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Unexpected effects of land fragmentation

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Abstract: Using instrumental variable method and Vietnam Access to Resources Household Surveys of 2008–16, I examine the effect of land fragmentation on child outcomes. The study shows that higher land fragmentation decreases child school dropout. Land fragmentation has significant impacts on school dropout of children aged 10–15, however, it does not have any impact on school dropout of children aged 6–10. I explain these findings through one particular mechanism—that is women empowerment. A higher level of land fragmentation increases women's empowerment to decide on visits to family, friends or relatives, on the purchase of daily goods, on large purchases, on her own health, and on her children's health.

Keywords: instrumental variable, land fragmentation, Vietnam
JEL classification: O12, Q12, A20, C26

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1 Introduction

Gender discrimination is a pervasive phenomenon in many developing countries. Women are considered as economically less productive forces in those countries. In agriculture-dependent economies, women are mostly engaged in household work. Therefore, women do not have much power in making decisions within a household. There is a link between labour market opportunities for women and the power over household resource allocation. Female labour force participation gives women more power and control to allocate the resources within a household (Anderson and Eswaran, 2009; Quisimbing and Malucio, 2003), and this in turn can improve child outcomes ((Duflo and Udry 2001; Duflo 2003).

Using data from rural Senegal, Lepine and Strobl (2013) find that an increase in women's power leads to a higher nutritional status of children. Women who spend a lot of time in agricultural activities or housework would not have time to take care of their children. This may have negative impacts on child development. Koolwal and Walle (2013) utilize the dataset in 18 African countries to examine the improvement of infrastructure and its effect on women's time spent on water collection. They find that improved access to water and time savings from decreased water collection burdens are correlated with reduced work on the family farm and lead to more leisure for women. They also indicate that reduced water collection of women increases the probability of children going to school. Allendorf (2007) shows that women with land rights have more power in household decisions and their young children have less probability of being severely underweight in Nepal. Similarly, Menon et al (2013) use Viet Nam Household Living Standards Surveys of 2004 and 2008 to consider the effect of land titling for women on improvements in child health and education. They find that female-only held land-use rights result in a decrease in the incidence of illness of children, an increase in their health insurance coverage, schooling enrollment, and reallocated household expenditures toward food and away from alcohol and tobacco in rural Viet Nam. All those studies suggest that giving women more empowerment in a household would lead to better child development.

Land fragmentation is common in Viet Nam. There were about 75 million land plots in 2004 (Marsh et al. 2007). On average, a rural household owns five different agricultural parcels and about 10 per cent of these plots are less than 100 square meters (Markussen et al, 2016). The land allocation policy of Viet Nam in 1989 was based on the population at the commune level, and there was no discrimination between women and men. Therefore, land fragmentation in Viet Nam may benefit women. When women get married, her parents would return her parcels of land. This suggests that women would have more power in making decisions in households. Given the context as described above, I hypothesize that land fragmentation in Viet Nam would increase women's empowerment in making household decisions. A better status of women in rural households would increase educational attainment of her children.

Although a large body of literature has examined the effect of land fragmentation, little is known about the impact of land fragmentation on school dropout of children and its mechanisms. This study attempts to investigate the impact of land fragmentation on child school dropout and explain the channels through which land fragmentation affects this. However, there is an endogeneity issue on land fragmentation. Given this issue, I exploit the context in which Viet Nam decollectivized collective land to individual households under Resolution 10 in 1988. This has led to land fragmentation since 1988. Land-allocating policy was based on the number of individuals in a household and land quality. As a result, households have highly-fragmented land if they live in a commune with higher population density. In other words, lower land per capita at the commune level increases the degree of land fragmentation at the household level. In addition, I use the

second instrument—that is the percentage of plots which a household acquired before 1993—to check the robustness of the results. I find that higher land fragmentation has a negative and significant impact on child school dropout. And land fragmentation has greater impacts on school dropout of female students aged 6–15 than male students aged 6–15. A higher degree of land fragmentation is also more likely to decrease the probability of students aged 11–15 to drop out of school. But the degree of land fragmentation is not statistically significant for school dropout of students aged 6–10. I explain these findings through one particular mechanism, which is women empowerment. A higher level of land fragmentation increases women empowerment on visits to family, friends or relatives, on purchase of daily goods, on large purchases, on her own health and on her child health.

The study will be organized as follows: section 2 presents the background of decollectivization. Section 3 provides the dataset and descriptive statistics. The empirical methodology is presented in section 4. Section 5 analyses the empirical results. Section 6 explains the robustness checks and section 7 summarizes the findings of the study.

