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Off The Farm: An Evaluation Of Non-Farm Earnings And Employment On Poverty Alleviation In Rural Nicaragua

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OFF THE FARM: AN EVALUATION OF NON-FARM EARNINGS AND EMPLOYMENT ON POVERTY ALLEVIATION IN RURAL NICARAGUA

A Thesis Presented

by

Magaly Vanessa Sáenz Somarriba

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ABSTRACT

OFF THE FARM: AN EVALUATION OF NON-FARM EMPLOYMENT ON POVERTY ALLEVIATION IN RURAL NICARAGUA

May 2019

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In Nicaragua, poverty disproportionately affects the rural population. Over the last two decades, rural inhabitants have increased their participation in the Rural Non-Farm (RNF) sector. This study uses four waves of data from the Living Standard Measurement Survey (LSMS) between 2001 and 2014 to test whether the transition to the RNF sector decreases poverty rates and increases consumption. To account for the endogeneity of RNF participation and measures of well-being like consumption, I use an instrumental variables approach. I use a policy enacted in 2006 that induced plausibly exogenous variation in electrification rates over the same period to instrument for the RNF decision. Results suggest that an additional member

of the household employed in the RNF sector increase household consumption by 17-25 percent and reduces the household's likelihood to be in a poverty status by 15-21 percentage points. These effects are greater among municipalities with higher levels of consumption prior to the electrification expansion, which implies that households engage in RNF taking advantage of the surrounding opportunities.

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LIST OF ABBREVIATIONS

ENATREL	Empresa Nacional de Transmisión Eléctrica
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
INIDE	Instituto Nacional de Información de Desarrollo
IV	Instrumental Variable
LSMS	Living Standard Measurement Survey
OLS	Ordinary Least Squares
PPP	Purchasing power parity
RNF	Rural Non-Farm

CHAPTER 1.
INTRODUCTION

In Nicaragua, poverty is a rural problem. In 2014, the rural population represented 42% of the total population, but 70% of the poor population.[1] Poverty is associated with high mortality, malnutrition, crime, lack of education, poor health and many other factors that end up perpetuating poverty (Banerjee and Duflo, 2011). While Nicaragua has made great strides in reducing poverty across the country, rural poverty remains a pressing issue. While urban poverty fell from 30.1% to 14.8% between 2001 to 2014, poverty rates in rural areas only fell from 67.8% to 50% over the same time period[2].

The rural non-farm (RNF hereafter) sector plays an important role in utilizing surplus labor and reducing poverty (Janvry and Sodoulet, 2000; Kung and Lee, 2001; Lanjouw and Lanjouw, 2001; Corral and Reardon 2001). Reardon et al. (1998) define RNF activities as income generated by rural inhabitants from wage-paying activities or self-employment in commerce, manufacturing, and other services. They argue that understanding the dynamics of RNF and the role it plays in a household's income is essential for three main reasons. First, there is an increasing share of rural households engaging in RNF; therefore, it has implications for food security, vulnerability, and overall expenditures. Second, rural households who undertake RNF activities, have higher income, reducing financial constraints allowing them to invest in more

[1] Authors' Calculations based on Living Standard Measurement Survey (LSMS) 2014.
[2] Author's Calculations based on LSMS 2001 and 2014.

productive farm inputs, impacting not only their profitability but achieving better performance of the food system, lowering urban food prices. Third, RNF can create resource transfers from urban to rural areas, when rural inhabitants commute to urban areas to make business or for their job, increasing expenditures locally. However, other authors argue that RNF activities push landless households into survival self-employment, creating low productivity employment and the loss of agricultural output (Ellis and Freeman 2005). As a result, RNF could be a mechanism that perpetuates poverty.

Ellis (2000) argues that households go into RNF, motivated by one of two factors. First, the pull factors, referring to them as a deliberate strategy to take advantage of the opportunities and growth around them. Second, the pull factors, in which households engage in RNF as an involuntary response to shocks.

In this paper, I address two main research questions. First, has RNF participation contributed to the observed poverty reduction in Rural Nicaragua? Second, conditional on observing an effect of RNF on poverty alleviation, which factors are driving Nicaraguan households into RNF? I use four waves of data from the Nicaraguan Living Standard Measurement Survey (LSMS), conducted under technical supervision of the World Bank: 2001, 2005, 2009 and 2014. Using a pooled cross-section from all the periods available of the LSMS, and given the endogeneity around RNF participation, I estimate an instrumental variables (IV) regression with time fixed effects to identify the causal effect of RNF participation on poverty. In particular, I instrument the participation in RNF with municipal electrification rates. Corral and Reardon (2001) find electrification to be one of the strongest determinants of RNF participation in Nicaragua, while others have uncovered the causal effect of electrification on employment increases (Dinkelman, 2011) and on increasing time spent working for money (Grogan and Sadanand, 2013).

Results suggest that RNF participation causes an increase in household consumption and poverty reduction. Specifically, RNF participation increases household consumption by 17% - 25% and decreases the likelihood of being on poverty by 15 -21 percentage points. Additionally, given that the effect is only present in low poverty municipalities, RNF seems to have reduced poverty by a pull mechanism, where households take the opportunities offered by the economic growth setting. At the same time, there is an increasing gap in household welfare characteristics between households in and out of the RNF sector.

This research makes two primary contributions to the literature of growth and rural development. First, previous research has primarily studied RNF in sub-Saharan countries. To my knpwledge, there is no piece researching RNF income using data for an extended period in Latin America. Second, although many pieces are investigating the implications of RNF to development (Msoo and Goodness , 2014; Ruben and Van Den Berge, 2001; Iqbal et al., 2018), very few are using quasi-experimental methods, like the one proposed in this study. This is important because it allows us to go beyond the exploration phase to infer causality.

The rest of this paper is organized as follows: Section 2 provides background on Nicaragua's economic outlook. In section 3, I describe the current body of literature on RNF. In section 4, 5 and 6, I outline the theoretical framework, the data, and the empirical strategy. Finally, I discuss my results and provide some robustness checks before concluding.

