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Migration, Remittances and Forests

Disentangling the Impact of Population and Economic Growth on Forests

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Abstract

International migration has increased rapidly in recent decades and this has been accompanied by a remarkable increase in transfers made by migrants to their home countries. This paper investigates the effect of the rural economic growth brought about by migration and remittances on Nepal's Himalayan forests. The authors assemble a unique village-panel dataset combining remote sensing data on land use and forest cover change with data from the census and multiple rounds of living standards surveys to test various inter-relationships between population, economic growth and forests. The results suggest that rural economic growth spurred by remittances has had an overall positive impact on forests. The paper also finds that remittances caused an increase in rural wages and an increase in income, but a decrease in land prices. Considered together, however, the relationship between forests and remittances is driven largely through the income channel, indicating that the demand for amenities provided by forests in the rural Nepali setting may have been more important than factor prices in influencing land use changes for the period of the study.

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Migration, Remittances and Forests: Disentangling the Impact of Population and Economic Growth on Forests

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1 Introduction

International migration has emerged as one of the most salient features of globalization in the twenty-first century. The World Bank estimated 215 million migrants worldwide in 2010. This represents 3 percent of the world population and almost a three-fold increase from an estimated 76 million migrants in 1975[1]. In addition to the sheer size of this increase, it is also noteworthy that 79 percent of the existing stock of migrants originates from developing countries. This rapid growth in international migration and the relatively large representation of developing countries in the stock of emigrants can primarily be attributed to two related phenomenon. The widening income gap between the developed and developing countries has made residents of poorer countries much more willing to cross international borders in search of economic opportunity. On the other hand, advances in transport and communication technology have not only facilitated a better flow of information across borders, but also lowered the costs of migration significantly, making newer destinations economically viable[2] .

This increase in the number of work related migrants has naturally led to a concurrent increase in private transfers made to their families back home in the form of remittances. Estimates from the World Bank indicate that the global flow of remittances to developing countries rose from $55 billion in 1995 to $307 billion in 2009 implying an annual growth rate of approximately 13 percent. This amount is 2.5 times the Official Development Assistance (ODA) and accounts for roughly 35 percent of the total financial flows to the developing world. For many countries hitherto poorly integrated with the global economy – be it through inadequate trade and movement of financial capital or direct foreign investments – the opportunity to "export" labor and benefit from earnings repatriated home represents a significant opening up. At the macroeconomic level, this presents an enormous opportunity for growth as large remittance flows can make countries resilient to shocks and bolster a country's creditworthiness and ability to access funds from international capital markets.

Understandably, the scale and the pace of the flow of people and the magnitude of the remittances they send back has heightened interest among policymakers and researchers to understand the socio-economic circumstances *within* the household and their communities that shape and are in turn shaped by migration and remittances[3]. Recent empirical work in this area has advanced mainly along four strands: the role of migration networks in channeling or inhibiting migration flows (Munshi (2003),Munshi and Rosenzweig (2009), McKenzie and Rapoport (2007)); methodological issues in estimating returns to migration (McKenzie, Gibson, and Stillman (2010)); determining labor supply response to migration and remittances (Amuedo-Dorantes and Pozo (2006), Lokshin and Glinskaya

[1]Migration and Remittances Factbook (2011), World Bank

[2]See Chiswick and Hatton (2003) for a detailed treatment of the historical evolution and underlying drivers of international migration

[3]Economic research on migration itself is not new. But historically it has either tended to focus on the performance of migrants in labor markets in the host country, often vis-à-vis the natives or remain circumscribed within concerns about "brain drain" and attendant consequences for growth. (See (Borjas, 1994) for a review.)

(2009)), and; a plethora of studies evaluating the effect of remittances on various aspects of economic and social well-being among households that receive them.

Among these themes, the literature on the impact of migration and remittances on household well being is perhaps the most well established and also the most voluminous. Recent research focusing on international migration highlights various channels through which remittances can be useful for the development process. Yang and Choi (2007) show that remittance flows can help households smooth consumption in the face of aggregate shocks that simultaneously render local risk-coping mechanisms ineffective [4]. Woodruff and Zenteno (2007) show that remittances and access to migration networks bolster entrepreneurship in Mexico. In a similar vein, Yang (2008a) finds an increase in hours in self- employment and greater likelihood of starting a capital-intensive enterprise among remittance receiving households in the Philippines. In addition, findings of a positive effect of remittances on measures of human capital accumulation such as schooling in Edwards and Ureta (2003), Yang (2008b) and Amuedo-Dorantes and Pozo (2010) point to the possibility that remittances may be important drivers of intergenerational economic mobility and longer term growth. Even in the short run, the growth in household consumption that is spurred by remittances has led to a decline in poverty incidence in many countries. Some examples are Adams et al. (2005), Lopez-Cordova (2005) and Lokshin, Bontch-Osmolovski, and Glinskaya (2010).

However, despite the fact that most emigrants from developing countries originate from rural, predominantly agricultural communities where households rely heavily on the natural environment for livelihood, there has been no research to our knowledge that assesses the relationship between increased labor mobility and the attendant rise in rural incomes on the one hand and changes in natural resources and land use within sending communities on the other[5]. This is partly because most of the research in this area has focused narrowly on private, household level outcomes and largely ignored important community level interactions, spillovers and general equilibrium effects. An exodus of working age men from economically isolated villages to cities or foreign labor markets may have implications for the prevailing agricultural wage in the local economies they leave behind [6].

[4] Everyone in a village may want to access credit right after a major disaster driving up the price of credit or everyone in the village may want to sell their livestock at the same time following a period of drought, driving down the price.

[5] Most work at the intersection of migration and the environment has either been motivated by the need to understand the environmental impact of immigrants on urban centers and coastal areas or focused on the plight of the environmental refuges or individuals dislocated from their homes and forced to migrate due to natural and environmental disasters.

[6] Sometimes these general equilibrium effects may large enough to drive a wedge between what may be beneficial for the society as a whole on the one hand and what is beneficial for each individual actor. If returns to schooling increased in the destination areas, this would in principle at least, incentivize children to stay in school longer and invest in their human capital. But on the other hand, an outflow of young workers may lead local agricultural wages to rise, inducing children to tradeoff future returns in a foreign labor market with high current wages in the local market. An example of a similar spillover effect is presented in Foster and Rosenzweig (2004) for the context of rural India during the Green Revolution. Technological growth raised returns to education for children coming from land-holding families but as they responded by increasing their investment in education, children coming from landless families saw wages grow in the market for child labor thereby reducing their incentive to go to school.

Similarly, remittances may well be private receipts for the households receiving them, but if the size and coverage (in terms of the number of households receiving them) of these transfers are large, they could fundamentally alter the economic landscape of the village. The increased economic activity may lead to a greater extent of the market, increased demand for local nontradeable services, and an increase in land rents. All of these changes could potentially further draw labor out of agriculture and cause a complete dislocation of the sector and this would in turn have important implications for land use changes and local natural resources. In addition, the income growth that comes with greater openness may have an independent effect on natural resource extraction.

In this paper, we study the effect of labor migration and remittances on one important natural resource: forests. We build a general equilibrium model of an isolated village economy and theoretically investigate the mechanisms through which the relationship between an outflow of labor, a concurrent inflow of capital and local forest resources would be mediated. We derive predictions from this model and test these predictions using a newly assembled village-panel dataset from Nepal. This dataset combines remote sensing data on land use and forest cover change together with data from multiple rounds of living standards surveys. What makes Nepal an ideal setting for this enquiry is that the country has experienced a sharp increase in rural emigration and this has been accompanied by an unprecedented increase in remittance receipts. On the one hand, the country is overwhelmingly rural with agriculture accounting for roughly two-fifths of the economy. On the other hand, livelihoods of rural Nepalis are linked intricately to forests which are the primary sources of firewood used extensively for cooking and heating as well as fodder (used as feed for livestock). In addition, the widespread perception in Nepal is that forests are declining. These perceptions are somewhat validated in government statistics which show that between 1995 and 2005 land area covered with forests declined from 41 percent to 32 percent.

The effect of out-migration and remittances on agriculture has been studied, among others, by Lucas (1987)and Taylor, Rozelle, and De Brauw (2003). However, these studies are confined largely to issues of agricultural investments, farm productivity, yields and income. More importantly, by treating land as a fixed factor, they are largely agnostic about expansion or shrinking of agricultural activity at the extensive margin. Research on forests in developing countries has typically taken place in the context of economic growth and how it interacts with the demand for forest resources. A particular emphasis has been on the investigation of whether there is evidence of an "environmental Kuznets curve" for forests as has been found for air and water (Grossman and Krueger, 1995). Some examples of rigorous micro-econometric work on this front are Bardhan, Baland, Das, Mookherjee, and Sarkar (2010), Foster and Rosenzweig (2003)and Chaudhuri and Pfaff (2002). However, except Foster and Rosenzweig (2003) none of these papers makes an effort to connect the changes in the consumption of resources such as fuelwood, for example, with actual forest area.

It is generally accepted that greater openness - be it through participation in trade, through expansion of economic activity or through migration to labor markets abroad for work - raises hosuehold incomes. In settings in which dependence on forests for livelihoods is large, it is natural to expect the increase in incomes to manifest itself through either an increase or decrease in the consumption of forest goods (such as firewood) depending on whether they are normal goods that complement other aspects of consumption or if they are inferior goods that lose favor as households modernize. In large parts, the "Kuznets curve" literature of forests has concentrated on determining the exact shape of this relationship. A bigger challenge is to extend this analysis a step further and consider how this increase or decrease in household demand for forest commodities will affect the size of the forests. Clearly, the local resource management regime in place plays an important role. In India, as Foster and Rosenzweig (2003) show, an increase in the demand for forest resources led to a greater allocation of land for forests. However, it is not hard to think of regimes under which the opposite would be true.

This paper contributes to two distinct bodies of research. First, given the fact that the overall growth in rural incomes is one of the most direct consequences of the growth in remittances, this paper adds to the small body of micro-econometric research that studies the impact of openness and economic growth on forests, particularly making an explicit linkage between an increase or decrease in the demand for forest products on actual forest area. In addition, we also add to the growing literature on the impact of remittances. This literature has focused primarily on private outcomes of households receiving these remittances and has, by and large, remained agnostic about broader, economy wide effects of the spatial mobility of labor. By bringing a general equilibrium perspective into the analysis of the relationship between remittances, local economic conditions and local commons, we hope to capture a richer and a more complete set of interactions that define the impact of remittances at the local level.

Empirically, one of the challenges we face in identifying the effect of remittances on forests is the possibility of reverse causality, that is the possibility, for example, that the villages that suffered adverse environmental shocks that caused a decline in forests were also the villages that witnessed the largest emigration and consequently the largest inflow of remittances. However, a large variation in remittances in the period we study was caused by a diversification of migration destinations which was in turn an upshot of a number of plausibly exogenous central government policies, particularly those regarding restrictions on foreign employment. We exploit this unique feature of the Nepali setting to deal with issues of bias. To be precise, we create a "synthetic remittance" variable that captures how per capita remittances in each village would have evovled had the diversification of migration destinations been the only thing to change in the migration patterns between the time periods we study. This generated variable serves as an instrument for true remittances with the underlying identifying assumption being that the diversification of migration destinations at the village level was truly exogenous to village circumstances and was driven largely by policy changes at the national level.