2 Background of decollectivization

In 1954 Viet Nam marked the independence from the French and the country was divided into two parts: North and South. In 1960 North Viet Nam collectivized agricultural lands. In the South, land distribution was called for by limiting maximum holdings of 100 hectares plus 15 hectares of ancestral land. However, by the end of 1967, less than one-eighth of South Viet Nam's cultivated land had been redistributed (Dang, 2010). In 1975, the Viet Nam war ended with the victory of North Viet Nam over South Viet Nam and the country was reunified. Land collectivization started to be implemented in South Viet Nam but the collectivization efforts achieved little success. The collectivization ratio varied across provinces in South Viet Nam. The Southern provinces close to North Viet Nam had a higher ratio of collectivization. Figure A1 in the Appendix shows the variations in the province-level collectivization ratio.[1]

With the issuance of Resolution No. 10 in 1988, the land reform distributed cooperative lands to individual households based on an equal per capita principle. The egalitarian allocation of agricultural land is necessary to avoid the inequality and the risks. Every household tended to receive plots of land with different qualities and distance, leading to a high level of fragmentation. It is noteworthy that farmers were allowed to be assigned the land they owned before 1975, this policy was mostly implemented in southern Viet Nam because the land collectivization had achieved little success. However, land which was confiscated from landlords either during or after the war could not be returned to them. This implies that land inequality is larger in the south than in the north. Further, the egalitarian allocation of agricultural land leads to equal plots of land between husband and wife within a household in the north. The land which had been owned before 1975 returned to previous owners, this leads to inequality in land ownership between husband and wife within a household. This is because a son is always given land inheritance from his parents.

[1] The data on collectivization ratio are taken from *Viet Nam Statistical Data in the 20th Century* (GSO, 2004)

3 Data and descriptive statistics

This study uses five rounds of Viet Nam Access to Resources Household Surveys (VARHS) 2008–16. These surveys were made in 12 provinces in Viet Nam. Although they are not nationally representative, they are representative at province level. These surveys include a lot of information on characteristics of households and communes. Starting in 2008, the survey was administered every two years. The surveys were conducted in collaboration with the Central Institute for Economic Management (CIEM) of the Ministry of Planning and Investment of Vietnam (MPI), and the Institute of Labour Science and Social Affairs (ILSSA) of the Ministry of Labour, Invalids, and Social Affairs of Vietnam (MoLISA). VARHSs 2008, 2010, 2012, 2014, and 2016 include 2,278, 2,245, 2,760, 2,725 and 2,669 households, respectively. These surveys establish a balanced panel dataset of 2,131 observations. The information on women empowerment is not available in VARHS 2012, 2014, and 2016. Therefore, when we run regressions for women empowerment, we only use VARHS 2008 and 2010.

Table 1 provides child school dropout by degree of land fragmentation. We divide land fragmentation into five quintiles. The analysis shows that the percentage of households with children dropping out of school mounts with the degree of land fragmentation and then decreases. Meanwhile, the share of children aged 6–15 dropping out of school also increases with the degree of land fragmentation at the beginning, and then falls with the degree of land fragmentation.

Table 1: Land fragmentation and school dropout

Degree of land fragmentation (Simpson index)	Percentage of households with children dropping out of school	Share of children dropping out of school
0-0.4	0.029	0.061
0.4-0.6	0.038	0.068
0.6-0.7	0.042	0.065
0.7-0.8	0.041	0.063
0.8-1.0	0.030	0.059

Source: Author's calculation based on VARHS 2008–16.

Table 2 analyses the percentage of women empowerment based on the degree of land fragmentation. The results show that woman empowerment to decide on visits to friends or relatives, daily goods, large purchases, contraception, her own health, child schooling, child health, and child birth tends to increase with land fragmentation at the beginning, and then it does not show clear links between the degree of land fragmentation and women empowerment.

Table 2: Land fragmentation and women empowerment

	Female household head's power over the decisions made on							
Degree of land fragmentation	Visits	Daily needs	Large purchase	Contraception	Her own health	Child schooling	Child health	Having a child
0-0.4	0.770	0.776	0.757	0.561	0.778	0.705	0.712	0.635
0.4-0.6	0.775	0.794	0.766	0.650	0.796	0.738	0.747	0.693
0.6-0.7	0.817	0.827	0.780	0.675	0.826	0.755	0.775	0.714
0.7-0.8	0.774	0.791	0.746	0.634	0.786	0.719	0.737	0.684
0.8-1.0	0.807	0.810	0.770	0.690	0.807	0.750	0.765	0.710

Source: Author's calculations based on VARHS 2008 and 2010.

4 Empirical methodology

To answer the questions above and test the hypothesis, our model specification will be as follows:

$$Y_{it} = \alpha_1 + \alpha_1 L_{it} + \alpha_2 X_{it} + \alpha_3 T_t + \varepsilon \quad (1)$$

where Y_{it} is the outcomes of interest, which are child school dropout, women empowerment, and real food per capita. I use eight measures of women empowerment, they are dummy variables on household decision-making processes: visits to family or relatives, household purchases for daily goods, large household purchases, use of contraception, own healthcare, schooling for children, health care for children and having a child. These variables equal one if the female household head or the female spouse of household head has the power to make household decisions alone, with husband, or with someone else, 0 otherwise. L_{it} is the index of land fragmentation, which will be calculated based on Simpson's index, $A=1-\sum_{i=1}^{N} s_i^2$ where s_i is the share of total farm area covered by plot i and N is the total number of plots operated by the household. A value of zero means that the farm household has only one parcel or plot of land, which indicates complete land consolidation, while a value close to one means the household has numerous plots and the farm is 'very fragmented'. X_{it} is the characteristics of households such as: total owned land, household size, education of household head, number of household members of active age (15–55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged above 60, number of boys aged less than 5, number of males aged 15 to 60, number of males aged above 60. X_{it} also includes the characteristics of commune such as: having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. T_t is the year dummy variables (year of 2008 is reference group). Standard errors are clustered at the commune level.[2] Tables A1 and A2 of the Appendix provide the descriptive statistics on dependent and independent variables, respectively.