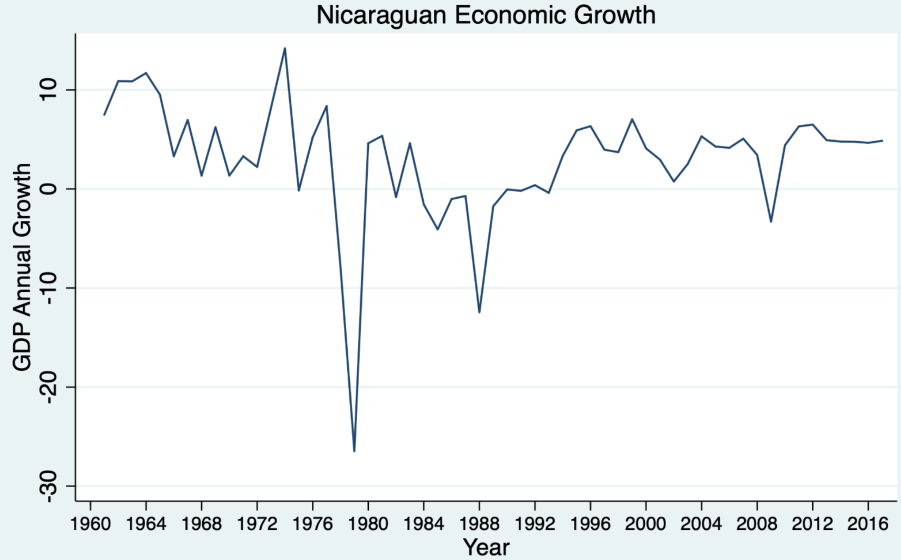
CHAPTER 2.

BACKGROUND

Nicaragua is the third poorest country in Central America and the second poorest in the whole Latin American region (World Bank, nd)[3]. Nicaraguan history is marked by political conflicts, civil wars and natural disasters which as shown in Figure 1, have not allowed the country to have sustainable growth for extended periods (Vélasquez, 2011).

Figure 1.

Nicaraguan Economic Growth



Source: World Bank Development Indicators 2019

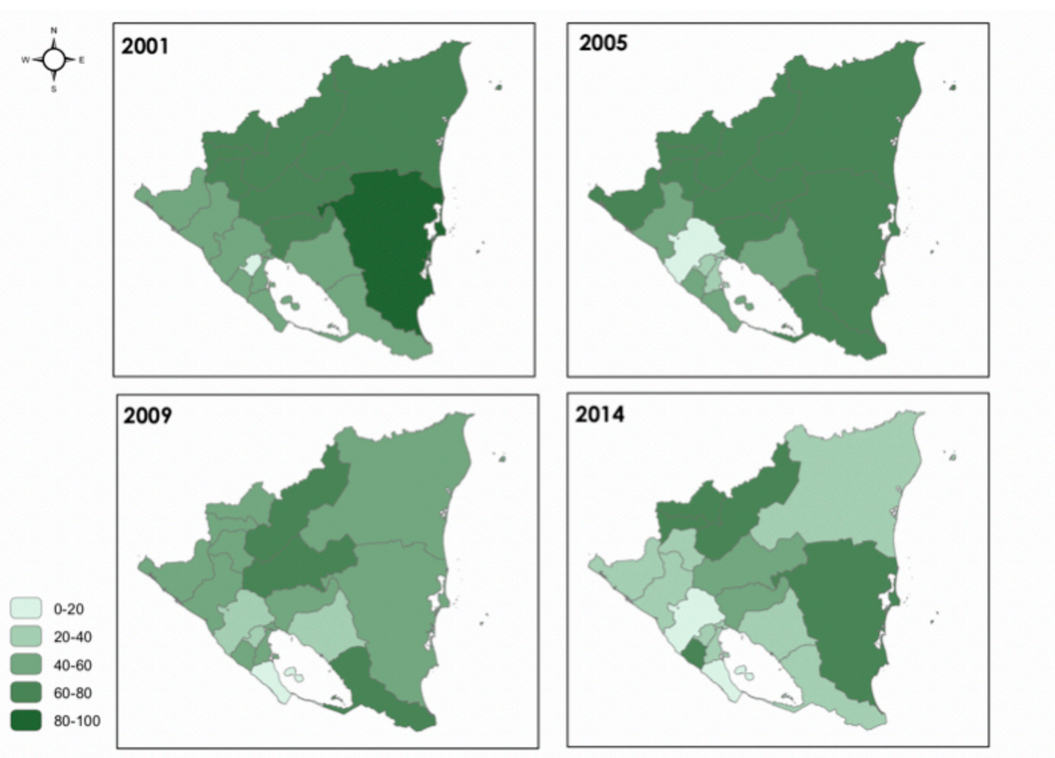
The rural sector in Nicaragua plays a vital role in the economy. According to the World Bank (2019), agricultural production contributed 16.7%, and more importantly, the

[3] Based on GDP per capita in constant 2011, international purchasing power parity (PPP).

agricultural sector hasn't shown a significant reduction in GDP contribution over the last two decades. Additionally, in 2014 the agricultural sector employed 31.4% of overall active labor force and 41% of the male active labor force.

Despite non-market factors affecting the economic cycle of the country, from 2001 to 2014 Nicaragua GDP had approximately a 4% average growth (World Bank, 2019). However, growth is heterogeneous across regions. As shown in Figure 2, moving from the rural areas of Managua located in the Pacific region (West) toward the Interior and then Atlantic region (East), poverty increases. The interior and the Atlantic regions contain 77% of the rural population.