The rest of the paper is organized as follows. In Section 2 we describe the context, the history and changing patterns of migration and a brief history of forestry management practices in Nepal. In Section 3 we develop a model of a village economy that captures the key aspects of the interaction between migration, remittances and forests. In Section 4, we describe the data and in Section 5 we outline the estimation method and discuss some key results. We conclude with an outline of the next steps in Section 6.

2 The Context

2.1 Background

With an average per capita GDP of about $440 ($1,180 in purchasing power parity terms), Nepal is the poorest country in South Asia and one of the poorest in the world. About 30 percent of the Nepali population was poor in 2004, 46 percent of the adult population illiterate, and almost half the children under five years are malnourished. During the period of liberalization in the mid-1980s and early 1990s, the economy grew at about 5 percent per year. The impact of this relatively high rate of economic growth on improvements in living standards was dampened by the country's high population and urban-centered growth, limited access to basic services, poor governance, and persistent political instability. Economic growth slowed in the early 2000s due to a global economic slowdown that diminished export markets, and the escalation of a violent Maoist conflict that took a heavy toll on the economy. Although the conflict eventually came to an end in 2006, the overall pace of economic growth has not been as robust as it was in the early 1990s.

The Nepali economy is overwhelmingly rural and agriculture comprises 40 percent of the GDP. A Labor Force Survey completed by the Central Bureau of Statistics in 2008 found that 74 percent of the working age population was engaged in agriculture. However, unlike neighboring India that witnessed substantial growth of the rural economy, particularly the agriculture sector, during its Green Revolution, rural incomes in Nepal were by and large stagnant between 1965 and 1995. The initial challenges of a difficult geography have never been overcome adequately as progress on the extension of roads and other essential infrastructure to remote areas has been very slow. Input and technology costs are high, coverage of irrigation facilities is low, access to markets is limited, and as a result agriculture largely remains for subsistence.

What has been remarkable in the villages of Nepal since the middle of 1990s is the sharp increase in remittance income that rural households have received from family members working in urban areas within the country as well as numerous destinations abroad. Migration itself is not a new phenomenon in Nepal and even in recent years, there has been only but a modest increase in the absolute number of migrants. What is new is that there has been a significant diversification in terms of destinations of these migrants. Until the early 1990s migrants predominantly went to India in search of seasonal agricultural work as well as other service sector jobs. In the mid-1990s, the wave of economic as well as political liberalization led to removal of restrictions on obtaining passports and visas that were required to seek work in international destinations outside India. Concurrently, the Government of Nepal entered into a series of labor agreements with fast growing countries in East Asia (Malaysia, South Korea) and the Gulf region (Saudi Arabia, UAE, Qatar) resulting in a large outflow of unskilled, predominantly rural, working age males to these destinations. Since the contracted wages in these countries are much higher in comparison to local wages and wages that could be expected in a variety of jobs in India, the transfers that these workers were able to remit back to their villages have been unprecedented. In the following sub-section we discuss the history of migration in Nepal and document how the composition of migrants as well as the destinations has changed in recent years in a greater detail.

2.2 History and Pattern of Migration

Nepal's history of international labor migration goes back at least 200 years. The earliest Nepali migrants were mercenaries in the army of the Sikh ruler Ranjit Singh in Lahore in modern day Pakistan. It is perhaps from here that the colloquial Nepali term for migrants, "lahure" is derived. After having established their reputation as fierce warriors in various regional wars at the time, including the Anglo-Nepal war of 1814-1816, Nepali soldiers became willing recruits to the British Army. After India gained independence, the Gurkha regiments of the British army were preserved although a significant number of erstwhile Gurkhas joined the Indian army. To this day an estimated 50,000 Nepalis work in these two armies alone. (Seddon, Adhikari, and Gurung, 2002)

In addition, a significant number of Nepalis were drawn to the tea plantations, construction, coal mining and land reclamation in the Indian states of Assam, Bengal, Darjeeling, Kumaon and Garhwal in the late 1800s (Thieme and Wyss, 2005). While a majority of these early migrants settled in these areas permanently, a lot of the newer migrants started to move to industrialized areas such as Delhi, Mumbai and Bangalore where employment was easier to find in the growing service sectors. Temporary migration across the open border to India in search of seasonal employment in agriculture in the bordering states of Uttar Pradesh, Bihar and Punjab has also been a fairly common phenomenon over the years.

The advent of democracy in 1990 and the subsequent liberalization of the economy throughout the 1990s opened up newer destinations for Nepali migrants. Obtaining travel documents and passports became easier and together with the reduced costs of acquiring information, international destinations that were either previously unknown or inaccessible to those outside the migration networks became feasible options. Toward the mid-1990s, the Government of Nepal made provisions by which Nepali workers could be recruited directly through procedures involving the Ministry of Labor and registered Kathmandu-based manpower agencies acting on behalf of recruiters in countries like Saudi Arabia, Qatar, UAE, Bahrain, Oman, Kuwait, Iraq, Malaysia, Brunei and South Korea(Seddon, Adhikari, and Gurung, 2002).

As a result of this "liberalization of international migration", the share of international migrants opting for these newer destinations increased dramatically between census years 1991 and 2001. Although there was a modest increase in the number of absentees between 1991 and 2001, migrants per 1000 population actually declined from 35 to 32 between 1991 and 2001 (see Figure 1). In terms of the composition however, whereas 90 percent of those absent from home were in India in 1991, the share had dropped to 75 percent in 2001. During the same period, the fraction of migrants that were in the Middle East increased from 1 percent to 12 percent and the fraction of migrants that were in East Asian countries went up from roughly 2 percent to 4 percent. (Figure 2).

Historically, the primary reason for migration out of Nepal has been inadequate round the year employment within the villages. This is also reflected in the stated reasons for migration in the most recent censuses. In 1991, 61 percent of the population absent from home were away seeking employment. This number had increased to 78 percent in 2001 (see Table 1). Given the cultural practice of patrilocal exogamy, it is not surprising that dependency or migration after marriage is the second largest self-reported reason for migration. While 95 percent of all international migrants seeking work were in India in 1991, the number had declined to 75 percent in 2001. In contrast, the Middle East which hosted 1 percent of all employment-seeking international migrants in 1991 was hosting 18 percent in 2001. There was a similar increase for East Asia as well.

There are two distinct aspects of this diversification of international migration destinations in Nepal that are highly important for us in this paper. The first is the large difference in the magnitude of wages that migrants could expect to earn in these newer destinations in comparison to the "traditional" destinations that were mostly urban areas within Nepal and Indian cities. Although wage data are not available, this is somewhat manifest in the average value of transfers made by migrants from these regions. Statistics from the national living standards survey conducted in 1995 show that the average annual transfer made by a migrant to regions outside India was Rs.79,183. The corresponding figures for urban Nepal and India were Rs.15,294 and Rs.10,532 respectively.[7] At the macroeconomic level, the increase in remittance inflows resulting primarily from the diversification of international destinations has been dramatic. Official statistics show that remittance receipts increased from 5 percent of GDP in 1995 to about 14 percent in 2003 (see Figure 3) propelling Nepal to the fifth position in the list of top remittance receiving countries.

The second aspect of the diversification of destinations that is equally salient is that it weakened the importance of traditional social institutions and overall "social capital" on opportunities

[7]This point however needs to be caveated as remittances are just as much a function of the cost of living at the destination and the cost of migration itself as they are a function of the wages. Migrating to cities within Nepal - and to a large extent across the open border to India as well - is not very expensive in comparison to the costs of migrating to these newer international destinations. Acquisition of travel documents, visas as well as up-front facilitation fees payable to manpower agencies responsible for work placements often range between Rs. 55,000-Rs. 80,000 - or roughly the average amount migrants to these regions remit in a year. But since the labor contracts typically run for a 3-5 year period, a typical migrant can expect to recover this investment in roughly a quarter of his time abroad.

to migrate abroad. The importance of social networks in determining the paths of migration is well documented (Munshi, 2003). Geography is clearly an important component of social capital. For example, specific villages in the district of Achham in Nepal are linked to particular localities in Mumbai and the primary destination for migrants from villages in Bajhang district is Bangalore. But linkages based on kinship, caste and ethnicity are equally important. The British Army for example has a formal, well-structured recruitment procedure. Yet they recruit mainly from certain ethnic groups, notably those from the Gurung, Magar, Rai, and Limbu caste groups. The significantly higher up-front costs notwithstanding, the opening up newer destinations did universalize access to international migration to a large extent even for potential migrants living in villages with no prior history of migration.

Overall, the diversification of destinations and the attendant rise in remittance receipts has emerged as a significant phenomenon in rural Nepal. Between 1995 and 2003, real per capita expenditures grew by 40 percent, rural poverty declined by 20 percent. This rapid, remittance-fueled improvement in the living standards of rural households, particularly in the context of a turbulent political and macroeconomic environment and a stagnant agricultural sector provides an interesting background against which the impact of income growth on the use of natural resources like forests can be studied.

2.3 Forestry - Uses and Management

Forests are an important source of livelihood for Nepal's overwhelmingly rural population. Firewood collected from forests is used extensively as the primary fuel for cooking fuel as well as heating. Forests are also an important source of fodder for livestock.

Prior to 1957 all forests in Nepal were privately owned. In 1957 all private forests were nationalized and the government created and empowered a bureaucratic machinery to regulate and manage the use of forest products as well as to stop agricultural encroachment. Interestingly, this change in policy precipitated the very outcome the policy was designed to avert: during the period from 1950 to 1980 about half a million ha. of forests were destroyed. Instead of relinquishing ownership of large tracts of forest land to the government, people rushed to level their forests and record it as agricultural land. Throughout the decades that followed under government ownership, forest degradation continued in the form of illegal logging (particularly in the *Terai* belt in the South bordering India), grazing and other forms of encroachment.

In 1993, the government of Nepal promulgated the Forest Act through which national management of forest was abandoned and all accessible forest land was transferred from central government management to local communities. Forest "user groups" were formed and given complete autonomy over the management and use of forest land designated to each user group for the extraction of firewood, fodder and small timber. Since the implementation of this policy, 1.2 million ha. or roughly 25 percent of the erstwhile national forests have been handed over to more than 14000 local community forest user groups. It is also estimated that 1.6 million households, or roughly 35 percent of the country's population are currently members of these user groups. Although there has been no rigorous study of the impact of this shift in policy except Edmonds (2002), there is a large body of descriptive evidence that suggests that there have been overall improvements in terms of better forest conditions, social mobilization and income generation for rural development and institutional building at the grassroots level.

3 Theory

In order to better understand the channels through which migration and remittances could influence land use decisions at the local level, we develop a general equilibrium model of an isolated village economy. The model closely follows Foster and Rosenzweig (2008) and Foster, Rosenzweig, and Behrman (1997).

Consider a representative household with a fixed endowment of land denoted $\bar{A}$ and an endowment of labor denoted L. Economic activity consists of an agricultural sector, a forestry sector and a local non-traded service sector. The agriculture and forestry sectors use land and labor as inputs while the non-traded service sector is assumed to require only labor as input. The technologies associated with the production of agricultural goods and the forest products are $g(l_g, A_g, \theta)$ and $f(l_f, A_f, \nu)$ respectively where l_g and and l_f signify labor inputs into agriculture and forestry and A_g and A_f are land allocated to the respective sectors. The level of prevalent agricultural technology in the village is captured by parameter θ while ν denotes the agro-climactic conditions (such as altitude, rainfall, temperature, soil quality etc) that determine the endowment of forest in any village.