There is an endogeneity issue on the impact of land fragmentation. The confounding factors such as: entrepreneurship, history, and risk preferences, may affect our results. These effects may not be measured by the data but can affect the outcomes of interest and land fragmentation simultaneously. The omitted variables are also likely to affect our results. When randomized experimental design can't be done, instrumental variable method is applied to deal with the endogeneity issue. However, finding a convincing instrument is challenging. This instrument only affects endogenous variable but does not affect directly the interest outcomes or error terms. In this study, I propose land per capita at the commune level as an instrumental variable, which is constructed by taking total annual crop, perennial crop and water surface land divided by the number of people living in a commune in 2008. I expect that commune-level land per capita is strongly correlated with land fragmentation but not correlated with outcomes of interest of equation (1).

The breakdown of common property systems may result in increased fragmentation. Several authors have suggested that egalitarian land-allocating policy is the main cause of land fragmentation in certain areas (Dahlman 1980; Georgescu-Roegen 1969; Grigg 1970; Quiggin 1988). Viet Nam's 1988 Land Law and Resolution 10 decollectivized agricultural land and returned it to individual households. Land allocation policy was implemented based on egalitarian

[2] Given the panel dimension, this study can't use household fixed-effects because the variation in land fragmentation is tiny over time.

principles, suggesting that households received land with good as well as bad quality. Population density is much higher in the northern than in the southern plains, therefore land fragmentation is much more pronounced in the north than in the south. Meanwhile, the ratio of collectivization was much larger in the north than in the south, and varied across southern provinces (Pingali and Vo, 1992). Based on this context, I contend that land per capita at the commune level is an excellent instrumental variable for land fragmentation at the household level.

However, it is more relevant to use more than one instrumental variable because a combination of instrumental variables will increase the consistency of the estimated effect of land fragmentation. Further, an over-identification test can be done when we have more than one instrumental variable. Therefore, I propose the second instrumental variable, which is the percentage of land plot acquisition before 1993 at the household level. As I described above, there was a large variation in ratio of collectivization in the Northern provinces. A lot of households did not participate in cooperatives or they only contributed a part of their land to cooperatives. Land Law 1993 formally allocated agricultural lands to individual households. Land which had been owned before 1975 was returned to farmers. This suggests that the percentage of land plot acquisition before 1993 is positively correlated with land fragmentation at the household level.

The first-stage of equation (1) will be as follows:

$$L_{it} = \alpha_1 + \alpha_1 M + \alpha_2 P + \alpha_3 X_{it} + \alpha_3 T_t + \varepsilon \qquad (2)$$

where M is annual, perennial crop and water surface land per capita at the commune level in 2008. P is the percentage of land plot acquisition before 1993 at the household level in 2008.

The instrument overcomes reverse causality concerns because land fragmentation of households is unlikely to influence land per capita at the commune level. The instrument would be problematic if factors at the commune level may affect land per capita at the commune level and interest outcomes of equation (1) simultaneously. To address these concerns, we employ a variety of control variables at the commune level such as dummy variable for commune with program for alcohol control, dummy variable for having daily market in a commune, dummy variable for having favorable weather for agriculture in the past 12 months, dummy variable for having malaria prevalent in a commune.

Table 3 presents the results of first-stage regressions. Model 1 shows that agricultural land per capita at the commune level has a negative and highly significant impact on land fragmentation. The result is statistically significant at 1 per cent level. It suggests that lower agricultural land per capita increases the degree of land fragmentation of households. The significance and magnitude of the coefficient of land per capita remain unchanged when we add other instrumental variable – ratio of plot acquired before 1993 (Model 2) and control for other commune-level factors including dummy variables for having flood, drought, typhoon, landslide, animal epidemics, plant disease, and having insects occurred in the survey year (Model 3). Meanwhile, ratio of plot acquired before 1993 has a negative impact on land fragmentation and it is statistically significant at 10 per cent level in model 2 and at 5 per cent level in model 3. The results on instrumental variables are unchanged even when I control for further commune-level factors (Model 3). F test of excluded instrument is greater than 10 for three models, implying that the instruments are strong.

Table 3: Result of first-stage regression (Dependent variable: Land fragmentation)

	Model 1	Model 2	Model 3
Log (land per capita +1)	-0.040***	-0.040***	-0.040***
	(0.008)	(0.008)	(0.008)
Ratio of plot acquired before 1993		-0.031*	-0.032**
		(0.016)	(0.016)
Having flood			0.005
			(0.018)
Having drought			0.014
			(0.016)
Having typhoon			0.037**
			(0.017)
Having landslide			0.056***
			(0.018)
Having animal epidemics			0.003
			(0.016)
Having plant disease			-0.028
			(0.017)
Having insects			-0.023
			(0.017)
Constant	0.286***	0.309***	0.293***
	(0.067)	(0.066)	(0.068)
N	10097	10097	10097
adj. R2	0.169	0.171	0.175
F test of excluded instrument	24.56	14.36	14.88

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for log (total land area+1), household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008–16.

