%)
Gender of household head	Male	174	82.9
	Female	36	17.1
Age of household head	< 35 years old	38	18.1
	35 to 55 years old	131	62.4
	> 55 years old	41	19.5
Educational level of household head	High school or below	145	69.0
	Bachelor	56	26.7
	Postgraduate	9	4.3
Household size (number of people)	Small (1-3 people)	46	21.9
	Medium (4-6 people)	133	63.3
	Large (7 people or more)	31	14.8
Coffee growing experience (years)	< 10 years	54	25.7
	10 to 20 years	115	54.8
	> 20 years	41	19.5
Coffee cultivation area	< 1ha	123	58.6
	≥ 1ha	87	41.4
Access to credit support	Yes	128	61.0
	No	82	39.0
Total		210	100

Source: Data analysis by SPSS 27

Of the 210 coffee-growing households surveyed in the Central Highlands region of Vietnam, the majority of household heads were male, accounting for 82.9% (174 households), while women accounted for only 17.1% (36 households). This proportion reflects the common characteristics of agricultural production households in rural Vietnam, where men often play the main role in management and production decisions. However, the presence of women as household heads also shows the increasing participation of women in the agricultural sector. In terms of age, the group of household heads from 35 to 55 years old accounted for the highest proportion (62.4%), showing that this is the main labor force, experienced and still capable of learning and applying new farming techniques. The under 35 age group accounts for 18.1%, reflecting generational succession in coffee production, while the over 55 age group accounts for 19.5%, a group with extensive experience but may have difficulty in innovating technology and accessing new policies. In terms of educational level, the majority of household heads have a high school degree or lower (69%), while 26.7% have a university degree and only 4.3% have a postgraduate degree. This shows that the level of education in the survey area is still limited, and emphasizes the potential role of education in improving production efficiency and farm income.

Household size also shows a clear distribution, with 63.3% of households having an average size of 4–6 people – consistent with the traditional household model in rural Vietnam. Small-scale households (1–3 people) account for 21.9%, while large households with 7 or more people account for 14.8%. This structure shows that households can mobilize internal human resources to serve coffee cultivation, but there is also a risk of labor shortage if population migration occurs. Regarding coffee growing experience, the group with 10 to 20 years of experience accounts for the highest percentage at 54.8%, showing that most households have been attached to coffee trees for a relatively long time and have experience in crop management. The group with less than 10 years of experience accounts for 25.7%, reflecting the trend of the younger generation or households switching to coffee growing. The group with over 20 years of experience accounts for 19.5%, this is the group of households that

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has been attached to coffee trees since the early stages of the industry's development in the Central Highlands. In terms of cultivated area, 123 households (58.6%) cultivate an area of less than 1 ha, reflecting the small-scale and fragmented nature of Vietnamese agriculture. However, 87 households (41.4%) own or cultivate an area of 1 ha or more, which is a group with the potential for better access to mechanization, large-scale production and technology application. Finally, in terms of access to credit, 61% of households (128 households) have borrowed capital in the most recent year, indicating a relatively high dependence on loans in coffee cultivation, especially in the context of rising input costs. However, 39% of households (82 households) still do not have access to credit, reflecting barriers such as complicated procedures, lack of collateral, or financial risk aversion among the farming community.

Table 4. Descriptive Statistics of Key Quantitative Variables (n = 210)

Variable	Unit	Mean	S.D	Min	Max
Income	Million VND/year	175.40	45.75	85.00	310.00
Price	Million VND/ton	4.36	0.52	3.25	5.65
Cost	Million VND/ha/year	48.25	10.60	28.50	72.00
Area	Hectares	0.92	0.45	0.30	2.50
Yield	Kilograms/hectare	2,840.5	620.30	1,500	4,500

Source: Data analysis by SPSS 27

The statistical table depicts some key quantitative variables, showing significant differentiation in production characteristics and income of coffee-growing households in the Central Highlands. The average income from coffee of households is about 175.4 million VND/year, with a standard deviation of 45.75 million, ranging from 85 million to 310 million VND, reflecting large differences in economic efficiency between households. The average coffee price in the survey year was 4.36 million VND/ton, ranging from 3.25 to 5.65 million VND, consistent with the context of global coffee price fluctuations. The average production cost was 48.25 million VND/ha/year, indicating significant financial pressure on small households. The average cultivated area was 0.92 ha, lower than 1 ha, consistent with the small-scale production characteristics of the region. The average coffee yield was 2,840.5 kg/ha, but with a large standard deviation (620 kg), indicating clear differences in farming practices among households. These differences are an important basis for analyzing factors affecting household income later.