We make the standard assumptions of diminishing marginal productivity of labor and land in the production of both of these goods. For simplicity, we also assume there is no alternative use of land. Labor is assumed to be fully mobile within villages while all goods produced within the village (agricultural goods, forest products and the service sector goods) are consumed locally. This assumption is reasonable in view of the relative isolation and lack of connectivity of many Nepali villages which makes the transport of bulky forest goods (firewood and fodder) and agricultural produces prohibitively expensive.

We assume a constant returns to scale production function for the non-traded services sector which allows us to write the profit function for this sector as,

$$\pi_s = p_s l_s - w l_s \tag{1}$$

where p_s is the equilibrium price, and l_s the equilibrium labor demand for this sector. Similarly, normalizing the price of agricultural outputs to be 1, the profit function for the forest sector and the agricultural sector can be written as,

$$\pi_f = p_f f(l_f, A_f, \nu) - wl_f - rA_f \tag{2}$$

$$\pi_g = g(l_g, A_g, \theta) - wl_g - rA_g \tag{3}$$

A fraction, ϕ of workers from every household migrates for work to destinations outside the village. Each migrant remits a transfer equivalent to τ relative to the local wage. Thus the budget constraint for the household is,

$$p_s c_s + p_f c_f + c_g = \pi_f + \pi_g + r\bar{A} + (1-\phi)Lw + \phi L\tau w \tag{4}$$

Migration outside the village itself is determined by the human capital of the potential migrant, the returns to his human capital in the destination chosen and the potential income from profits from economic activities and prevailing wages and rental rates within the village. Particularly, if we let the human capital level of the marginal migrant be h and the premium on human capital be ξ, then, under the assumption that migrants relinquish their right over profits accrued through economic activities at home, the following condition has to be true for a migration equilibrium,

$$\xi h = \frac{\pi_g + \pi_f}{(1-\phi)L} + w + \frac{r\bar{A}}{(1-\phi)L} + \frac{\phi\tau w}{1-\phi} \tag{5}$$

Each household has preferences defined over the consumption of the three goods produced within the economy. We also assume complete markets for both inputs and outputs and an efficient allocation of all inputs. These assumptions are similar to the ones made for the "benchmark case" in Foster, Rosenzweig and Behrman (1997) and are consistent for the typical Nepali village where forest commons are managed by community forest user groups and labor allocated to forest extraction is monitorable to a large extent. We consider solutions to the household's utility maximization problem in which optimal consumption of the forest and non-forest goods as well as allocation of household land and labor across the possible productive activities is determined.

The assumption of competitive markets allows the household's problem to be separated into two distinct steps. In the first step, given the prevailing wage and rental rate, the household chooses the optimal allocation of labor across the agriculture, forests and the service sector and the optimal allocation of land between the agriculture and forest sector to maximize total income. In the second step, taking the maximized income as given, the household chooses the level of consumption to maximize utility.

Using this basic setup, a number of implications about the inter-relationships between population, population density, wages, land prices, village income and land area devoted to forests can be derived.

3.1 The Effect of Population on Forests

The income maximization problem can be written formally as,

$$
\begin{aligned}
y = \max_{l_f, l_g, A_f, A_g} \quad & p_f f(l_f, A_f, \nu) + g(l_g, A_g, \theta) + w((1-\phi)L - l_f - l_g - l_s) + \\
& r(\bar{A} - A_f - A_g) + \phi L \tau w
\end{aligned}
$$

In equilibrium, the labor market must clear which implies that the demand for labor in the three sectors must equal the size of the working population that remains in the village.

$$l_f + l_g + l_s = (1-\phi)L \tag{6}$$

The household then also solves the following utility maximization problem.

$$
\begin{aligned}
\max_{c_f, c_g, c_s} \quad & u(c_f, c_g, c_s) \\
\text{subject to} \quad & p_f c_f + c_g + p_s c_s \leq y
\end{aligned}
$$

Under the assumption of non-tradeability of forest products across villages equilibrium in the forest goods market requires that the demand for forest goods equal the supply, or $c_f(p_f, y) = f(l_f, A_f, \nu)$. This, together with the first order conditions for the allocation of land and labor in the income maximization problem and the labor market clearing condition yields reduced form expressions relating forest area as well as other endogenous variables, namely wages, rent and income to the level of agricultural technology, local environment and population density and the remittance rate,

$$z = z(\theta, \nu, \tau, l_x, \bar{A}) \tag{7}$$

where $z = (A_f, w, r, y)$ and l_x is the size of the post-migration household, or equivalently $(1-\phi)L$.

As Foster, Rosenzweig and Behrman (1997) show, the assumption of complete-markets is not essential to arrive at the reduced form relationship between forest land and population density, level of agricultural technology, the level of infrastructure and village endowment of natural environment of the sort captured in (7). Similar relationships can be arrived at for settings in which there are different kinds of market failures in the management of the village commons. What the assumption of complete markets delivers, however, is the non-dependence of forest land allocation on the population density of the village conditional on wages, rents and income. This is a result that is established in Foster, Rosenzweig, and Behrman (1997) for the case without migration and remittances. Here we show it continues to hold for the case in which there is a stock of migrants absent from the village that send transfers.

Taking the stock of migrants as given and under the competitive market assumption, the optimal allocation of land and labor to the forest sector in the income maximization problem is determined by levels at which the marginal revenue product of forest labor is set equal to the wage and the marginal revenue product of the forest land is set equal to the rental rate.

$$p_f \frac{\partial f(l_f, A_f, \nu)}{\partial l_f} = w \tag{8}$$

$$p_f \frac{\partial f(l_f, A_f, \nu)}{\partial A_f} = r \tag{9}$$

These two conditions, together with the condition for equilibrium in the forest-product market, $c_f(p_f, y) = f(l_f, A_f, \nu)$ yield,

$$A_f = A_f(w, r, y, \nu) \tag{10}$$

which is a special case of (7) for A_f in which the household size (l_x) and land allocated per household ($\bar{A}$) is excluded[8]. This result then implies that any potential impact that migration may have on forests is mediated entirely through its effect on local wages, rental rates for land and income. Or in other words, the depopulation effect of migration in itself does not have any direct implication for forests. Remittances on the other hand, directly bolster the incomes of the receiving households and presumably could have an impact on forests. In the subsequent sections, we investigate how allocation of land area to forests responds to changes in income, wages and rental rates and how income, wages and rental rates in turn, respond to changes in population and remittances.

3.2 The Effect of Income, Wages, and Rents on Forests

In this model the effect of an increase in income on forests depends on the elasticity of demand for forest products. If forest-products are normal goods, then it is imaginable that forests will increase with income. However, given forest-products primarily take the form of firewood that is primarily used for cooking and heating purposes, higher incomes can also provide households with the wherewithal to switch to alternative sources of energy making forest-products inferior goods. The extent to which households in Nepali villages switch to alternative non-forest sources of energy or the approximate income threshold at which this switch takes place is difficult to gauge a priori rendering the question of how forests respond to income an entirely empirical issue.

The complete markets assumption that allowed us to obtain (10), however, also allows us to obtain formal expressions for the comparative statics of equilibrium A_f with respect to w and r. Implicit differentiation of (8), (9) and the condition for equilibrium in the forest-product sector yields,

[8]Caveat: Is firewood a public good or private good? If private then this is justified. However, if it is not, then returns to consumption is increasing in forests. This would imply that conditional on wages, rental rates and income, household size must be positively correlated with forests. If this is the case then l_x may not be excluded from this equation. We show later that this is not true.

$$\frac{\partial A_f}{\partial r} = \frac{1}{D}[f_l^2 + p_f f_{lA}\frac{\partial c_f}{\partial p_f} = \frac{f f_l}{l_f D}[\epsilon_{fl} + \frac{f_A}{f_l}\epsilon_{f_A l}\epsilon_{cp}] \tag{11}$$

$$\frac{\partial A_f}{\partial w} = -\frac{1}{D}[f_l f_A + p_f f_{lA}\frac{\partial c_f}{\partial p_f} = -\frac{f f_a}{l_f D}[\epsilon_{fl} + \epsilon_{f_A l}\epsilon_{cp}] \tag{12}$$

where f_l is the marginal product of forest labor, f_A the marginal product of forest land, ϵ_{fl} is the elasticity of the forest product with respect to forest labor, $\epsilon_{f_A l}$ is the elasticity of the marginal product of forest land with respect to forest labor, ϵ_{cp} is the price elasticity of demand for forest goods and

$$D = p_f f_{AA} f_l^2 - f_A f_{Al} f_l - f_{Al}^2 p_f \frac{\partial c_f}{\partial p_f} + f_A^2 f_{ll} + p_f f_{AA} f_{ll}\frac{\partial c_f}{\partial p_f} \tag{13}$$

where $D < 0$ for an equilibrium. From these equations, it is clear that as long as $f_{Al} > 0$ and $\epsilon_{cp} < 0$ - conditions that are easily obtained under standard assumptions for the production function and preferences - the effect of rental rates on equilibrium forest land is unambiguously negative. The effect of wage on forest area, however, is not immediately obvious and depends on the relative magnitudes of the price elasticity of demand for forest goods and the restriction on the elasticity of the marginal product of forest land with respect to labor implied by the production technology. [9]

3.3 Effect of Population and Remittances on Local Wages and Rental Rates

How do the size of the staying population and remittances affect local wages and rental rates? Intuitively, a decrease in the labor to land ratio - or population density - that inevitably results from an increased outflow of working age people from the village should increase wages relative to rents. However, given free movement of people across village borders, such an effect on wage should immediately be offset by an influx of workers from surrounding villages at least in theory. Increase in remittances, on the other hand, is a direct boost to local incomes and would presumably stimulate demand for the service sector goods thereby bolstering the demand for labor in this sector and thus pushing up wages. The effect of the size of the staying population on land rent is similarly positive as the higher the population density, the greater the relative scarcity of land. However, with remittances it is possible that the increase in demand for services within the village will draw labor out of agricultural employment mitigating the pressure on land and thereby lowering rents.

We investigate some of these possibilities more formally within the existing framework in this sub-section. For simplicity, we assume that the preferences are Cobb-Douglas with parameter $\eta < 1$

[9] Foster, Rosenzweig and Behrman (1997) note that for a Cobb-Douglas production function, the sign of the wage effect depends on the sign of $1 + \epsilon_{cp}$. Under this assumption forest area may be expected to be increasing with local wages for settings in which the demand for forest goods is highly inelastic, possibly lower than 1 in absolute value.

as the share of the non-traded service good. We also assume that the agricultural production function is such that $\frac{\partial g(l_g,A_g,\theta)}{\partial l_g} = \frac{(1-\beta)g(l_g,A_g,\theta)}{l_g}$ and $\frac{\partial g(l_g,A_g,\theta)}{\partial A_g} = \frac{\beta g(l_g,A_g,\theta)}{A_g}$. The market clearing condition for the service good then implies that,

$$l_s = \frac{\eta y}{w} \tag{14}$$

which together with the labor market clearing condition (6) implies,

$$w(l_x - l_f - l_g) = \eta y \tag{15}$$

Manipulating the expression for y, isolating l_g, plugging it into the first order conditions for income maximization in the agricultural sector and implicitly differentiating we arrive at a number of expressions for the comparative statics for w and r with respect to τ and l_x.

$$\frac{dw}{d\tau} = -\frac{\partial^2 g(l_g, A_g, \theta)}{\partial A_g^2} . \frac{\phi(1-\beta)\eta l_x}{(1-\beta+\eta\beta)(1-\phi)} > 0 \tag{16}$$

In this above expression, the diminishing marginal productivity of land guarantees that the effect of remittances on wages is positive. Conditional on the size of the population that remains in the village, higher remittances cause an increase in income level which in turn cause an increase in demand for the local service goods. This drives up the demand for labor in this sector and also the wage. We can also ask how the size of the staying population itself influences wages.

$$\frac{dw}{d_x} = -\frac{\partial^2 g(l_g, A_g, \theta)}{\partial A_g^2} . \frac{(1-\eta\tau)(\beta-1)}{(1-\beta+\eta\beta)} \tag{17}$$

It is evident from the above expression that if $\tau = 0$, or if there are no transfers, then the effect of the staying population on wages is unambiguously negative. In the presence of remittances however, the sign on the expression depends critically on the relative size of τ and $1/\eta$. In fact the wage effect of the staying population will continue to remain negative as long as $\tau < 1/\eta$.[10] However, if $\tau > 1/\eta$, then the dampening effect on wages of a larger potential workforce will be more than offset by the positive effect of remittances on labor demand in the services sector.