5 Empirical results

The estimation results with and without instrumental variable method are presented in Table 4, based on equation (1). I find that the OLS results are statistically and negatively significant for both household-level measures of school dropout of children aged 6–15: dummy variable for households with at least one child dropping out of school and share of school-aged children dropping out of school in households (Columns 1 and 2)[3]. The result is also statistically and negatively significant for dummy variable for school dropout of a child aged 6–15 at the individual level (Column 3). However, the estimations with 2SLS find a larger magnitude of coefficient of land fragmentation on child school dropout (Columns 4–9). Specifically, a 10 per cent standard deviation increase in land fragmentation leads to a 12.8 per cent decrease in households with at least one child dropping out of school (Column 4), a 26.4 per cent reduction in share of school-aged children dropping out of school (Column 5), a 34.3 per cent fall in the probability of a child dropping out of school at the individual level (Column 6). Columns 7–9 provide the similar results when I use two instruments. Further, Table 4 shows that P-values of Sargen test are not statistically significant, suggesting that our instruments overcome the exclusion restrictions. P-value of Hausman test for endogeneity is statistically significant, implying that domestic violence is an

[3] Note that using share of school-aged children dropping out of school as a measure of child school dropout would reduce the number of observations because there are a lot of households without children within 6–15 years old.

endogenous variable. The findings indicate that the regression estimations would be downward biased without using instruments.

Besides, total land area is positively and highly statistically significant for child school dropout, suggesting that larger land area increases the probability of children dropping out of school.

Table 4: The impact of land fragmentation on child school dropout

	OLS			IV: Instrument is Log (land per capita +1)			IV: Instruments are log (land per capita +1) at commune level and ratio of plot acquired at the household level before 1993		
	Dummy variable for households with children dropping out of school	Share of children dropping out of school	Dummy variable for school drop out of a child	Dummy variable for households with children dropping out of school	Share of children dropping out of school	Dummy variable for school drop out of a child	Dummy variable for households with children dropping out of school	Share of children dropping out of school	Dummy variable for school drop out of a child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Land fragmentation	-0.019**	-0.026*	-0.036**	-0.128***	-0.264***	-0.343***	-0.132***	-0.272***	-0.367***
	(0.008)	(0.015)	(0.016)	(0.048)	(0.094)	(0.127)	(0.046)	(0.091)	(0.127)
Log (total area+1)	0.002	0.003	0.002	0.008**	0.015**	0.016**	0.009***	0.015***	0.017**
	(0.002)	(0.004)	(0.004)	(0.003)	(0.006)	(0.007)	(0.003)	(0.006)	(0.007)
Constant	0.038**	0.117***	0.205***	0.047**	0.150***	0.243***	0.047**	0.151***	0.246***
	(0.018)	(0.037)	(0.050)	(0.020)	(0.044)	(0.058)	(0.020)	(0.044)	(0.059)
Sargan test (p-value)							0.715	0.673	0.403
Hausman test for endogeneity (p-value)				0.012	0.009	0.004	0.007	0.004	0.001
F test of excluded instrument				24.56	22.40	16.82	14.36	12.36	9.01
	Household level	Household level	Individual level	Household level	Household level	Individual level	Household level	Household level	Individual level
N	10097	4214	6556	10097	4214	6556	10097	4214	6556
adj. R2	0.074	0.054	0.078						

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008–16.

Land fragmentation may have a different impact on child school dropout by gender. Table 5 presents the estimation results with one instrument and two instruments for two sub-samples of male and female children. Using one instrument, I find that school dropout of a male student and school dropout of a female student are negatively and statistically significant at 5 per cent level. Using two instruments, the results are much unchanged. For example, the results with two instruments suggest that a 10 per cent standard deviation increase in land fragmentation decreases school dropout of a male student by 4.2 per cent and school dropout of a female student by 3.7 per cent (Columns 3 and 4). We find mixed evidence on the magnitude of the effect of land fragmentation on school dropout of a female student versus a male student. To put it differently, we reject the hypothesis that land fragmentation has a different effect on child school dropout by gender.

.Table 5: The impact of land fragmentation on child school dropout by gender at the individual level

	IV: Instrument is Log (land per capita +1)		IV: Instruments are log (land per capita +1) at the commune level and ratio of plot acquired at the household level before 1993	
	Male	Female	Male	Female
	(1)	(2)	(3)	(4)
Land fragmentation	-0.308**	-0.375**	-0.421***	-0.372**
	(0.143)	(0.150)	(0.146)	(0.149)
Log (total area+1)	0.016**	0.016*	0.021***	0.016*
	(0.008)	(0.010)	(0.008)	(0.009)
Constant	0.282***	0.185**	0.311***	0.185**
	(0.074)	(0.082)	(0.079)	(0.082)
Sargan test (p-value)			0.073	0.707
Hausman test for endogeneity (p-value)	0.056	0.004	0.002	0.005
F test of excluded instrument	11.18	18.04	7.38	9.02
N	3362	3194	3362	3194

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for age of a child, age of a child squared, household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008–16.

