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Abstract

Poverty remains a substantial threat in rural areas of many developing countries, and solving this problem requires an in-depth understanding of the income generating capacity that determines poverty. This paper examines the impact of agricultural commercialization on the capability of rural households to accumulate assets and on structural and multidimensional poverty. A longitudinal dataset of around 2000 households with a total of 9781 observations from five rural surveys undertaken in the period 2008 - 2017 in Vietnam is used. Results from a fixed effects regression with an instrumental variable and a control function approach show that agricultural commercialization has a positive effect on the accumulation of assets and reduces multidimensional and structural poverty over time. However, the effect is not homogeneous and larger for households not mainly engaged in rice commercialization. This suggests that commercialization can be a path out of poverty, especially if policy makers move towards utilizing other crops instead of rice.

Keywords: Asset growth; Asset-based income; Commercialization; Fixed effects; Instrumental variable; Control function

JEL: C21, I32, Q12, Q13

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1 Introduction

Within the last decades, the global community has achieved considerable poverty reductions. In 2015, 736 million people lived in poverty, with less than US$ 1.90 per day in 2011 purchasing power parity (PPP), compared to 1990 when this figure amounted to 1.9 billion (World Bank (WB), 2018). However, the progress has been uneven among countries and regions. Poverty is still much more prevalent and severe in rural areas of the developing world (Food and Agricultural Organization (FAO), 2018). Moreover, since 2014, the number of hungry people worldwide has increased by about 60 million, and about two billion people experienced hunger or did not have regular access to nutritious and sufficient food in 2019. This increase in the number of undernourished people is primarily attributed to the greater number of conflicts and climate-related shocks or economic slowdowns (FAO, 2020). These figures indicate that the world is not on track to end hunger by 2030, and that further actions are necessary to build on the success made in the past and to reach the sustainable development goal of zero hunger.

One of the channels for rural households in developing countries to escape poverty is the enhancement of income generating capacity through agricultural commercialization, which is commonly understood as a shift from subsistence to a more market-oriented production based on market signals (Zhou et al., 2013). The level of commercialization can range from the sale of surplus production after subsistence consumption up to the complete sale of production. Theoretically, commercialization can have various effects on poverty reduction. From a microeconomic perspective, commercialized households may have higher income which can be used to increase their food security and nutrition intake. Additionally, higher trade volumes and an improved coverage of markets can reduce volatility and counteract food shortages in difficult times for both agricultural and non-agricultural households (Carletto et al., 2017). Furthermore, increased trade and food supply may lead to a reduction in prices benefiting the poor the most, as they are often net food buyers (de Janvry and Sadoulet, 2009). From a macroeconomic perspective, unemployment can be reduced due to an increased demand for labor on fields as households shift their production to please market demand. This benefits mostly unskilled job seekers with little or without any farmland. Following initial investment in agriculture, second-round investment in non-farm activities can create new job opportunities, especially in the storage, transportation, and farm input industries. Higher demand might bring about spillover effects caused by an expansion of market infrastructure which in turn

benefits the commercialization of households (Govereh and Jayne, 2003). However, due to market imperfections, commercialization can also carry a risk for rural households, possibly expose them to volatile prices and increase the risk of land degradation by extensive use of fertilizers (Pingali, 2001). Unfortunately, agricultural commercialization does not offer a solution for poverty reduction for everyone in rural settings, as constricted access to credits and markets, high transaction costs and limited size and quality of land can hinder a change towards a more market-oriented way of production (Fischer and Qaim, 2012; Amare et al., 2019).

In this regard, a general understanding of how commercialization can affect poverty of rural households in the developing world is important to provide policy makers with useful information for reducing poverty and fostering rural transformation and economic growth. Several research questions are derived and addressed in this paper. The first is whether commercialized households are better off in terms of asset-based income than non-commercialized households. The second is whether commercialization affects the accumulation of assets and therefore prevents households from falling into structural poverty. The last question is if commercialization reduces multidimensional poverty.

We use an unbalanced panel dataset of about 2000 farm households in rural Vietnam during a ten-year period, 2008-2017, to investigate these questions. This choice is motivated by multiple factors. First, poverty is still more prevalent in Vietnam's rural areas. Second, the agricultural sector has been considered an important engine for Vietnam's structural transformation in general, and particularly for agricultural transformation. Last, the study period covers the aftermath of major policy developments still shaping the nature of Vietnam's agricultural sector, including the accession of the country to the WTO in 2007, and the food crisis of 2007/2008. All these factors warrant a closer inspection of the welfare effects of a shift from subsistence to commercialized agriculture within the dynamic environment of a fast-growing, lower middle-income country.

This motivation is complemented by several methodological considerations. To overcome the limitations of solely income-based poverty indicators, we identify structural poor households based on the income-generating capacity of the assets they own or access. Moreover, a multidimensional poverty index is included in the analysis. We employ different estimation specifications to address potential issues of endogeneity, which are

discussed in detail. These specifications include a fixed effects (FE) model, a FE model with a control function (CF) approach, a FE model with instrumental variables (FE-IV), and a FE-IV model with a CF approach. The results point to the plausibility of our considerations.

The rest of the paper is organized as follows. Section 2 provides background information on agriculture and poverty in Vietnam and reviews relevant literature. Section 3 describes the data. Section 4 presents the methods for our analysis. Section 5 presents the results and discusses the findings. Section 6 concludes.

2 Background information

2.1 Agriculture and poverty dynamics in Vietnam

Before 1986, the Vietnamese economy was agriculture-based and dominated by a system of state-owned farms and cooperatives (Nguyen et al., 2021). To overcome the resulting status as one of the poorest countries in the world, policy makers strove for a more market-oriented economy with the renovation policy package *Doi Moi*. One of the major reforms was the liberalization of the agricultural sector, including the distribution of cropland to farmers, the removal of price controls for farm inputs and outputs, and the legalization of private enterprises. The distribution of cropland to farm households was achieved through the process of de-collectivization of the agricultural sector (see Nguyen et al., 2016 for a detailed review). In 2003, farmland markets were officially allowed to operate despite several administrative barriers (Huy and Nguyen, 2018). Necessitated by the accession of Vietnam to the World Trade Organization in 2007, remaining price controls of key farm inputs such as chemical fertilizers and farm outputs such as rice were relaxed, and private firms and enterprises were allowed to operate in all sectors of the economy. As a result of *Doi Moi* and subsequent liberalization initiatives, Vietnam developed from one of the poorest countries with recurring food shortages to one of the biggest rice exporters in the world (Fortier and Trang, 2013; Nguyen, 2019). Although the share of the agricultural sector in the national gross domestic product (GDP) decreased from 39% in 2000 to 15% in 2018 (WB, 2019), the absolute value of agricultural production has been growing by 3.7% per year (Cazzuffi et al., 2020). However, the agricultural sector is still faced with several challenges. These include the use of a high share of the labor force, low labor productivity, and a small average farm size (Nguyen et al., 2021). In 2012, around 47% of the labor force was engaged in the sector, generating less than 20% of the national GDP.

This put Vietnam in the group of countries with the lowest agricultural labor productivity. The average farm size is about one hectare (ha), among the smallest in the world (WB, 2016). Another key obstacle for a further successful commercialization of agricultural activities is the continued prioritization of rice production by the Vietnamese government. Mainly motivated by food security concerns induced by the food price spikes in 2007/2008 and the continued importance of rice as staple crop, large farmland areas are still designated for rice production. The paddy field designation policy restricts the conversion of paddy fields from rice to other crops (Huy and Nguyen, 2019) and rice export controls persist, despite the fact that by the mid-2010s, rice contributed only 7% of the national GDP and 2% of export revenue (Cramb, 2020, p. 444). The goals of sustaining 3.8 million ha of paddy (rice) land and the restriction upon the conversion of paddy land are manifested in resolution No. 63/NQ-CP dated 23/12/2009 (Hoang et al., 2021). Despite a surplus of rice production for domestic consumption, the Vietnamese government still aims at maintaining a paddy land area of 3.5 million ha, as indicated in Resolution No. 34/NQ-CP dated 25/03/2021 (amendment of Resolution No. 63/NQ-CP above). This is in stark contrast to the empirical evidence regarding the role of rice. Due to rapid economic growth and urbanization (see Amare and Hohfeld, 2016), the demand in other crops, especially vegetables, has increased. As income from rice is generally lower than that from other crops (Hoang and Vu, 2021; Markussen et al., 2011), and rice apparently fails to deliver the benefits of other (cash) crops to farmers (Hoang et al., 2021), several recent studies have suggested the government remove restrictions on the conversion of land for paddy rice to land for other crops (Hoang and Vu, 2021; Hoang et al., 2021).

Due to Vietnam's rapid economic growth, the headcount poverty ratio fell from 20.7% in 2010 to 9.8% in 2016 (Huy and Nguyen, 2019). While these achievements may be substantial, they are not homogenously distributed. The income-based poverty headcount ratio in rural areas fell from 27% in 2010 to 13.6% in 2016, while that in urban areas decreased from 6% to 1.6%. 94.7% of the poor reside in rural areas (WB, 2019), where agriculture remains one of the most important income sources (Benjamin et al., 2017). Moreover, the results of poverty reduction in some rural areas are unsustainable, as households frequently fall back into poverty (OPHI, 2018; UNDP, 2018; Ho et al., 2022). Overall, these poverty developments, combined with the contrasting forces of increased liberalization and persisting restrictions, make for a highly dynamic environment. This is

reflected in the discussion of the development of commercialization at household level in section 3.2, and the methodology presented in sections 4.1 and 4.2.