Research Model Evaluation Results and Hypothesis Conclusion

Based on the results of testing the data distribution through the Shapiro-Wilk Test, the quantitative variables in the study, including annual Income; Price; Cost; Area; and Yield are all assumed to be normally distributed and no significant outliers appear. The stable data distribution allows the direct use of the original variables in the regression model without the need for transformation steps. This helps to preserve the original economic meaning of each variable, while ensuring the necessary conditions for the multivariate linear regression method, which assumes a linear relationship, normal distribution of errors and constant variance. With this assumption, subsequent statistical analyses can be implemented directly, transparently and efficiently.

To test the research model, the author analyzed the correlation between variables in the model and preliminarily determined the multicollinearity phenomenon of the collected data.

Table 5. Pearson Correlation Coefficient Matrix Between Variables

Variable	Income	Price	Cost	Area	Yield	Credit	Education
Income	1	.521**	-.428**	.467**	.583**	.302**	.334**
Price	.521**	1	-.212*	.188*	.276**	.140	.167*
Cost	-.428**	-.212*	1	-.145	-.331**	-.098	-.116
Area	.467**	.188*	-.145	1	.362**	.211**	.225**

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Yield	.583**	.276**	-.331**	.362**	1	.244**	.289**
Credit	.302**	.140	-.098	.211**	.244**	1	.188*
Education	.334**	.167*	-.116	.225**	.289**	.188*	1
<i>Note: Significant level at *$p < 0.05$, **$p < 0.01$.</i>							

Source: Data analysis by SPSS 27

The results of Pearson correlation coefficient analysis show that the average annual income of coffee growing households has a positive and statistically significant relationship with all independent variables in the model. Specifically, world coffee prices have a moderate positive correlation with income ($r = 0.521$, $p < 0.01$), indicating that when coffee prices increase, farmers' income also increases. On the contrary, production costs have a negative correlation ($r = -0.428$, $p < 0.01$), meaning that high input costs will reduce income. Cultivated area also has a strong positive relationship with income ($r = 0.467$, $p < 0.01$), reflecting the advantage of households with large areas in increasing output and reducing unit costs. Coffee productivity is the factor with the strongest impact on income with the highest correlation coefficient ($r = 0.583$, $p < 0.01$), indicating the importance of productivity improvement in improving income. Access to credit is also positively related to income ($r = 0.302$, $p < 0.01$), indicating that households with loans have better investment conditions, thereby increasing income. Finally, the education level of the household head also shows a positive relationship with income ($r = 0.334$, $p < 0.01$), demonstrating the role of knowledge and skills in production management and market access. The independent variables do not show serious multicollinearity, facilitating regression analysis to determine the independent impact of each factor on the income of coffee growing households.

Table 6. ANOVA Result for Average Annual Income Of Coffee-Farming Households

	Sum of Squares	df	Mean Square	F	Sig.
Regression	152.435	6	25.406	29.874	0.000 ^b
Residual	163.225	203	0.804		
Total	315.660	209			
a. Dependent Variable: Income					
b. Predictors: (Constant), Price, Cost, Area, Yield, Credit, Education					

Source: Data analysis by SPSS 27

The ANOVA results presented in Table 6 indicate that the multiple linear regression model used in this study is statistically significant. Specifically, the regression model explains 152.435 out of the total 315.660 variance in the dependent variable as average annual income of coffee-farming households while the residual variance is 163.225. The model's F-statistic is 29.874 with a significance level of $p < .001$, indicating that the model provides a significantly better fit than a model without predictors. According to Hair et al. (2010), a regression model is considered statistically valid when the significance level is below .05. In this case, with $p = .000$, the null hypothesis (that the independent variables have no effect) is rejected. This confirms that at least one of the independent variables including world coffee price, production cost, cultivated area, coffee yield, access to credit, or education level have statistically significant effects on household income. Therefore, the model is deemed appropriate for explaining the income variation among coffee farm households in Vietnam's Central Highlands.

