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RESEARCH ARTICLE

Natural resource extraction and ethnic inequality in Dak Lak, Vietnam

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Abstract
Natural resource extraction is an important livelihood strategy for poor rural households in developing and emerging countries. Despite the sharp decline in poverty in Vietnam, inequality still exists between the ethnic majority and minority. This paper aims to analyze the impact of natural resource extraction on ethnic inequality. We use panel data from Dak Lak in the Central Highlands of Vietnam. The Oaxaca-Blinder decomposition shows that ethnic differences in extraction are due to different group characteristics and different returns to these characteristics. Endogenous switching regressions find that extraction has heterogeneous effects on consumption across extracting and non-extracting households, and between majority and minority households. Treatment effects suggest that extraction sustains the consumption of extracting minority households because their consumption would decline if they stopped extracting. Our results indicate that it is important to improve the natural resource base and the ability of minorities to cope with shocks.

Keywords: endogenous switching regression; ethnic inequality; natural resource extraction; Oaxaca-Blinder decomposition; Vietnam

JEL classification: Q20; D63

1. Introduction

Natural resource extraction remains an important livelihood strategy for poor rural households in developing countries (Angelsen *et al.*, 2014; Medina Hidalgo *et al.*, 2021; Do *et al.*, 2022). Poverty and inequality in these countries are still major problems, exacerbated by multiple global crises (World Bank, 2022). Reducing inequality is essential in eradicating poverty (Thorbecke, 2013; Fosu, 2018). Thorbecke (2013) emphasizes the interrelationship between poverty, inequality and growth. While growth is considered to have a poverty-reducing effect, inequality can offset this effect. Especially in poor rural areas of developing countries, people benefit less from economic growth (Barbier and Hochard, 2018). Therefore, they are forced to rely on natural resources.

In Vietnam, poverty has fallen significantly in recent decades, although the gap between rich and poor still exists (Pimhidzai, 2018; United Nations Development Programme, 2018). While rural-urban inequality has declined, income and living standard disparities between ethnic groups has increased (Tuyen, 2016). There are officially 54 different ethnic groups in Vietnam. With a share of 86 per cent, the Kinh make up the largest part of the population. Together with the Hoa, a privileged ethnic group of Chinese origin, they are considered as the ethnic majority. However, the many smaller ethnic minorities in Vietnam continue to face a number of disadvantages in terms of education (Dang, 2012; Nguyen, 2019), employment (Tuyen, 2016), health care (Dang, 2012; Nguyen, 2017), and access to capital markets (Nguyen *et al.*, 2020). There are language and cultural barriers that exacerbate existing disparities (Nguyen, 2017). Furthermore, ethnic minorities live mainly in remote and rural parts of Vietnam, namely the Central Highlands and the Northern Uplands (World Bank, 2009).

Because of this socio-economic background, they rely heavily on agriculture and natural resources for their livelihoods (Tuyen, 2016; Dinh, 2020). Empirical studies have already found that ethnic minorities are more likely to extract natural resources (Nguyen *et al.*, 2015; Bierkamp *et al.*, 2021). Over the centuries, they have developed knowledge and farming practices adapted to local conditions (Tan *et al.*, 2023). Their lives and cultures are closely linked to the environment. At the same time, ongoing climate change and natural resource degradation threaten the livelihoods of minorities (Tan *et al.*, 2023). This may lead to a further increase in ethnic inequality. Although previous studies have shown that environmental income reduces income and consumption inequality in developing countries (López-Feldman *et al.*, 2007; Fonta and Ayuk, 2013; Chhetri *et al.*, 2015; Nguyen *et al.*, 2018*a*), there is no analysis that focuses on the importance of natural resource extraction for ethnic inequality and welfare in Vietnam.

Hence, this study aims to address the following research gaps: (1) How does environmental income contribute to reducing ethnic income inequality in Vietnam? Here, environmental income is the net revenue from the extraction of non-cultivated environmental products. (2) What are the socio-economic drivers of differences in natural resource extraction between majority and minority ethnic groups? According to previous literature, ethnic inequality is generally caused by differences in socio-economic characteristics as well as returns to productive characteristics (Van de Walle and Gunewardena, 2001; Baulch *et al.*, 2012; Tuyen, 2016). (3) What are the effects of natural resource extraction on household consumption of majority and minority ethnic groups?

This paper contributes to the current literature in several ways. (1) By using an Oaxaca-Blinder decomposition, we disaggregate ethnic inequality with respect to natural resource extraction. As an extension to previous research on ethnic inequality (Van de Walle and Gunewardena, 2001; Baulch *et al.*, 2012), we focus on extraction and identify the differences in socio-economic characteristics and the returns to these productive characteristics that contribute to inequality. (2) Extraction status and consumption are both endogenous. Thus, to analyze the effects of extraction on consumption, we apply endogenous switching regressions (Di Falco *et al.*, 2011; Do and Ho, 2022). Previous research has already shown that extraction sustains household consumption (Nguyen *et al.*, 2018*a*), but our analysis sheds light on the differential effects between majority and minority groups. (3) We then calculate the average treatment effects on the treated and untreated to determine the impact of extraction status on household consumption. Furthermore, we address the differences in consumption impact between majority and minority ethnic groups (Nguyen *et al.*, 2018*a*). Here, we consider that the household's extraction decision is influenced by social, economic and cultural barriers

(Van de Walle and Gunewardena, 2001; Baulch *et al*., 2007; Dang, 2012). (4) In addition, we use unique panel data from the long-term Thailand Vietnam Socio Economic Panel (TVSEP) project (TVSEP, 2016). The advantage of panel data is that changes over time can be examined. For our analysis, we refer to data from 2010, 2013, and 2016, collected in rural parts of Dak Lak province in Vietnam's Central Highlands. In addition to the Northern Uplands, this region is home to a large proportion of ethnic minorities (World Bank, 2009).

The rest of the paper is organized as follows. Section 2 provides a literature review on natural resource extraction and ethnic minorities in Vietnam. Section 3 introduces the data and methodology. Section 4 presents and discusses the findings, and section 5 concludes.