I also hypothesize that land fragmentation has a different impact on child school dropout by age. I divide the sample into two subsamples: one with children aged 6–10 and the other with children aged 11–15. The results are reported in Table 6. Both regression estimations with one instrument and two instruments provide similar results. In particular, land fragmentation has negative and significant effects on school dropout of children aged 11–15 (Columns 2 and 4). However, it is not statistically significant for school dropout of children aged 6–10 (Columns 1 and 3). A 10 per cent higher land fragmentation decreases school dropout of students aged 11–15 by 5.1 percent. This suggests that students aged 11–15 are more vulnerable to school dropout than those aged 6–10.

Table 6: The impact of land fragmentation on child school dropout by age at the individual level

	IV: Instrument is Log (land per capita +1)		IV: Instruments are log (land per capita +1) at commune level and ratio of plot acquired at the household level before 1993	
	Ages 6–10	Ages 11–15	Ages 6–10	Ages 11–15
	(1)	(2)	(3)	(4)
Land fragmentation	-0.085	-0.506***	-0.132	-0.513***
	(0.084)	(0.178)	(0.085)	(0.176)
Log (total area+1)	0.004	0.024**	0.007	0.024**
	(0.005)	(0.010)	(0.005)	(0.010)
Constant	0.016	0.257***	0.025	0.258***
	(0.045)	(0.069)	(0.046)	(0.069)
Sargan test (p-value)			0.121	0.662
Hausman test for endogeneity (p-value)	0.216	0.007	0.048	0.005
F test of excluded instrument	12.47	18.21	7.09	9.52
N	2756	3800	2756	3800

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for age of a child, age of a child squared, gender of a child, household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008–16.

Table 7 presents the estimates of impacts of land fragmentation on women empowerment[4]. I use a variety of measures of women empowerment. OLS regressions in Panel A show that land fragmentation is statistically insignificant for all measures of women empowerment, except for women empowerment on contraception. Using IV regressions, Panel B indicates that land fragmentation is positively and statistically significant for all measures of women empowerment (Columns 1–8). A 10 per cent standard deviation increase in land fragmentation increases the probability of women making decisions on visits to family, friends or relatives by nearly 3 per cent, on large purchases by 3.1 per cent, on whether to use contraception by 4.7 per cent, on her own health by 2.8 per cent, on schooling for her child by 2.8 per cent, on her child health by 4 per cent, on having a child by 3.7 per cent (Columns 1–8). Utilizing two instruments, Panel C provides very similar results on the impact of land fragmentation on women empowerment.[5]

Total land area has negative impacts on women empowerment. These imply that households with large land area specializing in agricultural activities cause a reduction in women empowerment because agricultural activities need men strength more than women strength and men would have more empowerment in agricultural economies.

[4] Note that information on women empowerment is only available for surveys of 2008 and 2010. This is the reason why the number of observations reduces significantly.

[5] Panel C also suggests that P-values of Sargan test are statistically insignificant except for contraception (column 4). It means that instruments overcome the over-identification test and they are valid. P-values of Hausman test for endogeneity are highly statistically significant.

Table 7: The impact of land fragmentation on women empowerment

	Visits	Daily needs	Large purchase	Contraception	Her own health	Child schooling	Child health	Having a child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: OLS regressions								
Land fragmentation	0.021	0.019	-0.011	0.083**	0.011	0.004	0.021	0.031
	(0.030)	(0.030)	(0.032)	(0.033)	(0.030)	(0.032)	(0.032)	(0.035)
Log (total area+1)	-0.005	-0.005	-0.005	0.013**	-0.006	0.001	0.002	0.013**
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
Constant	0.438***	0.462***	0.447***	0.063	0.487***	0.421***	0.391***	0.233***
	(0.053)	(0.053)	(0.058)	(0.059)	(0.053)	(0.056)	(0.056)	(0.060)
Adj. R^2	0.086	0.087	0.069	0.138	0.082	0.067	0.074	0.077
Panel B: Instrument is Log (land per capita +1)								
Land fragmentation	0.301**	0.230	0.310*	0.474**	0.277*	0.279*	0.399**	0.366*
	(0.152)	(0.146)	(0.166)	(0.200)	(0.153)	(0.162)	(0.184)	(0.206)
Log (total area+1)	-0.018*	-0.015*	-0.020**	-0.006	-0.018**	-0.012	-0.016	-0.003
	(0.009)	(0.009)	(0.010)	(0.012)	(0.009)	(0.010)	(0.011)	(0.013)
Constant	0.389***	0.425***	0.391***	-0.006	0.441***	0.373***	0.325***	0.174**
	(0.064)	(0.062)	(0.070)	(0.074)	(0.063)	(0.064)	(0.068)	(0.071)
Hausman test for endogeneity (p-value)	0.083	0.152	0.076	0.100	0.097	0.073	0.057	0.142
F test of excluded instrument	21.29	21.29	21.29	21.29	21.29	21.29	21.29	21.29
Panel C: Instruments are log (land per capita +1) at the commune level and ratio of plot acquired at the household level before 1993								
Land fragmentation	0.285*	0.226	0.299*	0.529***	0.267*	0.310*	0.400**	0.384*
	(0.148)	(0.143)	(0.161)	(0.187)	(0.149)	(0.160)	(0.180)	(0.203)
Log (total area+1)	-0.017*	-0.015*	-0.019*	-0.009	-0.018**	-0.014	-0.017	-0.004
	(0.009)	(0.009)	(0.010)	(0.011)	(0.009)	(0.010)	(0.011)	(0.013)
Constant	0.392***	0.425***	0.393***	-0.015	0.442***	0.368***	0.325***	0.171**
	(0.064)	(0.062)	(0.069)	(0.074)	(0.063)	(0.064)	(0.068)	(0.070)
Sargan test (p-value)	0.599	0.904	0.730	0.134	0.739	0.293	0.952	0.643
Hausman test for endogeneity (p-value)	0.099	0.150	0.081	0.015	0.104	0.040	0.046	0.102
F test of excluded instrument	12.83	12.83	12.83	12.83	12.83	12.83	12.83	12.83
N	4031	4031	4031	4031	4031	4031	4031	4031