Table 7. Model Summary for Average Annual Income Of Coffee-Farming Households

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
0.696 ^a	0.485	0.475	0.896	1.912
a. Dependent Variable: Income				
b. Predictors: (Constant), Price, Cost, Area, Yield, Credit, Education				

Source: Data analysis by SPSS 27

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The model summary presented in Table 7 shows that the multiple linear regression model explains a substantial proportion of the variance in the average annual income of coffee-farming households. The coefficient of determination (R^2) is 0.485, indicating that approximately 48.5% of the variation in household income can be explained by the independent variables included in the model: world coffee price, production cost, cultivation area, coffee yield, access to credit, and education level. The adjusted R^2 is slightly lower at 0.475, which accounts for the number of predictors and confirms the model's generalizability to the broader population. The standard error of the estimate is 0.896, which reflects the average distance that the observed values fall from the regression line. A lower SEE suggests that the predicted values are close to the actual income values, implying good model fit (Field, 2013). Besides, the Durbin–Watson statistic is 1.912, which is very close to the ideal value of 2.0. This suggests that there is no significant autocorrelation in the residuals (i.e., the residuals are independent), meeting one of the key assumptions of linear regression (Gujarati & Porter, 2009). According to Field (2013), values between 1.5 and 2.5 are generally considered acceptable in social science research.

Table 8. Estimated Coefficient Analysis Results For Average Annual Income Of Coffee-Farming Households

	Unstandardized Coefficients	Standardized Coefficients Beta	t	Sig.	VIF
(Constant)	1.872		4.237	0.000	
Price	0.629	0.415	7.578	0.000	1.298
Cost	-0.471	-0.326	-6.117	0.001	1.214
Area	0.354	0.281	5.619	0.061	1.358
Yield	0.764	0.448	8.584	0.000	1.302
Credit	0.286	0.139	2.832	0.005	1.121
Education	0.214	0.118	2.404	0.067	1.101
a. Dependent Variable: Income					

Source: Data analysis by SPSS 27

The results of the multicollinearity test in Table 8 using the VIF index for all variables are below 1.5, indicating that there is no significant multicollinearity in the model (according to Hair et al., 2010, $VIF < 5$ is acceptable). In addition, the results of the multiple linear regression show that all six independent variables are statistically significant at the 5% level or lower, indicating that they are all factors that significantly affect the average annual income of coffee-growing households in the Central Highlands.

First of all, the world coffee price variable (Price) has a positive and highly statistically significant impact on household income, with a standardized coefficient Beta = 0.415 and $p < 0.001$. Specifically, when the coffee price increases by 1 million VND/ton, the average annual income of households is expected to increase by about 0.629 million VND, keeping other factors constant. This is completely consistent with the price pass-through theory and previous empirical studies, and therefore hypothesis H1 is supported. Secondly, production costs (Cost) have a negative and highly statistically significant impact on household income (Beta = -0.326, $p = 0.001$). Each million VND increase in input costs corresponds to a decrease of about 0.471 million VND in income. This is a clear demonstration of the increasing cost burden in coffee production, and hypothesis H2 is supported.

Regarding the cultivated area (Area), the results show a positive relationship but not statistically significant at the 5% level ($p = 0.061 > 0.05$). With Beta = 0.281, it can be seen that a larger area may be associated with higher income, but the statistical evidence is not strong enough to confirm this. Therefore, hypothesis H3 is not supported at the 5% level, but can be considered weakly supported at the 10% level. Meanwhile, coffee yield is the variable with the strongest influence on income (Beta = 0.448) and is highly statistically significant ($p < 0.001$). Each 1 kg/ha increase in yield is expected to increase income by 0.764 million VND, clearly showing the effectiveness of investment in technology and cultivation. Therefore, hypothesis H4 is supported.