Figure 2. Poverty rates in rural Nicaragua

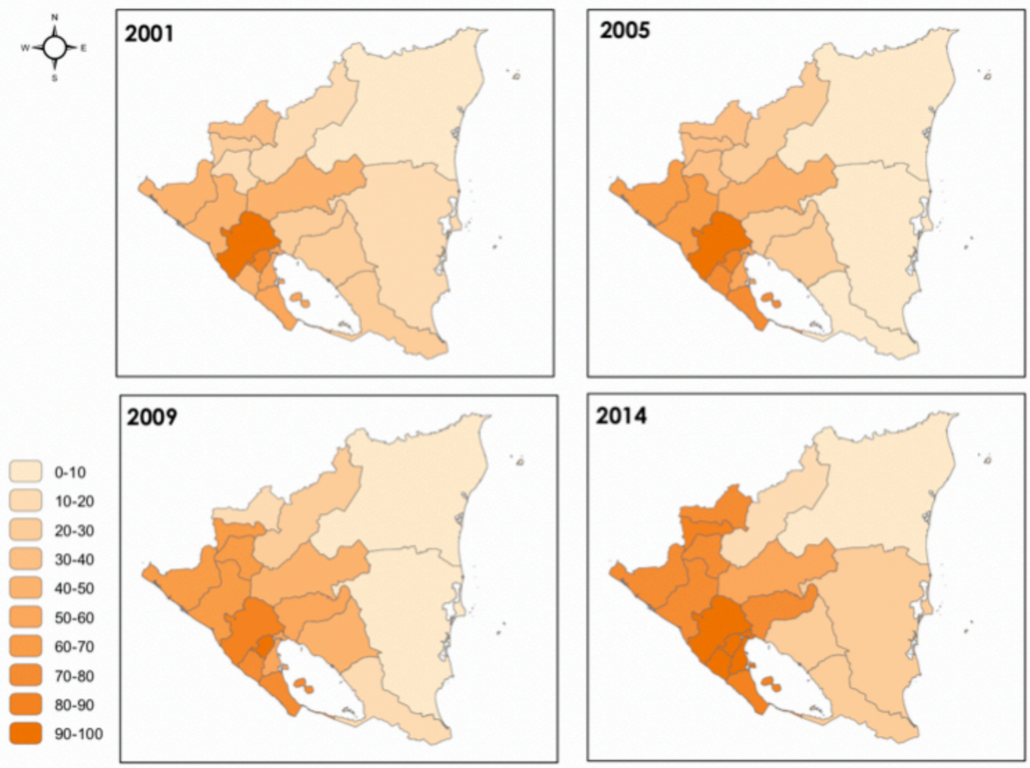


Source: Author's estimation based on LSMS 2001, 2005, 2009 and 2014

Nicaraguan governments have over the last few years developed a set of policies aimed to reduce poverty. Most of them consist of increasing access to health and education. Additionally, efforts have been made to support micro-enterprises and to improve infrastructure investments.

Regarding infrastructure access, in 2005 the president signed the *Nicaraguan Rural Electrification Policy.* The act aimed to reduce the gap between urban and rural electric coverage (more than 50 percentage point gap in 2005) and increase rural coverage. As of 2014, according to the LSMS, 57% of rural households had access to electricity, a 43% increase compared to 2001. Additionally, according to the National Office of Electric Transmission (ENATREL, 2015) as of 2014, approximately 89 million dollars were invested in electric coverage projects in around 3400 communities. Notwithstanding, the institutional efforts made, as of 2014 more than 1/3 of rural households still don't have access to electricity, and as shown in Figure 3, there is a strong coverage differential across regions.

Figure 3. Electrification rates in rural Nicaragua



Source: Author's estimation based on LSMS 2001, 2005, 2009 and 2014

CHAPTER 3.

THE ROLE OF RNF IN REDUCING POVERTY: A BRIEF LITERTURE REVIEW AND CONCEPTUAL FRAMEWORK

Literature Review

The relationship between RNF and poverty is complicated. First, there is a set of initial necessary conditions that drive RNF participation that are related to higher income, location, and particular household characteristics. Additionally, RNF participation is typically a diversification strategy and as such is often accompanied by a change in agricultural activities.

I have classified the empirical determinants of RNF participation found in the literature in two groups. On the one hand, are ones related to individual or household characteristics. On the other hand, are those related to structural features.

Among the individual and household characteristics, education seems to be the most important. Lanjouw and Shariff (2004) estimate a multinomial logit model with data from India and find education to be the most relevant determinant of RNF participation, showing that more educated individuals are the ones more likely to engage in RNF. This result is also consistent in studies for different countries, including Mexico, Pakistan, and China (Janvry and Sadoulet, 2001; Fafchamps and Quisumbing, 1997; Escobal, 2001; Janvry, Sadoulet, and Zhu, 2005; Awoniyi and Salman, 2011). According to the authors, education allows individuals to opt for more skilled, higher paying jobs. Also, household characteristics like credit access, land tenure, and income influence labor decisions. Beyene (2008) studying Ethiopian rural diversification, finds access to credit and higher income increases the likelihood of RNF participation. Additionally, he finds that small farms are the ones engaging in RNF which is also consistent with Corral and Reardon's (2001) findings that landless households are more likely to engage in RNF.