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008 and 2010.

The results on the impact of land fragmentation on real food per capita in the past 4 weeks in households are reported in Table 8, which shows that land fragmentation is negatively associated with log of real food per capita when we use OLS regression (Column 1). However, the IV estimates show that land fragmentation has a significant and positive effect on log of real food per capita (Column 2). Specifically, a 10 per cent standard deviation increase in land fragmentation

increases real food per capita of households by 5.41 per cent. The result is much similar when we use two instrumental variables (Column 3).

Table 8: The impact of land fragmentation on real food per capita in the past 4 weeks (Dependent variable: Log of real food per capita)

	OLS	IV: Instrument is Log (land per capita +1)	IV: Instruments are log (land per capita +1) at commune level and ratio of plot acquired at the household level before 1993
	(1)	(2)	(3)
Land fragmentation	-0.137***	0.541**	0.468*
	(0.040)	(0.271)	(0.255)
Log (total area+1)	-0.013	-0.049**	-0.046**
	(0.010)	(0.022)	(0.021)
Constant	5.591***	5.533***	5.539***
	(0.080)	(0.088)	(0.087)
Sargan test (p-value)			0.127
Hausman test for endogeneity (p-value)		0.004	0.012
F test of excluded instrument		24.49	24.49
N	10084	10084	10084
adj. R^2	0.224		

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008–16.

6 Robustness checks

I am concerned that the results may be biased due to the confounding factors. For instance, natural disasters may be the factors which affect the results. Besides, the unobservable factors at the commune level might affect the interest outcomes and the instrumental variables simultaneously. To address this issue, I control for the commune-level variables relating to natural disasters to check the robustness of the results. Those variables include dummy variables for having flood, drought, typhoon, landslide, animal epidemics, plant disease, and having insects occurred in the survey year. I re-run regressions for Tables 4, 7, and 8 both models with more control variables as just mentioned. The regression estimations on child school dropout and women empowerment are reported in Table 8A. Panel A presents the results using one instrument and Panel B reports the results using two instruments. We show that the results are mostly unchanged compared with those in Tables 4, 7, and 8. Similarly, I also re-run regressions at the individual level for Tables 5 and 6 with adding control variables relating to natural disasters. The results with one instrument and two instruments are presented in Table 8B. I find that the findings remain similar. Those findings suggest that our instrument is strong and robust.

Table 8A: Robustness checks (IV regressions)

	Land fragmentation	Standard errors	N
Panel A: Instrument is Log (land per capita +1)			
Panel A1: child school dropout			
Dummy variable for households with children dropping out of school	-0.138***	(-0.049)	10097
Share of children dropping out of school	-0.274***	(-0.096)	4214
Dummy variable for school dropout of a child aged 6-15	-0.369***	(-0.13)	6556
Panel A2: women empowerment			
Visits	0.288*	(-0.158)	4031
Daily needs	0.217	(-0.156)	4031
Large purchase	0.301*	(-0.173)	4031
Contraception	0.478**	(-0.207)	4031
Her own health	0.267*	(-0.162)	4031
Child schooling	0.279	(-0.174)	4031
Child health	0.398**	(-0.197)	4031
Having a child	0.362*	(-0.217)	4031
Panel A3: Real food per capita in the past 4 weeks			
Log of real food per capita	0.607**	(0.269)	10084
Panel B: Instruments are log (land per capita +1) at the commune level and ratio of plot acquired at the household level before 1993			
Panel B1: child school dropout			
Dummy variable for households with children dropping out of school	-0.147***	(-0.046)	10097
Share of children dropping out of school	-0.283***	(-0.092)	4214
Dummy variable for school dropout of a child aged 6-15	-0.384***	(0.127)	6556
Panel B2: child school dropout			
Visits	0.279*	(-0.153)	4031
Daily needs	0.222	(-0.152)	4031
Large purchase	0.296*	(-0.167)	4031
Contraception	0.548***	(-0.191)	4031
Her own health	0.265*	(-0.156)	4031
Child schooling	0.319*	(-0.171)	4031
Child health	0.409**	(-0.191)	4031
Having a child	0.390*	(-0.213)	4031
Panel B3: Real food per capita in the past 4 weeks			
Log of real food per capita	0.505**	(0.256)	10084

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level. Source: Author's calculation based on VARHS 2008–16 for Panels A1, A3, B1 and B3, on VARHS 2008 and 2010 for Panels A2 and B2.

