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The Impact of Migration on Poverty and Inequality in Myanmar

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ABSTRACT

Using the Myanmar Poverty and Living Conditions Survey (MPLCS) 2015 household survey, this paper investigates the impact of migration on the welfare of left-behind households. Although applying panel data is an efficient way of identifying migration impacts, the availability of such kind of panel data is limited in developing countries and thus consistent calculations is not always possible. Therefore, by applying cross sectional survey data, this paper estimates counterfactual outcomes for a household which decides not to participate in migration. In order to impute the counterfactual per capita expenditure for migrant-sending households, this paper follows Heckman's two-step model with selection. The findings show that migration with remittances decreases poverty and inequality, with a poverty reduction effect of 11 percent and inequality reduction by 25 percent. These effects vary between different agro-ecological zones, and between rural and urban areas. Households in Coastal Zones are more dependent on remittances from migrants to reduce poverty and inequality.

Keywords: Inequality, Migration, Poverty, Remittances

JEL Classification: O1, O10, O150

1. Introduction

Recently migration has played an important role in the world economy. As migration is considered a development process, poverty and migration have always been interrelated. Migration has become a crucial process for many developing countries across the world. In order to study the relationship between poverty and migration, it is first required to understand how issues regarding poverty is outlined in migration research (Haan et.al, 2009). This paper focuses on internal migration because most poor households tend to engage in this form of migration. This is because while the literature on migration tends to focus on international migration, the more significant factor in poverty reduction is internal migration. Globally, the number of internal migrants is nearly four times the number of international migrants (UNDP, 2009). In Myanmar 9 million people, approximately 20 percent of total population, were counted as internal migrants (census report, 2014). The factors that drive internal migration are large rural-urban and inter-regional disparities, rising labor demand in expanding industrial and services sectors, and land scarcity and few off-farm opportunities in many rural areas (Harris and Todaro, 1970; Stark, 1991; Rozelle, Taylor, & De Brauw, 1999).

Taylor et al. (2005) highlighted that most of the rural areas in the world are the origin of migrants and are also the places where most of the poor are concentrated. Considering this fact, they proposed that the impacts of migration on poverty could be found somewhere in between two extremes, called "optimistic" and "pessimistic" scenarios. In the optimistic scenario, migration reduces poverty in low-income areas by moving people to relatively high-income urban areas. Remittances, as the return of migration, contributes to the incomes of households left-behind. Thus in this view, poor

left-behind households receiving remittances may help to reduce rural poverty. At the other end in the pessimistic scenario, there may be some obstacles which limit the ability of poor households to participate in migrant labor markets. Then, the beneficiaries from participating in migration may exclude the rural-poor due certain constraints, while households able to participate in the migrant labor force benefit. A framework of positive impacts from migration on source communities, developed by Kleinwechter (2012), highlights the positive role of rural-urban migrants in the development of source communities, while also noting that the impact of rural-urban migration are influenced by the administrative, institutional and social environment. Theoretically, extra funds received from migrants could ease households with credit constraints and allow them to take part in investment opportunities (Rozelle, Taylor, & De Brauw, 1999; Stark, 1991). The combination of the effect of migration and remittance may generate changes in production and economic conditions of the source community. Since remittances directly increase the income of households left-behind, these households can spend more on current consumption as well as on investments. Through productive investments, households receiving remittances could create new businesses which in turn increases labor demand in the source community, generating employment opportunities for non-migrant households in the source community.

Most of the studies on the impact of international migration find it consistent with reducing poverty, but the impacts are different depending on the characteristics of recipient countries. Moreover, literature on both internal and international migration has stressed on the selectivity of migrants. If the selection of households with migrants is not random, there could be a methodological issue in attempting to estimate the household welfare effects of migration focusing

on remittances (Phangaphanga, 2013). The absence of randomized selection and the presence of endogeneity of migration in the household welfare model can produce biased estimates. Thus, given that migration of past household members could be an integral part of a household's livelihood strategy, this paper attempts to model the impact of migration on household welfare and to investigate the impact of internal migration on the welfare of left-behind households. In terms of impacts, left-behind households can be positively as well as negatively affected by migration and the impact of migration could be different between poor and non-poor households, as well as between rural and urban households. Therefore, this paper tries to answer followings questions:

- Can migration affect the wellbeing of left-behind households? If yes, is the effect positive or negative? Can migration reduce poverty and inequality?
- Does migration have the same impact on households from different agro-ecological zones?
- Does migration have the same impact on poor and non-poor households?

In the rest of the paper, section 2 reviews relevant literature, while methodological issues and empirical strategy are discussed in section 3. Data and summary statistics are presented in section 4. Estimated results are discussed in section 5. Finally, a conclusion and policy recommendations are provided in section 6.

2. Literature review

Since 1960, a large amount of research on migration has been conducted, starting with the works of Sjasstad (1962), Todaro (1969), and Harris and Todaro (1970). According to the Todaro model, migration takes place because of existing expected earnings disparity between source and destination.

Operating as a cost-benefit process, this model focuses on the welfare of individual migrants who decide to migrate only for their benefit. However, this conceptualization was criticized by the authors who state that migration can be explained as a collective decision of the whole household in order to reduce risks such uncertainty and market failures, especially in developing countries (Stark and Bloom, 1985; Stark, 1991). Later on, the new economics of labor migration restructured the Todaro model into a form of collective household decision making.

In the literature on migration, a number of studies investigate the extent and effects of migration-related remittances. However, the effect on poverty and inequality due to migration is a developing field of study. Most studies have reached a consensus, indicating that both international and internal migrations reduce poverty (Adams, 2006; Adams & Cuecuecha, 2010; Adams & Page, 2005; Taylor et al., 2009) and contribute to the development process by decreasing production and investment constraints in the economy (Goldring, 1990; Rozelle et al., 1999; Stark, 1991; Stark & Lucas, 1988; Stark et al., 1988; Taylor, 1999; Taylor et al., 1996). Depending on the initial level of sources of migrants, however, migration may increase or decrease income inequality and there seems to be no strong consensus on both the direction and extent of the redistributive impact of migration related remittances (Lopez-Feldman et al., 2007; Taylor, 1999; Adams, 1989; 2006).

Most of the existing studies on migration-poverty interactions are based on rural and village-level data. In a study of rural Egypt, applying counterfactual income scenario, Adams (1989) shows that although the effect of international remittances is small, it is favorable on poverty and an increase in remittances leads to a decline in income inequality in rural Egypt. In the case of Guatemala, comparing the poverty

headcount, poverty gap and squared poverty gap of households that received remittances from international and/or internal migrants, with those of households that did not receive remittances, Adams (2006) found that both internal and international remittances reduced poverty. In a study of 2400 municipalities, studying the proportion of households receiving remittances and the poverty headcount measure, Lopez Cordova (2004) found that a higher level of remittances was associated with lower poverty in 2000.

At the cross-national level, the findings of Adams and Page (2003) suggests that a 10 percent increase in per capita remittances would lead to a 3.5 percent decline in the share of people living in poverty. Similarly, the World Economic Outlook (2005) showed that a 2.5 percent increase in the remittances to GDP ratio would lead to a 0.5 percent decline in poverty. Using a large cross-country panel dataset, Acosta et al. (2008) showed that, given initial country conditions, remittances in Latin American and Caribbean (LAC) countries generally lower poverty, but the elasticity of poverty reduction with respect to remittances differs significantly by country.

To the author's knowledge, no study has explored the impact of remittances from migration in relation to the poverty in Myanmar. This gap is due to the lack of comprehensive and nationally representative data on migration and remittances. This chapter attempts to find enough evidence to interpret any causal impact of migration related remittances on poverty.

3. Methodology

Although the idea that migration is consistent with the reduction of poverty seems to be a conventional fact, careful methodological attention to measure the extent of such impact is still an important issue. Generally, assessing such an impact requires the observation of at least two different states for

observed households. Therefore, longitudinal data are required in obtaining consistent results to analyze the impact of migration. However, the availability of panel data is limited in developing countries. Thus, a consistent estimate of such impact in developing countries is difficult to achieve.