2.2 Literature review

The impact of agricultural commercialization on rural households' income and poverty reduction has been studied extensively, with mixed evidence. Granja and Wollni (2017) find no significant effect of commercialization on income, while Ogutu and Qaim (2019) present evidence that commercialization increases per capita income and decreases multidimensional poverty, with stronger effects on income poverty than on multidimensional poverty. Ogutu et al. (2020) argue that commercialization contributes to food security and improves the nutrition status of rural households due to increased income, while in contrast, Carletto et al. (2017) do not find any effects of commercialization on nutrition intake in several African countries. Ntakyo and van den Berg (2019) identify a negative effect of income increases caused by commercialization on nutrition intake, as households shift their expenses from food purchases to non-food products. Tipraqsa and Schreinemachers (2009) conclude that households that focus primarily on cash crops are extremely exposed to price volatility, which affects their food security negatively. The evidence on the indirect effects of commercialization has produced similarly mixed results. Govereh and Jayne (2003) find that commercialization affects households indirectly by increasing second-round investments and decreasing poverty through developing the residential area of the households. However, Tipraqsa and Schreinemachers (2009) point to land degradation resulting from an overuse of chemicals and fertilizers accompanying an increase in crop productivity.

This paper aims at addressing the shortcoming of previous research along three major points, which leads to the following contributions. First, many previous studies use income and consumption thresholds as short-term measures of poverty. This approach has the disadvantage of failing to distinguish between the structural poor and those who are classified as poor because they fell below the poverty line at the time of observation (Carter and May, 2001; Carter and Barrett, 2006). Do et al. (2019) and Nguyen et al. (2020) show that holding assets can help overcome fluctuation in income and consumption. Cazzufi et al. (2020) show that commercialization positively influences asset accumulation, but not income. Because they also identify a short-term negative effect on food consumption, the net welfare effect of commercialization remains unclear. They also fail to discuss how

exactly an increase in the asset index translates into long-term benefits. To more precisely identify the mechanisms at play, we replace their asset index based on factor analysis with asset-based expected income (ABI). This metric allows us to distinguish between two types of households: Those whose earnings are expected to fall short of the income poverty line and actually do so, the structural poor; and those whose earnings are expected to exceed that income, but fail to do so due to unanticipated events, the stochastic poor. Assessing the effects of commercialization on ABI and structural poverty therefore complements and extends previous studies on the topic. Second, most previous studies use monetary poverty indicators which might fail to describe the actual situation faced by households. Even though these might be capable of generating sufficient income to purchase food, educational and health services as well as sanitation may potentially still be unavailable (Alkire and Foster, 2011). To shift the focus from a monetary dimension to a broader perspective of human well-being, we use an adjusted multidimensional poverty index (MPI) approach (Alkire and Santos, 2014) to provide a more comprehensive insight on the effect of commercialization on poverty reduction. As the MPI has been developed relatively recently and requires the collection of a broad array of data, research on the commercialization-multidimensional-poverty nexus has been scarce. Ogutu and Qaim (2019) identify positive effects of commercialization in a cross-section of Kenyan farmers, but to the best of our knowledge, there is no similar research using panel data as of now. Finally, the paper aims at an extensive and comprehensive combination of methods that can be employed to estimate the effect of commercialization on both asset growth and multi-dimensional poverty. This analysis is facilitated by the use of a long-term panel covering five waves from 2008 to 2017. Such data have been known to enable addressing unobserved sources of heterogeneity that possibly lead to estimation bias, and multicollinearity (Hsiao, 1985; Baltagi and Song, 2006). In methods section 4.3, a detailed overview of possible sources of endogeneity is provided. Subsequently, it is described how accounting for these concerns leads to the use of several distinct FE, IV, and CF estimators.

3 Data source and description

3.1 Data source and commercialization measures

The data for this study are from five rural survey waves undertaken within the research project "Thailand Vietnam Socio-economic Panel (TVSEP)"[1]. This project is funded by the German Research Foundation (DFG) to establish a long-term socioeconomic panel for examining socio-economic changes in these two emerging economies (Klasen and Waibel, 2015). In Vietnam, the project focuses on agriculture and rural poverty, and thus three rural provinces (Ha Tinh, Thua Thien Hue, and Dank Lak) are selected. As becomes apparent from table 1, the three provinces represent the rural population of Vietnam in terms of income and poverty. This can be attributed to the fact that they display low average per capita incomes, a high dependence on agriculture, and poor infrastructure (Nguyen et al., 2017). Ha Tinh and Thua Thien Hue are along the central coast, while Dak Lak is located in the Central Highlands, the most important coffee producing region of Vietnam (Nguyen et al., 2020).

Table 1: Income and multidimensional poverty headcount ratio by residence, province, and year

	Income Poverty					Multidimensional Poverty	
	2008	2010	2012	2014	2016	2016	2017
Whole country	13.4	14.2	11.1	8.4	5.8	9.2	7.9
Rural	16.1	17.4	14.1	10.8	7.5	11.8	10.8
Northern Central Area and Central coastal area	19.2	20.4	16.1	11.8	8.0	11.6	10.2
Ha Tinh	26.5	26.1	20.7	15.6	11.0	12.5	10.9
Thua Thien-Hue	13.7	12.8	8.9	6.0	3.7	7.3	6.5
Central Highlands	21.0	22.2	17.8	13.8	9.1	18.5	17.1
Dak Lak	21.3	21.9	17.3	12.6	7.3	15.4	13.5

Source: GSO (2022).

The procedure of data collection follows the guidelines of the United Nations Department of Economics and Social Affairs (UN, 2005). First, sampled communes were selected based on the size of the population. In the following, two villages per commune were selected, also based on the size of the population. Lastly, ten households in each sampled village were randomly chosen with equal probability. The predetermined sample includes 2200 households in 220 villages. The surveys were undertaken from May to June each year. All enumerators had previous experience in conducting household surveys and were trained intensively before the surveys took place. Each enumerator conducted face-to-face interviews at the household homes. An interview took two hours on average. Data recorded in the questionnaires were cross-checked by other enumerators and then by the team

[1] For more information, see www.tvsep.de, the survey instruments are also available from this page.

leaders at the end of the day for consistency and plausibility. In case of implausible or missing data, the responsible enumerator had to collect the information during another visit to the household, or by phone. There have been six survey waves in 2007, 2008, 2010, 2013, 2016 and 2017. In 2007, asset values were not captured.

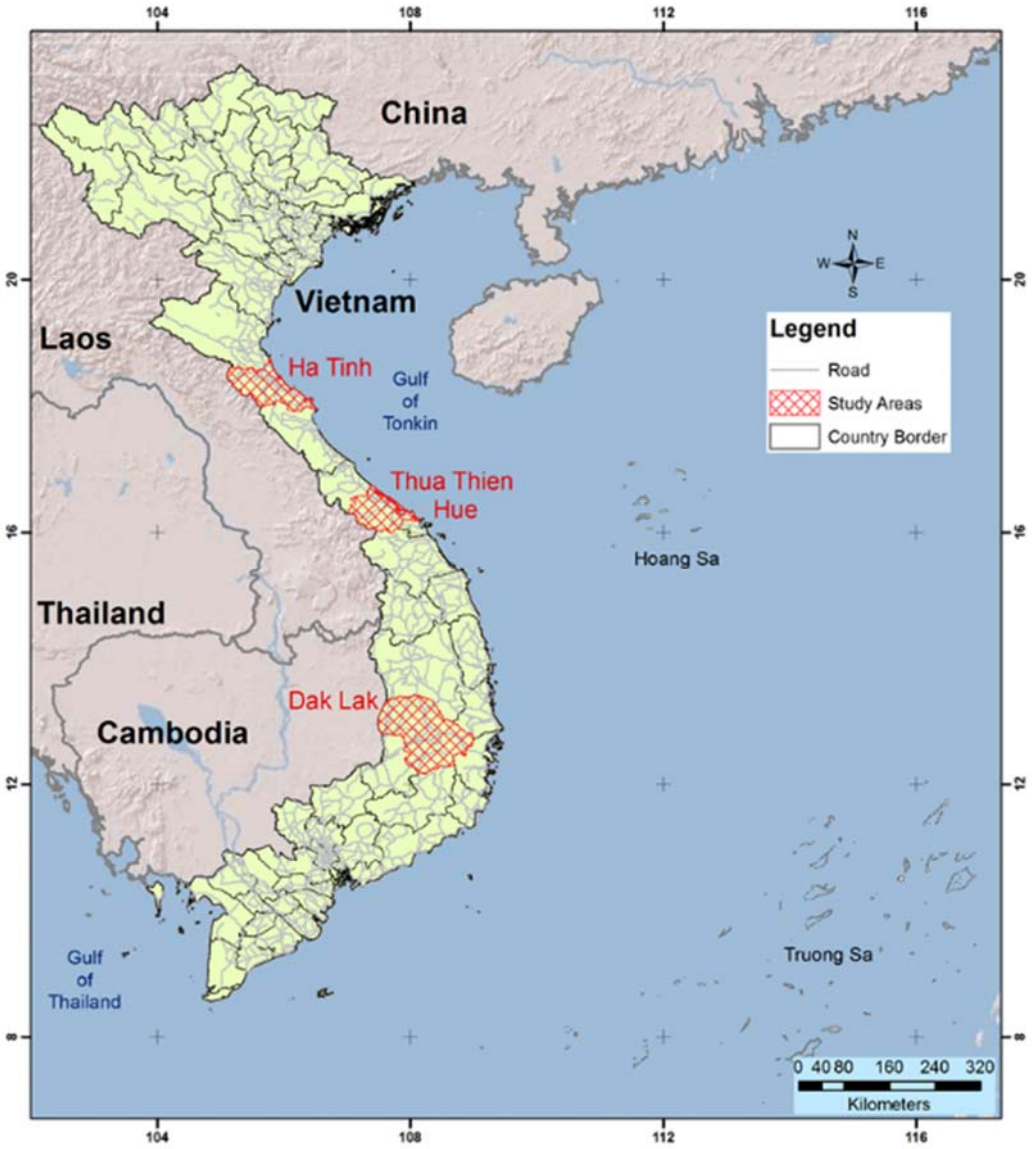

Figure 1: Map of selected provinces as our study sites in Vietnam (Source: Nguyen et al. 2021)