2. Literature review

2.1 Natural resource extraction

Natural resource extraction refers to the harvesting of natural products from non-cultivated sources, such as wood from natural forests or fish from lakes (Angelsen *et al*., 2014). In this study, environmental income is defined as the difference between total extraction output at market price and extraction cost. Hence, it is the net revenue from extraction. According to previous research (Córdova *et al*., 2013; López-Feldman, 2014; Wunder *et al*., 2018), households in resource-rich areas are particularly poor. They also spend more effort on extraction and have fewer alternatives in times of crisis. Dependence on natural resources is further exacerbated by the fact that these households use environmental products for subsistence rather than for sale (Nerfa *et al*., 2020). Thus, environmental income in our study includes both – consumed and sold environmental products.

Although households that extract natural resources are more likely to be income poor, empirical research suggests that natural resource extraction can reduce poverty and income inequality (López-Feldman *et al*., 2007; Fonta and Ayuk, 2013; Chhetri *et al*., 2015). Without environmental income, some households may even be at risk of not meeting their basic needs and slipping into deeper poverty (López-Feldman *et al*., 2007). Using Mexico as an example, López-Feldman *et al*. (2007) show that environmental income from non-timber forest products (NTFP) reduces poverty and inequality. Since not all households participate in extraction, environmental income is unequally distributed. Nevertheless, it has an equalizing effect on overall income inequality as it favors the poor. Using data from rural Nepal, Chhetri *et al*. (2015) find that, unlike other sources of income such as remittances, environmental income reduces income inequality.

Nguyen *et al*. (2018*a*) examine the differences between extracting and non-extracting households in the welfare impacts of extraction in rural Laos. They show that if extracting households ceased their extraction activity, they would experience a reduction in household income, consumption and food security. However, non-extracting households that are forced to extract would also have higher levels of food security from extraction, but lower household income and consumption due to the loss of income and consumption from their current activities. Although these results provide valuable insights, they cannot be extrapolated to other regions. In Vietnam, the rural population is characterized by its distinction between ethnic majority and minority (Dang, 2012). It is likely that there are also ethnic differences in natural resource extraction and in the welfare impacts of extraction, driven by differences in socio-economic characteristics and the returns to these characteristics. This is the topic of the following subsection.

2.2 Ethnic minorities in Vietnam

Some ethnic minorities have lived in Vietnam for centuries, such as the Tay-Thai groups. Others have been in the country only since the last millennium, such as the Nung (Dang, 2012). The 53 ethnic minorities differ in their culture, language and religion. Some of the groups are so small that they consist of only a few hundred people. The largest groups are the Tay, Thai, Muong, Khmer, and Hmong. The ethnic minority groups also differ in their socio-economic status. While some are better able to lift themselves out of poverty, others – particularly those based in the Central Highlands – still have very high rates of multidimensional poverty (United Nations Development Programme, 2018).

Previous research has identified three main factors driving ethnic poverty (Baulch *et al.*, 2007): objective factors (e.g., infrastructure, climate), subjective factors (e.g., education, capacities), and institutional factors (e.g., politics, poor targeting). An important aspect is the remoteness of ethnic minorities – not only in terms of geographical location, but also in terms of language and cultural barriers. Van de Walle and Gunewardena (2001) point out that inequality is the result of different characteristics as well as different returns to these characteristics. Unequal returns to productive characteristics such as education can be interpreted as a structural component of inequality, which may include, for example, past discrimination or different cultural backgrounds. Ethnic inequality affects many areas of daily life. Adults belonging to the ethnic majority are better educated and have higher literacy rates (Dang, 2012). At the same time, school enrolment rates of minorities remain lower. One of the reasons is that they have to travel longer distances to reach primary and secondary schools. This problem is exacerbated by an age bias among school children due to later enrollment, class repetition or school dropout (Dang, 2012; Nguyen, 2019). Furthermore, Vo *et al.* (2021) report an ethnic wage gap. Ethnic minorities are also more dependent on agriculture and natural resources to make a living (Tuyen, 2016). The majority, on the other hand, is more involved in off-farm activities. Nguyen (2017) emphasizes the lower health insurance coverage of poor people and the lower quality of health care in remote areas. Minorities living in these areas are particularly affected. In addition, ethnic minorities face difficulties in accessing formal credit (Nguyen *et al.*, 2020).

Overall, ethnic minorities are forced to rely on natural resources. However, minorities who have lived in the remote mountainous areas of Central Vietnam for centuries have adapted to these living conditions (World Bank, 2009; Tan *et al.*, 2023). They have built up a unique body of knowledge that is well-adjusted to the environment. It includes expertise in agroforestry, traditional medicine as well as resource and natural disaster management. Each ethnic group has its own customs and practices that can affect the use of natural resources. Although there are interactions among ethnic groups, indigenous minorities have an advantage in knowledge compared to the ethnic majority and to immigrated minority groups. Traditional knowledge improves climate change adaption and provides a basis for self-sufficiency and self-determination for many ethnic minorities, as they are less dependent on external factors and are already familiar with indigenous practices (Tan *et al.*, 2023). Accordingly, this could be beneficial in terms of ethnic inequality and welfare.

3. Data and methodology

3.1 Study site and data collection

For our analysis, we use household and village level data from the TVSEP project (TVSEP, 2016). This long-term project has collected data from six rural provinces in

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Thailand and Vietnam since 2007 to study income and poverty dynamics. The TVSEP data are representative of poor rural regions because of the sampling procedure which includes the following three steps (Hardeweg *et al*., 2013). In the first step, provinces were selected based on their low average per capita income, high dependence on agriculture, and poor infrastructure. In the second step, two villages per sub-district were chosen with probability proportional to the population size of the sub-district. In the final step, a fixed sample size of ten households per village was randomly selected from a list of households with equal probability.

For our analysis, we focus on the dataset from Dak Lak province because it is inhabited by a high proportion of ethnic minority people and includes large forest areas (World Bank, 2009; Pham *et al*., 2021). The province is located in the Central Highlands of Vietnam and close to neighboring Cambodia (figure 1). Our analysis sample includes the 2010, 2013, and 2016 panel waves. In total, we refer to 2,053 household observations from 76 villages in rural communes (appendix table A1). Villages are marked as small dots in figure 1.