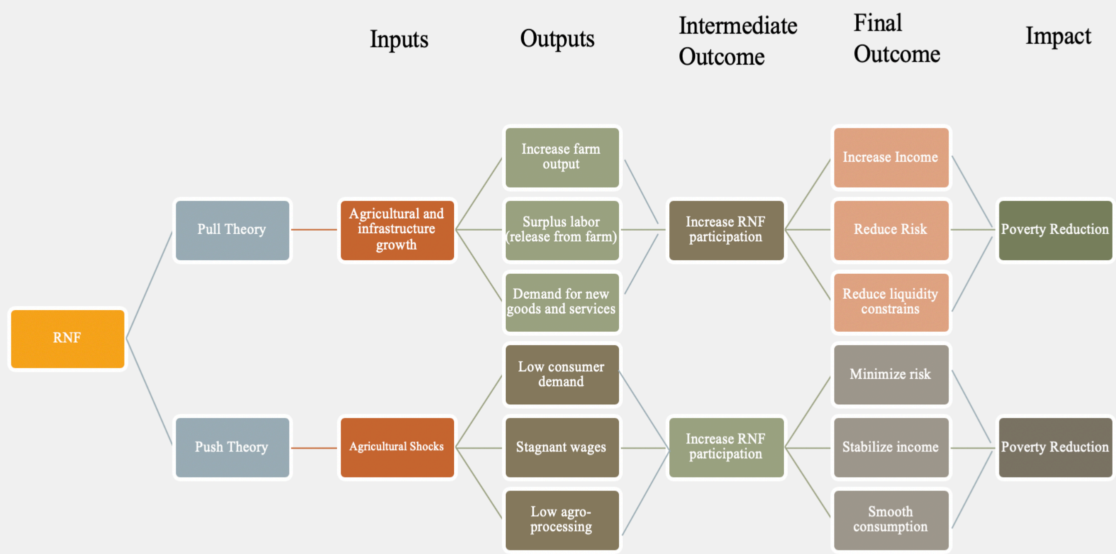
The structural determinants of RNF are those reducing gaps between urban and rural areas including road access, electricity, and city proximity. These characteristics help rural inhabitants to reduce barriers to a more integrated and dynamic economy (Corral and Reardon, 2001; Barrett et al., 2001; Winters et al., 2010; Demissie A, 2013; Asmah, 2011; Jonasson & Helfand, 2010).

Once a household has decided to engage in RNF, the literature generally shows positive impacts on household well-being. Hoang, Pham, and Ulubasoglu (2014) researching RNF effects in Vietnam use an IV estimate, where they instrument RNF participation with RNF networks. They find that having an additional member working in the RNF sector increases household expenditure by 14% over a two-year period. Holden et al. (2004) researching RNF in Ethiopia find access to low-wage RNF employment has a positive effect on total household income. Zereyesus et al. (2017) instrumenting RNF participation with ownership of a motorbike, ownership of a mobile phone, household head's education, and locality find that RNF participation plays an essential role in overcoming food insecurity in Northern Ghana. Owuse et al. (2011) using propensity score matching on farm households in Northern Ghana find RNF employment to have a positive and significant effect on income and food security status. For Nigeria, Oseni and Winters (2009) find households engaged in RNF to have fewer credit constraints, improving farm production and helping to smooth consumption. Janvry, Sadoulet, and Zhu (2005) studying the Hubei province in China perform a counter-factual analysis finding that in the absence of RNF, poverty would be much higher and severe. Iqbal et al. (2018) find that RNF not only reduces poverty but also reduces the time spent in poverty. However, some researchers find rural diversification to be a short-term solution that ends up trapping households in low return activities (Ellis and Freeman 2004) and increasing income inequality (Zafarullah and Harun, 2012; Haggblade Hazell, and Reardon 2010; Iqbal et al. 2018).

Conceptual Framework

Ellis (2000) argues that income and labor diversification can either occur as a deliberate strategy or as an involuntary response to shocks, but that the motivation for diversification is going to vary across household characteristics, location, opportunities, and institutional and social relationships. Authors have classified the drivers of RNF participation in “push” and “pull” factors (Ellis, 2005; Möllers and Buchenrieder, 2005; Haggblade, Hazell, and Reardon, 2010). On the one hand, the pull scenario refers to the existence of local growth opportunities where farmers face better trading opportunities for their agriculture production, caused by an increase in demand or market prices. Also, farmers can introduce new technologies to increase agricultural productivity that create a labor surplus that can be absorbed by a more dynamic economy (Barrett et al. 2001). This setting allows farmers to increase income, reduce risk and liquidity constraints, resulting in poverty reduction. On the other hand, the push scenario happens due to the nature of agricultural activities involving risk and seasonality. Farm households are “forced” into RNF activities due to a downward pattern in agriculture, resulting in low consumer demand, stagnant wages, low agroprocessing, etc. In this scenario, RNF allows farm households to minimize risk, stabilize income and smooth consumption (Lay et al., 2008; Banerjee and Duflo, 2011). As detailed in figure 4, on one hand, RNF driven by pull factors reduces poverty by increasing general income and activity levels. On the other hand, RNF driven by push factors reduces poverty by reducing the effect of an already adverse scenario.

Figure 4. RNF Drivers And Mechanism To Poverty Reduction



Ellis, 2005; Möllers and Buchenrieder, 2005; Haggblade, Hazell, and Reardon, 2010

CHAPTER 4.

EMPIRICAL STRATEGY

In this research, I investigate how RNF participation affects poverty. Later, I test if the observed RNF effect respond to a set of pull or push factors.

RNF Effects on Poverty Reduction

This paper primarily aims to uncover the causal relation between RNF participation and poverty alleviation, measured as consumption increase. However, household's decision to participate in RNF is not random and is commonly explained by variables that usually occur simultaneously (e.g. income or land holding). This issue violates the basic OLS assumptions where the endogenous variable is uncorrelated with the error term ($E[\varepsilon_{it}|RNFparticipation] = 0$), generating a biased estimator.

Bias can come from three sources. First, reverse causality in which labor decisions influence consumption patterns, or consumption patterns influence labor decision. Second, selection bias where households who decide to participate in RNF activities would have higher consumption levels regardless of labor participation. Lastly, unobservable variable bias, where households who decide to participate in non-farm activities make the decision based on non-observable or non-measurable characteristics.

Following the literature (e.g, Babatunde and Qaim, 2010; Hoang, Pham, and Ulubasoglu, 2014; Zereyesus et al., 2017), I am proposing the method of instrumental variables to address those issues. This method eliminates the issues related to endogeneity, omitted variables bias and measurement errors.

The Instrumental Variable estimation is usually an estimation of two steps. The first step involves fitting a regression of RNF participation on the instrument Z and other control variables. In the second stage, the fitted values from the first estimation are regressed on the dependent variable along with a set of control variables.