Similarly, the effect of population size and remittances on land rents can be analyzed using formal expressions derived out of this framework.

$$\frac{dr}{d\tau} = -\frac{\partial^2 g(l_g, A_g, \theta)}{\partial A_g \partial l_g} . \frac{\phi\eta l_x}{(1-\phi)(1-\eta) < 0} \tag{18}$$

Since the cross partial derivative of the agricultural production function with respect to agricultural

[10]Note that it is not necessary that τ be less than 1 in the way we have specified this model. Whereas it may well be true that $\tau < 1$ in some circumstances - in which case the derivative will remain non-positive irrespective of the relative size of remittances - in the sample of village that we have, remittances are higher than local wages by a factor that is much higher than 1.

labor and land can be assumed to be positive, the effect of remittances on land rents is unambiguously negative conditional on the population that remains within the village. This result is a bit surprising at first glance and is perhaps driven by our assumption that the production of non-tradeable services within the village is an economic activity that doesn't require land as an input. While this assumption itself is founded on the observation that in most isolated Nepali villages, economic activities such as tailoring, shoe-making, metal works, tea-shops etc. typically take place within the ambit of existing homes, it does not necessarily have to be so. Remittances could imaginably alter the economic landscape drastically by increasing the extent of the market and inducing those engaged in these activities to want to expand beyond the immediate realms in which they are traditionally organized. However, here we ignore such a possibility.

Conditional on the level of remittances, the following expression summarizes the relationship between land rental rates and village population.

$$\frac{dr}{dl_x} = \frac{\partial^2 g(l_g, A_g, \theta)}{\partial A_g \partial l_g} . \frac{(1-\phi)(1-\eta) - \tau\phi\eta}{(1-\phi)(1-\eta)} \tag{19}$$

It is clear that if $\tau = 0$ then the effect of population on land rental rate is positive. However, as τ takes on positive values this may not continue to hold. Particularly, the effect of population on land rental rates will become negative as soon as

$$\tau > \frac{(1-\phi)(1-\eta)}{\phi\eta}$$

Much of what we have derived above relies on the argument that remittances increase demand for non-tradeable services and in some way draw labor out of agriculture into these non-farm sectors. It is natural to ask what prediction, if any, the framework we have used here has on equilibrium employment in the agricultural sector. Implicitly differentiating the expression for l_g that we have obtained before, it can be shown that,

$$\frac{dl_g}{d\tau} = \frac{\phi\eta l_x}{(1-\phi)(\eta-1)} < 0 \tag{20}$$

Finally, although the framework we have developed here has generated a number of predictions on how population and remittances interact with endogenous variables such as wages, rental rates and income within the village, we have not been able to predict theoretically what the overall impact of remittances will be on forests. Depopulation due to migration reduces land rents and that is reinforced by the remittances that migrants send back. We showed that land rents should have a negative effect on forests which implies that we can expect remittances to have a net positive effect on forests. But the picture is not so clear for income and wages. The effect of a remittance induced boost to income on forests is theoretically ambiguous. Similarly, the lowering of the size of the population due to migration as well as the remittances sent back by migrants has a positive effect of wages. However, the impact of wages on land allocated to forests is indeterminate. Thus, the discussion here serves to highlight the fact that there are various channels through which migration and remittances may affect forests but some of their individual effects as well as their joint impact on forests are not clear theoretically.

4 Data

We combine satellite data for land use and land cover change together with two rounds of nationally representative household surveys to create a unique village-level panel dataset spanning 1995-2004. In this section we describe these data in detail.

4.1 Satellite Data

We use satellite imagery from the Multispectral Scanner (MSS), the Thematic Mapper (TM), and the Enhanced Thematic Mapper (ETM+) for various years to derive a measure of land use and land cover change. Ideally, we would have liked the land use data to coincide perfectly with our base years of interest, particularly 1995 and 2003. However, this was not possible due to unavailability of the satellite data for particular years and due to excessive cloud cover. Additionally, given the particular vegetation phonology in Nepal, most of the vegetation contains a minimum amount of leaf moisture during the months of October and February rendering scenes captured during these months best suited for measurement and analysis of land cover. This put a further restriction on the images we could use for our analysis. In the end, we were left with MSS images for 1975 and 1976, TM for 1991, 1992, and 1996 and ETM+ for 2000, and 2001. In this paper, we obtain land use data for the years 1975, 1995 and 2003 using TM and ETM+ imageries respectively.

Shadows in the mountainous areas especially above 2,400m elevation, and mostly those with aspects facing east posed a significant challenge. We tried correcting for these shadows using ATCOR 3 in Erdas Imagine 9.3, but did not have much success. Additionally, there were cloud covers in MSS (1975-1976) images and TM (1991, 1992, 1996) images. All shaded and shadow areas were manually digitized from the panchromatic eighth bands of 2000 and 2001 ETM+ images and the resultant polygons were used to represent the shaded and cloud cover areal extents. Generally, these shaded areas occurred in the higher elevation ranges in extremely hilly and mountainous terrain. Further, we overlaid the polygons digitized from the panchromatic image of 2000 and 2001 on all other images under the assumption that if mature forest was present in 2000-2001 panchromatic images, forests were present in all the earlier images because Nepal lies between 26-30 N latitudes and vegetation can maintain maturity between 20-25 years.

All images are classified individually because images of different dates could have specific spectral properties that complicate analytical comparisons. Theoretically, calibration should standardize all the images to the atmospheric radiance values; thus, merging the radiometrically-calibrated images should not produce any anomalous results in classification. However, errors were observed when a merged image was classified for entire Nepal. Therefore, we classified all images separately according to a guided classification scheme using Erdas Imagine 9.3, using hybrid methods combining unsupervised and supervised classification techniques. Initially, an unsupervised Iterative Self-Organizing Data Analysis Technique (ISODATA) routine was run on Landsat bands 1, 2, 3 and 4 of MSS and 15 and 7 of TM and ETM+ to cluster individual images into 25 classes. These classes were visually analyzed using flicker to assign specific class names. Spectral profile curves were used to examine the objects reflection by electromagnetic radiations. Pixels that correspond to clouds, land surfaces under cloud shadows, and shadows caused by the terrain (about 5-7% of the image area) were then removed from the images. The remaining portions of the image areas were then clustered into 20 classes by a second ISODATA routine. Clusters were labeled to represent specific land-cover classes, and signatures of the labeled clusters of each image were used as the basis for a supervised maximum likelihood classification of the individual images. Class names were assigned to various land use and cover classes.

Identification of roads on the classified images was reconfirmed by overlaying the vector layers available from the national Department of Survey. After the proper identification of roads and rivers, they were extracted from the images as separate raster files.[11] We separated these roads and rivers into layers, and merged these classes with the bare-land as bare-land and roads showed overlapping values (1550 - 1680, 1700) in the Transformed Divergence Index (TDI). A TDI calculates standard divergences between pairs of classes, and it is used to measure the separability between land use classes, such as mature forest, secondary growth, and farmlands. In satellite image classification, TDI is needed to assess the quality of the statistics prior to image classification. After careful analysis of the TDI, we ended up using eight land use classes: mature forests, secondary growth, degraded forest land, farmland, barren land, water, cloud, and no data. We classified cloud in the images if clouds were seen in all the images. However, if the 2000 and 2001 panchromatic images showed forest in a certain area and that area was under cloud cover in rest of the images, we used a mask to categorize such areas under forest for all the images.

Ideally, we would have liked to validate satellite data by using information collected on location. However, the scope at which such a ground-truthing exercise would have to be conducted would not only be prohibitively expensive but also time consuming. To a large extent, we have verified our land use and cover classes using a priori knowledge of a number of forest officers who have worked in various regions of Nepal for the past 25-30 years. Some areas that were not confirmed in the images prior to 2000 and 2001 from this a priori knowledge were cross-checked using the aerial photos and topographic maps. We also cross validated the ETM+ 2000 and 2001 classified images using the IKONOS (1m x 1m) images taken in 2003. These cross-validations were only conducted on selected

[11] Road lengths were calculated using this procedure on the classified images.

complex mosaics of land use and land cover areas, forests and urban fringes where the boundaries between forest and non-forest areas were not clear.

We also conducted accuracy assessment for each individual image using the maximum likelihood method. In order to assess classification accuracy, we generated contingency matrices and the corresponding Kappa statistics. Kappa values quantify how much better a particular classification is in comparison to a random classification, making it possible to calculate a confidence interval for comparing two or more classifications. In addition we also assess procedural accuracy to measure the percentage of pixels of a given land cover type that is correctly classified. User accuracy is generated to measure the commission errors useful for examining whether or not a pixel classified into a given class actually represents that class on the ground. We used a subjective scale in accuracy assessment and found Kappa values greater than 80 percent for all the images. [12]

After checking their accuracies, all individual images are subset to the actual classified areas and mosaics made to the base images to cover the entire study area. These mosaic images are re-sampled to 60m x 60m to bring them to the same resolution. For example, all MSS images are upgraded to 60m x 60m from 80m x 80m, while the TM and ETM+ images are degraded to 60m x 60m from 28.5m x 28.5 m. The decision to resample the images into 60m x 60m was made only after ensuring that no significant information would be lost during the exercise. After these re-samplings, the land use and land cover classes were generated by overlaying the village development committee (VDC)[13] polygons. All road lengths were calculated in meters for each individual VDC. These road lengths were calculated by using the Spatial Analyst Zonal method.

4.2 Household Survey Data

The primary economic data we use come from a repeated cross-section of the Nepal Living Standards Survey (NLSS) which is a nationally-representative survey of households and communities conducted by the Nepal Central Bureau of Statistics with assistance from the World Bank. The first round of the household survey, NLSS-I covered 3,373 households in 274 wards sampled from four geographic and ecological strata: Mountains, Urban Hills, Rural Hills and Terai. Between 12 and 16 households were interviewed in each ward between June 1995 and May 1996.

The NLSS-II, on the other hand, was conducted between April 2003 and April 2004 and its cross-sectional sample was constructed using a stratified design similar to NLSS-I. It covered 73 districts of Nepal (excluding the Rasuwa and Mustang districts) and enumerated 3912 households in 326 wards. Both rounds collected detailed information on household consumption of a wide range of food and non-food items, data on socio-demographic composition of the interviewed households, labor status of household members, health and educational status, information on various sources

[12]Kappa values in this range are considered 'excellent'.(Monserud and Leemans (1992))

[13]Village Development Committee is administrative name for villages in Nepal

of household income including wages. Both rounds also have a detailed module on remittances received by households during the month of the survey as well as the age and migration destination of the senders. The surveys also had a community component in which various community level characteristics were recorded.