Two survey instruments were used to collect data at the village and household level. A village questionnaire was designed to interview village heads about specific village location, economics, infrastructure, and social structure endowments. The household questionnaire documents many aspects of household demographic characteristics,

production and consumption. A specific section was designed for agricultural production, including sales and home consumption. This study uses data of agricultural households from five survey waves from 2008 to 2017. The number of rural households in each survey wave is 2117 in 2008, 2084 in 2010, 1978 in 2013, 1789 in 2016, and 1803 in 2017. Among these, 1666 households are in all five waves, accounting for 77.85% of households and 85.17% of observations. The sample includes a total of 9781 observations of rural households, and 2140 different households. The balanced sub-panel and the remaining households did not show significant differences in the main variables apart from multidimensional poverty (see Appendix 22).

To reflect the continued emphasis of government policies on the cultivation of rice, and the simultaneously growing importance of cash crops, we compute two measures of commercialization, one for all crops and the other for rice only as follows:

$$CI_{it} = \frac{Gross\ Value\ Sold\ on\ Market_{it}}{Gross\ Value\ of\ Crop\ Production_{it}} \quad (1)$$

$$RCI_{it} = \frac{Gross\ Value\ of\ Rice\ Sold\ on\ Market_{it}}{Gross\ Value\ of\ Rice\ Production_{it}} \quad (2)$$

where CI is the commercialization index (including rice), and RCI is the rice commercialization index of household i in year t. CI and RCI range from zero (the household has sold none of its agricultural output/rice), to one (the household has sold all of its agricultural output/rice).

We divide the surveyed households into two groups: the non-commercialized group (NoCI or NoRCI) without any sales, and the commercialized group (CI or RCI). For the commercialized group, we further identify a subgroup of the households who sold less than 25% of their total production (CI25 or RCI25), and another subgroup containing those who sold more than 75% of their total production (CI75 or RCI75). This division into two additional subgroups is based on the argumentation of Ogutu and Qaim (2019) that households who sell less than 25% or more than 75% of their total production might follow a different income generating strategy than medium level commercialized households. To calculate the values of production and sold output, the district-level average price by crop was used to circumvent endogenous bias resulting from household heads who might fail to remember the prices or due to other unobserved circumstances such as the preferred market for a transaction (Ogutu and Qaim, 2019). The average prices only differ slightly from farm gate prices available in the data.

3.2 Data description

Tables 2 (for CI) and 3 (for RCI) present the summary statistics of several household and farm characteristics for 2008 and 2017 (summary statistics for 2010, 2013, and 2016 in Appendices 1, 2, and 3, respectively; differences in the variables of interest between 2017 and 2008 in Appendix 4, and Summary statistics of assets held by households in appendix 5). The CI slightly increases over the years up to the point where commercialized households sell on average 67% of their production in 2017, while RCI increases from 44% to 50%. This general trend towards commercialization corresponds to the policy developments on the national level. On average, the CI25 group has sold 13%-17%, while the CI75 households have sold 85%-93% of their total production.

Table 2: Summary statistics by level of agricultural commercialization (2008-2017)

	2008				2017			
Household characteristics	**NoCI**	**CI**	**CI25**	**CI75**	**NoCI**	**CI**	**CI25**	**CI75**
Commercialization (0-1)	0.00	0.59	0.14	0.94	0.00	0.67	0.15	0.92
	(0.00)	(0.31)	(0.07)	(0.08)	(0.00)	(0.29)	(0.07)	(0.08)
Age of household head (years)	49.08	48.67	48.93	46.83	57.65	55.45	57.95	53.99
	(15.42)	(13.08)	(13.16)	(12.58)	(14.11)	(11.98)	(12.93)	(12.34)
Female household head (yes=1)	0.19	0.14	0.16	0.13	0.22	0.20	0.22	0.19
	(0.40)	(0.35)	(0.36)	(0.34)	(0.42)	(0.40)	(0.41)	(0.39)
Minority household head (yes=1)	0.19	0.23	0.17	0.31	0.19	0.25	0.11	0.35
	(0.39)	(0.42)	(0.38)	(0.46)	(0.40)	(0.43)	(0.31)	(0.48)
Average education of adult household members (years)	7.57	7.80	8.05	7.72	8.35	8.22	8.42	8.10
	(3.10)	(2.67)	(2.65)	(2.72)	(3.11)	(2.73)	(2.73)	(2.77)
Farm size owned (ha)	0.68	0.82	0.72	1.07	0.43	0.86	0.50	1.16
	(2.44)	(1.13)	(1.39)	(1.21)	(1.04)	(1.32)	(0.92)	(1.39)
Number of crops grown	2.29	2.98	3.71	2.22	2.00	2.83	3.03	2.78
	(1.37)	(1.66)	(1.61)	(1.36)	(1.10)	(1.36)	(1.33)	(1.34)
Ratio of land devoted to rice in total land	0.64	0.45	0.64	0.15	0.63	0.45	0.67	0.21
	(0.40)	(0.37)	(0.30)	(0.25)	(0.42)	(0.39)	(0.36)	(0.30)
Ratio of rice value in total production value	0.68	0.40	0.61	0.09	0.52	0.35	0.50	0.15
	(0.41)	(0.38)	(0.29)	(0.22)	(0.45)	(0.38)	(0.36)	(0.29)
Annual household income (US$)	4179	7184	4969	9982	9658	8948	8222	9654
	(10222)	(8581)	(5580)	(10520)	(11786)	(8863)	(7730)	(9838)
Crop sales (US$)	0	3303	197	7642	0	3445	283	6005
	(0.00)	(6866)	(209)	(9852)	(0.00)	(5747)	(387)	(7234)
Income from off-farm employment (US$)	897	716	528	909	2398	2326	2403	2148
	(1971)	(1679)	(1088)	(2197)	(3719)	(3666)	(3237)	(3837)
Income from self-employment (US$)	817	710	424	906	2364	1232	1189	1345
	(2418)	(2909)	(1308)	(3589)	(7551)	(3840)	(3990)	(4354)
Livestock income (US$)	482	858	935	625	928	709	1000	453
	(1317)	(1895)	(1828)	(2064)	(5714)	(2330)	(1914)	(1861)
Remittances received (US$)	376	514	391	535	1989	1667	2028	1407
	(1584)	(1712)	(1080)	(1583)	(3320)	(3268)	(3523)	(2976)
Distance to market (km)	13.94	13.53	11.90	15.12	11.26	11.81	9.80	13.14
	(9.40)	(10.60)	(7.66)	(11.86)	(10.20)	(9.99)	(7.37)	(10.25)
Observations	**346**	**1549**	**280**	**569**	**270**	**1259**	**152**	**602**

Standard deviations are in parentheses. NoCI.: non-commercialized households; CI: all households participating in commercialization; CI25: least commercialized households; CI75: most commercialized households. Kinh Vietnamese and Han Chinese are considered ethnic majorities. Monetary values

are in purchasing power parity 2005 US$. Some observations are excluded due to missing values of a variable. Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

The average age of household heads does not differ among the groups, except for the CI75 households, which tend to be younger compared to the other groups. It is possible that younger household heads are more risk-taking and open to new ideas, therefore deciding to pursue commercialization. Since 2008 more households are headed by a woman, while female-led households commercialize less often than male-led households. However, it seems that commercialization becomes independent from gender over time, as the share of female household heads is similar over all groups in 2017. There are relatively more minority households in the CI group than in the NoCI group, with the highest share in the CI75 group. This can in part be explained by the geographical distribution of ethnicities and crops, as minority households more frequently reside in the coffee-growing Dak Lak province. Additionally, minorities frequently lack the possibilities to generate income from other sources, and therefore commercialization by default becomes their highest income source. Over time, the most commercialized households have the fewest average years of education. One of the reasons could be that households with a high level of education look for opportunities outside agriculture and more often work in off-farm or self-employment sectors. Regarding farm size, NoCI households own less land than CI households, with CI75 households owning most land. CI and CI75 households increased the amount of land owned, while NoCI and CI25 households reduced the amount of land owned over time. CI households have higher income than NoCI households. Nearly half of the annual income for CI75 households is from selling crops. The rest is from several other income sources, such as off-farm activities, self-employment, and remittances. However, over the years the importance of non-farm income and remittances increases, while the share of crop income in total household income decreases for all CI groups. The CI25 households display a higher share of rice in total production value and land devoted to rice in total cultivated land than the CI75 households. These seem to generate income mainly through the cultivation of other crops.

The statistics for the RCI households in Table 3 are distinct from Table 2. The age gap between the most RCI households and the rest disappears over time. The trend towards more female-led households is, however, similar to Table 2. The distribution of minority household heads differs slightly, as there are relatively more NoRCI households led by a minority head than in the CI groups in Table 2. Regarding farmland size, there is no difference between NoRCI and RCI households for 2008. However, in 2017 all groups have

a reduced average amount of land in their possession. A similar trend is visible for number of crops, while the share of land devoted to rice stays constant over time at a high level of above 70%. The RCI75 had the highest annual income in 2008 but the lowest in 2017. It appears that households focusing on rice miss other economic opportunities, possibly at least in part due to land use restrictions and zoning policies constraining the households' choice of crop.