In the study of the impact of migration, a number of statistical techniques use longitudinal, as well as cross sectional data. Although the application of panel data is an efficient way to identify migration impact because the researcher can use the control of time-invariant factors that cannot be observed, the availability of such kind of panel data is limited in developing countries. Thus, consistent calculations may not be obtained in these countries. Subsequently, counterfactual analysis is applied to evaluate the impact of migration by estimating the potential outcomes for households without migrant members using cross section data and to solve the problem of scarce panel data (Adams, 1989; Ravallion, 2009). Therefore, in applying cross sectional data, this paper will estimate counterfactual outcomes that would be obtained if the household decides not to migrate.

3.1 Parametric counterfactual analysis

If the migrant had positive earnings before leaving his/her household, the income of remittance-not-receiving households is likely to be lower after migration takes place. Thus income reported by household with migrants, but not receiving remittances, is not a good representation of the situation of households before having migrants. Therefore, estimating the effect of migration and remittances on welfare and inequality would necessitate the consideration of counterfactual income that the household would have had if the household had decided not to send migrants. To solve this problem, this paper imputes per capita household expenditure for remittances-

received household in the counterfactual scenario of not receiving remittances and not having migrants. If the characteristics of households with migrant and without migrants are identical or if it is randomized selection within the population, coefficients obtained for households without migrants can be transposed onto households with migrants. There are several issues that need to be discussed. In the absence of migrants' characteristics, assumptions about the number and the demographics of migrants are required. Generally, if migrants are more qualified and skillful, then they can earn more money than those who remain at home. The new economics of labor migration suggests that decisions to migrate depend not only on the characteristics of individual migrants but also on the household's characteristics (Stark & Bloom, 1985: Stark, 1991). Based on the decisions of household and individual migrants, some households participate in sending migrants while others do not. In this case, the use of ordinary least squares (OLS) with the sample of households without migrants overlooks the bias of endogenous selection of households having migrants and provides over-estimates for the impact of migrant remittances. To control the for the possibility of having migrants, a variable that represents the "propensity to migrate" is added in the context of the two-step estimation framework proposed by Heckman (1979). This framework has been applied for surveys in Latin America and Caribbean countries and sub Saharan Africa (Acosta et al., 2008).

3.2 Econometric framework

In this paper, migration is considered an indicator variable of binary type. Such binary treatment effect can be estimated using social experiments, regression models, matching estimators, and instrumental variables (Imbens & Wooldridge,

2009). Each of these methods has pros and cons depending on the type of available data. In this paper, migration is treated as an indicator variable of binary type. The empirical analysis of this paper is based on the method of instrumental variables. The basic structures of equations that can show the effect of treatment on outcomes are as follows:

$$E(y_i \backslash x_i, m_i) = f(\alpha x_i + \delta m_i) \quad (1)$$

$$\Pr(m_i = 1 \backslash x_i, z_i) = g(\theta x_i + \beta z_i) \quad (2)$$

Where (y_i) is the outcome of primary interest and the expected value of y_i, given x_i and m_i is explained by a linear combination of explanatory variables x_i and indicator variable m_i indicating whether the dependent variable is observed or not. x_i and z_i are vectors of exogenous variables, while α, β, δ and θ are vectors of unknown coefficients.

Under the parametric estimation, this paper imputes per capita household expenditure for remittances received by households with migrant members in the counterfactual scenario of not receiving remittances and not having migrants. The estimated model is the following log-level household per capita expenditure equation:

$$logY_i = \alpha + \beta X_i + \gamma H_i + \mu_i \quad (3)$$

where Y_i is the per capita household expenditure.

The vector X_i contains all variables of household characteristics including demographic and location covariates that predict household welfare. Vector H_i is a set of characteristics describing the household's head and μ_i is unobserved heterogeneity in expenditure pattern. The resultant estimated coefficients allow for the prediction of the counterfactual expenditure for remittances-receiving

households. Following Heckman, this paper constructs Heckman's selection equation using a probit specification.

$$M_i^* = \alpha_1 + \beta_1 X_i + \gamma_1 H_i + \omega Z_i + v_i \quad (4)$$

$$M_i = \begin{cases} 1, & if \ M_i^* > 0 \\ 0, & otherwise \end{cases} \quad (5)$$

$$logY_i = \alpha_2 + \beta_2 X_i + \gamma_2 H_i + \beta_\lambda \lambda_i + \varepsilon_i \quad (6)$$

Where M_i^* is a latent variable and a linear outcome of the covariates Z_i and a residual term v_i.

Although the covariates Z_i may overlap with H_i, it is assumed that at least one element of Z_i is a unique and significant determinant of M_i but this element needs to be independent from the expenditure of household with no migrants. In practice, it is difficult to obtain the variables that are exogenous in migration and expenditure equations (Adams and Cuecuecha, 2010). Realizing that social networks are an important force to make decision for sending migrants, this paper chooses the proportion of household with migrants in a specific geographic location as a proxy for social networks to determine M_i with no correlation to household per capita expenditure. This implies that the higher the proportion of household with migrants is, the greater the probability of sending migrants will be. This is because better social networks provide information about job opportunities and secure employment with the lower costs of migration especially for rural people. In equation (4), only the sign of M_i^* can be observed, that is, M_i^* is equivalent to a negative or a positive value. According to the sign of M_i^*, the binary choice of households, that is whether receiving or not receiving remittances, can be observed as in equation (5). It means that negative value of M_i^* indicates the household that does not

receive remittances from migrants and positive value of M_i^*, otherwise. For a second step, equation (6) is an expenditure equation for non-recipient households.[1]

The Heckman selection model provides consistent, asymptotically efficient estimates for all parameters. Therefore, the estimation procedure consists of a two-stage process. In the first stage, probit estimates of the selection equation are obtained to account for differences between the two sub-samples for household with remittances sending migrant and without migrant (not receiving remittances). In other words, the decision for sending or not sending migrants is a function of observed variables and unobserved ones. Basically, the idea of this estimator is to evaluate the impact of indicator for being a household with and without migrant and to control directly for the correlation of indicator dummy variable with the unobservable error term in the outcome equation. In Heckman's model, this is referred as the inverse of the Mills' ratio. Following Heckman's procedure, probit estimates are obtained from following the selection equation.

$$\begin{aligned}\Pr(y_i \ observed \,|z_i) &= \Phi(z_i\gamma) \\ &= \Phi(\alpha_1 + \beta_1 X_i + \gamma_1 H_i + \omega Z_i)\end{aligned}$$

From these estimates, Heckman's inverse of the Mills' ratio, λ_i for each observation *i* is computed as:

$$\lambda_i = \frac{\varphi(z_i\hat{\gamma})}{1 - \Phi(z_i\gamma)}$$

[1] For equation (4) and (6) the assumptions are $\mu_i \sim N(0,\sigma)$, $v_i \sim N(0,1)$, and $corr(\mu_i, v_i) = \rho$, where $\rho \neq 0$ and standard regression techniques applied to the first equation yield biased result.

$$\lambda_i = \frac{\varphi(\alpha_1 + \beta_1 X_i + \gamma_1 H_i + \omega Z_i)}{1 - \Phi(\alpha_1 + \beta_1 X_i + \gamma_1 H_i + \omega Z_i)} \quad (7)$$

$$\beta_\lambda \lambda_i = E\left(\frac{v_i}{u_i} > -\beta_1 X_i - \gamma_1 H_i - \omega Z_i\right) \quad (8)$$

where φ is the normal density and Φ is normal distribution.