For our analysis in this paper, we focus primarily on rural wards. This is for two reasons. First, the dependence of households on forests is more pronounced in villages than in urban areas. Second, roughly 73 percent of remittance receiving households resided in rural areas in 1995. This number had gone up to 75 percent in 2004. A natural level of geographical aggregation for us would have been the level of the district. However, aggregating at such a high level would come at a cost, particularly because it is difficult to regard a district as one, closed, isolated economic unit. Instead, what we do is geocode sampled villages and manually inspect their geographic location. If a pair of villages, within a district, sampled in two different survey years is separated in space by up to two other villages, we consider this cluster of villages to be one. Using this method, we end up aggregating at a much smaller level and ensuring that the villages in a cluster are part of the same "local market" and we obtain a panel of 122 village clusters that form the unit of analysis in our empirical work.

Mean characteristics of these village clusters are presented in Table 2. Total forest area per household declined from 6.6 hectares from 1995/96 to 5.0 in 2003/04. In terms of forests share of total village area, the fraction was 52 percent in 1995/96 and 44 percent in 2003/04. Real per capita remittances increased from Rs. 455.4 to Rs. 1012.5 during this period and was accompanied by an increase in mean daily wages from Rs. 22.1 to Rs. 44.3. During this period, there was a decline in the average price of land and a significant increase in the real incomes of rural households, particularly the non-poor households. Nevertheless, incidence of poverty declined in the sampled villages from 49 percent in 2003/04 to 35 percent in 2003/04. The fraction of sampled villages with some form of community forestry user groups increased from 37 percent to 59 percent during this period. Note also that while in general village population increased in our sample villages, the population of males in the age group 15-29 actually declined.

In Table 3, we present statistics on the use of forest resources in these rural villages. Firewood is used as a primary source of cooking and heating fuel in rural Nepal. In our sample, the mean fraction of households that used firewood as primary fuel was 93 percent in 1995/96 and had gone up to 96 percent in 2003/04. Of the households that use firewood as their primary fuel, a significant majority appear to collect their own firewood. Roughly 62 percent of firewood that was collected in 1995/96 was collected from government forests. In 2003/04, however, this number had declined to 39 percent as the tracts of government land were progressively handed over to local communities for management and the fraction of firewood collected from community forests rose from 12 percent to 34 percent. The other major use of forests is extraction of fodder for livestock. The pattern of forest use for fodder is similar to that of firewood.

5 Estimation and Results

5.1 Empirical Strategy

We estimate log-linear approximations to equation (7) which relates variations in equilibrium forest land, household income, wages and land prices in villages to the population density, remittance income, the level of connectivity of villages as measured by the road density. These reduced form relationships provide us with a quantitative estimates of the effect of remittances and population on the endogenous variables and by doing so allow us to test the implications of the model we have developed. If remittances do have an effect on forests, we want to test the channels through which this effect may work. In order to get at this, we estimate log-linear approximations of the equilibrium equation (8). This estimation will also provide us with a test of whether forests are managed in a first-best efficient manner in Nepal. [14]

The reduced form regressions we run are as follows,

$$z_t = \beta_{zt} + \beta_{z\theta}\theta + \beta_{z\tau}\tau_t + \beta_{z\gamma}\gamma_t + \beta_{z\kappa}\kappa_t + \beta_{z\nu}\nu + \epsilon_{zt} \tag{21}$$

where as before $z_t = \{A_{ft}, r_t, w_t, y_t\}$. A_{ft} represents village forest area measured by forest area per household as well as forest as a share of total land area in the village; r_t is a measure of the average price of land in the village; w_t is the average male agricultural wage rate and y_t represents household income in the village. τ_t is the average per capita remittance in the village while γ_t is a measure of the population density and is simply the ratio of the village population to total village land area. κ_t is the village connectivity variable and is measured in our data by road density.
Similarly, the forest equilibrium regression we run is as follows,

$$A_{ft} = \alpha_t + \alpha_y y_t + \alpha_w w_t + \alpha_r r_t + \alpha_\gamma \gamma_t + \alpha_\kappa \kappa_t + \alpha_\nu \nu + \psi_t \tag{22}$$

The coefficient on γ would then be a test of first-best efficient management of forests as $\gamma \neq 0$ would imply that independent of its effect on wages, land prices and household income, population density would have some relationship on local forests.

Estimation of (21) and (22) by ordinary least squares would yield biased estimates. This is because the unobservable village characteristics in both equations are most likely correlated with the regressors. In (21) for example, it is imaginable that villages situated in the hills and mountains - by virtue of their difficult terrain - have low road densities, low population densities and also low wages, land rents and household income. Failure to control for this aspect would lead us to

[14] This follows Foster, Rosenzweig and Behrman (1997) closely. FRB conducted a similar test for Indian villages during the technical change due to the Green Revolution. They found that village population had an significant effect on forests even after conditioning for local wages, rents and income. This was rejection of the first-best efficient management of forests.

incorrectly attribute a much larger variation in the dependent variables to the variables we include as regressors than is true. Similarly, in (22), it is possible that the unobservable climate, soil and other topographical conditions that render a village unsuitable for forest growth also make it unsuitable for agriculture which would in turn limit human settlement and give rise to low population densities. On the other hand, villages endowed with a more benign geography in the form of fertile soil, adequate rainfall and easier access to local markets are likely to have higher population densities, higher levels of agricultural technology and thus, ceteris paribus, higher incomes and higher land prices.

In order to control for these time invariant village characteristics that could bias our estimates, we exploit the fact that we have panel data which allow us to observe villages at two points in time. Particularly, by differencing both equations across the two time periods, we can sweep out the fixed effects and end up with,

$$Dz_t = \beta_{zt} + D\beta_{z\tau} D\tau_t + \beta_{z\gamma} D\gamma_t + \beta_{z\kappa} D\kappa_t + D\epsilon_{zt} \tag{23}$$

and

$$DA_{ft} = D\alpha_t + \alpha_y Dy_t + \alpha_w Dw_t + \alpha_r Dr_t + \alpha_\gamma D\gamma_t + \alpha_\kappa D\kappa_t + D\psi_t \tag{24}$$

where D is the difference operator.

Although the fixed-effect specification eliminates time-invariant characteristics of villages that may bias our coefficients, it is still imaginable that the *change* in village unobservables between the years of our analysis are correlated with the change in the regressors during the same period. For example in (23), if we interpret $D\epsilon_{zt}$ as an adverse weather shock then this shock could be negatively correlated with village population as households may send out more migrants. By the same token, households that already have migrants working abroad may receive a larger remittance in response to this shock. This is in fact one of the major endogeneities that we have to contend with even after controlling for fixed effects. Similarly a positive weather shock in the first period could independently increase forest area while at the same time increasing village income by triggering adoption of better agricultural technology.

In order to control for contemporaneous effects of weather shocks, we include a village level rainfall variable in all of our specifications. Additionally, to account for the possibility that these first period shocks could have an effect on future realizations of the control variables (good rainfall in the first period leading to better agricultural technology, higher fertility and higher incomes in the subsequent periods), we need instruments that are correlated with the change in income, wages, land prices and population, but are uncorrelated with the shocks. Village population density in 1991 and road density in 1975 provide us with a valid set of instruments for the equilibrium equation.[15] For the reduced form equation, we use population density in 1991, road density in 1975 and an artificial

[15]The equilibrium equation is under-identified right now as I don't have enough pre-period variables I can use as instruments.

"synthetic remittance" variable as instruments for the change in population, change in road density and change in remittances between 1995-2004.

What is the "synthetic remittance" variable? Our goal is to identify the effect of remittances on forests. However, as we just discussed, shocks that directly affect forests could well be correlated with remittances, confounding any estimate we may obtain through a fixed effects estimation. In order to deal with this issue, we exploit the plausibly exogenous diversification of migrant destinations at the village level to come up with a measure of the change in the per capita potential remittances between the census years 1991 and 2001. We use this change in potential remittances - a synthetic variable - as an instrument for the change in actual remittances between 1995 and 2004.

Let $\tilde{N_{ij}}$ and N_{ij} be the number of migrants from village i in destination j in 1991 and 2001 respectively. Let r_j be time-invariant average remittance from destination j. Then the total change in per capita remittances between 1991 and 2001 can be written as,

$$\sum_j \frac{N_{ij}}{P_i}.r_j - \sum_j \frac{\tilde{N_{ij}}}{\tilde{P_i}}.r_j \tag{25}$$

where P_i and $\tilde{P_i}$ represent population of village i in years 2001 and 1991 respectively. This can be re-written as,

$$\delta_i \sum_j \gamma_{ij} \times r_j - \tilde{\delta_i} \sum_j \tilde{\gamma_{ij}} \times r_j \tag{26}$$

where δ_i and $\tilde{\delta_i}$ are the migration rates for village i in year 2001 and 1991 respectively and γ_{ij} and $\tilde{\gamma_{ij}}$ are the fraction of migrants in village i that are in destination j in 2001 and 1991 respectively. Note that the change in remittances between the two periods is driven by the change in the aggregate village migration rate as well as the change in the composition of migrants. In the synthetic remittance variable we construct, we allow the change to be driven solely by the change in the composition of migrant destinations. Thus the variable we construct and use as instrument is,

$$SR_i = \tilde{\delta_i} \sum_j \gamma_{ij} \times r_j - \tilde{\delta_i} \sum_j \tilde{\gamma_{ij}} \times r_j \tag{27}$$

The key identifying assumption here is that environmental shocks can be correlated with migration but conditional on the level of migration, they are uncorrelated with the destination that is chosen by the migrant. For instance, an accidental forest-fire that razes your local forests and damages the source of your livelihood may make you more likely to leave your village and seek opportunities elsewhere but conditional on your decision to leave, it will have no influence over whether you end up migrating to India or Malaysia or any other destination. To what extent is this argument valid? After all, it is completely imaginable that the sharper the negative environmental shock experienced by the village, the more likely it is for potential migrants to actively seek out destinations that are better paying. However, the cost of migration drives a wedge between the destination a migrant seeks to relocate to and a destination he may have to settle for. In addition, these costs vary both at the village level through measures of, among others, ease of access to the nearest urban center or the capital city and at the individual level by things like educational attainment. As long as the attributes that make an individual more or less likely to migrate to a higher cost-higher return country are uncorrelated with the likelihood of occurrence of environmental shocks or natural disasters, this identification should hold.

5.2 Estimation

We present the first-stage relationship between this constructed per capita remittance variable and the observed per capita remittance in Table 4. We test this relationship under a number of specifications controlling progressively for all of the exogenous village level characteristics. Overall, there appears to be strong positive correlation between the two as one would expect. In all specifications, we cannot reject the hypothesis that the exogenous variables jointly explain significant degree of variation in remittances. The F-statistic ranges from 9.07 to 17.6. Note that in addition to the size of the staying population, we also control for the size of the young population in the village and separately for males of this particular age group. The idea is that individuals - particularly males - of ages between 15 and 29 are most likely to be work related migrants. An increase in openness and opportunity to migrate is likely to affect the size of this particular age group the most. The size of this age group that remains within a village is also likely to have the strongest implications for wages and may have differential proclivities toward use of forest resources.