Table 3: Summary statistics by level of rice commercialization (2008-2017)

	2008				2017			
Household characteristics	NoRCI	RCI	RCI25	RCI75	NoRCI	RCI	RCI25	RCI75
Rice commercialization (0-1)	0.00	0.44	0.17	0.87	0.00	0.50	0.14	0.86
	(0.00)	(0.21)	(0.05)	(0.09)	(0.00)	(0.24)	(0.07)	(0.08)
Age of household head (years)	48.08	49.30	48.84	45.25	55.55	55.47	54.13	54.96
	(13.55)	(12.55)	(12.80)	(11.59)	(12.45)	(10.76)	(10.94)	(12.20)
Female household head (yes=1)	0.17	0.12	0.14	0.15	0.20	0.18	0.19	0.19
	(0.38)	(0.33)	(0.35)	(0.36)	(0.40)	(0.39)	(0.40)	(0.39)
Minority household head (yes=1)	0.29	0.13	0.14	0.17	0.26	0.12	0.06	0.24
	(0.45)	(0.34)	(0.35)	(0.38)	(0.44)	(0.33)	(0.23)	(0.43)
Average education of adult household members (years)	7.58	7.62	7.67	7.23	8.20	8.08	8.23	7.92
	(2.66)	(2.48)	(2.31)	(2.63)	(2.76)	(2.52)	(2.37)	(2.22)
Farm size owned (ha)	0.74	0.72	0.73	1.19	0.59	0.72	0.55	0.83
	(1.13)	(0.88)	(0.98)	(0.94)	(1.01)	(1.06)	(0.79)	(0.92)
Number of crops grown	3.32	2.84	3.29	2.46	2.90	2.62	3.01	2.45
	(1.64)	(1.51)	(1.72)	(1.38)	(1.45)	(1.28)	(1.45)	(1.13)
Ratio land devoted to rice in total land	0.57	0.78	0.71	0.72	0.61	0.75	0.72	0.71
	(0.31)	(0.25)	(0.27)	(0.29)	(0.33)	(0.29)	(0.28)	(0.31)
Ratio of rice value in total production value	0.52	0.72	0.64	0.66	0.46	0.64	0.52	0.68
	(0.36)	(0.29)	(0.29)	(0.37)	(0.38)	(0.34)	(0.36)	(0.35)
Annual household income (US$)	5236	6452	5402	11958	8971	8877	10658	7900
	(9298)	(6453)	(4488)	(9363)	(10327)	(7728)	(10725)	(5550)
Crop sales (US$)	0	1180	217	4718	0	1148	161	2889
	(0.00)	(1937)	(149)	(4869)	(0.00)	(1567)	(141)	(2868)
Income from off-farm employment (US$)	595	579	468	606	2396	2281	2621	1749
	(1320)	(1232)	(1091)	(1302)	(3356)	(3243)	(3282)	(2854)
Income from self-employment (US$)	557	772	547	1857	1670	995	1471	798
	(1903)	(3091)	(1674)	(5843)	(6105)	(2596)	(3666)	(1881)
Livestock income (US$)	781	1075	1128	1111	931	957	1156	629
	(1671)	(1895)	(1581)	(2688)	(4348)	(2858)	(2238)	(1823)
Remittances received (US$)	390	590	303	777	1722	2060	2301	1851
	(1417)	(2032)	(891)	(1818)	(3168)	(3717)	(4115)	(4233)
Distance to market (km)	13.22	13.98	12.18	18.79	11.98	10.98	11.82	14.07
	(10.18)	(10.91)	(7.79)	(17.03)	(10.34)	(10.25)	(12.69)	(13.48)
Observations	**801**	**581**	**128**	**48**	**461**	**566**	**89**	**95**

Standard deviations are in parentheses. NoRCI.: non-commercialized households (rice); RCI: all households participating in rice commercialization; RCI25: least commercialized households (rice); RCI75: most commercialized households (rice). Kinh Vietnamese and Han Chinese are considered ethnic majorities. Monetary values are in purchasing power parity 2005 US$. Some observations are excluded due to missing values of a variable. Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

4 Methods

4.1 Identifying asset-based income and structural poverty

Traditional poverty measures rely on the definition of one money-metric poverty line to assess households' poverty status based on consumption expenditures or income.[2] One limitation of this approach is that even repeated measurements cannot explain why households are either poor, non-poor, or move between the two states. Carter and Barrett (2006) build on the work by Carter and May (1999, 2001) to construct an improved poverty measure that reflects the underlying asset endowments of households. Based on these productive assets that households own and access, and the return to those assets, it is possible to predict a household's income in the absence of any stochastic income flows. Contrasting this asset-based income (ABI) with the observed income then permits to sort households into four categories along two dimensions: Whether they are *expected* to earn an income below or above the poverty line based on the ABI, and whether they *actually* earn an income below or above this poverty line. It is therefore possible to distinguish between the effects of random events such as unexpected yields, changing prices, gifts, volatile remittances etc., and the long-term prospects of a household given its asset base. An interesting feature of this approach in the context of our work is that we can identify structural poverty transitions, which are reflections of long-term improvements in households' endowments. However, it must be noted that the underlying asset dynamics are not explicitly modelled, as they would be in measures of poverty that focus on the accumulation of assets and the existence of poverty traps and multiple equilibria.

The ABI approach has been applied in several studies (Barrett, 2005; Amare and Hohfeld, 2016; Bühler and Cunningham, 2018). The ABI is the product of household *i*'s productive assets at time t, illustrated by the vector A_{it}, and a vector R_{it} capturing the expected returns per unit of the respective asset held or accessed by the household (equation 3) (Amare and Hohfeld, 2016; Bühler and Cunningham, 2018). Assets can range from natural capital, such as land, crops and livestock, over physical capital such as machinery, to social capital such as membership in a socio-political organization; ε_{it}^{T} represents a transitory exogenous income that is independent of assets; ε_{it}^{M} is the standard measurement error term. Vector R_{it} is stochastic and consists of the expected return r_{it}, and an exogenous

[2] For brevity, we only mention income measures in the following segment. However, any consumption-based measures would work exactly the same.

shock term ε_{it}^{R} capturing for instance weather conditions, which lowers physical productivity.

$$Y_{it} = A'_{it}R_{it} + \varepsilon_{it}^{T} + \varepsilon_{it}^{M} \text{ with } R_{it} = r_{it} + \varepsilon_{it}^{R} \quad (3)$$

By substituting $R_{it} = r_{it} + \varepsilon_{it}^{R}$ into $Y_{it} = A'_{it}R_{it} + \varepsilon_{it}^{T} + \varepsilon_{it}^{M}$, followed by total differentiation, one can express income changes as a function of changes in assets and their returns, which reflects the underlying structural well-being based on assets as in equation (4). Following Barrett (2005), it is assumed that all error terms share a mean of zero, constant variance, and serial independence. As illustrated in equation (5), one can drop ε_{it}^{R}, ε_{it}^{T}, and ε_{it}^{M}. The power of equation (5) lies in the easy translation of how the expected income depends on the changes in both assets and the return on assets. It also shows that increasing transfers ε_{it}^{T} does not sustainably alleviate poverty. The transfer term disappears in equation (5), indicating that transfers have little to no influence on expected asset-based income.

$$\Delta Y_{it} = \Delta A'_{it}(r_{it} + \varepsilon_{it}^{R}) + A'_{it}(\Delta r_{it} + \Delta\varepsilon_{it}^{R}) + A_{it}\Delta\varepsilon_{it}^{R} + \Delta\varepsilon_{it}^{T} + \Delta\varepsilon_{it}^{M} \quad (4)$$

$$E[\Delta Y_{it}] = \Delta A'_{it}r_{it} + A'_{it}\Delta r_{it} \quad (5)$$

The empirical model presented in equation (6) is based on these considerations and therefore includes a set of assets *j* that influence a household's *i* livelihood. The latter is expressed in daily income Y_{it} at time *t*. Dividing by the poverty line Z_{it} ensures that the dependent variable is expressed in poverty line units (PLU), where a value below 1 indicates poverty (Adato et al., 2006). Setting the poverty line at US$1.90 corresponds to Vietnam's status as a low-income country at the beginning of our study period; US$3.20 could be the second natural choice to reflect its transformation into a middle-income county. A comparison of both poverty lines to the measures used by the GSO (2011; 2017; 2021), MOLISA (Nguyen, 2020) and the GSO-World Bank (also Nguyen, 2020) shows that these alternatives do not differ significantly.[3] In accordance with Adato et al. (2006), we use a polynomial expansion of the *j* basic assets, such that each asset features in its linear form, as a squared term ($(A_{jit})(A_{kit})$ when j=k), and in interaction with every single other asset (for $j \neq k$). The squared terms ensure that diminishing or increasing marginal returns are captured (Adato el al. 2006; Amare and Hohfeld, 2016), while the interaction terms reflect the influence of holding certain assets on the marginal returns of other assets

[3] Robustness checks for the outdated definition of poverty at US$1.25PPP and the definition of poverty in lower middle-income countries at US$ 3.20 PPP are provided in Appendix 20.