According to Wooldridge (2015) for the validity of the instrument (Z) on eliminating endogeneity, it is necessary for the instrument to satisfy two properties:

1. Exogeneity: Z is uncorrelated with the error term

$$E[\varepsilon_i|Z_i] = 0$$

2. Relevance: Z is correlated with the independent variable

$$Cov(RNFparticipation, z_i] \neq 0$$

In other words, the validity of the IV depends on the predicting power of the independent variable and that the independent variable is the only transmission mechanism where the instrument impact the dependent variable. For this study, I have chosen municipal electrification rates[4] as an instrument of RNF participation. Electrification is empirically proven to significantly increases employment in rural by operating as a labor-saving technology shock, releasing labor from farm activities allowing the participation on new goods and services for the market (Dinkelman , 2011). Furthermore, Corral & Reardon (2001) find that electricity is one of the most important determinants of non-farm participation in

[4] Percentage of households in a municipality-year that have access to residential electricity.

Nicaragua, and in the last decades Nicaragua experienced a significant increase in the rural electrification rates. Lastly, using a municipal measure is a proxy of municipal dynamism and development, and is not reflecting a household choice, allowing to reduce the endogeneity around RNF participation.

In this study, I am evaluating two outcomes; household consumption and household poverty status. For the measure of RNF participation, I use a variable indicating the total number of members in the household employed in the RNF sector. On the first stage of the IV I estimate RNF participation using a Tobit model given the distribution of the dependent variable, where a significant portion of the sample does not participate in RNF (and therefore members employed in RNF are zero).

Recalling the relationships of interest, the first stage equation using RNF participation as the endogenous variable, I estimate the following Tobit model

$$\text{Eq (1).}\ RNF\_members_{it} = \alpha_0 + \alpha_1 Z_{mt} + \lambda_t \gamma_m + \delta' X_{it} + \mu_{it}$$

where $RNF\_members_{it}$ is the number of members in the households employed in the RNF sector in household *i* at time t; $\alpha_1 Z_{it}$ is the electrification rate for municipality *m* at time *t;* $\lambda_t \gamma_m$ is a vector of municipal and time fixed effects; and $\delta' X_{it}$ is a vector of time varying controls, including sociodemographic characteristics of the household head (gender, age and years of schooling) and the number of total household members.

The predicted values of equation 2.1, go into the second stage OLS equations of each of the outcomes:

$$\text{Eq (2.1).}\ LogHHconsumption_{it} = \alpha_0 + \widehat{RNF\_members}_{it} + \lambda_t \gamma_m + \delta' X_{it} + \upsilon_{it}$$

$$\text{Eq (2.2).}\ Poverty\ Status_{it} = \alpha_0 + \widehat{RNF\_members}_{it} + \lambda_t \gamma_m + \delta' X_{it} + \epsilon_{it}$$

Both models include the predicted values of RNF participation, and the same set of controls and fixed effects used in the first stage and I am clustering standard error at the municipal level.

The IV strategy eliminates the endogeneity issue of RNF participation and allows me to interpret the coefficient of the equation as a causal estimate. The main argument behind electrification in Nicaragua, is that it affects labor decisions by altering RNF labor supply and demand, and that given the residential use of electricity in rural Nicaragua, it's not affecting farm output. Tests of relevance and validity are presented in the following sections.

Driver Mechanism of the RNF effects

In order to test if the RNF effect respond to a set of pull or push factor, I am classifying municipalities based on their poverty rate in the period before the national electrification expansion effort. Taking the average poverty rate of each municipality between 2001 and 2005, I create poverty quartiles. In other words, I create four groups of municipalities going from those with the lowest to highest poverty rates. With this classification, I am able to estimate the same instrumental variable equations in four different sub-samples. The variations of the effect across the different sample is going to help isolate the drivers of the effect. On one hand, If the effect is bigger in low poverty municipalities, the effect is most likely driven by pull factors, where the general economic growth and dynamism of opportunities are allowing households to go into RNF. On the other hand, if the effect is bigger in high poverty municipalities, the effect is more likely driven by push factor, where households are engaging in RNF as a survival activity.

CHAPTER 5.

DATA

Description of the Dataset

This study uses data from the Living Standard Measurements Survey (LSMS) of Nicaragua conducted by the Institute of Information for Development (INIDE) during the years 2001, 2005, 2009 and 2014[5]. It was conducted to obtain information about the socioeconomic situation of the Nicaraguan households, containing detailed information about consumption, income, and different socioeconomic characteristics. The survey provides sample weights that makes it representative at the national, rural and urban level.

This study focuses on rural households; in Nicaragua rural areas are defined as areas with low population density and agricultural activities as the main activity in the area. The survey provides a variable indicating if the household is in a rural or urban area. The resulting sample contains 1,805 households for 2001, 3,397 households for 2005[6], and 1,718 households for 2009 and 1,318 households for 2014; representing the total number of rural households of Nicaragua per each year. These databases are combined to create a pooled cross-section database that includes the household observations of those years, composing a data set of 8,238 households.

[5] All four waves of the survey are available at INIDE's website http://www.inide.gob.ni
[6] 2005 sample is significantly larger because in 2005 the National Census was conducted.

Variable Description

This study's most relevant variables are municipal electrification, RNF participation, consumption and poverty status. Municipal electrification rates are constructed as the percentage of households in a municipality that have electricity in their home.

As specified in the section above, RNF participation is measured by the number of employed members in the household employ in the RNF sector. The survey provides activity classification for all active members base on the national account system. RNF sector is restricted to those activities not related to agriculture, livestock, hunting, forestry or wood extraction.

Consumption is collected following Deaton (1997). The consumption aggregate is based on observed expenditures on food and non-food items. For food items, the survey asks for a seven days recall period. For non-food items, the recall period varies from a week, a month and a year. All expenditures items are annualized and aggregated at the household level. The enumerator is instructed to ask for the person who is in charge of the shopping. Additionally, the survey accounts for auto-consumption, in the sense that it asks for items that were taken out of own farms and own business.