In Table 5 we present our results from the reduced form regression results for forests. We consider two measures of forests: forest area per household and forests share of total village land area. We instrument remittances, population and road density variables with synthetic remittance, population in 1991 and road density in 1975 respectively. We control for time trend and the presence of community forestry user groups in all specifications and present results from the OLS, FE and FE-IV specifications for both measures of forest land.

Remittances and population appear to have a strong negative association with forests per household in the pooled OLS specification. However, when we control for fixed effects, remittance becomes insignificant while population continues to remain significant and has a negative sign. Controlling for the endogeneities, the FE-IV specification shows a positive and significant relationship between remittances and forests. That the OLS underestimates the effect of remittances on forests confirms the possibility that unobservable shocks that affect forests negatively must have an opposite effect of remittances. Similar pattern is observed for forest share of total land as well. The OLS coefficient starts out negative, becomes less negative controlling for fixed effects and switches over to become positive and significant in the FE-IV specification. Population continues to appear with a negative sign but is imprecisely measured. The same is true for the share of 15-29 age group in the population for the fixed effects and FE-IV specifications. Road density has a negative sign across all specifications although it is never significant. Presence of community forestry user groups has a significantly positive association with forests only in the OLS specification. In the FE-IV specification it actually appears with a negative sign indicating the possibility that the handover of forests to communities for management may actually be taking place in villages with deteriorating forest conditions.

In order to investigate the possible channels through which remittances may affect forests, we run reduced form regressions of the key endogenous variables - wages, land prices and household income. We present the results in Table 7. From the theoretical framework we developed, we should expect remittances to have a positive effect on household income and an unambiguously negative effect on land prices. The effect on local wage is theoretically ambiguous. From the FE-IV specification in Table 7, we find the data to be broadly consistent with the predictions of theory. Land price appears with a significant negative sign while household income has a strong positive correlation with remittances. Wages seem to have a positive and significant relationship with remittances as well. The size of the village population has a positive effect on land price and household income but the relationship is not significant for the FE-IV specification. The size of the staying population as well as the share of this population that is young seem to have a significant negative association with wages which is consistent with what we would expect from theory.

Finally, we estimate an equilibrium regression for forests in order to test the strength of the feedback from the endogenous variables on equilibrium forest area. An additional benefit of this step is also that it allows us to test the assumption of first-best management of forests. The prediction from theory is that if forests are first-best efficiently managed then net of its effect on local wages, rents and income, the size of the population should have no effect on forests. The population variable appears significant in the OLS specification for forest area per household measure, but as we control for village fixed effects, it becomes indistinguishable from 0. On the other hand, the only variable that remains statistically significant after controlling for the possible endogeneities is the household income variable, which suggests that the only channel through which remittances have an effect on forests is through the household income. Though significant only in the OLS specification, the coefficient on land price is consistently negative confirming the prediction we had from theory. Finally, given the results from our reduced form regressions in Table 6 we would expect the depopulation of the youngest age group due to migration and the consequent inflow of remittances both to raise wages. However, from the equilibrium regressions it appears that net of their contributions to raising incomes, wages have no independent effect on either measure of forest area.

5.3 Robustness

Both rounds of the living standards survey contained a community questionnaire that collected information from village representatives on the subjective perception of whether overall forest area within the villages increased or decreased compared to five years ago. Information was also collected on whether the time to collect firewood from forests increased or decreased compared to five years ago. If forests were depleted faster than they were replenished through afforestation or regrowth, then given the reliance of these rural households on firewood as a primary source of energy, it is imaginable that the time to collect firewood would increase. In order to test the effect of remittances on forests that we found through our satellite data, we run a probit model with a binary variable indicating the increase and decrease of forest area as well as time to collect firewood. We restrict attention to responses in 2004 and run these specifications using 2004 levels as well as the change from 1995 to 2004 in the continuous independent variables. The marginal effects are reported in Table 8.

Controlling for the change in population, rainfall, road density and the presence or absence of community forestry user groups in the villages, we find that the remittances have a significant negative effect on the probability of forested area declining in villages. Similarly, point estimates also seem to indicate that remittances are positively associated with forest area increasing and time to collect firewood decreasing compared to five years ago. This gives us additional corroborative evidence on our earlier finding that rural economic growth caused by remittances may have ended up having a positive effect on forests.

An additional dimension that needs to be addressed given the time period we are looking at in Nepal is the possible biases due to conflict. Nepal experienced a Maoist insurgency that escalated into a low-level civil war between 1996 and 2004. A total of 13,000 people lost their lives and many more were displaced. To the extent that the intensity of this conflict was correlated with migration rates, the attendant inflow of remittances and forest area, failure to account for this may bias our results. In particular, we may be attributing to remittances what could actually be driven by conflict. There have been numerous efforts to study the proximate causes of conflict in Nepal and the overt political mobilization notwithstanding, there seems to be a general agreement that intensity was the highest in poorer, underserved areas (see Do and Iyer (2010) and Murshed and Gates (2005) for example).

However, in order for the unobserved conflict variable to be driving our results on remittances, it would have to be the case that it is either positively or negatively correlated with both remittances and forests; it cannot be positively correlated with one and negatively with the other. If it were, then the omitted conflict variable would actually be biasing our finding for remittance downwards. As it happens, this is something we can test for explicitly using a crude, albeit reasonably acceptable measure of conflict at the district level. Conflict in Nepal was manifest in three main forms: deaths (targeted killings as well as those killed in crossfires); abductions and 'disappearances', and; displacements from home villages. A normalized weighted average of the frequency of each of these incidents can serve as an index of conflict intensity. We present the correlation between remittances and forests on this measure of conflict in Table 9. The results show that conditional on the size of the staying population and the share of them that are young, conflict intensity is negatively correlated with remittance inflows (though not statistically significant). On the other hand, forest area is postively and significantly associated with conflict intensity. We interpret this as suggestive evidence that the correlation between conflict and remittances on the one hand and conflict and forests on the other, may be in the opposite direction. This result gives us reasonable confidence in concluding that even if conflict were to be an important omitted variable, it is probably biasing what we find for remittances results downward.

6 Conclusion

In this paper we investigated the demographic and economic consequences of migration on Nepal's Himalayan forests. Preliminary evidence that we have presented suggests that rural economic growth caused by large influx of remittances into rural Nepal may have had a positive effect on forests. Given the geographical and economic isolation of the typical Nepali village and the attendant need to rely solely on local forests for all consumption of forest-products, the result we find is consistent with Foster and Rosenzweig (2003) finding of a broadly positive causal relationship between economic growth and forests for Indian villages.

Remittance-driven economic growth is necessarily accompanied by large changes in the working age population within the village as remittances are not possible without migrant workers. Therefore, it is important to decouple the effect of this depopulation from the effect of remittances on forests as often they may be opposite forces. In addition, how changes in the demand for forest products influence or are influenced by the supply in a rural agricultural setting is closely determined by the natural resource management regime in place. Dealing with this issue carefully, we derive a testable prediction for the identification of whether forests in Nepal are first-best efficiently managed. Empirically, we find support for efficient management as net of its effect on income, wages and land prices, the size of the staying population appears not to have an independent effect on forests in Nepal.

We also examined the channels through which remittances may affect forests. Paying particular attention to changes in factor prices that can be expected when hitherto closed local economies open up we examine the possible effect these prices can have on forests both theoretically and empirically. We find that remittances caused an increase in wages, an increase in income but a decrease in land prices. Considered together however, we find that the relationship between forests and remittances is driven largely through the income channel indicating that the demand for amenities provided for by forests in the rural Nepali setting may have been more important than factor prices in influencing land use changes in Nepal for the period we study.

Overall our results shed some light on how greater linkages to the global economy through an increase in the opportunity to migrate internationally alter the economic landscape in rural sending communities. Greater factor mobility - particularly of labor - has given rural households an opportunity to see rapid growth in income. But in the context of rejuvenated efforts to increase agricultural producitivty to deal with the perils of climate change and food shortages in the future, the expedited exodus of the most productive work force out of their villages and possibly out of agriculture raises concerns of permanent dislocation in the agricultural sector. How agricultural activities and local resource management practices evolve in response to rapid rural off-farm economic growth are interesting avenues for future research.

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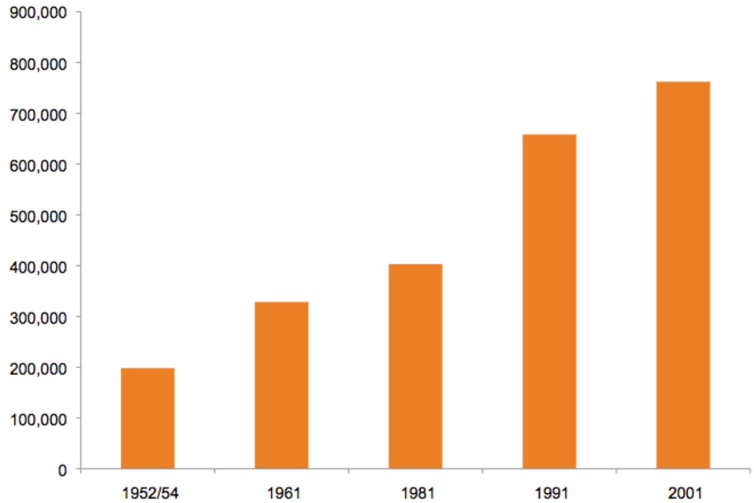
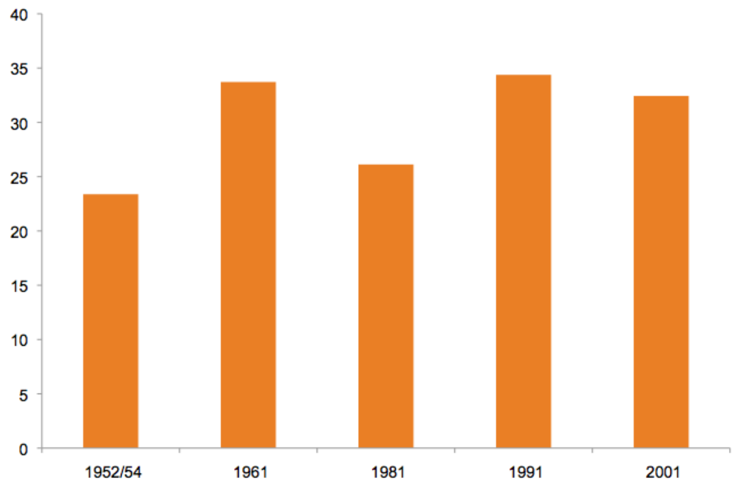


(a) Total population absent from households



(b) Migration rate (per '000 population)