In the second step, the expenditure equation is estimated to obtain β by adding the regression equation with the choice of households. Under the assumption where the unobservable error term and unobserved variables are assumed to follow a joint normal distribution, the conditional outcome expectations are:

$$E(Y_i \backslash M_i = 1) = E(y_i \backslash M_i^* > 0) = \acute{\beta}_1 X_i + \gamma_1 H_i + \beta_\lambda \lambda_i$$

Where $\beta_\lambda = \rho\sigma_v$ and the impact of being household with remittances sending migrants can be constructed easily. If λ_i can be controlled, the remaining unexplained component ε_i will have the usual desirable i.i.d. properties. If λ_i is a significant predictor of earnings, it means that the selection into the non-migration status is indeed correlated with factors that affect the household earnings, implying that OLS estimates of equation (3) would be inconsistent. Since, the purpose of this paper is to analyze an underlying regression model or to predict the per capita expenditure household that would be observed in the absence of selection, it is appropriate to apply the Heckman's two-step procedure.

3.3 Variable selection

Considering the choice of basic unit of analysis is important before constructing the empirical model in relation to welfare. In Myanmar, where agriculture and small enterprises are major sources of income and where expenditure

is collected among household members, choosing the household unit as the unit of analysis is an appropriate choice. Household consumption and household incomes are commonly used to indicate poverty and welfare. Shan and Stifel (2003) suggest that income is commonly used to measure poverty in developed countries, whereas consumption expenditure was used favorably as an indicator for poverty in developing countries. In Myanmar, being a developing country, welfare aggregates based on consumption expenditure seems to provide a more accurate indication of household's well-being than welfare aggregate based on income because income usually varies across seasons, whereas consumption remains stable. Moreover, households normally remember exactly what they have consumed rather than what they have earned. An accurate estimate of income is difficult to obtain because most people who take part in the agricultural sector are self-employed. Thus, using per capita household expenditure as an indicator of poverty and welfare of household seems practical.

The next challenge is to decide which variables should be included in the analysis of household welfare. Generally, based on a theoretical model for how household income, consumption, or poverty is determined, a standard choice of variable can only be made. According to growth and production theory, as the income and consumption of households and individuals are related to their production capacity, their income and consumption depend on their access to production factors and the quality of these production factors. Principally, a significant determinant of income or production is human capital, in terms of education or experiences (Mincer, 1958; Schultz, 1988). The environmental condition can also influence the income and consumption of the household or individual in several ways. Thus, institutions, public policy, and the amount and quality of public

infrastructure are important characteristics that affect household production that may differ in terms of location.

As mentioned above, information on household consumption are collected from household members, which takes into account additional household characteristics, such as household size or the share of working age people relative to dependent children and elders. Most household heads often act as the main income earner. Thus, in this paper, the human capital characteristics of household heads, such as age and gender are included in predicting household expenditure. If more than one income earner exists in households, the head's education level likely affects the household's earning capacity. In this case, the highest educational attainment of people in the household should be included as household income predictors (Joliffe, 2001).

From the probit specification, households who are non-recipients of remittance are obtained by using the same set of variables as in per capita expenditure equation. The basic idea of using these variables follows the standard human capital model (Becker, 1993), specifying that human capital variables are likely to affect migration because more educated people could enjoy greater possibilities of employment and expected income earning in destination areas. Following the standard literature on migration and remittances, this equation is augmented by one additional variable as the exclusion restrictions, the proportion of household with migrants in a specific geographic location as a proxy for the presence of migrant social networks.

4. Data and Summary Statistics

4.1 Data

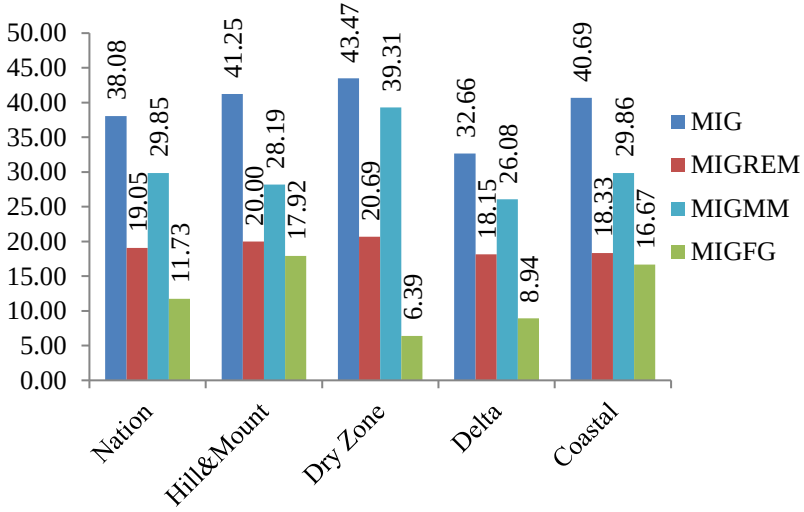
This study uses both ground survey data and satellite data. The ground survey data, the Myanmar Poverty and Living Conditions Survey (MPLCS), was conducted by the World Bank and Myanmar's Ministry of National Planning and Economic Development in the year 2015. Further, daytime and nighttime satellite imageries are applied in order to present human activities and urban change at regional scale. Daytime high spatial resolution imagery (HSRI) data are obtained from Open Street Map (OSM) data files providing geographically referenced data, information on transport networks and location or service centers. Nighttime light (NTL) emissions obtain from the Version 4 DMSP-OLS Nighttime Lights Time Series of National Oceanic and Atmosphere Administration (NOAA).

The MPLCS data set provides the demographic composition of household members and socioeconomic characteristics that contain the information that is applicable to the purposes of this study. Regarding the information about migration and remittances, the MPLCS asks the questions "Are there any individuals who were part of the household during the last 10 years, but currently live abroad or elsewhere in Myanmar and are no longer part of this household?" and "Has anyone in the household has received remittances from anyone outside of the household (either abroad or elsewhere in Myanmar) during the last 12 months?" On the basis of the first question, households with migrant members can be observed directly. The second question focuses on whether the household receives remittances or not. The important fact to be noted is that some household may face the case in which

they may have family members living elsewhere as migrants but do not receive remittances.

Applying the information from these two questions, this paper classifies households with at least one migrant (MIG) member, households with at least one migrant and receiving remittances (MIGREM), households with at least one internal migrant (MIGMM), and households with at least one international migrant member (MIGFG) in all agro-ecological zones. In all zones, migration can be studied because more than one third of the households in each zone have at least one migrant member (Figure 1).

Figure 1. Shares of Households



Source: Author's calculation

On average among households with migrants, almost half receive remittances (19.1 percent of the 38.1 percent of households with migrants). It should be stressed that the share of households with at least one internal migrant are much higher than that of households with at least one international

migrant in all zones. In order to complement the survey based household data, building density, paved and unpaved road lengths and NTL are added in this study (Appendix A). Krizhevsky, Sutskever, and Hinton (2012) state that the objects obtained from daytime and nighttime satellite imaginaries are strongly correlated with local income and wealth. A list of variables used in this paper is presented in Table 1, including log per capita expenditure, explanatory variables and exclusion restriction.

Table 1. Description of Variables

Variable name	Description
log(Y)	Log of per capita household expenditure
hh_mig	Dummy variable for household with at least one migrant: yes=1
hh_migrem	Dummy variable for remittance receipt household from migrant
poor	Dummy variable for poor household
Household head Characteristics	
hd_age	Head's age in years
hd_age2	Age-squared of head
hd_gender	Dummy variable for gender of head: male=1
hd_edu	Years of schooling for head (formal education)
hd_noedu	Dummy variable for head with no education
hd_infedu	Dummy variable for head with no formal education
hd_priedu	Dummy variable for head with primary education at most
hd_secedu	Dummy variable for head with secondary education at most
hd_hgedu	Dummy variable for head with higher education
Human capital characteristics	
avg_edu	Average years of schooling in each household
max_edu	Maximum level of educational attainment of household member
u15	Number of household member younger than 15

o65	Number of household members aged older than 65
hh_priedu	Number of household members with primary education
hh_secedu	Number of household members with secondary education
hh_hgedu	Number of household members with higher education
tot_work	Number of household members currently works
temp_job	Number of household members with temporary job status
Physical capital characteristics	
hh_ownland	Dummy variable for owned-land household
hh_ownhouse	Dummy variable for owned-house household
Exclusion restriction	
pro_mig (Network)	Proportion of household with migrants in primary sampling unit
rual	Dummy for household lives in rural
HM_zn	Dummy for household lives in Hills and mountains zone
Dry_zn	Dummy for household lives in Dry zone
Delta_zn	Dummy for household lives in Delta zone
Coastal_zn	Dummy for household lives in Coastal zone
NTL-index	Night time light index
Building	Density of building in districts
Road	Road length in districts (kilometer)

4.2 Characteristics of the sample

According to the MPLCS, a summary of socioeconomic and demographic characteristics of all households and the sub-samples that (i) receives remittances from migrants, (ii) does not have migrants, and (iii) receive remittances are presented in Table 2. The subsample of remittance received households includes the households who answered completely to the question of whether or not they received remittances from migrants. According to MPLCS about 20 percent of all households reported that they received remittances.