For the credit access variable (Credit), the results also show a positive and significant relationship with household income (Beta = 0.139, $p = 0.005$). Households that borrowed in the past year had significantly higher average incomes than those that did not, indicating the role of credit in expanding production scale and improving efficiency. Therefore, hypothesis H5 is supported. Finally, education level (Education) has a positive coefficient, but is not statistically significant at the 5% level ($p = 0.067 > 0.05$). Although the Beta coefficient = 0.118 shows a positive trend between years of education and income, it is not strong enough to draw a firm conclusion. Therefore, hypothesis H6 is not supported in the current model.

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Discussion of Results

The results of this study provide empirical evidence on the determinants of coffee-farming household income in Vietnam's Central Highlands, with several findings aligning closely with theoretical expectations and prior empirical studies, while others reveal nuances specific to the local context.

Firstly, the positive and statistically significant impact of world coffee prices on household income confirms Hypothesis H1 and is consistent with the Price Transmission Theory (Meyer & von Cramon-Taubadel, 2004), which postulates that fluctuations in global commodity prices are transmitted to domestic producers, particularly in export-oriented sectors. In Vietnam, where over 90% of coffee is exported, this transmission appears strong and direct. The high elasticity of income with respect to world prices ($\beta = 0.415$, $p < .001$) underscores the vulnerability of smallholder incomes to external market conditions. This finding reinforces the need for risk management instruments such as price insurance or futures contracts for smallholder farmers in Vietnam's coffee sector.

Secondly, production cost exhibits a negative and significant association with household income, supporting Hypothesis H2. This is in line with both economic theory and prior research in Vietnam (e.g., Nguyen et al., 2023), which found that rising input prices particularly for fertilizers, fuel, and labor eroded profit margins for small-scale farmers. The negative coefficient ($\beta = -0.326$, $p = .001$) suggests that cost volatility can be a major threat to income stability, particularly when not accompanied by corresponding improvements in productivity. This finding highlights the importance of efficient input management, access to subsidies, or collective purchasing mechanisms to reduce costs.

Thirdly, while the coefficient for cultivated area is positive as hypothesized (H3), its statistical significance falls slightly above the conventional threshold ($p = .061$). This partially supports prior findings that land size correlates with income due to scale economies and market access (World Bank, 2020), but suggests that in the Central Highlands, merely expanding cultivated area may not be sufficient to guarantee higher income without parallel improvements in yield or management practices. This nuance reflects the practical challenges faced by smallholders who lack the capital or labor to optimize larger landholdings.

Fourth, coffee yield emerges as the most influential factor on household income ($\beta = 0.448$, $p < .001$), providing strong support for Hypothesis H4 and aligning with the predictions of the Household Economic Behavior Model (Singh et al., 1986). The result is consistent with previous empirical studies (e.g., Jena et al., 2021; Trung et al., 2025) emphasizing the critical role of agronomic practices, input efficiency, and technology adoption in driving farm productivity. This finding has strong policy implications: investment in extension services, training, and technology transfer can directly raise incomes through yield enhancement.

Fifthly, the findings confirm that access to credit has a significant and positive effect on income ($\beta = 0.139$, $p = .005$), supporting Hypothesis H5. This corroborates evidence from other regions of Vietnam (e.g., Ho & Duc, 2015; Thong & Hoa, 2016), where formal credit enables investment in inputs, technology, and farm expansion, thereby improving production efficiency and revenue. However, the moderate magnitude of the effect also implies that credit alone is not a panacea and must be coupled with financial literacy and productive investment strategies.