In Nicaragua, the official measure of poverty relies on consumption, based on the argument that consumption is less prone to variation than income, due to households finding mechanism to smooth consumption (Deaton and Zaidi, 2002), and that consumption includes auto-consumption and auto-production, a crucial factor in rural economies. For each wave of the survey, there is an official poverty consumption threshold, usually called a poverty line that is a fixed amount of resources an individual needs to meet all his/her basic needs, including food and non-food items. The poverty line increased from 1.05 dollars per capita daily in 2001 to 1.77 dollars in 2014 per capita daily. Given that the monetary system in Nicaragua, where the exchange rate dollars-córdobas deflates by a fixed 5% annually, dollar values accounts for almost all inflation meaning that the increase on the line represents an increase of people's needs.

Descriptive Statistics

The following tables describe household characteristics, differentiating by RNF participation. First, I summarize these statistics for the full sample by year in Table 1. Next, I break these statistics down by whether or not the households participate in RNF displayed in Table 2. Additionally, I present relevant summary statistics aggregating municipalities by poverty status before the electrification expansion in Table 3.

As shown in Table 1, over time, there has been a reduction in poverty in rural areas, and notably, the share of households participating in RNF has increased. Additionally, welfare-related characteristics like consumption, income, education, and electricity access have also increased.

Table 1. Household Characteristics: Full Sample

Mean Values

	2001	2005	2009	2014
Poverty rate	0.60	0.59	0.53	0.42
RNF participation rate	0.40	0.36	0.47	0.52
Per capital annual consumption ($)	400.59	460.85	644.90	900.01
Monthly total income ($)	133.69	205.02	233.62	278.38
Monthly RNF household income ($)	65.69	79.80	100.27	118.57
Monthly farm household income ($)	53.44	99.74	106.63	134.77
Household members	5.73	5.52	5.18	4.58
Household active workers	2.14	2.24	2.04	1.95
Female headed households	0.19	0.20	0.23	0.22
Age of household head	46.39	47.95	46.80	45.54
Head years of schooling	2.42	2.51	3.20	3.68
Household with electricity	0.40	0.43	0.47	0.57
Observations	1805	3397	1718	1318

Notes

1. Descriptive Statistics are weighted
2. RNF participation refers to households that have at least one member in the RNF sector.
3. Income and consumption values are in dollars.

Comparing households with or without RNF participation in Table 2, households participating in RNF (have at least one employed member in the RNF sector) seem to be better off. Those households participating in RNF have lower poverty rates, higher incomes, more female-headed households, higher education, and electricity access. Furthermore, the difference in between those households participating in RNF and those who are not in RNF seems to be getting greater over time, suggesting that particular types of households are the ones not able to engage in RNF. These results are consistent with the literature, where RNF households have higher education levels and electrification rates. Additionally, farm income is higher in non-RNF households, but total income is less.

Table 2. Household Characteristics: Difference between RNF household status

	2001	2005	2009	2014
Poverty rate	-0.14***	-0.21***	-0.19***	-0.21***
Per capital annual consumption	95.98***	105.00***	219.54***	266.58***
Monthly total income ($)	97.77***	127.38***	192.40***	192.86***
Monthly RNF household income ($)	138.42***	177.15***	276.21***	313.57***
Monthly farm household income ($)	-37.33***	-54.06***	-84.93***	-122.24***
Household members	0.57***	0.46***	0.09	0.00
Household active workers	0.55***	0.68***	0.40***	0.37***
Female headed households	0.04**	0.08***	0.10***	0.12***
Age of household head	-0.49	1.26**	-2.76***	-1.72**
Head years of schooling	1.46***	1.57***	2.57***	2.07***
Household with electricity	0.34***	0.31***	0.44***	0.36***

Notes:
Base group: households without RNF participation
* p<0.10, ** p<.05, *** p<.01

Lastly, comparing different groups of municipalities based on their pre-electrical expansion poverty rate, low poverty municipalities have not decreased their poverty rate significantly and had high electrification rates even before the expansion. The differences in income and poverty rates of the second and third quartile have reduced over time, and the poverty rates are close to the ones in low poverty municipalities. High poverty municipalities have seen a significant decrease in poverty; however, poverty rates are still considerably high. Additionally, high poverty municipalities experienced a greater increase in electrification after the expansion process (going from 2009 to 2014). Also, in low poverty municipalities, income type is bias towards RNF income versus in high poverty municipalities where it is bias towards farm income.

Table 3. Household Characteristics by municipal poverty status
Mean values

		2001	2005	2009	2014
Low Poverty	Poverty rate	0.38	0.34	0.41	0.35
	Monthly total income ($)	171.86	255.63	289.24	306.70
	Monthly RNF household income ($)	107.07	140.18	191.15	188.53
	Monthly farm household income ($)	44.13	68.53	64.73	85.57
	Household with electricity	0.65	0.72	0.71	0.72
2nd quartile	Poverty rate	0.56	0.56	0.51	0.33
	Monthly total income ($)	139.60	216.07	267.95	286.83
	Monthly RNF household income ($)	69.35	76.28	123.32	114.80
	Monthly farm household income ($)	56.58	121.69	116.66	147.38
	Household with electricity	0.42	0.42	0.52	0.51
3rd quartile	Poverty rate	0.69	0.66	0.58	0.38
	Monthly total income ($)	114.01	189.23	201.62	284.34
	Monthly RNF household income ($)	46.95	59.06	50.01	90.73
	Monthly farm household income ($)	55.85	108.23	128.79	169.68
	Household with electricity	0.28	0.35	0.42	0.57
High Poverty	Poverty rate	0.83	0.83	0.61	0.57
	Monthly total income ($)	100.98	155.98	196.99	238.03
	Monthly RNF household income ($)	30.95	38.98	53.61	75.56
	Monthly farm household income ($)	58.46	103.46	119.76	144.74
	Household with electricity	0.21	0.21	0.26	0.48

Notes:

1. Income values are in dollars.
2. Poverty quartiles are based on average municipality poverty rate between 2001 and 2005.