Table 2. Summary statistics

Variable of interest	All households	Households		Difference	T-test
		With remittance	Without remittances		
Sample size	3648	695	2953		
Sample proportion	1	0.19	0.81		
Per capita Expenditure (mean)	4704.925	4533.059	4745.374	0.0541	0.244
	(164.238)	(321.111)	(188.307)		
Poverty incidence	0.33	0.31	0.33	-0.0180	0.92
(headcount index)	(0.47)	(0.46)	(0.47)		
Household head characteristics					
Age	50.96	57.27	49.47	7.7925	0.00
	(14.42)	(12.72)	(14.39)		
Male	0.78	0.68	0.80	-0.1263	0.00
	(0.42)	(0.47)	(0.40)		
Average years of schooling	4.99	4.58	5.08	-0.4953	0.0042
	(4.11)	(3.96)	(4.14)		
No education	0.0140	0.0086	0.0152	-0.0068	0.182
	(0.0019)	(0.0035)	(0.0022)		

Informal education	0.1228	0.1583	0.1144	0.0349	0.0015
	(0 .0054)	(0.01385)	(0 .0058)		
Primary	0.400	0.401	0.400	0.001	0.954
	(0.008)	(0.019)	(0.009)		
Secondary	0.29	0.27	0.30	-0.03	0.1653
	(0.45)	(0.44)	(0.46)		
Higher	0.06	0.05	0.06	-0.01	0.145
	(0.24)	(0.21)	(0.24)		
Other households' characteristics					
Household size	4.56	4.34	4.62	-0.28	3.13
	(2.15)	(2.14)	(2.14)		
Aged under 15	1.32	1.21	1.35	-0.14	2.47
	(1.32)	(1.33)	(1.32)		
Working age (15-65)	2.97	2.73	3.02	-0.29	4.50
	(1.54)	(1.55)	(1.54)		
Aged over 65	0.28	0.39	0.25	0.14	-6.35
	(0.55)	(0.62)	(0.53)		
Human capital					
Max-education	10.24	10.53	10.17	0.36	0.1181
	(0 .0883)	(0.2075)	(0.0976)		

primary	2.91	2.80	2.94	-0.14	0.0922
	(2.05)	(1.89)	(2.08)		
Secondary	1.34	1.27	1.35	-0.08	0.1708
	(1.41)	(1.36)	(1.43)		
Higher	0.32	0.27	0.33	-0.06	0.0891
	(0.78)	(0.66)	(0.81)		
No. of work-person	1.88	1.59	1.95	-0.36	0.000
	(1.32)	(1.27)	(1.32)		
No. of person with permanent job status	0.474	0.355	0.5025	-0.148	0.0001
	(0.0147)	(0.0265)	(0.0171)		
No. of person with temporary job status	0.18	0.15	0.18	-0.03	0.1155
	(0.50)	(0.46)	(0.51)		
Agriculture income	0.44	0.38	0.45	-0.07	0.0011
	(0.50)	(0.49)	(0.50)		
Manufacture income	0.2099	0.1856	0.2157	-0.0301	0.0796
	(0.0067)	(0.0147)	(0.0075)		
Service	0.4213	0 .3827	0.4304	-0.048	0.0220
	(0.0081)	(0.0184)	(0.0091)		
Physical capital					
owned-house	0.86	0.92	0.84	0.08	-5.43

	(0.35)	(0.27)	(0.36)		
Regional characteristics					
Rural	0.63	0.67	0.63	0.04	**-0.77**
	(0.48)	(0.48)	(0.48)		
HM	0.20	0.21	0.20	0.01	-0.72
	(0.40)	(0.41)	(0.40)		
Dry	0.20	0.21	0.19	0.02	-1.25
	(0.40)	(0.41)	(0.40)		
Delta	0.41	0.39	0.41	-0.01	1.16
	(0.49)	(0.49)	(0.49)		
Coastal	0.20	0.19	0.20	-0.01	0.55
	(0.40)	(0.40)	(0.40)		
Urbanization Index					
NTL	3.90	3.56	4.00	0.402	0.93
	(10.25)	(10.27)	(10.24)		
Building	38090.08	34969.12	38824.61	-3855.49	1.34
	(68137.73)	(62824.29)	(69318.71)		
Road	5.00	5.23	4.93	0.3461	-2.34
	(3.51)	(3.25)	(3.57)		

Standard errors in parentheses
Source: Author's calculation

The mean value of per capita household expenditure of remittance household is lower than both of the whole samples and subsample of non-remittances households. This means that, on average remittance households have lower per capita expenditure than non-remittances household. Applying the national poverty line[2], the samples are categorized into poor and non-poor households. Although according to per capita household expenditure remittance-received households are poorer than remittance-not-received households, it can be suggested that remittance from migrant can reduce poverty incidence since 31 percent of migrant households are poor while 33 percent of its counterpart subsamples and the whole sample are being poor and on average, heads of remittance-received households are less educated than heads of remittance-not-received households. About 12 percent of all households in the sample are headed by a person who did not attend formal education system, while the subsample of remittance-received households has the higher proportions in that category. However, the proportions of households in primary education category are indifferent between both sub-samples. Thus, it can be concluded that remittance-not-received households have more educated household heads than remittance-received households.

Average household size of remittance-received households is lower than that of remittance-not-received households. When household members are grouped into 3 categories according to age (below 15, equal and between 15 and 65, and over 65), remittance-received households have a larger elderly dependency ratio than average household. According to household size and household member in each

[2] According to 2015 living condition in Myanmar, poverty line is set at 1303 kyat per day. An individual in Myanmar considered being poor if he or she lives in a household which can only afford 1303 kyat per capita consumption expenditure per day or less.

age category, it can be suggested that some of household members in working age category have migrated. Overall, the sample characteristics describe that on average remittance-received households in Myanmar are less poor and small family size with a higher educational attainment.

5. Results and discussion

Firstly, this paper explores per capita household expenditures for remittances-received households in the counterfactual scenario of the case in which household does not receive remittances and does not have migrants. Following Heckman's two-step procedure, the results of the estimation are reported in Table 3 with three models. Each pair of equations refers to three specification based on the different representations of education variables (head's educational attainment in category, and maximum and average of household education). In all models, the inverse Mills' ratio (λ), the variable associated with the propensity to not receive remittances from migrants, is positive and statistically significant at the 1 percent level and it can be suggested that the error component in non-selection equation and the error component in expenditure equation are positively correlated. It means that households with a higher probability of not having migrant are more likely to have higher per capita income. According to the standard migration argument, the findings are consistent because potential migrants decide whether to move for work by comparing the returns at home and in their potential destination. Thus, OLS estimation would provide upward biased parameter estimates. It means that unobserved factors that make remittances from migrants are more likely to be associated with higher per capita expenditure.