Due to government resettlement programs, many people from the Kinh majority migrated from the lowland regions to the Central Highlands (World Bank, 2009). The government wanted to promote economic development in these rural areas, which had previously been predominantly inhabited by indigenous minorities (e.g., Ede, Mnong) (table A2). Although most migrants belong to the Kinh majority, ethnic minorities (e.g., Tay, San chai) from other parts of the country also settled in the Central Highlands. Economic opportunities for the migrants arose from financial support and increasing opportunities for coffee cultivation. Today, the economy in Dak Lak is dominated by the production of coffee, which, along with rice, is Vietnam's most important export commodity (Ho *et al*., 2018; Byrareddy *et al*., 2020). However, the changing population composition has increased inequality in Dak Lak, particularly between the Kinh majority and ethnic minorities (World Bank, 2009). These tensions erupt in conflicts over land and other natural resources (Baulch *et al*., 2007; World Bank, 2009).

The TVSEP data contain a large amount of information on household and village characteristics. For the following analysis, we use the questionnaire sections that ask about the socio-demographic structure of households, sources of income, assets, and consumption behavior. The data collected consider the last 12 months before the date of the survey.

3.2 Econometric specifications

3.2.1 Identifying ethnic differences in the determinants of natural resource extraction

The Oaxaca-Blinder decomposition investigates mean outcome differences between groups. It was originally developed by Oaxaca (1973) and Blinder (1973). The technique is commonly employed in labor economics to study wage differentials, but can also be used for many other applications (Jann, 2008). In our analysis, we want to examine ethnic differences in natural resource extraction. Therefore, we apply the Oaxaca-Blinder two-fold decomposition to several indicators of extraction, namely environmental income, environmental income per capita, and extraction participation. The mean values Y_{eth} for these indicators are determined as follows:

$$Y_{eth} = X_{eth}\alpha_{eth} + \varepsilon_{eth} \; eth \in (\text{Majority}, \quad \text{Minority}), \tag{1}$$

where X is a vector containing the predictors and α includes the corresponding coefficients. The formula differentiates between the mean values of ethnic majority and

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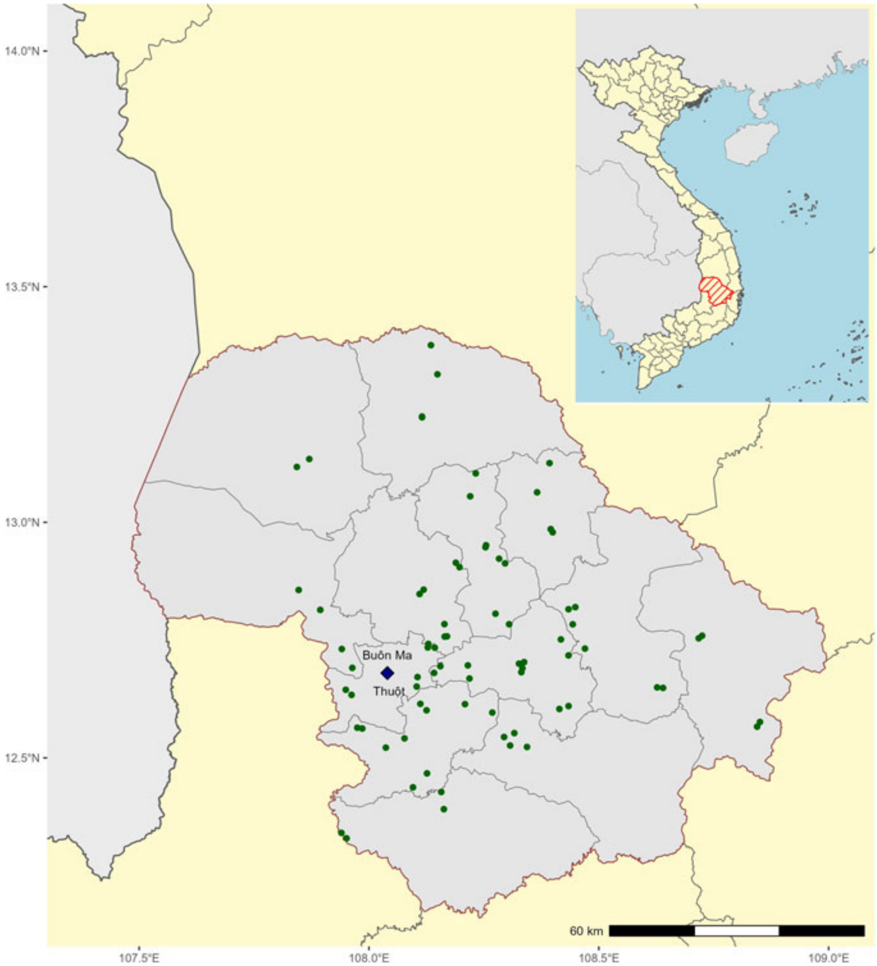

Figure 1. The studied province Dak Lak in Vietnam.
Shape source: Humanitarian Data Exchange (2023).

minority households. Since the error term ε is assumed to be uncorrelated with X and to have a zero mean, the differences in mean outcome can be written as:

$$Y_{\mathrm{maj}} - Y_{\mathrm{min}} = X_{\mathrm{maj}}\alpha_{\mathrm{maj}} - X_{\mathrm{min}}\alpha_{\mathrm{min}} \tag{2}$$

$$\begin{aligned} &Y_{\mathrm{maj}} - Y_{\mathrm{min}} = \alpha_{\mathrm{maj}}(X_{\mathrm{maj}} - X_{\mathrm{min}}) + X_{\mathrm{min}}(\alpha_{\mathrm{maj}} - \alpha_{\mathrm{min}}), \\ &\text{(characteristics)} \ \text{(structure)} \end{aligned} \tag{3}$$

where the first component on the right-hand side of equation (3) represents the differences in characteristics weighted by the majority coefficients. The second component on the right-hand side reflects the structural differences weighted by the minority predictors. It reflects the expected change in outcome assuming majority coefficients in the

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characteristics component and assuming minority predictors in the structural component. Majority and minority weights in the components are interchangeable, since there can be negative discrimination against minorities or positive discrimination against the majority (Oaxaca, 1973; Cotton, 1988).