CHAPTER 6.

RESULTS

Endogeneity of RNF Participation (First Stage)

As previously stated, the validity of the instrument depends on whether the exogeneity and the relevance assumptions are satisfied. The exogeneity condition is not possible to test; however, the relevance condition can be tested regressing the instrument on the endogenous variables. In table 4 below, I present the results of the first stage where I instrument RNF participation with municipal electrification rates.

Table 4. Municipal Electrification Rate on RNF participation

	Eq (1)
	Number of members employed in RNF
Municipal Electrification Rate	0.628**
	(0.269)
Household members	0.210***
	(0.027)
Household members square	-0.005***
	(0.002)
Female HH head	0.429***
	(0.055)
Age of HH head	0.037***
	(0.009)
Age of HH head Square	-0.000***
	(0.000)
Access to piped water	0.580***
	(0.079)
HH head years of schooling	0.099***
	(0.009)
Municipality Fixed Effects	Yes
Year Fixed Effects	Yes
Constant	-3.187***
	(0.239)
R-squared	0.13
N. of cases	8238
F- Stat	29.59
Estimation	Tobit

Robust standard errors clustered at the municipal level in parentheses.

* p<0.10, ** p<.05, *** p<.01

The results on equation 1 suggest that municipal electrification rate does satisfy the relevance condition, the parameters are statistically significant, and the F stat of the estimation is greater than 10. This means municipal electrification rate is a relevant variable to predict RNF participation.

Interpreting the parameter, an increase of 1 percentage point on the municipal electrification rate increase the number of the members employed in the RNF sector of the household by .628. The result is statically significant at the 5% level.

Effect of RNF Participation on Household Consumption and Poverty

Table 5 below presents the results of the main IV estimation, evaluating the two outcomes, log household consumption, and a dummy variable of poverty status.

Table 5. Instrumental variable estimation on household consumption and poverty

	Eq (2.1)	Eq (2.2)
	Log household total consumption	Poverty Status
Instrumented RNF participation	0.253***	-0.209***
	(0.090)	(0.075)
Household members	0.119***	0.173***
	(0.020)	(0.017)
Household members square	-0.005***	-0.006***
	(0.001)	(0.001)
Female HH head	-0.175***	0.140***
	(0.042)	(0.036)
Age of HH head	0.008**	-0.006*
	(0.004)	(0.003)
Age of HH head Square	0.000	0.000
	(0.000)	(0.000)
Access to piped water	0.03	0.011
	(0.058)	(0.047)
HH head years of schooling	0.022**	-0.006
	(0.009)	(0.008)
Municipality Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Constant	9.309***	0.01
	(0.269)	(0.224)
R-squared	0.635	0.304
N. of cases	8238	8238

Robust standard errors clustered at the municipal level in parentheses.

* p<0.10, ** p<.05, *** p<.01

Results of equation 2.1 in Table 5 suggests that an additional member of the household employed in the RNF sector increases household consumption by 25.3%. In equation 2.2, the same addition of an RNF employed member causes a reduction of 20.9 percentage points on the likelihood of being in poverty. The results are consistent with previous research (Holden et al., 2004; Zereyesus et al., 2014; Owuse et al., 2011).

The control variables of the estimation have the expected impact on consumption and poverty. Household members increase consumption, but not linearly. Female-headed households have lower consumption levels and consequently higher poverty. Education increases consumption and has a negative but not significant effect on poverty.

Driver Mechanism of RNF as a Poverty Reduction Strategy

Table 6 below presents the results from the IV equation estimated in different sub-samples, where municipalities are classified according to their average poverty rate between 2001 and 2005.

Table 6: Instrumental Variable estimation by pre expansion poverty quartile

Instrumented RNF participation	Log consumption	Poverty	N
Low poverty municipalities	0.284**	-0.244**	
	(0.134)	(0.107)	2076
2nd quartile	0.197*	-0.113	
	(0.107)	(0.089)	1893
3rd quartile	-0.02	-0.095	
	(0.207)	(0.194)	1837
High Poverty municipalities	-0.007	0.013	
	(0.683)	(0.528)	2085
Vector of Covariates	x	x	
Municipality Fixed Effects	x	x	
Year Fixed Effects	x	x	

Robust standard errors clustered at the municipal level in parentheses.
* p<0.10, ** p<.05, *** p<.01

The results suggest that RNF only has an effect on household consumption in low poverty municipalities, specifically in the two top bottom quartiles. Additionally, the effect is bigger in magnitude and significance in the least poor municipalities that the municipalities in the second quartile. In the least poor municipalities RNF participation increases household consumption by 28.4%, while in the second quartile RNF participation increases household consumption by 19.7% and it's only significant at the 10% level. Examining poverty status, similarly, RNF only has an effect in the least poor municipalities. RNF participation decreases the likelihood of being in poverty by 24.4 percentage points.

These results indicate that the reduction of poverty in Nicaragua caused by RNF participation comes from a set of pull factors, where households take advantage of the opportunities given by the general economic growth and diversify of their labor activities.

CHAPTER 7.

DISCUSSION

Validity of the Instrument

The main argument behind this strategy is that electrification affects labor decisions by altering RNF labor demand and supply. One could argue that there are other mechanisms where electrification affects consumption, violating the exclusion restriction. However, the assumption made in this paper is that electrification in rural areas is limited to residential use and that electrification does not affect farm output. Under these assumptions, the channels in which electrification affects income are limited, allowing electrification to address the endogeneity problem of RNF caused by reverse causality, selection bias or omitted variables.