Table 8B: Robustness checks (IV regressions)

	Male	Female	Ages 6-10	Ages 11-15
	(1)	(2)	(3)	(4)
Panel A: Instrument is Log (land per capita +1)				
Land fragmentation	-0.327**	-0.397**	-0.075	-0.532***
	(0.143)	(0.155)	(0.082)	(0.183)
Constant	0.179***	0.158**	0.017	0.275***
	(0.056)	(0.067)	(0.045)	(0.069)
Panel B: Instruments are log (land per capita +1) at the commune level and ratio of plot acquired at the household level before 1993				
Land fragmentation	-0.436***	-0.391**	-0.127	-0.543***
	(0.143)	(0.153)	(0.083)	(0.179)
Constant	0.205***	0.159**	0.025	0.279***
	(0.062)	(0.068)	(0.046)	(0.070)
N	3362	3194	2756	3800

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The regressions control for household size, education of household head, number of household members of active age (15-55/66), number of girls aged less than 5, number of females aged 15 to 60, number of females aged 60 above, number of boys aged less than 5, number of males aged 15 to 60, number of males aged 60 above, having a program to control or reduce consumption of alcohol in a commune, having daily market in a commune, having good weather for agriculture in a commune, dummy variable for malaria prevalent in a commune. The regressions also control for year fixed-effects. Standard errors are clustered at the commune level.

Source: Author's calculation based on VARHS 2008–16.

7 Conclusion

This study uses five rounds of Viet Nam Access to Resources Household Surveys of 2008–16 to investigate the impact of land fragmentation on child school dropout. Most previous studies on land fragmentation concentrate on agricultural performance (Hung et al, 2007; Desiere and Dean, 2017; Deinninger et al, 2017), little is known about the effect of land fragmentation on child education. To overcome the endogeneity issue of land fragmentation, I use area of land per capita at commune level as instrumental variable for land fragmentation at the household level. Meanwhile, the second instrument—that is percentage of plots which a household acquired before 1993—is also proposed to check the consistency of the results.

The findings are that highly-fragmented households have a lower probability of children dropping out of school. And the impact of land fragmentation on the probability of female students aged 6–15 dropping out of school is no different from that of land fragmentation on the probability of male students aged 6–15 dropping out of school. Land fragmentation does not have any effect on the probability of students aged 6–10 dropping out of school, however land fragmentation does have a significant impact on school dropout of students aged 11–15. I explain these findings through one particular mechanism – women empowerment. I find that higher land fragmentation is strongly related to women empowerment in making decision in households.

Obviously, women's land ownership increases their bargaining power within the household (Mishra and Sam, 2015). Better women empowerment improves the child education attainment. This study deepens the understanding on the positive side of land fragmentation. Land fragmentation is not as bad as widely assumed, and it offers an important tool for increasing women empowerment in Viet Nam. Land consolidation policies need to be considered carefully. Land consolidation must be implemented by the market rather than the will of the government.