Table 3. Per capita expenditure model with household head's categorized education and maximum and average education in household using Heckman's model

	Model A		Model B		Model C	
Variable	(1) Exp	(2) Rem	(1) Exp	(2) Rem	(1) Exp	(2) Rem
hd_age	-0.010	-0.099***	-0.013	-0.097***	-0.013	-0.099***
	(0.010)	(0.014)	(0.010)	(0.014)	(0.010)	(0.014)
hd_age2	0.000	0.001***	0.000	0.001***	0.000	0.001***
	(0.000)	(0.000	(0.000)	(0.000)	(0.000)	(0.000)
hd_male	0.041	0.188***	0.050	0.175***	0.037	0.176***
	(0.056)	(0.062)	(0.056)	(0.061)	(0.055)	(0.061)
avg_edu			0.063***	-0.017		
			(0.013)	(0.016)		
max_edu					0.013***	-0.002
					(0.004)	(0.005)
hd_noedu	0.132	0.408*				
	(0.176)	(0.247)				
hd_inf	0.065	-0.083				
	(0.082)	(0.097)				
hd_pri	0.017	-0.095				
	(0.064)	(0.078)				
hd_sec	0.019	-0.069				
	(0.075)	(0.092)				

u15	-0.131***	-0.030	-0.097***	-0.054**	-0.130***	-0.029
	(0.017)	(0.021)	(0.019)	(0.023)	(0.017)	(0.021)
o65	-0.114**	-0.015	-0.054	-0.048	-0.125**	-0.011
	(0.055)	(0.063)	(0.057)	(0.065)	(0.055)	(0.062)
age15_65	-0.139***	0.068**	-0.118***	0.055*	-0.143***	0.069***
	(0.022)	(0.028)	(0.023)	(0.028)	(0.021)	(0.027)
tpr_educ	0.082***	-0.019	0.008	0.005	0.074***	-0.021
	(0.022)	(0.028)	(0.025)	(0.031)	(0.019)	(0.024)
tsec_educ	0.129***	0.053	0.038	0.088*	0.106***	0.066
	(0.034)	(0.043)	(0.037)	(0.048)	(0.032)	(0.042)
hhm_work	0.084***	0.070*	0.103***	0.073**	0.089***	0.071**
	(0.027)	(0.035)	(0.027)	(0.036)	(0.027)	(0.035)
temp_job	-0.092**	-0.019	-0.095**	-0.012	-0.092**	-0.019
	(0.044)	(0.058)	(0.045)	(0.058)	(0.044)	(0.058)
nfarmown	0.084***	0.003	0.070**	-0.005	0.081***	0.003
	(0.027)	(0.037)	(0.028)	(0.037)	(0.027)	(0.037)
farmown	-0.004	0.033	-0.018	0.026	-0.007	0.033
	(0.028)	(0.038)	(0.029)	(0.038)	(0.028)	(0.038)
ownhouse	0.160**	-0.147	0.164**	-0.130	0.161**	-0.155**
	(0.063)	(0.090)	(0.066)	(0.091)	(0.063)	(0.090)
rural	-0.090*	0.084	-0.043	0.071	-0.081	0.089
	(0.055)	(0.067)	(0.058)	(0.069)	(0.055)	(0.066)
hm_zn	0.154**	0.217**	0.232***	0.204**	0.163**	0.225**
	(0.075)	(0.093)	(0.078)	(0.094)	(0.075)	(0.093)
dry_zn	0.174***	0.183**	0.196***	0.174**	0.173***	0.186**

	(0.061)	(0.078)	(0.064)	(0.079)	(0.061)	(0.078)
cos_zn	-0.218**	0.248***	-0.218***	0.230***	-0.215***	0.241***
	(0.070)	(0.087)	(0.071)	(0.088)	(0.069)	(0.087)
NTL	-0.022**	0.030**	-0.022**	0.027**	-0.023**	0.029**
	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.013)
Building	0.000	0.003**	0.000	0.003*	0.000	0.003**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Road	27.385	-34.979	24.469	-18.54	28.760	-35.606
	(28.37)	(36.18)	(29.30)	(36.75)	(28.28)	(36.10)
Pro-mig		-1.780***		-1.745***		-1.789***
		(0.152)		(0.149)		(0.151)
_cons	8.146***	4.203***	7.854***	4.164***	8.115***	4.170***
	(0.253)	(0.393)	(0.274)	(0.408)	(0.248)	(0.389)
athrho		0.777***		0.836***		0.776***
		(0.126)		(0.113)		(0.125)
lnsigma		0.122***		0.127***		0.120***
		(0.023)		(0.022)		(0.023)
Obs	3648	3648	3648	3648	3648	3648

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's calculation

The results in column 1, obtained from all models, are corrected for the selection bias associated with not having a migrant by the selection equation in column 2. All the selection equations show that the use of exclusion restriction variable, the proportion of households that received remittances from migrants in primary sampling unit, as the proxy of presence of migrant networks, is negative and statistically significant at 1 percent level. It means that the higher the presence of migrant networks, the lower the probability of the household never having had a migrant. Other estimates in the selection equations allow the model to be identified and explain the characteristics of the non-migrant households such as household head age, gender, number of working age people and number of currently working people and regional characteristics. Households with younger heads are less likely to have migrants but when they get older, the effect will be lower. Households with a man as head of household have a lower probability of having a migrant. Generally, woman headed households are often poor and remittances from migrants become one of the possible sources when they want more income to fulfill the requirements of their living condition. On the other hand, the need for income is lower in households with a larger number of working age people and currently working people. Although coefficients are not significant, it may be observed that higher dependency and more people with temporary work are "push" factors for migration. Since regional dummies of Hills-Mountains Zone, Dry Zone and Coastal Zone are statistically significant with positive value, households in these zones are less likely to have migrants than household in Delta Zone. Only dummy variable of household head with no education is positive and statistically significant while other estimates of education are not significant. Although estimates of education are not significant in all models, it can be suggested that the higher

educational attainment for both head and all household members reduce the probability of never having migrants. The explanations of urbanization index state that the greater the density of NTL and building is, the lower the probability of having migrants. It can be suggested that people in more urbanized areas are less likely to leave their home of origin since they satisfy their current settlement and employment condition. Although estimates of road lengths are not statistically significant, their explanation for migration is acceptable. The ease of transport networks induces people to move from one place to another. The explanations of all of urbanization index prove that they are practical to include in the shaping of migration decisions.

The obtained estimates form the log per capita expenditure equations can be used to interpret exactly as though observed data for all households in the sample and all estimated coefficients represent the marginal effects of the regressors in the log per capita expenditure equation. The obtained results state the significance of households' demographic composition. The number of persons at all ages in the household reduces the log per capita expenditure, while number of persons working and persons with higher educational attainment raises log per capita expenditure. The number of persons with temporary job status reduces the capability of spending. If a household owns a house or non-farm enterprises, the household can spend more. The marginal impact is weak for expenditure of households in farm enterprises reflecting that non-farm enterprise owners in Myanmar are more profitable than farm enterprise owners. Rural households can spend less than urban households. In terms of agro-ecological zones, household in coastal-zones spend less compared to households in other zones. Economic activities in coastal zone are not favorable for those who live in this zone. Although the marginal impact is far weaker for

density of building and road length, nighttime light index warrants a study of whether urbanization can reduce welfare of people.

These estimates allow constructing and comparing observed and counterfactual household per capita expenditure in order to know the impact of migration through remittances on the welfare of households left-behind (Margolis et.al., 2013). Following Joliffee (2001), the rest of this paper applies model C, assuming that the maximum education attainment of people in the household is better to include as household income predictors. With model C, the next section will discuss about the impact of migration on welfare of left-behind household.

5.1 Impact of migration on welfare of remittance-received

Table 4 shows the observed average of per capita expenditure of household with remittances from migrants and its counterfactual to find the impact of migration on welfare of households left-behind. The results attempt to predict the welfare-increasing effect of remittances from migration, based only on the analysis of before (obtained from counterfactual scenarios) and after (observed) remittances receiving households. Generally, migration raises the welfare of households left-behind. However, the degree of impact is different across agro-ecological zones or rural and urban areas and also between poor and non-poor. In all agro-ecological zones, households with remittances from migrants experience the positive effect of migration and among these zones Hills and Mountains Zone has the highest positive effect of migration. It should be noted there is a surplus of labor in these zones. If they are able to participate in migration and get chances to get a job at their potential destination, their remittances can ease the credit constraint of their household

left behind. This finding is also consistent with the previous findings of probit estimate for not having migrants. Households with migrants in Coastal Zone receive the lowest welfare-increasing impact of migration. This result is same as the one discussed in the descriptive analysis.