On table 7, I present a test to explore if electricity predicts farm output. In other words, I am testing the first stage to examining if the municipal electrification rate is a good instrument for farm participation. I present two outcomes, log of household farm income, and the number of members employed in farm activities. Farm activities and their income take into consideration wage workers working in someone else's farm and individuals working in their own land. As with the previous estimations, this test uses a Tobit model to account for the left-centered distribution of both outcome variables.

Table 7. Municipal Electrification Rate on Farm Participation

	Log farm income	Number of members employed in farm activities
Municipal Electrification Rate	-0.587	-0.25
	(0.594)	(0.192)
Household members	0.391***	0.259***
	(0.055)	(0.022)
Household members square	-0.013***	-0.001
	(0.004)	(0.002)
Female HH head	-1.730***	-0.489***
	(0.127)	(0.053)
Age of HH head	0.071***	0.061***
	(0.017)	(0.006)
Age of HH head Square	-0.001***	-0.001***
	(0.000)	(0.000)
Access to piped water	-0.862***	-0.289***
	(0.209)	(0.068)
HH head years of schooling	-0.240***	-0.085***
	(0.023)	(0.006)
Municipality Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Constant	2.337***	-1.312***
	(0.518)	(0.169)
F-Stat	0.98	1.70
R-squared	0.09	0.17
N. of cases	8238	8238
Estimation	Tobit	Tobit

Robust standard errors clustered at the municipal level in parentheses.

* p<0.10, ** p<.05, *** p<.01

The results suggest that municipal electrification rate is not a good predictor of any of the farm output variables mentioned. In both cases, municipal electrification rate doesn't have a statically significant effect. Additionally, both estimations have an F statistic lower than 10, confirming that the estimation does not predict well the dependable variable. This test suggests that in the case of Nicaragua, the increase of rural electrification hasn't influence farm production.

Furthermore, in Latin America electrification is proven to impact farm production by allowing farmers to use irrigation (Assunção, Lipscomb et al., 2014). In Nicaragua, irrigation is not a common practice, especially among small farmers. Based on the Agricultural Census, in 2001, 1.4% of the productive land was irrigated; in 2010, that number increased to 1.6%, highlighting that irrigation hasn't changed in the country[7].

Sensitivity Tests

One of the limitations of this study is that some variables are not consistent between survey waves. In particular, the month in which the survey was collected is not available in the 2014 wave. This variable would allow controlling for the seasonal nature of farm activity. Also, farm size is not available in the 2014 data, which is important to account for productive differences among farmers. However, both variables are available in 2001, 2005 and 2009 waves. On Table 8 below, I present estimations accounting for those variables for the household consumption outcome.

[7] Author's calculations based on FAO, 2002; INIDE, 2002; and INIDE 2012.

Table 8. Instrumental variable estimation on household consumption

	Month of survey	Land tenure	Month of survey + land tenure
	Log household total consumption	Log household total consumption	Log household total consumption
Instrumented RNF participation	0.171**	0.191**	0.179*
	(0.080)	(0.076)	-0.081
Total land		0.002***	0.001***
		(0.000)	(0.000)
Worked on land			
Vector of covariates	Yes	Yes	Yes
Month of interview	Yes	No	Yes
Municipality Fixed Effects	Yes	Yes	Yes
Year Fixed Effects (2001 - 2009)	Yes	Yes	Yes
Year Fixed Effects (2001 - 2014)	No	No	No
Constant	9.472***	9.189***	9.506***
	(0.272)	(0.242)	-0.27
R-squared	0.549	0.555	0.558
N. of cases	6920	6920	6920

Robust standard errors clustered at the municipal level in parentheses.
* p<0.10, ** p<.05, *** p<.01

The results suggest that even on different specifications including variables to account for land tenure and farm seasonality; RNF have a positive and significant effect on household consumption. Controlling for the month in which the survey was conducted and/or farm size results in a smaller coefficient than the ones in the main estimation; however, the effect is still statically and economically significant.

CHAPTER 8.

LIMITATIONS AND CONCLUSIONS

RNF participation serves as a diversification strategy that allows smooth consumption when shocks occur and the integration to higher return activities. The study tests if RNF participation has a causal effect on consumption and subsequently poverty. I correct for the endogeneity of RNF participation using a plausibly exogenous electrification expansion that occurred after 2005.

I find that RNF participation increases household consumption by 17-25% and reduce the likelihood of being in a poverty status by 15-21 percentage points. Additionally, given that the effect is only present in low poverty municipalities, the results suggest RNF poverty reduction in Nicaragua worked by the mechanism of pull factors, where households took advantage of the economic setting to diversify into higher return activities. Lastly, I find the gap between households participating in RNF and households not participating in several household characteristics like income, consumption, education, electrification to be increasing over time.

This study has two major limitations. First, the measure of RNF participation used (number of employed members in the RNF sector) does not say anything about the quality of the job, or even the compensation. A better measure would be differentiating income by source; however, consistency in how the income questions are asked in the survey make it hard to reconcile. Second and more important, is not possible to identify the roll out of the electrification expansion, meaning that it's not possible to observe in the data the order in which geographic areas got electrification interventions. This issue arises probably because the roll out was done at the community level, and not at the municipal level. This is a threat to the validity of the IV because it fails to account for the variation within municipalities.

The results imply that RNF participation reduces poverty, but because it does so primarily in low poverty areas, it also increases inequality. This finding is consistent with the literature. This result highlights the need to adapt and improve rural development policies, especially to develop policies targeted at high poverty municipalities. Given that in those areas, households depend more on agricultural activity it is crucial to promote input-intensive agricultural technologies that increase productivity and reduce farm labor demand to incentivize diversification. Also, it would be essential to develop a type of community risk insurance and or saving mechanism, to protect farm households from external shocks, and to create a credit mechanism to finance new activities. Additionally, infrastructure development needs to continue being a priority to reduce to urban-rural area gap and allow the integration of the production activities. More importantly, actions need to be taken to understand the dynamics of the most deprived areas and municipalities, in the sense of understanding their livelihood strategies to support their actions into poverty reduction.

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