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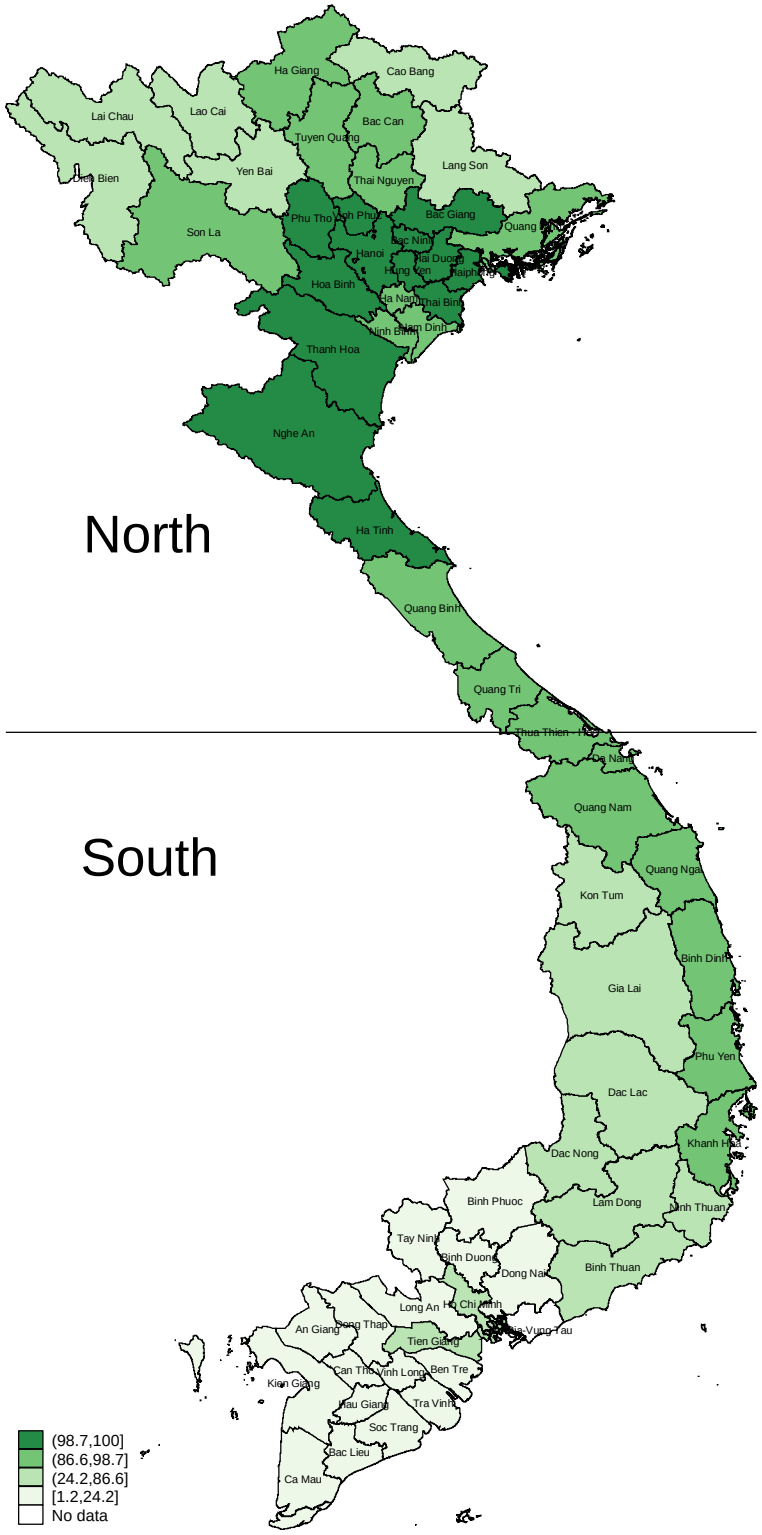
Appendix

Figure A1: The collectivization ratio across provinces in 1988



Source: Author's illustration based on Viet Nam Statistical Data in the 20th Century (GSO, 2004).

Table A1: Descriptive statistics on dependent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Dummy variable for households with children dropping out of school	10,097	0.037	0.188	0	1
Share of children dropping out of school	4,214	0.064	0.224	0	1
Dummy variable for school drop out of a child aged 6-15	6,556	0.068	0.251	0	1
Dummy variable for school drop out of male students aged 6-15	3,362	0.072	0.258	0	1
Dummy variable for school drop out of female students aged 6-15	3,194	0.063	0.243	0	1
Dummy variable for school drop out of students aged 6-10	2,756	0.030	0.170	0	1
Dummy variable for school drop out of students aged 11-15	3,800	0.095	0.293	0	1
Real food per capita	10,084	5.720	0.756	0.228	8.650
Women empowerment on					
Visits	4,031	0.789	0.408	0	1
Daily needs	4,031	0.799	0.401	0	1
Large purchase	4,031	0.763	0.425	0	1
Contraception	4,031	0.647	0.478	0	1
Her own health	4,031	0.798	0.401	0	1
Child schooling	4,031	0.734	0.442	0	1
Child health	4,031	0.748	0.434	0	1
Having a child	4,031	0.688	0.464	0	1

Source: Author's calculation based on VARHS 2008-2016.

Table A2: Descriptive statistics on independent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Log (total area+1)	10,097	7.770	1.524	0	12.33488
Household size	10,097	4.307	1.786	1	14
Education of household head	10,097	2.828	0.931	0	5
Number of household members of active age (15-55/66)	10,097	2.815	1.571	0	10
Number of girls aged less than 5	10,097	0.107	0.339	0	3
Number of females aged 15 to 60	10,097	0.309	0.478	0	3
Number of females aged 60 above	10,097	0.107	0.332	0	3
Number of boys aged less than 5	10,097	1.488	0.986	0	6
Number of males aged 15 to 60	10,097	0.744	0.436	0	1
Number of males aged 60 above	10,097	0.514	0.500	0	1
Having a program to control or reduce consumption of alcohol in a commune	10,097	0.483	0.500	0	1
Having daily market in a commune	10,097	0.206	0.404	0	1
Having good weather for agriculture in a commune	10,097	0.702	0.457	0	1
Having malaria prevalent in a commune	10,097	0.786	0.410	0	1
Having flood in a commune	10,097	0.680	0.466	0	1
Having drought in a commune	10,097	0.628	0.483	0	1
Having typhoon in a commune	10,097	0.726	0.446	0	1
Having landslide	10,097	0.739	0.439	0	1
Having animal epidemics	10,097	0.702	0.457	0	1
Having plant disease	10,097	0.739	0.439	0	1
Having insects	10,097	0.702	0.457	0	1

Source: Author's calculation based on VARHS 2008-2016.