Natural resource extraction is influenced by a number of different predictors X (table A3). These include socio-demographic characteristics such as the average household age, average education, size, dependency ratio, and the gender of the household head. Previous studies have shown that these factors are important determinants of extraction (Angelsen *et al*., 2014; Nguyen *et al*., 2015, 2018*a*) and a source of ethnic inequality (Dang, 2012; Nguyen, 2017, 2019; Vo *et al*., 2021). We use averages to better represent the diversity of household members. Furthermore, a large study from Sunderland *et al*. (2014) indicates that the responsibility for extraction is not limited to the household head. Asset value[1] includes the household's long-term accumulated wealth, which enables investment in extraction (Nerfa *et al*., 2020), but also reveals past discrimination (Van de Walle and Gunewardena, 2001). Farmland size reflects the household's involvement in its own farming. Agriculture and natural resource extraction have been shown to be closely linked (Nguyen *et al*., 2018*b*). The distance between the household's home to the extracting ground relates to the effort required to carry out extraction activities (Kabubo-Mariara, 2013; Nguyen *et al*., 2018*a*). Off-farm employment is considered as a non-farm component. The calculation of variance inflation factors (VIF) indicates that there is no multicollinearity between independent variables (table A4). Robust standard errors are bootstrapped with 1,000 replications and clustered at the village level.

3.2.2 Identifying ethnic differences in the impact of natural resource extraction on household consumption

Endogenous switching regressions estimate the impact on an outcome variable depending on two different states. To account for endogeneity and selection bias, this technique has been used in several studies to study consumption impacts (Ahmed and Mesfin, 2017; Jaleta *et al*., 2018; Nguyen *et al*., 2018*a*). For instance, Ahmed and Mesfin (2017) find that membership in agricultural cooperatives improves consumption among smallholder farmers in Ethiopia. However, only Nguyen *et al*. (2018*a*) investigate the impact of extraction on consumption and find that extraction contributes to household consumption in rural Laos. Our analysis further identifies ethnic differences in household consumption based on the decision to extract. It is a two-stage procedure with a selection and an outcome model. Selection is modeled as follows:

$$\begin{aligned} I_j^* &= Z_j\beta + \upsilon_j I_j = 1 \text{ if } I_j^* > 0 \\ I_j &= 0 \text{ otherwise}, \end{aligned} \tag{4}$$

where I_j^* is a latent variable. Since households' extraction preferences depend on factors which are not fully observable, such as personal attitudes, I_j^* approaches the realized extraction decision I_j of household j. A household j decides to extract if $I_j^* > 0$, and not to extract otherwise. In order to improve the identification, a selection instrument Z_j is included. β contains the corresponding parameters. The error term is given as υ_j.

[1] All monetary values are converted to 2005 PPP$.

In the second stage, we estimate the impact of the extraction status on household consumption. The outcome model is defined as follows:

$$\text{Extraction} : c_{1j} = Q_{1j}\gamma_1 + \eta_{1j} \text{ if } I_j = 1 \tag{5a}$$

$$\text{No extraction} : c_{2j} = Q_{2j}\gamma_2 + \eta_{2j} \text{ if } I_j = 0, \tag{5b}$$

where c_{1j} and c_{2j} denote annual per capita household consumption, including food and non-food consumption, in the situation of extraction ($I_j = 1$) and no extraction ($I_j = 0$). Q_{1j} and Q_{2j} are the independent variables with γ_1 and γ_2 as the corresponding parameters. η_{1j} and η_{2j} capture the error terms. As we have already shown in equation (4), the extraction decision is endogenous: the selection into extraction and non-extraction is influenced by many observable and unobservable factors which simultaneously impact the level of consumption. This selection bias leads to erroneous estimates. Endogeneity can also arise from a reverse causal relationship between the extraction decision and consumption, i.e., not only does extraction affect consumption, but consumption can also influence the decision to extract. To solve the endogeneity problem, we need a selection instrument Z_j (Wooldridge, 2010). Following Di Falco *et al.* (2011), this instrument is valid if it affects the decision to extract but not the level of household consumption. This exclusion restriction is satisfied by the distance from the household's home to the extracting ground (table A5). Since some households report no extraction, we imputed the variable for these households by replacing the missing values with the average distance at the village level. Households that are further away from the extracting ground have higher opportunity costs and are therefore less likely to extract (Kabubo-Mariara, 2013; Nguyen *et al.*, 2018*a*).

We approximate the endogenous switching regressions with a full information maximum likelihood estimation, which is more efficient than two-stage least squares or maximum likelihood estimation (Lokshin and Sajaia, 2004; Di Falco *et al.*, 2011). Standard errors are consistent because the model's binary and continuous equations are computed simultaneously. Furthermore, standard errors are bootstrapped with 1,000 replications and clustered at the village level.

After estimating the model parameters, we compare the expected consumption (6a) of households that decide to extract and (6b) of households that decide not to extract. At the same time, we estimate the counterfactual cases, i.e., the expected consumption (6c) of extracting households that do not extract and (6d) of non-extracting households that extract. These conditional expectations for household consumption are as follows:

$$E(c_{1j}|I_j = 1) = Q_{1j}\gamma_1 + \sigma_{1\upsilon}\frac{f(Z_j\beta)}{F(Z_j\beta)} \tag{6a}$$

$$E(c_{2j}|I_j = 0) = Q_{2j}\gamma_2 - \sigma_{2\upsilon}\frac{f(Z_j\beta)}{\{1 - F(Z_j\beta)\}} \tag{6b}$$

$$E(c_{2j}|I_j = 1) = Q_{1j}\gamma_2 + \sigma_{2\upsilon}\frac{f(Z_j\beta)}{F(Z_j\beta)} \tag{6c}$$

$$E(c_{1j}|I_j = 0) = Q_{2j}\gamma_1 - \sigma_{1\upsilon}\frac{f(Z_j\beta)}{\{1 - F(Z_j\beta)\}}, \tag{6d}$$

where $\sigma_{1\upsilon}$ stands for the covariance between υ_j and η_{1j}; $\sigma_{2\upsilon}$ is the covariance between υ_j and η_{2j}; $f(\cdot)$ indicates a normal density distribution function and $F(\cdot)$ a cumulative normal distribution function.