(Amare and Hohfeld, 2016) (for instance, machinery that increases the marginal returns for larger land holdings). Equation (6) therefore includes: the vectors A_{jit} and A_{kit} of assets j and k; the vector η_{gvt} that controls for geographical capital g such as sanitation, electricity, and natural assets on village level v; ω_{it}, which captures if household i reports an economic, environment or health shock at time t, and γ_i representing household fixed effects. Province-year dummies λ_{pt} were added to account for differences in the provinces. To construct the ABI, a FE model is employed.[4] The estimated coefficients presented in Appendix 6 are used to generate the fitted values, which form the ABI. We denote this as $\widehat{\Lambda}_{it}$.

$$\Lambda_{it} = \frac{Y_{it}}{Z_{it}} = \alpha + \sum_{j=1} \beta_j (A_{jit}) + \sum_{jk} \beta_{jk} (A_{jit})(A_{kit}) + \beta_g \eta_{gvt} + \beta_{it} \omega_{it} + \gamma_i + \lambda_{pt} + \varepsilon_{it} \quad (6)$$

A household is classified as (i) structural poor if $\frac{Y_{it}}{Z_{it}} < 1$ and $\widehat{\Lambda}_{it} < 1$; (ii) structural non-poor if $\frac{Y_{it}}{Z_{it}} > 1$ and $\widehat{\Lambda}_{it} > 1$; (iii) stochastic poor if $\frac{Y_{it}}{Z_{it}} < 1$ and $\widehat{\Lambda}_{it} > 1$, and (iv) stochastic non-poor if $\frac{Y_{it}}{Z_{it}} > 1$ and $\widehat{\Lambda}_{it} < 1$ (Carter and May, 2001).

Table 4 illustrates the different categories of poverty and their share of households based on this approach. Most of the households in our sample are structural non-poor, with an income and an expected asset-based income above the poverty line of US$1.90 per day and capita. The shares of stochastic poor and stochastic non-poor are approximately 12-18% of all households depending on the year. The share of structural poor decreases from 22% in 2008 to 6% in 2017, indicating that much of Vietnam's success in poverty eradication can in fact be attributed to structural poverty transitions.

Table 4: Structural and stochastic poverty over the study period

Poor status	Definition	2008	2010	2013	2016	2017
Structural poor (%)	$\frac{Y_{it}}{Z_{it}} < 1 \,\&\, \widehat{\Lambda}_{it} < 1$	0.22	0.24	0.19	0.07	0.06
Structural non-poor(%)	$\frac{Y_{it}}{Z_{it}} > 1 \,\&\, \widehat{\Lambda}_{it} > 1$	0.61	0.59	0.65	0.82	0.82
Stochastic poor (%)	$\frac{Y_{it}}{Z_{it}} < 1 \,\&\, \widehat{\Lambda}_{it} > 1$	0.07	0.07	0.06	0.02	0.04
Stochastic non-poor(%)	$\frac{Y_{it}}{Z_{it}} > 1 \,\&\, \widehat{\Lambda}_{it} < 1$	0.10	0.10	0.10	0.09	0.08
Observations		**1730**	**1546**	**1585**	**1417**	**1398**

Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

Table 5: Asset-based income and structural poverty over the study period

[4] Hausman test did not support random effects.

	NoCI	CI	CI25	CI75	NoRCI	RCI	RCI25	RCI75
Asset Based Income (US$ annually)	1300	1368	1180	1533	1185	1344	1238	1540
Asset Based Income (US$ daily)	3.56	3.75	3.23	4.20	3.25	3.68	3.39	4.22
Share of structural poor (%)	0.19	0.13	0.20	0.10	0.20	0.12	0.16	0.09
Asset Based Income 2008 (US$ annually)	1043	1239	1002	1493	1009	1187	1060	1624
Asset Based Income 2008 (US$ daily)	2.86	3.39	2.75	4.09	2.77	3.25	2.90	4.45
Share of structural poor 2008 (%)	0.32	0.17	0.28	0.10	0.28	0.15	0.19	0.13
Asset Based Income 2010 (US$ annually)	1001	1124	993	1235	1008	1055	898	1203
Asset Based Income 2010 (US$ daily)	2.74	3.08	2.72	3.38	2.76	2.89	2.46	3.30
Share of structural poor 2010 (%)	0.25	0.19	0.23	0.15	0.26	0.18	0.24	0.13
Asset Based Income 2013 (US$ annually)	1273	1234	1120	1288	1108	1257	1221	1301
Asset Based Income 2013 (US$ daily)	3.49	3.38	3.07	3.53	3.04	3.44	3.34	3.56
Share of structural poor 2013(%)	0.17	0.17	0.22	0.16	0.22	0.14	0.20	0.14
Asset Based Income 2016 (US$ annually)	1544	1674	1492	1894	1420	1593	1530	1969
Asset Based Income 2016 (US$ daily)	4.23	4.59	4.09	5.19	3.89	4.36	4.19	5.39
Share of structural poor 2016 (%)	0.09	0.06	0.08	0.05	0.10	0.06	0.08	0.03
Asset Based Income 2017 (US$ annually)	1759	1640	1576	1718	1540	1669	1622	1675
Asset Based Income 2017 (US$ daily)	4.82	4.49	4.32	4.71	4.22	4.57	4.44	4.59
Share of structural poor 2017 (%)	0.06	0.05	0.07	0.05	0.06	0.04	0.05	0.03
Observations	**1516**	**6953**	**985**	**2888**	**3258**	**2859**	**514**	**374**

Standard deviations are in parentheses. NoCI./NoRCI.: no household is participating in (rice) commercialization; CI/RCI: all households participating in (rice) commercialization; CI25/RCI25: least commercialized households (rice); CI75/RCI75: most commercialized households (rice). Monetary values are in purchasing power parity 2005 US$ per capita. Some observations are excluded due to missing values of a variable. Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

Table 5 presents an overview of the calculated income and incidences of poverty. The most commercialized households have the highest ABI and the lowest incidence of structural poverty. In general, commercialized households are better off than non-commercialized households. Only the least commercialized household group contains relatively more households being structural poor than non-commercialized households. As in Table 4, a decrease in poverty over the years becomes apparent. The increase in poverty for commercialized households between 2008 and 2010 corresponds with a high share of reported shocks in 2008 and an increase in economic and health shocks from 2008 to 2010. In contrast to Table 3 where rice commercialized households are worse off in terms of income than other groups, the group of most rice commercialized households contain the smallest relative number of structural poor. However, even though the households were worse off in Table 3, they managed to generate an income and an ABI above the poverty line. These findings align with the theory of Carter and May (1999, 2001) and Carter and Barrett (2006) that pure static income poverty measures struggle to picture the true state of households. Even though rice commercialized households might generate less

income in a year than other groups, they are structural poor relatively less often than members of other groups. This might be explained by the high amount of remittances they receive compared to other groups. Remittances are included in the calculation of ABI as they can be considered financial assets, particular the return on former investments, such as in education. However, even though the importance of transfers is decreasing over time, they are still often one of the main stable financial assets of a household.

4.2 Determining multidimensional poverty index (MPI)

The TVSEP-MPI employed in this study is based primarily on the indices of Alkire and Santos (2014) and OPHI (2018).[5] The three dimensions health, education and living standards feature in the TVSEP-MPI, and are complemented with the income dimension proposed by the World Bank (2018). The weights of the indicators on child malnutrition (1/4), adult education (1/8), children missing school (1/8), and the six indicators on living standards (1/24 each) follow the weighting proposed in the literature closely. Child malnutrition is weighted more heavily, as the TVSEP project does not cover child mortality, which would be the second indicator routinely included. Consequently, the TVSEP-MPI penalizes child malnutrition stronger than other indices (weight=1/6), which can arguably be justified by its adverse long-term effects. Moreover, the proposed weights reflect that each dimension has a weight of 1/4 only, which is due to the addition of the dimension on income. The two indicators of this dimension are income poverty (1/8), and an ABI below the poverty line (1/8). These are incorporated to account for the argumentation of the World Bank (2018), which stresses the role that income can play in enhancing households' livelihoods and alleviating possible deprivations faced in other dimensions. This view can also be recognized in the treatment of multidimensional poverty by the General Statistics Office (GSO) (2021) of Vietnam, which classifies households as poor if they earn an income below the poverty line, or if they earn an income below the slightly higher income-based minimum living standards and are deprived in three further indicators.

The inclusion of ABI is motivated by the fact that structural poverty is thus also mirrored in the TVSEP-MPI. By our definition, a household is classified as multidimensional poor if it is deprived in indicators whose weights add up to at least 1/4, equivalent to the weight

[5] For a full overview of all major MPI's, see Aguilar and Sumner (2020). Additionally, we provide information on all dimensions, indicators and weights of the TVSEP-MPI in Appendix 7, alongside information on the GSO's definition of multidimensional poverty.

of an entire dimension. This is based on the cut-off other authors have suggested (1/3), but once again adapted to the fact that the TVSEP-MPI incorporates four dimensions. A desirable feature is that structural poor households, being deprived in both income and ABI, are classified as multidimensional poor. Moreover, stochastic poor and stochastic non-poor are classified as poor if they are additionally deprived in one of the two educational indicators or three of the living standards indicators. Thereby, the TVSEP-MPI closely follows the propositions of the GSO, combining information on income and possible other deprivations.

Robustness checks were executed using rank correlation, Cramer V correlation, and redundancy tests. Appendices 8 and 9 visualize different rank correlation tests and indicate that the development of the poverty headcount ratio is not sensitive to the inclusion of the income dimension or the chosen cut-off level. As anticipated, the headcount ratio is consistently highest for the lowest cut-off at 1/4. It is also higher when income is included, accentuating its influence in the measurement of poverty. Appendix 10 presents the results of a Cramer V correlation test showing that only income poverty and asset-based income poverty have a high correlation; the results of redundancy tests also feature in the respective table and point only to the possible redundancy of the indicators safe water and cooking stove. However, these were kept to ensure comparability to the global MPI's.