Figure 1: Migration Trends, 1950-2001

Source: Various population census

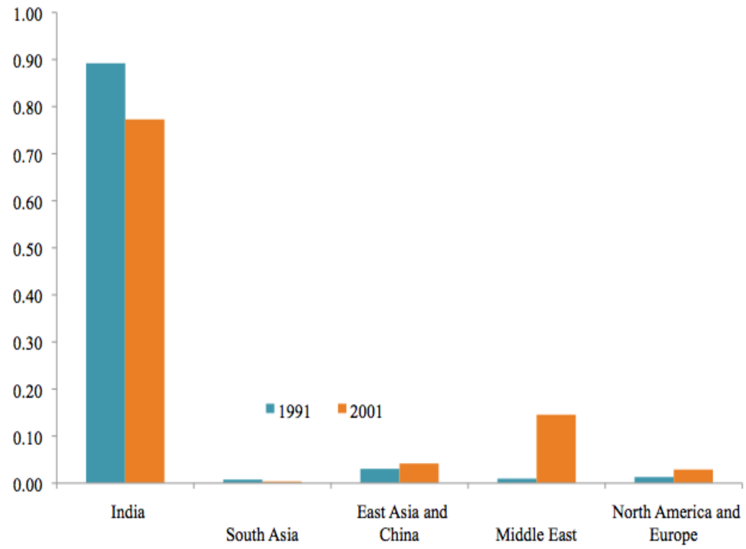
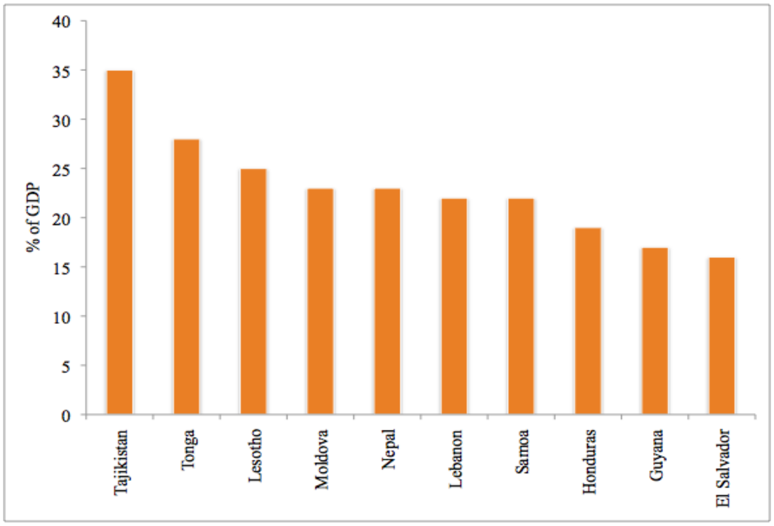
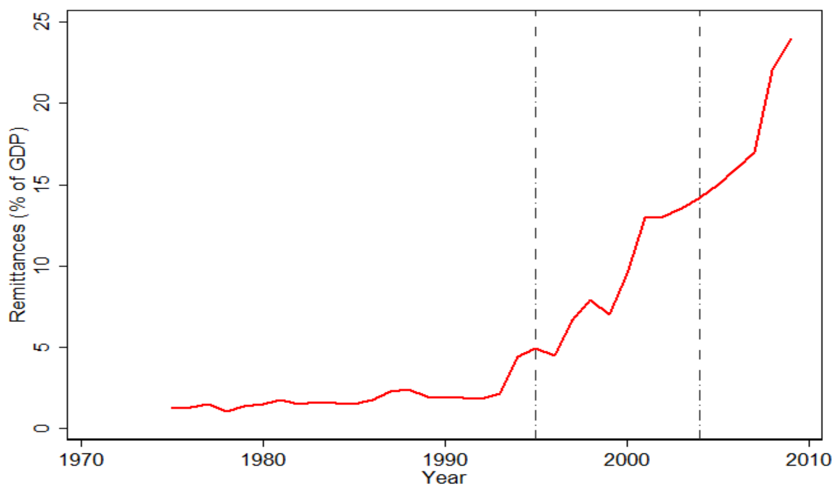


Figure 2: Fraction of International Migrants by Major Destinations, 1991 and 2001



(a) Countries with the highest flow of remittances relative to GDP.

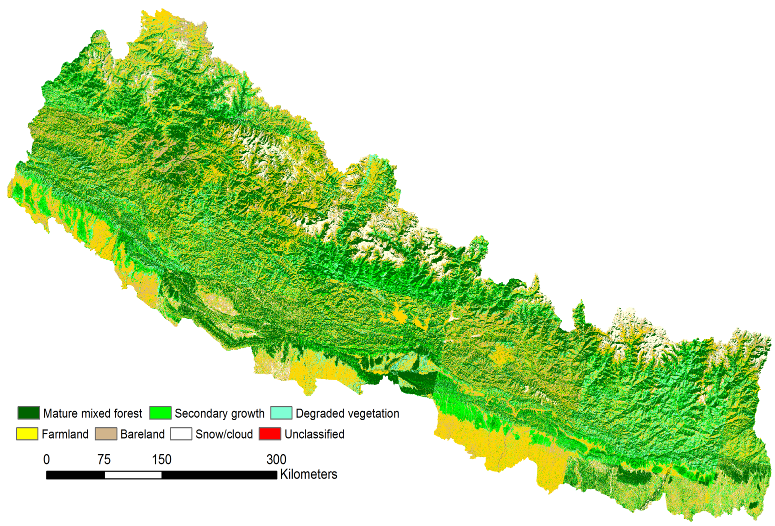


(b) Remittance trends in Nepal, official statistics

Figure 3: Remittance Trends

Source: International remittances figures from the Migration and Remittances Factbook 2011, World Bank. Remittances numbers from Nepal drawn from various statistical bulletins of Nepal Rastra Bank and various Economic Surveys of the Ministry of Finance.

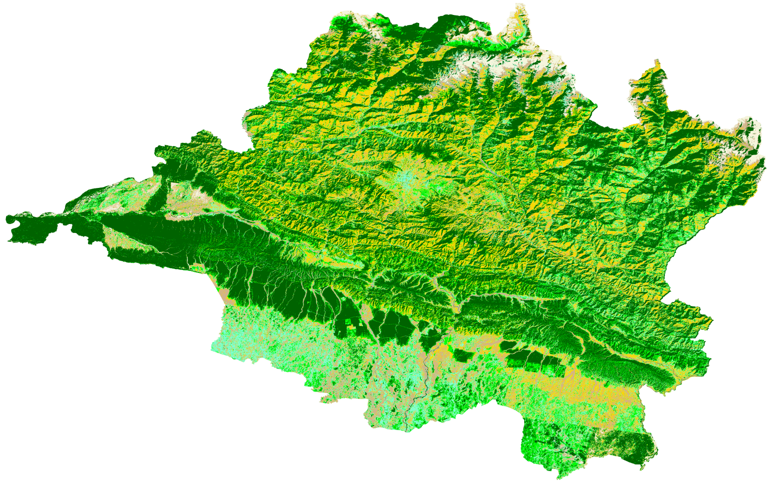
(a) 1996



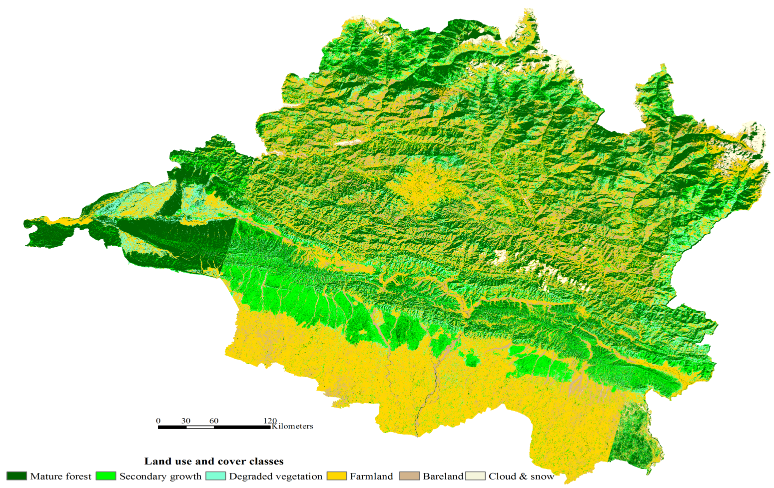
(b) 2003

Figure 4: Land Use and Land Cover Change in Nepal, 1995-2003

Note: The 1996 image is composed of various satellite images obtained from Thematic Mapper for the period between 1991 and 1996. The 2003 image is composed of using various images obtained from the Enhanced Thematic Mapper (ETM+) for the period 2000-2003. All images used were obtained for the period between October to February which is usually the dry season in Nepal.



(a) 1996



(b) 2003

Figure 5: Land Use and Land Cover Change in the Central Development Region of Nepal, 1995-2003

Note: The 1996 image is composed of various satellite images obtained from Thematic Mapper for the period between 1991 and 1996. The 2003 image is composed of using various images obtained from the Enhanced Thematic Mapper (ETM+) for the period 2000-2003. All images used were obtained for the period between October to February which is usually the dry season in Nepal.

Table 1: Breakdown of International Migrants by primary destinations and reasons for migration

Panel A: By reason for migration for every destination						
1991						
	India	South Asia	East Asia	Middle East	North America and Europe	Total
Agriculture	0.05	0.00	0.00	0.00	0.00	0.04
Trade	0.02	0.05	0.05	0.02	0.02	0.02
Employment	0.68	0.46	0.54	0.84	0.38	0.66
Education	0.02	0.09	0.05	0.01	0.23	0.02
Dependency	0.18	0.26	0.22	0.10	0.28	0.19
Others	0.06	0.14	0.15	0.03	0.09	0.06
2001						
	India	South Asia	East Asia	Middle East	North America and Europe	Total
Agriculture	0.01	0.00	0.00	0.00	0.00	0.01
Trade	0.02	0.06	0.01	0.00	0.02	0.02
Employment	0.76	0.47	0.80	0.94	0.54	0.78
Education	0.04	0.32	0.10	0.01	0.31	0.05
Dependency	0.03	0.03	0.02	0.00	0.03	0.02
Others	0.14	0.13	0.08	0.06	0.11	0.13
Panel B: By destination for every reason for migration						
1991						
	India	South Asia	East Asia	Middle East	North America and Europe	
Agriculture	1.00	0.00	0.00	0.00	0.00	
Trade	0.88	0.02	0.07	0.01	0.02	
Employment	0.95	0.01	0.02	0.01	0.01	
Education	0.78	0.03	0.06	0.01	0.02	
Dependency	0.93	0.01	0.04	0.01	0.02	
Others	0.89	0.02	0.07	0.00	0.02	
2001						
	India	South Asia	East Asia	Middle East	North America and Europe	
Agriculture	1.00	0.00	0.00	0.00	0.00	
Trade	0.90	0.01	0.02	0.03	0.04	
Employment	0.75	0.00	0.05	0.18	0.02	
Education	0.67	0.02	0.10	0.02	0.19	
Dependency	0.92	0.00	0.04	0.01	0.04	
Others	0.87	0.00	0.03	0.07	0.03	

Source: Census 1991 and 2001

Table 2: Basic Characteristics of Villages in the Sample, 1995-96 and 2003-04

	1995-96	2003-04
Forest area per household (ha.)	6.63	5.04
	(7.28)	(5.09)
Farm land per household (ha.)	4.23	4.61
	(5.85)	(4.62)
Forest share of total land	0.52	0.44
	(0.21)	(0.17)
Road density (km./1000 sq.km.)	2.7	11.7
	(1.41)	(5.75)
Mean household size	5.8	5.3
	(1.1)	(0.9)
Mean number of households	6027	6338
	(4098)	(4035)
Mean population	25907	29880
	(18262)	(21643)
Mean population aged 15-29	6991	7247
	(5290)	(5304)
Mean male population aged 15-29	4564	3022
	(3552)	(2358)
Fraction of households receiving remittances	0.18	0.33
	(0.16)	(0.16)
Mean per capita remittances (aggregate) (Rs.)	455.4	1012.5
	(1094)	(1173)
Mean male daily wages (Rs.)	22.1	44.3
	(4.4)	(10.1)
Mean land price (Rs. per ha.)	52990.7	40767.6
	(31149)	(50436)
Mean per capital household income (Rs.)	5140.9	7321.2
	(21731)	(20549)
Proportion of HHs poor	0.49	0.35
Mean per capita income of poor HHs	1866.8	2089.9
	(1097)	(1251)
Mean per capita income of non-poor HHs	4636.6	9789.1
	(3456)	(6309)
Rainfall shock (standardized z-score)	1.2	0.9
	(1.51)	(0.94)
Fraction of villages with community forestry user groups	0.37	0.59

Notes: The source of the data is Nepal Living Standards Survey, 1995/96 and 2003/04. All monetary values are in real 1995 Rs. All means are calculated using village land area as weights. Standard deviationss in parentheses.