Since equations (6a) and (6b) reflect the actual cases, whereas equations (6c) and (6d) represent the counterfactual cases, the average treatment effects on the treated (ATT) and on the untreated (ATU) are calculated as follows:

$$ATT = E(c_{1j}|I_j = 1) - E(c_{2j}|I_j = 1) = (\gamma_1 - \gamma_2)Q_{1j} + (\sigma_{1\upsilon} - \sigma_{2\upsilon})\frac{f(Z_j\beta)}{F(Z_j\beta)} \tag{7a}$$

$$ATU = E(c_{1j}|I_j = 0) - E(c_{2j}|I_j = 0) = (\gamma_1 - \gamma_2)Q_{2j} + (\sigma_{1\upsilon} - \sigma_{2\upsilon})\frac{f(Z_j\beta)}{\{1 - F(Z_j\beta)\}}. \tag{7b}$$

To get the ATT, equation (6c) has to be subtracted from equation (6a). This is the difference between the actual expectation of extracting household's consumption and the counterfactual expected consumption if extracting households did not extract. For the ATU, equation (6b) has to be subtracted from equation (6d). Equally, this is the difference between the actual expectation of non-extracting household's consumption and the counterfactual expected consumption if non-extracting households did extract.

3.3 Descriptive statistics

Within the total sample, 1,292 household observations (63 per cent of the sample) belong to the ethnic majority, while 761 observations (37 per cent) belong to one of the minority groups (table A6). This ratio is similar to the results of a 2017 census in Dak Lak: the majority accounts for 67 per cent of the provincial population and, accordingly, 33 per cent belong to the minority groups (Ministry of Natural Resources and Environment Vietnam, 2019). It appears that minority households are significantly younger than majority households. They also have lower average education levels. Minority households are larger and have a higher dependency ratio, meaning there are fewer household members caring for dependent members. Minority households also have fewer valuable assets than majority households. In addition, they are less likely to be employed off-farm. This suggests that minority households may need to rely more heavily on other livelihood strategies such as farming and natural resource extraction. Therefore, they cultivate larger areas of farmland. Descriptive statistics further reveal that the majority households live closer to the extracting ground. Since they have migrated to Dak Lak, they have settled in the periphery of the villages, closer to the forest and water areas.

With respect to indicators on natural resource extraction, ethnic minority households have significantly higher environmental income for the household as a whole and per capita (table A7). Moreover, minorities are more likely to participate in extraction. Figure 2 shows the sum of environmental income by ethnic status and extracted products. Firewood and timber products are by far the most important environmental products (Nguyen *et al.*, 2018*a*). The category mainly includes firewood, as timber harvesting is highly regulated (Pham *et al.*, 2021). Animals (e.g., fish, small amphibians), fruits and vegetables, as well as other products (e.g., honey, mushrooms) are extracted less and are of lower value (Bierkamp *et al.*, 2021).

4. Results and discussion

4.1 Environmental income and the reduction of ethnic inequality

Figure 3 presents the poverty headcount ratio by ethnic status and by extraction status. To appropriately reflect the cost of living during the survey period, we use the global

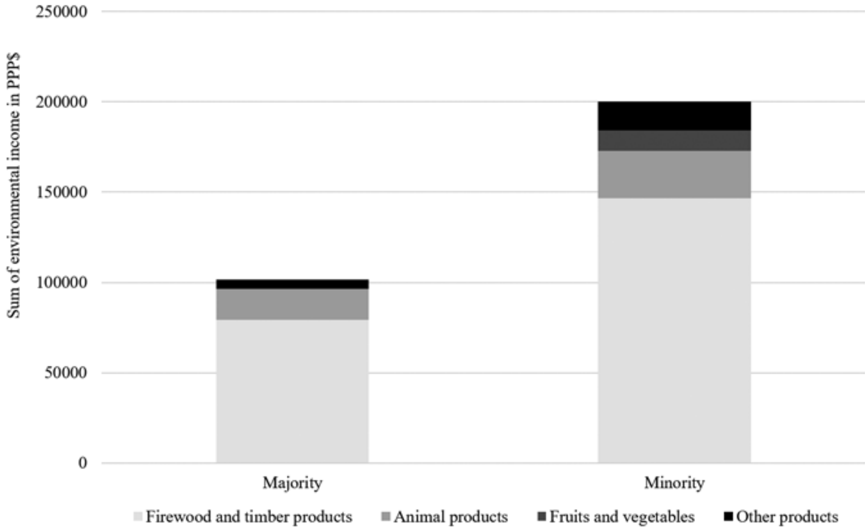

Figure 2. Sum of environmental income from all household observations in 2010, 2013, and 2016 by ethnic status and extracted products.

poverty line of 1.90$ per capita and day (Cruz *et al.*, 2015). Although poverty declined in our sample between 2010 and 2016, minority households are still poorer than majority households. Nevertheless, they experienced a slightly larger decline in poverty. The same is true for extracting households as they are still more likely to live below the poverty line. However, their headcount ratio declined somewhat more than that of non-extracting households.

Table 1 shows the Gini coefficients of total household income per capita by year and ethnic status. Inequality among majority households is comparable to inequality among minorities. The values further indicate that the Gini coefficient increases slightly once environmental income is subtracted from total income, i.e., environmental income smooths income inequalities, which is in line with previous research (López-Feldman *et al.*, 2007; Fonta and Ayuk, 2013; Chhetri *et al.*, 2015; Nguyen *et al.*, 2018*a*). This effect is particularly true for ethnic minority households. For instance, if environmental income is excluded from the 2016 calculation, the Gini coefficient for minority households would increase by 1.54 per cent. Minority groups differ with respect to their economic development as well as their economic and cultural assimilation to the Kinh-Hoa majority (Baulch *et al.*, 2007; Tam and Linh, 2022). More traditional minority households may be better able to manage and utilize natural resources because their practices are well adapted to their environment (Tan *et al.*, 2023). However, compared to more assimilated minority groups, they are worse off in terms of other income sources. Hence, environmental income appears to offset these differences between minority groups. For majority households, the equalizing effect of environmental income is less pronounced because they are more homogeneous and all relatively new to the Central Highlands.