Table 6 summarizes multidimensional poverty by year and type of household. Similar to the results regarding structural poverty, non-commercialized households are more frequently poor than commercialized ones. Only the least commercialized households are poorer than non-commercialized households in some of the years. Overall, commercialized households are less frequently multidimensional poor, and face fewer deprivations. Appendices 11 and 12 illustrate the average share of households who are deprived in the respective indicator by group. CI households were better off than NoCI households on average. The highest incidence of deprivation is in the living standard dimension, such as access to safe drinking water and the usage of an improved cooking stove, followed by a high contribution of deprivation in monetary and asset income to total headcount poverty. Over the years, deprivation in all indicators decreased substantially with a shift of contribution to poverty from the monetary dimension to the health dimension.

Table 6: Multidimensional headcount poverty by commercialization status

	2008	2010	2013	2016	2017	Average	Change 2008-2017
NoCI.	0.536	0.455	0.296	0.203	0.185	0.347	-0.352***
	(0.240)	(0.187)	(0.121)	(0.081)	(0.069)	(0.145)	
CI	0.387	0.371	0.299	0.173	0.162	0.285	-0.025***
	(0.157)	(0.145)	(0.118)	(0.064)	(0.060)	(0.112)	
CI25	0.486	0.435	0.331	0.192	0.169	0.355	-0.317***
	(0.204)	(0.179)	(0.128)	(0.075)	(0.064)	(0.144)	
CI75	0.339	0.350	0.306	0.161	0.166	0.262	-0.173***
	(0.131)	(0.133)	(0.120)	(0.057)	(0.062)	(0.099)	
NoRCI	0.513	0.445	0.367	0.241	0.202	0.371	-0.310***
	(0.221)	(0.181)	(0.146)	(0.094)	(0.075)	(0.152)	
RCI	0.361	0.345	0.252	0.143	0.108	0.245	-0.253***
	(0.141)	(0.132)	(0.098)	(0.051)	(0.039)	(0.093)	
RCI25	0.409	0.445	0.273	0.151	0.163	0.303	-0.246***
	(0.160)	(0.176)	(0.112)	(0.055)	(0.064)	(0.118)	
RCI75	0.378	0.269	0.279	0.092	0.085	0.207	-0.292***
	(0.142)	(0.096)	(0.096)	(0.032)	(0.032)	(0.074)	
Total sample	0.412	0.383	0.297	0.178	0.168	0.295	-0.245***
	(0.171)	(0.151)	(0.117)	(0.066)	(0.062)	(0.117)	

Adjusted headcount ratio MPI in brackets calculated by the multidimensional deprivation headcount (H) multiplied with the average multidimensional poverty intensity (A). ***$p < 0.01$. NoCI./NoRCI.: no household is participating in (rice) commercialization; CI/RCI: all households participating in (rice) commercialization; CI25/RCI25: least commercialized households (rice); CI75/RCI75: most commercialized households (rice). Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

4.3 Examining the impact of commercialization on asset growth and poverty

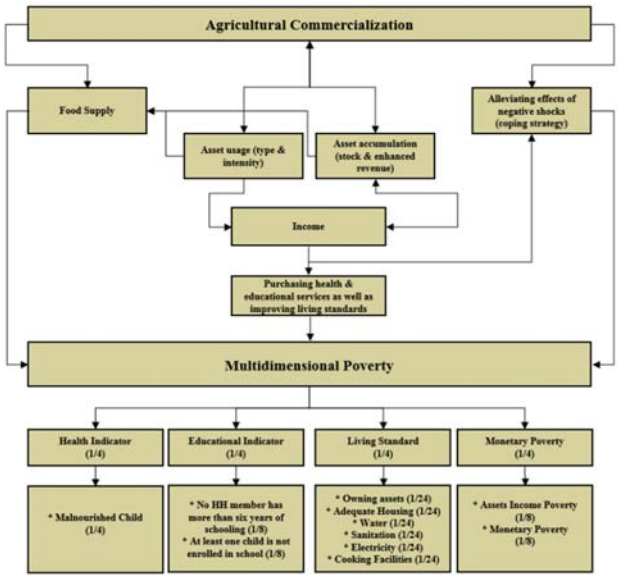

Figure 2: Potential effects of commercialization on structural and multidimensional poverty through asset growth

Figure 2 summarizes how commercialization might affect poverty in rural Vietnam. When households place more emphasis on their agricultural production, they can use some of the output to stabilize their food supply, which has a direct effect on the multidimensional

poverty in terms of fewer malnourished household members (Zhou et al., 2013; Carletto et al., 2017). The findings from previous sections agree to some extent with this hypothesis, as most RCI and CI households were less frequently deprived in the health dimension.

Commercialization might affect the use of assets through the reallocation of existing assets to increase productivity, and by contributing to the accumulation of assets (Cazzuffi et al., 2020). Both the productivity and endowment effect are captured in the construction of the ABI and jointly form the asset growth (Amare and Hohfeld, 2016). This in turn might affect the income and food supply through increased production. Table 5 shows that CI households generate comparatively high asset income over nearly all years. To identify the impact of commercialization on asset growth, multidimensional poverty and structural poverty, this study undertakes the following regressions:

$$\Delta\Lambda_{it} = \alpha + \beta_1 CI_{it-1} + \beta_2 H_{it-1} + \beta_3 V_{vt-1} + \beta_4 A_{vt-1} + \gamma_i + \varepsilon_{it} \quad (7)$$

$$P_{it} = \oint + \nu_1 CI_{it} + \nu_2 H_{it} + \nu_3 V_{vt} + \gamma_i + \lambda_{it} \quad (8)$$

In equation (7) $\Delta\Lambda_{it}$ is the asset growth between $t-1$ and t, calculated by subtracting the ABI of household i at time $t-1$ from the ABI at time t. The effect of commercialization on asset growth is captured by the coefficient β_1 of the continuous lagged level of (rice) commercialization $(R)CI_{it-1}$, bounded between zero and one (equations (1) and (2)). $(R)CI_{it}$ is the variable of interest and the primary focus of all coming regressions; H_{it-1} is a vector of lagged household characteristics such as gender, education, off-farm as well as self-employment activities, and further control variables capturing the socio-economic status of households, while V_{vt-1} is a vector of lagged village controls such as infrastructure, irrigation, and distance to district market; A_{vt-1} captures effects of the lagged mean initial asset baseline on village level to account for possible spillover effects from other households; γ_i represents household fixed effects; and ε_{it} is the error term. In equation (8) P_{it} is either the multidimensional poverty index (MPI), bounded between zero and one, or a binary variable indicating if a household is structural poor or not; λ_{it} is the error term. The independent variables in equation (8) are the same as in equation (7) with two adaptions. First, the nature of the dependent variable no longer necessitates the use of lagged values, so present values are employed. Secondly, while A_{vt-1} might influence a household's asset growth through spillover effects, its inclusion in the regression becomes unjustified once multidimensional or structural poverty are the dependent variable. We therefore exclude it for a more efficient estimation.

Several possible sources of endogeneity with respect to the commercialization variable preclude the use of OLS. A correlation between CI_{it-1} and ε_{it} (equation (7)) and between CI_{it} and λ_{it} (equation (8)) can lead to biased estimates of β_1 or ν_1, respectively, and calls for more advanced estimators. The concerns consist of reverse causality, both time-variant and time-invariant unobserved heterogeneity, self-selection, and measurement error. The issue of reverse causality derives from the fact that households with more assets might be more likely to sell inferior goods such as rice and other crops to purchase normal goods and services. We include the lagged value of commercialization in equation (7) to account for this, so that the effect of past sales of crop output on asset growth is estimated. Time-invariant unobserved heterogeneity is addressed by the use of a fixed effects estimator, in which mean-differencing leads to the cancellation of the respective factors, including systematic measurement errors. There are two possible ways in which time-variant unobserved heterogeneity, which is not captured by the control variables in equations (7) and (8), and which results in a dynamic self-selection of households, might bias the estimates. On the one hand, commercialization might be limited to the households which benefit over-proportionally, while not proving remunerative enough for others to engage in. On the other hand, households that develop more remunerative livelihood strategies outside of farming might reduce their market sales while at the same time displaying high rates of asset growth and poverty reduction. This is indicated by Schulte et al. (2022) who find that increased off-farm income reduces the probability of market participation and the quantity of sales in the 2017 cross-section of our data. Depending on the magnitude of these effects, they could either result in an over-estimation or under-estimation of β_1 or ν_1, or cancel each other out leading to non-significant coefficients close to zero. To address this, IV-estimation is utilized, and complemented in a last step by the use of a CF approach. The CF approach has the advantage of being more flexible with respect to the functional form. This could improve the results, as the censored nature of $(R)CI_{it}$ can lead to non-linear corner solutions (Wooldridge, 2015).