Table 4. Average impact of migration on welfare of household left-behind

Level of interests	Average per capita household expenditure of remittances received household (Kyat)		
	After receiving remittances form migrants (Observed)	Before sending Migrants (Counterfactual scenarios)	Differences
Nation	4533.06	1784.51	2748.55
Hills-Mountains	5949.31	1872.66	4076.66
Dry Zone	6070.71	2080.38	3990.33
Delta Zone	3866.33	1780.82	2085.52
Coastal Zone	2616.13	1361.93	1254.20
Urban	5036.04	2047.76	2988.28
Rural	4259.22	1641.19	2618.03
Non-poor	6218.45	1882.31	4336.14
Poor	845.31	1570.52	-725.21

Source: Author's calculations

In terms of differences between rural and urban, urban households benefit more from migration than rural households. The reason is that rural migrants would lead to loss of labor and reducing production in agricultural activities if the wages earned by migrants are lower than the earnings from their source and if household receiving remittances do not invest in improving agriculture. However, in terms of poverty status, the poor suffers more from the negative impact of migration. If migration is costly and risky, there may be obstacles to participate in migrant labor markets for poor

households. Then the poor are excluded from the positive effects of migration.

5.2 Impact of migration on inequality

Table 5 shows estimates of the Gini Coefficient[3] using counterfactual imputed non-remittance income for household with remittance sending migrants.

Table 5. Gini coefficient of remittance-received households and their counterfactual scenarios

Region	Gini coefficient
Nation	
Before receiving remittances from migrants	0.61507
After receiving remittances from migrants	0.36786
% Change	-0.40192
Urban	
Before	0.61109
After	0.33305
% Change	-0.45499
Rural	
Before	0.61405
After	0.3766
% Change	-0.38669
Hills-Mountain	
Before	0.67781
After	0.42155
% Change	-0.37807

[3] Although many measures of inequality have been developed, this paper applies the Gini Coefficient, which is the most widely used single measure of inequality. It is based on the Lorenz curve, depicting the variance of the size of distribution of income from perfect equality.

Dry Zone	
Before	0.57831
After	0.40842
% Change	-0.29377
Delta Zone	
Before	0.59171
After	0.30093
% Change	-0.49142
Coastal Zone	
Before	0.57151
After	0.31513
% Change	-0.4486

Source: Author's calculations

In comparison to results obtained when using observed income of household with no remittances from migrants, for the whole nation, remittances from migrants contribute to a 40.19 percent decrease in inequality. Thus, remittances from migrants have a positive equalizing effect. Comparing urban and rural effects, positive equalization effect in urban (45.50 percent change) is larger than that in rural (38.67 percent change). Income distribution becomes more equal in Delta Zone with the lowest Gini coefficient of 0.3 after receiving remittances from migrants. And also, it can be seen that the Delta Zone has the highest positive equalization effect of migration (percent change of 49.14).

5.3 Impact of migration on poverty

This section attempts to estimate the poverty reducing effect of remittances based on the analysis of observed per capita expenditure assuming that the effects of migration would be over-estimates. In order to analyze the poverty impact of migration, this paper applies FGT weighted poverty

measures[4] developed by Foster, Greer and Thorbecke (1984). According to the FGT weighted poverty measure, headcount poverty index, poverty gap and squared poverty gap are applied based on poverty line set by 2015 living condition in Myanmar. In 2015, an individual in Myanmar is considered to be poor if he or she lived in a household with per consumption expenditure of 1303 kyat per day or less.

Using this poverty line, Table 6 summarizes the simulations of effects of remittances from migration on poverty levels. The results are what we would expect. On average, when moving from a scenario without remittances to with remittances, poverty is estimated to fall by 34 percent. It can be seen that remittances from migration leads to large reduction in poverty levels of 31.03 percent and 20.44 percent in the scenario without remittances and with remittance respectively. It can be seen that this level of impact of migration on poverty headcount figures hide important disparities between urban and rural and among agro-ecological zones. Notably, urban poverty is estimated to fall by more than 52 percent while rural poverty is estimated to fall by 25 percent. Besides, more than one-fourth of rural households are still below the poverty line despite sending out migrants while about 10 percent of urban households are poor. The level of poverty reduction caused by migration is much lower in rural areas compare to urban areas. Among the agro-ecological zones, the lowest level of poverty reduction caused by migration (6 percent) is found in coastal zone. After having

[4] An estimate of FGT poverty measures can be expressed as $P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z-y}{z}\right)^\alpha 1(y_i \leq z)$: where N= total numer of household, q = the number of poor households, z = scalar value of poverty line, y = household per capita expenditure per day, α = degree of poverty aversion meaning that P_0 is poverty headcount index, P_1 is poverty gap and P_2 is squared poverty gap.

migrants, the poverty incidence in Coastal Zone is 44 percent which is far higher than the national poverty incidence, 20 percent.

Table 6. Poverty measures of migrant-sending households and their counterfactual scenarios

Region	Poverty headcount (%)		Poverty Gap (%)		Squared Poverty Gap (%)	
Nation						
Before remittances	31.0307	(0.4627)	11.1638	(0.2096)	5.64	(0.1383)
After remittances	20.4222	(0.4032)	4.9874	(0.1321)	1.99	(0.0732)
% Change	-0.3419		-0.55325		-0.6466	
Urban						
Before	23.0481	(0.4213)	7.44	(0.1676)	3.36	(0.1009)
After	9.3844	(0.2917)	1.86	(0.0755)	0.60	(0.0336)
% Change	-0.5928		-0.74943		-0.8200	
Rural						
Before	35.62176	(0.4790)	13.31	(0.2276)	6.95	(0.1542)
After	26.77029	(0.4429)	6.78	(0.1527)	2.79	(0.0873)
% Change	-0.2484		-0.49021		-0.5983	
Hills-Mountain						
Before	28.75	(0.4529)	12.45	(0.2382)	7.22	(0.1728)
After	15.13889	(0.3587)	4.05	(0.1264)	1.76	(0.0725)
% Change	-0.4734		-0.67495		-0.7563	
Dry Zone						
Before	21.3889	(0.4103)	6.99	(0.1678)	3.30	(0.1059)
After	12.2222	(0.3278)	2.72	(0.1004)	1.08	(0.0569)
% Change	-0.4286		-0.61078		-0.6730	
Delta Zone						
Before	29.2339	(0.4550)	9.58	(0.1887)	4.48	(0.1163)
After	15.5242	(0.3623)	2.99	(0.0929)	0.95	(0.0427)
% Change	-0.469		-0.6877		-0.7871	

Coastal Zone						
Before	46.6667	(0.4992)	17.33	(0.2410)	8.80	(0.1607)
After	44.0278	(0.4968)	12.32	(0.1944)	5.29	(0.1162)
% Change	-0.5655		-0.289		-0.3990	

Source: Author's calculations

Regarding poverty gap and squared poverty gap, the results suggest that, on average, remittances from migrants tend to reduce the intensity and severity of poverty. At the national level, intensity and severity of poverty are reduced from 11.2 to 5 percent, and from 5.6 to 2 percent respectively. Comparing rural and urban areas, migration can reduce more poverty in urban than in rural areas, by 74.9 percent and 49.02 percent respectively. Among the agro-ecological zones, migration greatly reduces poverty by 68.8 percent in the Delta Zone. Therefore, at the national level there is a positive association between migration and reducing the intensity and severity of poverty.