4.2 Ethnic inequality in determinants and returns to natural resource extraction

Table 2 shows the results of the Oaxaca-Blinder decomposition of natural resource extraction by ethnic status. The mean log environmental income is 1.81 for the majority

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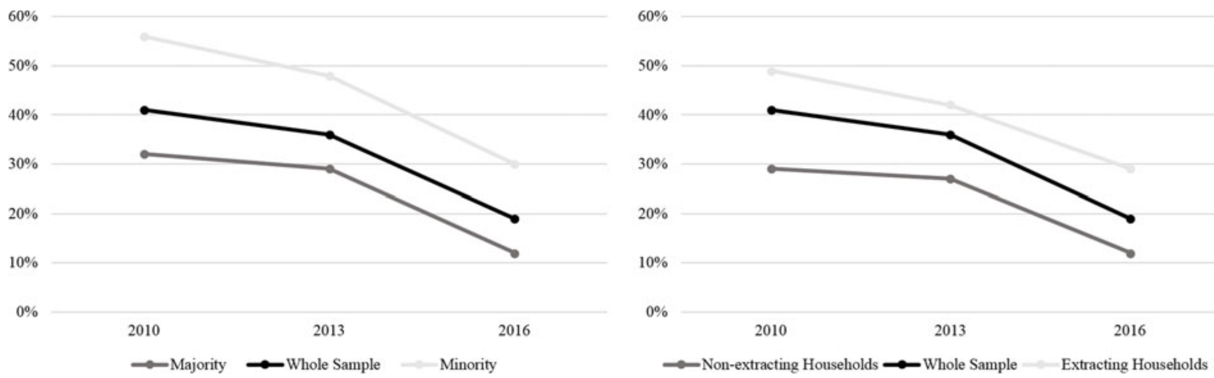

Figure 3. Poverty headcount ratio by ethnic status (left) and by extraction status (right).

Table 1. Gini coefficient of total household per capita income by year and ethnic status

	2010		2013		2016	
	Majority	Minority	Majority	Minority	Majority	Minority
With environmental income	0.4591 (0.0137)	0.5149 (0.032)	0.5243 (0.0188)	0.5073 (0.0218)	0.4604 (0.0193)	0.4709 (0.0279)
Without environmental income	0.4668 (0.0143)	0.5354 (0.032)	0.5310 (0.0187)	0.5226 (0.0222)	0.4619 (0.02)	0.4863 (0.0287)
Mean differences	−0.0077 (0.0019)	−0.0205 (0.0027)	−0.0067 (0.0013)	−0.0153 (0.0029)	−0.0015 (0.0005)	−0.0154 (0.0043)

Note: Standard errors (in parentheses) bootstrapped with 1,000 replications in parentheses.

ethnic group and 3.87 for the minority ethnic groups. The majority-minority gap can be divided into a part that can be explained by differences in the determinants of natural resource extraction and a part that cannot be explained by such group differences. The ethnic differences are significant and amount to 2.06, with 1.8 explainable and 1.26 not explainable. In the results for environmental income per capita and extraction participation, the explainable and unexplainable parts of the ethnic differences are significant at the 1 per cent level, although the unexplained components are larger.

The explained inequality increases due to differences in age, education, household size, asset value, farmland size and off-farm employment. Previous research has already reported that on average younger and less educated households are more likely to engage in extraction (Córdova *et al.*, 2013; Angelsen *et al.*, 2014; Bierkamp *et al.*, 2021). Besides, larger households depend more on extraction because they have more people to do the labor-intensive work (Angelsen *et al.*, 2014; Nguyen *et al.*, 2018*a*). Because ethnic minority households tend to be younger, less educated, and larger, they are more involved in natural resource extraction than majority households. Furthermore, a higher asset value implies lower dependence on natural resources, especially in times of crisis (Nerfa *et al.*, 2020). However, ethnic minorities generally own fewer assets (World Bank, 2009; Pham and Mukhopadhaya, 2022). They are more reliant on farming and less likely to engage in off-farm employment, which provides an alternative to extraction and diversifies a household's livelihood (Tuyen, 2016; Ho *et al.*, 2022). The decomposition further reveals that the distance to the extracting ground reduces ethnic differences in extraction participation. Since majority households live closer to the forest and water areas, this closer distance increases the likelihood of extraction.

With respect to the unexplained part of ethnic inequality, only asset value, farmland size and distance to the extracting ground yield significant results. The higher returns of minorities to farmland size seem to reduce ethnic disparities in extraction participation. Minorities may work harder on their farms to compensate for poorer off-farm employment opportunities (Van de Walle and Gunewardena, 2001). Returns to assets increase ethnic inequality, presumably as a result of past discrimination that resulted in the accumulation of less wealth. In addition, returns to the distance further increase ethnic differences, as the minorities in particular lack transport options to better reach extracting grounds (Baulch *et al.*, 2007; World Bank, 2009). This makes extraction even more burdensome for minorities.

Table 2. Oaxaca-Blinder decomposition of natural resource extraction by ethnic status

	Environmental income (ln)	Environmental income per capita (ln)	Extraction participation
Ethnic majority ($n = 1{,}292$)	1.81 (0.12)	1.18 (0.08)	0.41 (0.025)
Ethnic minority ($n = 761$)	3.87 (0.12)	2.55 (0.086)	0.8 (0.023)
Difference	−2.06 (0.17)	−1.37 (0.12)	−0.39 (0.034)
Explained	−1.8 (0.1)	−0.48 (0.072)	−0.16 (0.021)
Unexplained	−1.26 (0.17)	−0.88 (0.12)	−0.23 (0.036)
Explained			
Age	−0.05 (0.023)	−0.038 (0.018)	−0.01 (0.004)
Education	−0.22 (0.049)	−0.16 (0.035)	−0.044 (0.01)
Household size	−0.11 (0.027)	0.008 (0.014)	−0.016 (0.005)
Dependency ratio	−0.01 (0.014)	0.0003 (0.01)	−0.003 (0.003)
Gender (female = 1)	0.003 (0.006)	0.003 (0.005)	0.00002 (0.001)
Asset value (ln)	−0.27 (0.06)	−0.2 (0.045)	−0.058 (0.013)
Farmland size (ln)	−0.05 (0.027)	−0.031 (0.018)	−0.013 (0.006)
Off-farm (yes = 1)	−0.13 (0.047)	−0.088 (0.033)	−0.027 (0.01)
Distance (ln)	0.03 (0.025)	0.2 (0.018)	0.01 (0.006)
Year 2010 (2016 as basis)	−0.0005 (0.004)	−0.0004 (0.002)	−0.0001 (0.0006)
Year 2013 (2016 as basis)	−0.005 (0.004)	−0.003 (0.002)	−0.001 (0.001)
Unexplained			
Age	−0.29 (0.35)	−0.32 (0.28)	−0.063 (0.071)
Education	0.32 (0.31)	0.28 (0.22)	0.023 (0.063)
Household size	−0.02 (0.3)	0.22 (0.21)	0.033 (0.06)
Dependency ratio	−0.074 (0.3)	−0.074 (0.23)	−0.01 (0.05)