Both IV and CF approaches require instruments that are correlated with the level of (rice) commercialization $(R)CI_{it}$ and do not affect income or poverty outcomes ($\Delta\Lambda_{it}$ or P_{it}). We follow Bartik (1991) to construct two instruments based on the averages of commercialization and asset-based income at village level. The idea of using regional averages as instruments has been used widely in the labour and trade economics literature (see Jaeger et al., 2018 for a review). Bühler and Cunningham (2018) argue that the average village-level asset base is exogenous to individual households in the village. Our

first instrument ($\frac{1}{N-1}\sum_{n\neq i}^{N} CI_{it-1}$) is the jack-knifed average of commercialization level of households in village v at time $t-1$; and the second instrument ($\frac{1}{N-1}\sum_{n\neq i}^{N} CI_{it-1} * A_{vt-1}$) is the jack-knifed average of commercialization level of households in village v ($\frac{1}{N-1}\sum_{n\neq i}^{N} CI_{it-1}$), weighted by the average village-level asset-based income A_{vt-1}. These instruments reflect the possibility of less commercialized household learning from their neighbours, resulting in spillover or learning effects; at the same time, they might also benefit from lower transaction cost and input price through shared transport (Cazzufi et al., 2020; Krishnan and Patnam, 2013). Since $(R)CI_{it}$ is a censored variable bounded between zero and one, all its first-stage estimations are run in a fractional logit model as follows:

$$(R)\widehat{\mathrm{CI}}_{it} = \lambda + \sigma_1 \frac{1}{N-1}\sum_{n\neq i}^{N}(R)CI_{it-1} + \sigma_2 A_{vt-1} + \sigma_3 \frac{1}{N-1}\sum_{n\neq i}^{N}(R)CI_{it-1} * A_{vt-1} + \sigma_4 H_{it-1} + \sigma_5 V_{vt-1} + \varepsilon_{it} \quad (9)$$

These instruments need to be relevant and exogenous. We thus undertake the correlation analysis and the Hansen test for joint validity of the instruments (Verbeek, 2005, pp. 146-147) (the exclusion restriction ($Corr_{(R)CI_{it},\Delta\Lambda_{it}} = 0$, or $Corr_{(R)CI_{it},P_{it}} = 0$)). The relevance of the instruments is supported by the significant correlation between CI and the respective instrument (Appendix 13), and by their highly significant coefficients in the first stage (Appendix 16). Thus, the instruments fulfil the first condition of instrument validity. Regarding instrument exogeneity, we cannot reject the null hypothesis of joint exogeneity of instruments based on the results of the Hansen over-identification test (Appendix 15 and Tables 7 and 8). Even though binary correlations between the instruments and the dependent variables are significant (Appendix 13), a regression containing all control variables, the endogenous explanatory variable $(R)CI_{it}$ and the instruments results in insignificant coefficients of the instruments, except for the effects of RCI on structural poverty (Appendix 14). Additionally, to account for the idea that local commercialization might affect off-farm opportunities, we consider possible linkages between the instruments and off-farm income. The correlations between the instruments and off-farm income are significant, yet small in magnitude (rho<0.1, Appendix 13). The much stronger correlation between the instruments and the household's commercialization (rho>0.35 for RCI, and rho>0.5 for general commercialization, Appendix 13) indicate that the instruments work through a household's commercialization. Overall, the exogeneity condition of instrument validity is supported by the combined evidence.

Due to the endogeneity considerations discussed above, we complement our results by the CF approach. Following a regression of CI_{it} on the instruments in the first stage using fractional logit, the predicted $\widehat{CI_{it}}$ is subtracted from the observed CI_{it} to generate the residuals. These are subsequently included as additional explanatory variable $\widehat{CF_{it}}$ in the second-stage regression (equations (10) and (11)) (Wooldridge, 2015):

$$\Delta\Lambda_{it} = \alpha + \beta_1 CI_{it-1} + \beta_2 H_{it-1} + \beta_3 V_{vt-1} + \beta_4 A_{vt-1} + \beta_5 \widehat{CF}_{it-1} + \gamma_i + \varepsilon_{it} \quad (10)$$

$$P_{it} = \oint + \nu_1 CI_{it} + \nu_2 H_{it} + \nu_3 V_{vt} + \nu_4 \widehat{CF}_{it} + \gamma_i + \lambda_{it} \quad (11)$$

5 Results and discussion

5.1 Effect of commercialization on asset growth

Table 7 shows the regression results of the effect of (rice) commercialization on asset growth as outlined in equations (7) and (10). In total, a set of four regressions each for commercialization and rice commercialization was run to estimate the effects of commercialization on the log transformed dependent variable $\Delta\Lambda_{it}$. The first columns in both groups show the fixed effects results (CI FE and RCI FE), while the second columns contain the estimates for the fixed effects adjusted with a CF approach (CI CF and RCI CF). The third column displays the instrumental variable (CI IV-FE and RCI IV-FE) estimates, while column four illustrates those of the instrumental variables with the control function approach (CI IV-CF and RCI IV-CF). It was discussed in section 4.3 how the use of these different estimators can account for the multiple possible sources of endogeneity. In Table 7, the coefficient of commercialization increases in magnitude and gains significance when applying the IV estimator compared to columns 1 and 2, regardless of the type of commercialization or nature of the dependent variable. This underlines the validity of our considerations, as time-variant unobserved heterogeneity does in fact seem to bias the results in columns 1 and 2. This apparent under-estimation can be explained by the increasing importance of off-farm and self-employment opportunities, which provide households with an alternative outside of commercialization to accumulate assets. Even though we control for these considerations, the estimators seem to not fully capture the dynamic environment in which household operate. Because column 3 and 4 display remarkably similar estimations, and the non-significance of the included residual term in column 4 points to the IV-FE estimator as the more efficient solution, we treat this as our main regression in the following discussion.

All effect sizes are discussed based on an increase of the level of (rice) commercialization by 0.10 (10 percentage points). As the dependent variable is log transformed, the calculation $100 * (e^{\beta} - 1)$ provides the actual percentual change in the dependent variable. Thus, an increase in commercialization by 10 percentage points would lead to an increase in asset growth of 4.70%. For rice commercialization, the estimate is smaller at 2.65%. The results show that households can extend their asset level by increasing their share of production sold in the previous period. This indicates that commercialization helps to raise income so that households face fewer liquidity problems and can realize

productivity-enhancing investments. It is important to stress for future policies that the non-rice component of commercialization is the driver of asset growth, visible in the larger magnitude of the coefficient of general commercialization. This corresponds to both previous literature stressing the importance of cash crops and the problematic effects of land use restrictions and the prioritization of rice cultivation by the Vietnamese government.

Table 7: Truncated regression results of commercialization on asset accumulation

	CI FE	CI CF	CI IV-FE	CI IV-CF	RCI FE	RCI CF	RCI IV-FE	RCI IV-CF
$\Delta\Lambda_{it}$								
Lagged (rice) commercialization (0-1)	0.041	0.026	0.385**	0.373**	0.018	0.008	0.235**	0.251**
	(0.032)	(0.033)	(0.187)	(0.180)	(0.024)	(0.024)	(0.118)	(0.116)
First stage residuals		-0.007		0.060		-0.018		0.017
		(0.032)		(0.047)		(0.022)		(0.029)
R^2	0.247	0.248	0.224	0.226	0.247	0.248	0.241	0.226
Adjusted R^2	0.243	0.244			0.244	0.245		
Hansen J statistic			0.625	0.547			0.160	0.150
F	40.99	38.40	37.06	34.78	40.84	38.43	40.06	34.72
$\Delta\Lambda$ Linear								
Lagged (rice) commercialization (0-1)	0.066	-0.006	2.242**	2.038**	0.006	-0.041	1.529**	1.474**
	(0.180)	(0.183)	(1.099)	(1.033)	(0.132)	(0.129)	(0.685)	(0.661)
First stage residuals		-0.041		0.351		-0.019		0.197
		(0.222)		(0.307)		(0.108)		(0.166)
R^2	0.157	0.155	0.118	0.121	0.156	0.155	0.119	0.117
Adjusted R^2	0.153	0.151			0.153	0.151		
Hansen J statistic			0.593	0.467			0.789	0.376
F	15.59	14.67	16.26	15.17	16.06	15.17	16.19	15.31
Observations	5223	5111	5015	4895	5223	5111	5015	4895

Standard errors in parentheses. Appendix 17 contains the full estimates for the log-transformed regressions. Adjusted R-squared for IV regressions omitted due to no statistical meaning (Sribney et al., 1999). *p < 0.1, **p < 0.05, ***p < 0.01. Some observations are excluded due to missing values of a variable. Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

Appendix 17 reports the coefficients of all control variables. The age of the household head and the household size have an important influence on asset growth. Older household heads may benefit from their experience and can use the knowledge to actively extent their asset value. A larger household positively affects the growth in assets as more family members contribute to the overall household well-being. However, only adult members, excluding children and the elderly, have a positive effect on the accumulation of assets. Having experienced a shock in the previous period indicates a positive relationship, which is contradictory at first sight. However, the positive coefficient of the lagged shock variable

reflects the accelerated growth in assets after a reduction of asset levels during and shortly after the shock. Households use assets to reduce the negative effects of health and economic shocks by, for instance, selling land or livestock. Furthermore, households could be affected by an environmental shock and be subjected to the loss of agricultural assets, which cannot be used for the rest of the year. Nevertheless, the results show that household rebuild the stock level afterwards (Cazzuffi et al., 2020), therefore supporting the hypothesis of Figure 2 that commercialization through asset growth reduces the vulnerability to shocks (Nguyen et al., 2020).

The results shown above align with previous studies. Cazzuffi et al. (2020) report a positive effect of commercialization on asset accumulation in Vietnam, however of smaller magnitude. The importance of crops other than rice is supported by their findings. As the asset growth in this study happens for the most part within the income channel, the results shown in Table 7 can be, to some extent, interpreted as income increase. Therefore, this study confirms increasing income effects of previous studies in other countries such as Ogutu and Qaim (2019) for Kenya, Mitiku (2014) for Ethiopia, and Tipraqsa and Schreinemachers (2009) for Thailand.