6. Conclusion

This paper aims to estimate the household welfare impact of migration through remittances in the case of Myanmar. In order to predict household per capita expenditure, following Heckman's two-step procedure, this paper finds evidence of sample selectivity, where the probability of being a household with remittance sending migrants would be higher if welfare outcomes of household are high because of the decision of households to take part in migration is a function of their individual characteristics and those of their families and their communities. It can be concluded that overall the impact of migration through remittances on welfare of households left-behind is positive. However, there is a difference in impacts from migration among agro-ecological zones and between

rural and urban areas. Moreover, migration in Myanmar has a positive equalizing effect and positive poverty reducing effect. Similarly, the degree of these effects varies among zones and between rural and urban areas.

This study also finds evidence of the negative impact from migration on the welfare of poor households. It is likely that if migration is costly and risky, when poor households take part in migration, they may acquire more cost than benefit from migration while non-poor obtain positive migration impact. Some poor in Myanmar use informal loans with high interest rates to cover the cost to migrate. Mostly, in the migrant labor market, unskilled labor are vulnerable to losing their jobs. In this case, households left-behind need to pay interests before receiving remittances from their migrants and the systems used for sending remittances to households left-behind are informal, since most of poor in Myanmar do not have education for using bank and other financial business. In order to be pro-poor and allow poor households to benefit from migration, the obstacles to participating in migration should be lowered for the poor.

Based on the findings, this paper suggests that among the agro-ecological zones, the conditions of labor market are better in Delta Zone. The reason is that although it has the lowest share of household with migrants as well as households with remittances sending migrants, the poverty reducing impact and equalizing impact are high in the Delta Zone. Moreover, the results from the non-selection of migration equation states that the probability of not being households with migrants from other zones are less. It can be suggested that households in these zones face lack of employment opportunities and they are likely to send their labor surplus as migrants to Delta Zone where employment opportunities are better. Since Yangon, the former capital city, is located in Delta Zone, formal employment is more developed and the

reduction of poverty and equalizing effect are larger in Delta Zone than those in other zones. Although this paper focuses on the effects of internal migration on poverty and inequality in Myanmar, it captures the patterns of international migration. Beyond internal migration, international migration from Myanmar has also increased. Therefore, further study is needed to compare the effects of remittances between internal and international forms of migration.

Finally, this study finds the evidence that there exists linkages between urbanization, migration and welfare outcomes of households. Households in more rural areas are more likely to have migrants. Mostly, in the early stage of development, growth may exist in urbanized areas while stagnation may be found in peripheral rural areas. As economic development proceeds, individuals move from rural to urban areas. Therefore, it can be suggested that in the context of development urbanization and migration plays a vital role in Myanmar. According to the results, degree of urbanization can somewhat affect the welfare of households. This evidence encourages conducting further study to investigate whether urbanization can raise welfare of people. Understanding the relationship between urbanization, migration and economic growth could contribute to conducting policy in more effective and socially desirable ways. Therefore, the role of urbanization and migration need to be studied for boosting economic growth, poverty reduction and balancing economy.

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Appendix

Nighttime and daytime satellite imageries have produced significant interest as a potential supplement to household data. Historically, nighttime lights (NTL), measuring human light activity captured by satellites, have been utilized in many economic models (Elvidge et al, 2007; Doll et al., 2000; Sutton et al., 2007). Nighttime light emissions are derived from nighttime satellite imagery provided by the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS). With six sensors: F10(1992-1994), F12(1994-1999), F14(1997-2003), F15(2000-2007), F16(2004-2009) and F18(2010-2013), an archive of annual time series NTL data from the year 1992 to 2013 can be freely available from the website of Earth Observation Group, EOG: https://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html.

Table A1 presents average NTL of Myanmar. Figure A1 shows differences of NTL in 1992 and NTL in 2012 and differences of NTL among all districts of Myanmar in 2012.

Table A1. Average NTL of Myanmar

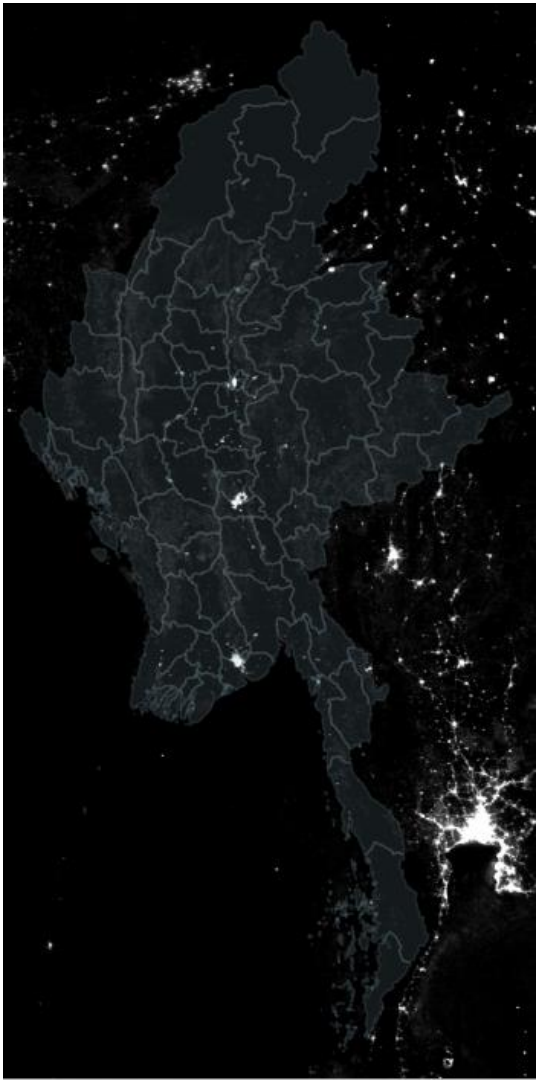
Variable	Mean	Std.Dev	Min	Max
Average NTL (1992-1995)	0.6129	0.2922	0.2424	0.9057
Average NTL (1996-1999)	0.7997	0.2171	0.5878	1.0490
Average NTL (2000-2003)	0.7307	0.1362	0.5937	0.9045
Average NTL (2004-2007)	0.8162	0.2451	0.6034	1.1466
Average NTL (2008-2011)	1.3730	0.5036	0.9308	2.0300
Average NTL (2012-2013)	1.2809	0.6520	0.8199	1.7420