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Table 2. *Continued.*

	Environmental income (ln)	Environmental income per capita (ln)	Extraction participation
Gender (female = 1)	0.002 (0.053)	−0.004 (0.038)	0.003 (0.01)
Asset value (ln)	−1.8 (0.75)	−1.27 (0.55)	−0.36 (0.15)
Farmland size (ln)	0.27 (0.21)	0.18 (0.15)	0.072 (0.043)
Off-farm (yes = 1)	0.05 (0.096)	0.037 (0.069)	0.007 (0.02)
Distance (ln)	−0.31 (0.11)	−0.22 (0.076)	−0.053 (0.024)
Year 2010 (2016 as basis)	0.098 (0.11)	0.062 (0.077)	0.032 (0.022)
Year 2013 (2016 as basis)	0.37 (0.081)	0.28 (0.06)	0.069 (0.015)
Constant	0.14 (0.97)	−0.044 (0.75)	0.008 (0.18)

Note: Standard errors (in parentheses) bootstrapped with 1,000 replications and clustered at the village level in parentheses.

4.3 Impact of natural resource extraction on household consumption

Table 3 shows the results of the endogenous switching regressions on annual per capita consumption by extraction status. The correlation between extraction decision and consumption, denoted as rho, is significant for the extracting majority households as well as for extracting and non-extracting minority households. This implies that there is a selection bias, confirming the need for an endogenous switching regression.

The relationship between extraction and consumption is theoretically inferred from reverse causality. Since extracted products can be used for both sale and home consumption, extraction may have a positive impact on household consumption. Simultaneously, households with low consumption might be more likely to extract natural resources to maintain the current consumption level or to even cope with shocks (Cavendish, 2003). This is especially true for minority households as majority households have better alternatives to extraction, implying higher opportunity cost of extraction. Endogenous switching regressions and treatment effects allow us to infer a causal relationship.

The results of the endogenous switching regressions suggest heterogeneous factors influencing the decision to extract between ethnic majority and minority households. Higher education, higher asset values, and a greater distance to the extracting ground significantly reduce the likelihood of extraction for both groups. At the same time, household size has a positive effect on the extraction decision. However, average age and farmland size only influence the decision of majority households. Regarding minority households, conversely, the dependency ratio increases the likelihood of becoming an extractor and off-farm employment decreases this likelihood.

Annual per capita consumption is positively and significantly influenced by education, asset value, farmland size and off-farm employment. Here, heterogeneity is observable with respect to the significance of the effects between minority extractors and

Table 3. Endogenous switching regressions on annual per capita consumption (ln) by ethnic status and by extraction status

	Whole sample			Ethnic majority			Ethnic minority		
		Outcome model			Outcome model			Outcome model	
	Selection model	Extracting group	Non-extracting group	Selection model	Extracting group	Non-extracting group	Selection model	Extracting group	Non-extracting group
Age	−0.013 (0.003)	0.005 (0.002)	0.006 (0.002)	−0.011 (0.004)	0.007 (0.002)	0.006 (0.002)	−0.003 (0.005)	0.001 (0.002)	0.0001 (0.004)
Education	−0.092 (0.015)	0.035 (0.006)	0.03 (0.006)	−0.07 (0.022)	0.035 (0.009)	0.031 (0.006)	−0.096 (0.022)	0.008 (0.008)	0.073 (0.017)
Household size	0.1 (0.018)	−0.11 (0.009)	−0.08 (0.01)	0.067 (0.027)	−0.08 (0.013)	−0.076 (0.012)	0.072 (0.029)	−0.088 (0.009)	−0.1 (0.023)
Dependency ratio	0.075 (0.056)	−0.13 (0.028)	−0.15 (0.032)	0.007 (0.059)	−0.12 (0.033)	−0.16 (0.036)	0.2 (0.11)	−0.12 (0.037)	−0.11 (0.086)
Gender (female = 1)	0.038 (0.1)	−0.059 (0.039)	−0.0002 (0.041)	0.026 (0.15)	−0.11 (0.059)	0.012 (0.04)	0.003 (0.14)	−0.026 (0.049)	0.072 (0.1)
Asset value (ln)	−0.27 (0.043)	0.21 (0.016)	0.29 (0.021)	−0.21 (0.052)	0.17 (0.023)	0.27 (0.019)	−0.15 (0.048)	0.15 (0.016)	0.34 (0.04)
Farmland size (ln)	0.17 (0.037)	0.043 (0.018)	0.018 (0.019)	0.15 (0.043)	0.072 (0.02)	0.03 (0.018)	0.002 (0.059)	0.08 (0.02)	0.053 (0.044)
Off-farm (yes = 1)	−0.34 (0.084)	0.16 (0.033)	0.15 (0.039)	−0.13 (0.11)	0.097 (0.045)	0.11 (0.038)	−0.27 (0.12)	0.041 (0.043)	0.36 (0.092)