5.2 Effect of commercialization on structural and multidimensional poverty

In contrast to Table 7, all coefficients of CI_{it} in Table 8 are statistically significant, and indicate a significant reduction of poverty P_{it} when increasing the level of (rice) commercialization.[6] As before, non-rice products seem to drive the results, as indicated by the smaller magnitude of the RCI coefficients. The significance of the residual terms in columns 2 and 4 indicate that both the simple fixed effects estimator and the IV approach fail to control for all sources of endogeneity that were discussed above. Moreover, the IV estimates seem to be inflated, which is remedied by the CF approach. Consequently, the IV-CF results are discussed in the following, except for the effect of rice commercialization on structural poverty, where the RCI-CF will be considered instead. This is because the instruments used to estimate RCI IV-CF turned out to be weak for this specific case (Appendix 14).

[6] These results are robust when restricting the sample to the balanced sub-panel, accounting for possible differences in multidimensional poverty shown in Appendix 22. Results available from authors upon request.

Table 8: Truncated regression results of commercialization on structural and multidimensional poverty

P_{it}	CI FE	CI CF	CI IV-FE	CI IV-CF	RCI FE	RCI CF	RCI IV-FE	RCI IV-CF
Structural Poverty (0/1)								
(Rice) Commercialization (0-1)	-0.044**	-0.290***	-0.533**	-0.296***	-0.034**	-0.121*	-0.433*	-0.137**
	(0.020)	(0.088)	(0.241)	(0.102)	(0.016)	(0.067)	(0.223)	(0.066)
First stage residuals		0.224** (0.089)		0.230** (0.102)		0.117* (0.067)		0.130** (0.066)
R^2	0.130	0.140	0.051	0.140	0.126	0.129	0.000	0.129
Adjusted R^2	0.127	0.136			0.123	0.122		
Hansen J statistic			0.208	0.395			0.592	0.895
F	21.90	11.70	13.04	13.76	21.3	6.27	6.91	7.33
Multidimensional Poverty (0-1)								
(Rice) Commercialization (0-1)	-0.020**	-0.097***	-0.217**	-0.103***	-0.015**	-0.044*	-0.162*	-0.046*
	(0.021)	(0.029)	(0.029)	(0.026)	(0.021)	(0.039)	(0.040)	(0.036)
First stage residuals		0.071** (0.031)		0.077** (0.037)		0.044* (0.024)		0.045* (0.023)
R^2	0.257	0.210	0.119	0.210	0.253	0.194	0.095	0.194
Adjusted R^2	0.254	0.206			0.251	0.187		
Hansen J statistic			0.505	0.233			0.885	0.412
F	61.94	23.27	24.03	26.5	60.08	13.33	14.23	15.27
Observations	**7478**	**4451**	**4135**	**4135**	**7478**	**3111**	**2688**	**2688**

Standard errors in parentheses. Appendices 18 and 19 contain the full regressions. Adjusted R-squared for IV regressions omitted due to no statistical meaning (Sribney et al., 1999). *p < 0.1, **p < 0.05, ***p < 0.01. Some observations are excluded due to missing values of a variable. Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

The results show that an increase in the level of commercialization by 10 percentage points decreases structural poverty by -2.96%, while the decrease in multidimensional poverty is smaller with -1.03%. For rice commercialization the decrease in structural poverty is -1.21%, and -0.44% for multidimensional poverty. The results are in line with previous literature regarding poverty reduction (Mitiku, 2014) and multidimensional poverty (Ogutu and Qaim, 2019). It is in order to recall the estimated effect of (rice) commercialization on asset growth, and the fact that the MPI uses a monetary dimension which is in fact an indication of structural poverty. Building on these insights, it can be hypothesized that that (rice) commercialization does reduce multidimensional poverty mainly in the monetary dimension through the income and asset growth channel. Households can spend increased income on assets, accelerating asset growth and reducing asset poverty. However, the income gains might fail to contribute to reduced deprivations in other poverty dimensions, especially as many investments such as an electricity grid

cannot be established by households, and other solutions like an off-grid system may be still potentially unavailable due to its high costs (Alkire and Santos, 2014).

Table 9: Effect of commercialization on MPI dimensions

Dimension	CI-Health	CI-Education	CI-Living	CI-Monetary	RCI-Health	RCI-Education	RCI-Living	RCI-Monetary
(Rice) commercialization (0-1)	0.0288	-0.0029	-0.0001	-0.0738***	0.0016	-0.0017	-0.02***	-0.0443***
	(0.0227)	(0.0086)	(0.0093)	(0.0027)	(0.0139)	(0.0053)	(0.0057)	(0.0139)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	**4599**	**4599**	**4599**	**4451**	**3213**	**3213**	**3213**	**3111**

Partial average effects used. Standard errors in parentheses. Dependent variables ranges from 0-0.25. Same control variables are used as in the regressions before (Appendices 17-19) but excluded for brevity. *p < 0.1, **p < 0.05, ***p < 0.01. Some observations are excluded due to missing values of a variable. Source: TVSEP 2008-2017 Thailand Vietnam Socio-economic Panel.

Table 9 underlines the results by showing the effect of CI_{it} on the different dimensions used to calculate the MPI. Hereby, this study follows Ogutu and Qaim (2019) and implements an average partial effect approach. For each dimension a new dependent variable was introduced. Instead of a binary variable that indicates if a household is deprived in the dimension, the dependent variables range between 0-0.25, which is the corresponding value of the deprivation in the dimension and therefore allows to capture the effects of CI_{it} on the individual indicators as well.

The results for the health and education dimension are statistically insignificant. For the health dimension the results are surprising as Appendices 11 and 12 report lower incidences of deprivation for commercialized, especially rice commercialized households, compared to non-commercialized households. Therefore at least a small significant positive effect was expected. However, many studies found no significant effects of commercialization on food supply and therefore on the health dimension (Carletto et al., 2017; Cazzuffi et al., 2020), possibly due to the household spending the additional income primarily on non-food items instead of increasing the food supply (Ntakyo and van den Berg, 2019). The effect on the education dimension is also statistically insignificant. However, due to already few deprivations in education, no effects were anticipated a priori. Additionally, the educational level of household members will barely increase through additional income (Ogutu and Qaim, 2019). Rice commercialization does have a statistically significant positive effect on the living standard dimension. We assume that the different effects between commercialization in general and rice commercialization are not distorted by initially high levels of deprivations (Appendices 11 and 12), but by the fact that rice commercialized households have to purchase fewer nutriments externally, and

thus have more of their additional income left at their disposal. The results of CI_{it} on the monetary dimension are the strongest and statistically significant, showing that the effect of CI_{it} on poverty works mainly through the income and asset growth channel.

6 Conclusions

Using a ten-year panel dataset of rural households from three provinces in Vietnam and utilizing different regression methods, this study analysed the effects of commercialization on asset growth and structural and multidimensional poverty. The contribution to the current state of literature lies in the analysis of long-term development of households by utilizing assets to shift from the predominant focus on simple income patterns and income poverty lines to asset-based income patterns and multidimensional poverty.

The first issue examined in this study was if commercialized households were better off in terms of ABI and if commercialization increases asset growth. To this end, the ABI was estimated by using a FE model based on asset values. The ABI then was used to determine asset growth over time. Results show that commercialized, especially high commercialized households, have the highest asset-based income, on account of the positive effect of commercialization on asset growth.

The second issue examined in this study was how commercialization affects structural poverty. After combining the ABI and observed income to categorize households and identify structural and stochastic poor, a significant effect of commercialization on the reduction of structural poverty could be identified. This indicates that commercialization not only affects income, but also asset growth. If interventions targeting poverty aim at such permanent, structural poverty transitions, then this speaks to the importance of agricultural commercialization.

The last issue examined in this study was the contribution of commercialization to alleviating multidimensional poverty. Compared to previous literature using the multidimensional poverty index, this paper added a monetary dimension as a fourth dimension in addition to the dimensions of education, health, and living standards. The novelty in this approach is that the monetary dimension is defined as being structural poor by adding the asset-based income and income poverty lines. Therefore, households are immediately considered as multidimensional poor when earning less (asset) income than the proposed poverty lines and therefore lacking financial power to purchase basic needs.

As expected, an increase of the commercialization level leads to positive and significant results in reducing multidimensional poverty. However, the effects work mainly through the income channel, making commercialization a viable policy option for alleviating (multidimensional) poverty.

Agricultural commercialization offers a meaningful opportunity to increase the well-being of rural households. However, policy makers need to be sure about the needs of households and the goal which should be achieved, as commercialization might be a good tool to decrease income and asset poverty, but not necessarily deprivations in education or health indicators. This study suggests that increased commercialization of farmers should be facilitated. This can be done by encouraging farmers to expand their farmland size through market mechanisms within land sale or land rental markets. In addition, self-employment and off-farm employment correlate with commercialization, and should thus be encouraged. To overcome deprivations in public goods which cannot be remedied by commercialization and income effects alone, increased investments in large infrastructure projects targeting sanitation, drinking water, and education should be considered and carefully checked.

Some limitations must be considered for further research. First, this paper used a static asset poverty line to divide households in being structural poor and structural non-poor. It focused only on households who were capable of changing their well-being status over time. To provide policy makers with comprehensive information, the effects of commercialization on households stuck in a poverty trap would be interesting and need to be analysed to eradicate poverty in a sustainable way. Second, as Vietnam is one of the largest exporters of rice worldwide, this study calculated the effects of agricultural commercialization in general and rice commercialization separately. A deeper analysis of the trade-offs is highly recommended as this study provides larger positive effects for agricultural commercialization than for rice commercialization. However, we have not been able to provide any results on the effects of agricultural commercialization on food supply. These limitations should be addressed in future studies.

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