Source: Author's calculations based on DMSP-OLS/NTL dataset

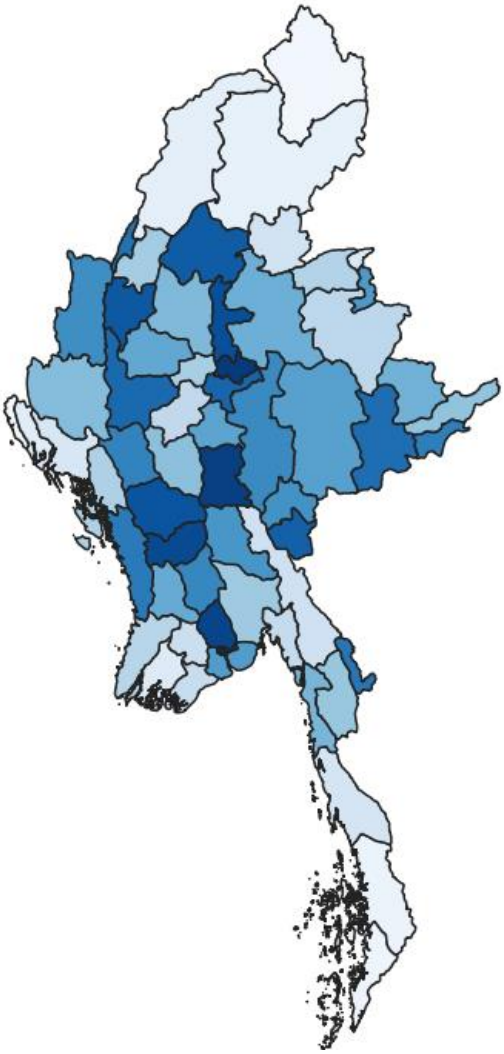
Figure A1: NTL in Myanmar

a. Average NTL in 1992

b. Average NTL in 2012



c. Average NTL among districts in 2012

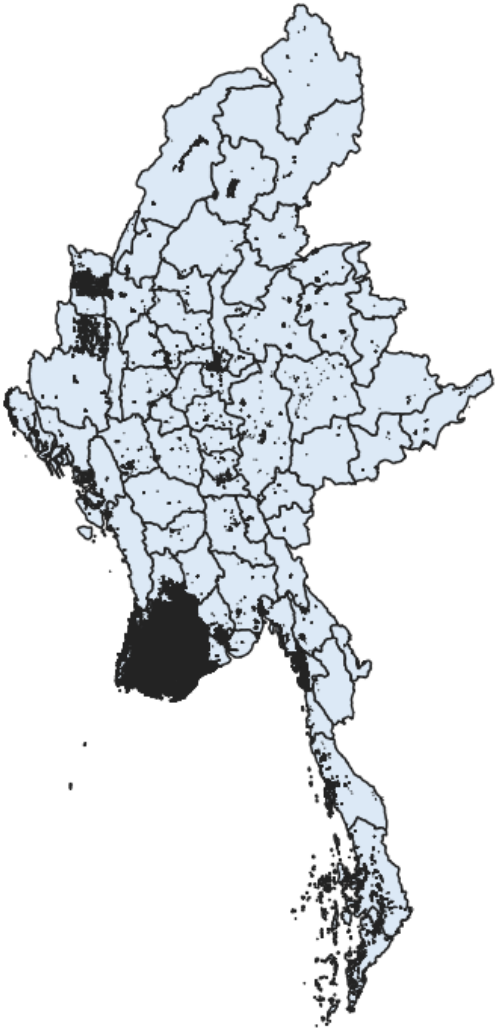


Source: Author's calculations based on DMSP-OLS/NTL dataset

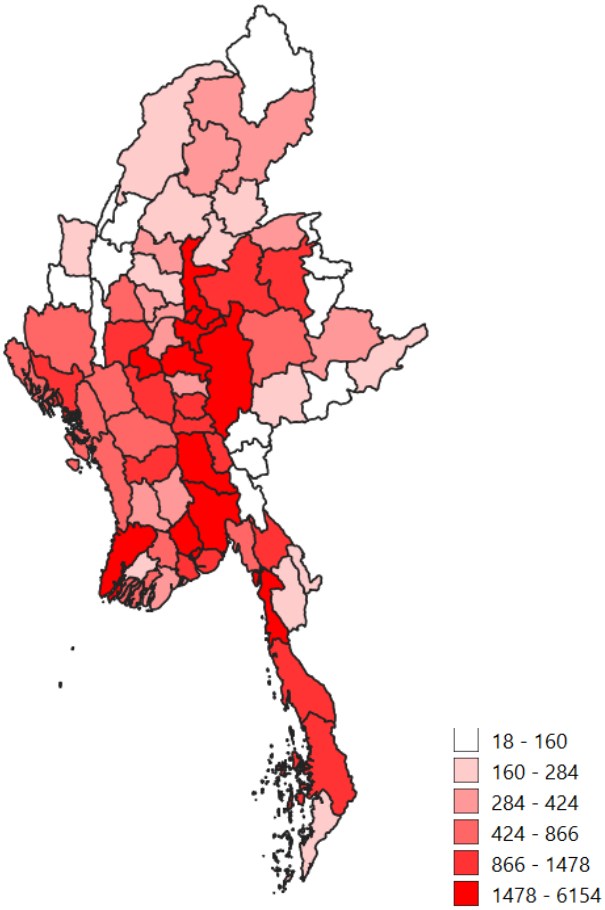
Moreover, continued technological advances in computer vision algorithms are allowing analysis to utilize valuable information from daytime satellite imageries. Daytime high spatial resolution imagery (HSRI) data can be obtained from Open Street Map (OSM) which provides object-based features by a topological data model including number of building and the density of paved and unpaved roads of different widths. Any interested parties can download OSM datasets from Open Street Map web site, https://www.openstreetmap.org. In this study, the data about number of buildings and length of road are from OSM and these data are converted into shapefiles data format by using Geographic Information System, QGIS. Obtaining data are presented in Figure-A2 and Figure-A3.

Figure A2. Number of Buildings in Myanmar

a. Number of buildings in Shapefiles Data format



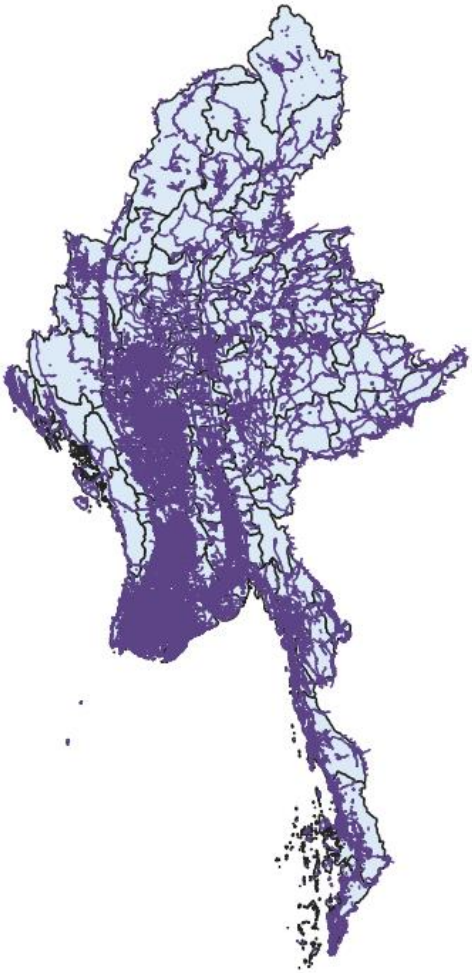
b. Distribution of buildings among districts in Myanmar



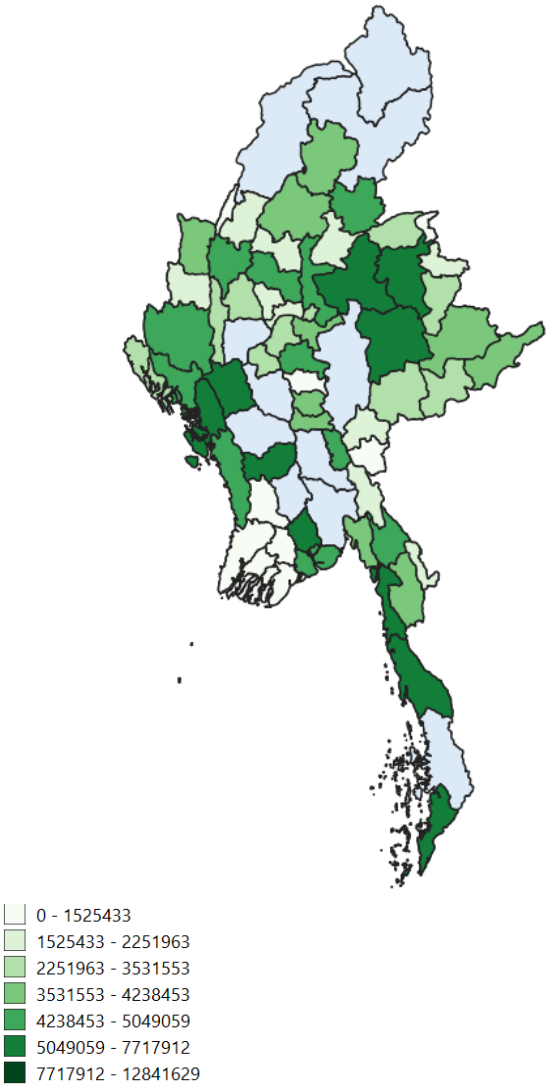
Source: Author's calculations based on OSM dataset

Figure A3. Length of roads in Myanmar

a. Length of roads in Shapefile data format



b. Length of roads among districts in Myanmar



Source: Author's calculations based on OSM dataset