Table 3. *Continued.*

	Whole sample			Ethnic majority			Ethnic minority		
		Outcome model			Outcome model			Outcome model	
	Selection model	Extracting group	Non-extracting group	Selection model	Extracting group	Non-extracting group	Selection model	Extracting group	Non-extracting group
Year 2010 (2016 as basis)	0.14 (0.11)	0.038 (0.038)	−0.075 (0.04)	0.41 (0.16)	−0.15 (0.049)	−0.11 (0.04)	0.038 (0.14)	0.004 (0.048)	0.083 (0.1)
Year 2013 (2016 as basis)	0.49 (0.072)	0.13 (0.047)	−0.12 (0.049)	0.77 (0.083)	0.02 (0.048)	−0.14 (0.052)	0.22 (0.13)	0.12 (0.046)	−0.037 (0.1)
Distance	−0.58 (0.092)			−0.77 (0.12)			−0.16 (0.063)		
Constant	3.01 (0.36)	5.62 (0.12)	5.37 (0.23)	2.23 (0.46)	5.88 (0.21)	5.53 (0.18)	2.13 (0.48)	5.9 (0.15)	3.66 (0.44)
Sigma		0.44 (0.014)	0.43 (0.015)		0.41 (0.02)	0.42 (0.014)		0.46 (0.019)	0.65 (0.074)
Rho		0.14 (0.15)	0.14 (0.2)		0.28 (0.1)	0.19 (0.13)		0.78 (0.067)	−0.91 (0.044)
Number of observations	2,053			1,292			761		
Log likelihood	−2,226.87			−1,312.08			−734.1		
Wald χ^2 (10)	489.77			385.12			296.05		
Prob. $> \chi^2$	0.000			0.000			0.000		

Note: Standard errors (in parentheses) bootstrapped with 1,000 replications and clustered at the village level in parentheses.

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Table 4. ATT and ATU effects of natural resource extraction on annual per capita consumption (ln) by ethnic status

		Decision		
		To extract	Not to extract	Treatment effects
Whole sample	Extracting group	6.971 (0.013)	7.195 (0.015)	ATT = −0.224 (0.02)
	Non-extracting group	7.244 (0.013)	7.558 (0.015)	ATU = −0.314 (0.02)
Majority	Extracting group	7.293 (0.015)	7.46 (0.017)	ATT = −0.167 (0.023)
	Non-extracting group	7.355 (0.013)	7.646 (0.015)	ATU = −0.291 (0.02)
Minority	Extracting group	6.695 (0.015)	5.745 (0.022)	ATT = 0.95 (0.026)
	Non-extracting group	6.306 (0.035)	7.107 (0.039)	ATU = −0.801 (0.053)

Note: Standard errors in parentheses.

non-extractors. Household size and the dependency ratio have a negative impact on consumption. Again, there is a heterogeneous effect between minorities since the impact of the dependency ratio is only significant for extracting minority households. In addition, age positively influences consumption of majority households and a female household head decreases consumption solely for extracting majority households.

Table 4 shows the ATT and ATU effects of natural resource extraction on annual per capita consumption by ethnic status. All treatment effects are significant at the 1 per cent level. The results indicate that for the whole sample the consumption of non-extracting households would decrease by 516 PPP$ (calculated by $e^{7.244} - e^{7.558}$) if they started to extract. These findings support the argument that natural resource extraction is a temporary strategy to cope with shocks (Angelsen *et al.*, 2014; López-Feldman, 2014). For instance, a working household member who falls ill and loses their job might be forced to extract. Income from extraction is lower than the previous income. Hence, not only does income decrease, but household consumption as well. This finding is in line with Nguyen *et al.* (2018*a*). However, in contrast to their study, our results for rural Vietnam indicate that the consumption of extracting households would increase by 267 PPP$ if they stopped extracting because quitting the extraction activities implies that the shock is mitigated.

In our analysis, the distinction into ethnic majority and minority suggests that these two previous effects also hold to a similar extent for ethnic majority households. For the ethnic minority, conversely, it appears that the consumption of non-extracting households would drop considerably, by 673 PPP$, if they started to extract. Additionally, even the consumption of extracting minority households would drop by 496 PPP$ if they stopped extracting. This finding implies that extraction sustains the consumption of minority households. It can be explained by the fact that they have less physical and financial capital (Nguyen *et al.*, 2020; Pham and Mukhopadhaya, 2022). Therefore, they are less able to cope with a shock. Cultural factors and (past) discrimination can further push minorities towards extraction (Baulch *et al.*, 2012). In order to improve the situation of minorities, their shock-coping capacity should be strengthened by improving their access to education as well as to labor and capital markets. This has to be accompanied by an ongoing development of rural infrastructure. The aim is to improve welfare for rural households, especially for ethnic minorities, without degrading natural resources.

5. Conclusion

Ethnic inequality in Vietnam continues to push ethnic minorities into low-return activities such as agriculture and natural resource extraction, making it even more difficult to escape poverty. At the same time, environmental income is shown to reduce inequality. Therefore, this study analyzes how natural resource extraction contributes to ethnic inequality and the well-being of minorities.

Poverty headcount ratios show that minority households are still poorer than majority households, and extracting households are poorer than non-extracting ones. However, the calculation of Gini coefficients reveals that environmental income smooths income inequalities, which is particularly true among ethnic minority households. The Oaxaca-Blinder decomposition points out that ethnic differences in natural resource extraction are due to group differences in age, education, household size, asset value, farmland size, off-farm employment and the distance to the extracting ground. Additionally, different returns to asset value, farmland size, and distance to the extracting ground further drive ethnic inequality. Endogenous switching regressions show that extraction has heterogeneous effects on consumption of extracting and non-extracting as well as majority and minority households. Treatment effects suggest that natural resource extraction sustains consumption of minority households. Consumption of extracting minority households would fall if they stopped extracting. However, the consumption of extracting majority households would increase if they stopped extracting.

Our results imply that strengthening shock-coping capacities and preserving the natural resource base are particularly important for ethnic minorities. Although extraction can reduce inequality, it is not associated with lower poverty rates. Access to alternative livelihood strategies such as off-farm employment needs to be further improved for ethnic minorities. Moreover, starting conditions still differ between ethnic groups. For instance, better education improves consumption and enables the choice of livelihood strategies. Equal opportunity requires education that is tailored to the needs of minorities in terms of language, culture and geographic remoteness.

Although our study provides crucial insights into the importance of natural resource extraction for ethnic minorities, our study is limited to just one Vietnamese province. Future research should extend the analysis to further provinces, e.g., in the Northern Uplands where a high percentage of minorities also live. Additionally, a larger number of different ethnic minorities in the sample could enable a closer look at the plurality of minority groups, as they also differ among themselves.

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