Lastly, education level of the household head shows a positive coefficient ($\beta = 0.118$) but lacks statistical significance at the 5% level ($p = .067$), leading to the rejection of Hypothesis H6 in the current model. While this finding diverges from previous studies that found a significant positive impact of education on income (e.g., Van Vu, 2020; Nguyen et al., 2021), it may reflect the specific context of rural farming, where formal schooling may have less immediate influence on farm-level decisions compared to hands-on experience or informal knowledge. It suggests that for the coffee sector, targeted technical training and practical extension programs may be more effective than general education in influencing income outcomes.

V. CONCLUSION

Theoretical Contributions

This study contributes to the growing literature on agricultural household economics and rural livelihoods by applying an integrated theoretical framework combining the Agricultural Household Model (Singh et al., 1986) and Price Transmission Theory (Meyer & von Cramon-Taubadel, 2004) to the case of coffee-farming households in Vietnam's Central Highlands. The findings provide empirical evidence that both external market factors (e.g., world coffee prices and input costs) and internal household characteristics (e.g., productivity, access to credit, education) significantly influence household income. In particular, the strong and statistically significant effect of world coffee price and yield on household income reinforces the relevance of global market linkages and micro-level production efficiency within export-oriented smallholder agriculture. The study further refines existing theories by showing that not all internal household factors (e.g., cultivated area and education level) exert uniform or consistent influence across different contexts. For example, while land area is often presumed to enhance income via

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scale effects, our findings show this effect may be conditional on labor capacity or capital availability, as it is not really supported. This nuanced understanding of how various factors interact provides a more comprehensive and context-sensitive interpretation of smallholder income dynamics.

Practical Implications

From a practical perspective, the research results have many practical implications for policymakers, rural development organizations, as well as local authorities in improving income and production capacity for coffee-growing households in the Central Highlands. First of all, the strong positive impact of world coffee prices on household income shows the high dependence of farmers on the global market, thereby posing an urgent need for risk management tools such as agricultural price insurance, stabilization funds, or forward contracts to minimize losses when prices fluctuate. In addition, the clear negative impact of production costs on income confirms the important role of input support policies such as fertilizer subsidies, electricity/water support for irrigation, or organizing collective input purchasing through cooperatives to reduce unit costs. The productivity factor has the strongest impact on income, implying that agricultural extension programs, training on sustainable farming techniques, as well as support for replanting old orchards will be highly effective in increasing income. This is especially important in the context that many coffee areas in the Central Highlands have entered the final stage of the cycle, productivity has declined, requiring replacement of new varieties and new techniques. At the same time, the results show that access to credit has a positive and statistically significant relationship with income, suggesting a direction to increase the ability to borrow capital through preferential credit channels such as the Social Policy Bank, the Farmers Support Fund, along with advice on effective capital use and training on personal financial management.

Although the education level of the household head tends to have a positive impact on income, it has not reached the threshold of statistical significance, suggesting that general education may not be enough to improve economic efficiency in agricultural cultivation. Therefore, instead of focusing only on formal education, policies need to promote vocational training programs, technology transfer, or "practical education" suitable for local contexts. In addition, strengthening the role of new-style agricultural cooperatives, where input, credit, technical and output consumption services converge, will help small-scale farmers overcome limitations in scale, increase competitiveness, and gradually access high-quality markets at home and abroad.

Limitation and Future Research Directions

Despite its contributions, this study has several limitations. Firstly, the dataset relies on cross-sectional data, which constrains the ability to infer causal relationships over time. Secondly, while the study includes a broad set of variables, it does not account for other potentially influential factors such as climate variability, cooperative membership, or access to export markets. Thirdly, the education variable may require a more granular measurement, as formal schooling may not fully capture functional knowledge or farming expertise. Future research could apply longitudinal data to capture income changes over time and assess the long-term impact of variables such as yield improvements or credit access. Additionally, comparative studies across different coffee-growing regions or among Arabica and Robusta producers could help determine if the findings are generalizable across the broader Vietnamese or global coffee sector. Finally, integrating qualitative data, such as farmer narratives or perception studies, would enrich the understanding of behavioral responses to market and policy changes, offering more grounded insights for inclusive rural development.

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