Table 3: Sources and Use of Fuelwood and Fodder

	1995-96	2003-04
Mean fraction of HHs that used firewood as primary fuel	0.93	0.96
	(0.21)	(0.12)
Mean fraction of HHs that collected own firewood	0.88	0.91
	(0.27)	(0.17)
Mean fractionf of HHs that collected firewood from community forests	0.12	0.34
	(0.19)	(0.31)
Mean fraction of HHs that collected firewood from government forests	0.62	0.39
	(0.33)	(0.33)
Mean fraction of HHs that collected own fodder	0.88	0.89
	(0.12)	(0.13)
Mean fraction of HHs that collected fodder from community forests	0.05	0.12
	(0.08)	(0.19)
Mean fraction of HHs that collected fodder from government forests	0.32	0.18
	(0.24)	(0.27)

Notes: The source of the data is Nepal Living Standards Survey, 1995/96 and 2003/04. All means are calculated using village land area as weights. Standard deviationss in parentheses.

Table 4: The First Stage: Relationship Between Actual Remittances and Synthetic Remittance

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Remittances (per capita)					
Synthetic remittance (per capita 1995 Rs.)	0.69***	0.46***	0.47***	0.46***	0.48***	0.31***
	(4.21)	(2.84)	(3.03)	(2.87)	(2.97)	(3.57)
Log population		365.21			149.43	881.76
		(0.47)			(0.19)	(0.65)
Log population (aged 15-29)			-62.4			
			(0.08)			
Log population (males aged 15-29)				-174.81		
				(0.45)		
Share of individuals aged 15-29 in the population					-1039.18	-2077.85
					(0.29)	(0.41)
Log road density					166.72	-175.88
					(0.73)	(0.62)
Log wages						144.25
						(0.60)
Log land price						12.72
						(0.15)
Log per capita household income						1,056.36**
						(2.36)
Rainfall shock					-349.04	-431.57
					(0.27)	(0.19)
Year (= 1 for 2004)		501.63***	495.52**	499.28***	341.16*	216.09
		(2.69)	(2.61)	(2.72)	(1.91)	(0.74)
Observations	242	242	242	242	242	205
R-squared	0.1	0.14	0.14	0.15	0.15	0.21
Village fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
F Statistic	17.6	12.05	11.44	12.16	9.07	8.32

Notes: Absolute value of robust t-statistics in parenthesis. Each column is a separate regression. Synthetic remittance is a constructed variable and is described in detail in the data appendix. The unit of observation is village-year. ***p<0.01, **p<0.05,*p<0.1

Table 5: Reduced form impact of remittances on forests

VARIABLES	Forest area per household			Forest share of total land		
	OLS	FE	FE-IV	OLS	FE	FE-IV
Remittance	-0.16***	-0.02	0.21**	-0.05	-0.04*	0.11**
	(3.15)	(1.01)	(1.92)	(1.37)	(1.82)	(1.99)
Log population	-0.43***	-1.09***	-1.46	-0.07	-0.19	-0.65
	(2.66)	(4.21)	(1.19)	(0.75)	(0.78)	(0.54)
Share of individuals aged 15-29 in the population	0.90	-1.23*	-1.45	0.62	-1.20**	-1.42
	(0.33)	(1.86)	(1.04)	(0.5)	(2.03)	(1.03)
Log road density	-0.51***	-0.07	-0.11**	-0.14	-0.09	-0.11**
	(4.45)	(1.02)	(2.21)	(1.53)	(1.24)	(1.98)
Rainfall shock	-0.76	-0.92	-0.56	0.22	-1.68	-1.20
	(0.75)	(0.56)	(0.33)	(0.37)	(1.00)	(0.72)
Year (= 1 for 2004)	-0.19***	-0.02**	-0.03***	-0.12	-0.14***	-0.02***
	(3.25)	(2.18)	(3.90)	(1.19)	(2.74)	(3.58)
Community forestry user groups in the village? (= 1)	0.75***	-0.02	-0.05	0.43***	0.05	-0.05
	(4.26)	(0.35)	(0.50)	(4.16)	(0.87)	(0.37)
Observations	224	224	224	224	224	224

Notes: Absolute value of robust t-statistics in parenthesis. Each column is a separate regression. The unit of observation is village-year. Remittance, log population and log road density are instrumented using per capita synthetic remittance, log of the village population in 1991 and the log of the road density in 1975. ***$p<0.01$, **$p<0.05$,*$p<0.1$

Table 6: The Reduced Form Effect of Remittances on Wages, Land Prices and Household Income

VARIABLES	Log Wages			Log Land Price			Log Household Income		
	OLS	FE	FE-IV	OLS	FE	FE-IV	OLS	FE	FE-IV
Remittance	0.06*	0.17**	0.34*	-1.25**	-0.06	-1.94**	0.10***	0.09***	0.45***
	(1.7)	-2.2	(1.9)	(2.3)	(0.6)	(2.6)	(4.9)	(3.2)	(5.7)
Log population	0.08	0.01	-5.61*	0.31	2.59***	15.81	0.01	-0.13	-1.63
	(1.3)	(0.3)	(1.7)	(1.6)	(3.03)	(0.1)	(0.3)	(0.4)	(0.5)
Share of individuals aged 15-19 in the population	-0.37	-4.12*	-2.34***	3.33	-2.14	493.46	2.01***	-0.29	-4.93
	(0.3)	(1.8)	(2.9)	(0.8)	(0.5)	(0.2)	(2.9)	(0.4)	(0.5)
Log road density	0.05	0.16	0.16	0.35	0.5	3.86	4.02	2.17	4.15
	(0.7)	(0.9)	(0.8)	(1.5)	(1.0)	(0.1)	(0.4)	(0.1)	(0.1)
Rainfall shock	0.60	0.99	8.15	-0.23	-5.9	-322.87	0.13	0.79	3.46
	(1.3)	(0.3)	(1.0)	(0.2)	(0.7)	(0.1)	(0.5)	(0.6)	(0.1)
Year (= 1 for 2004)	0.44***	0.37**	0.24	-0.16	-0.47	12.06	0.21***	0.28***	0.06
	(3.9)	(2.6)	(0.6)	(0.5)	(1.1)	(0.9)	(3.8)	(4.0)	(0.6)
Observations	191	191	191	223	223	223	224	224	224

Notes: Absolute value of robust t-statistics in parenthesis. Each column is a separate regression. The unit of observation is village-year. Remittance, log population and log road density are instrumented using per capita synthetic remittance, log of the village population in 1991 and the log of the road density in 1975. ***p<0.01, **p<0.05,*p<0.1

Table 7: Equilibrium Relationship Between Forests, Wages, Land Prices and Village Income

	Forest area per household			Forest share of total land		
VARIABLES	OLS	FE	FE-IV	OLS	FE	FE-IV
Log household income	0.21	0.11	0.52*	0.07	0.03	1.41*
	(0.8)	(1.0)	(1.9)	(0.6)	(0.3)	(1.8)
Log wage	-0.15	0.05	0.20	-0.06	0.09	-0.31
	(-1.0)	(0.7)	(0.3)	(1.0)	(1.1)	(0.4)
Log land price	-0.13***	-0.02	-0.02	-0.11***	-0.03	-0.01
	(2.7)	(0.6)	(0.3)	(4.4)	(0.7)	(0.1)
Log population	-0.94***	-0.09	-0.17	-0.02	-0.15	-0.93
	(6.6)	(0.7)	(0.4)	(0.3)	(1.5)	(1.2)
Share of individuals aged 15-19 in the population	-5.02*	-0.88	-0.56	-2.37	-0.74	-0.21
	(1.8)	(0.8)	(0.3)	(1.6)	(0.8)	(0.1)
Log road density	-61.03***	-1.94	-2.71	-22.77**	-5.03	-9.94
	(4.2)	(0.3)	(0.5)	(2.3)	(0.8)	(1.1)
Year (= 1 for 2004)	0.04	-0.06***	-0.09*	-0.02	-0.03**	-0.11
	(1.1)	(4.7)	(1.9)	(1.1)	(2.5)	(1.4)
Observations	192	192	192	192	192	192

Notes: Absolute values of robust t-statistics in parenthesis. Each column is a separate regression. The unit of observation is village-year. The instruments for the endogenous variables are per capita synthetic remittance, log of the village population in 1991 and the log of the road density in 1975. ***p<0.01, **p<0.05,*p<0.1

Table 8: Marginal Effects of Remittances, Population and Road Density on Self REported Changes in Forest Area and Time to Collect Firewood

Panel A: 2004 Levels

VARIABLES	Forest area decreased compared to 5 years ago?	Time to collect firewood increased compared to 5 years ago?	Forest area increased compared to 5 years ago?	Time to collect firewood decreased compared to 5 years ago?
Remittance	-0.09*	-0.02	0.06	-0.03
	(1.94)	(0.53)	(1.48)	(0.96)
Log population	0.01	0.12*	0.03	0.01
	(0.09)	(1.90)	(0.51)	(0.23)
Rainfall	-0.34	-0.13	0.55	-0.15
	(0.58)	(0.23)	(0.79)	(0.29)
Log road density	-19.92***	-6.91	10.20*	-0.05
	(3.19)	(1.29)	(1.78)	(0.01)
Community forest user groups in village?	-0.53***	-0.09	0.52***	0.09
	(4.85)	(0.89)	(5.08)	(1.01)
Observations	121	121	121	121

Panel B: 1995-2004 Change

VARIABLES	Forest area decreased compared to 5 years ago?	Time to collect firewood increased compared to 5 years ago?	Forest area increased compared to 5 years ago?	Time to collect forewood decreased compared to 5 years ago?
Remittance ($\times 10^{-4}$)	-0.67**	-0.03	0.46	0.05
	(2.19)	(0.12)	(1.61)	(0.28)
Population ($\times 10^{-4}$)	-0.06	0.03	0.1	-0.01
	(0.85)	(0.67)	(1.57)	(0.15)
Rainfall	-0.36	0.2	0.28	-0.28
	(0.84)	(0.52)	(0.61)	(0.78)
Log road density	-13.29**	-3.37	9.75**	0.21
	(2.57)	(0.77)	(2.12)	(0.06)
Community forest user groups in village?	-0.52***	-0.12	0.52***	0.12
	(5.08)	(1.19)	(5.06)	(1.32)
Observations	121	121	121	121

Notes: Robust z-statistics in parenthesis. Each column within each panel represents a probit regression. What is reported is the marginal effects from these regressions. ***p<0.01, **p<0.05,*p<0.1

Table 9: Relationship between conflict, remittances and forests

VARIABLES	Log per capita remittances	Log forest area per household
Normalized conflict intensity index	-1.99	5.83***
	(0.5)	(3.4)
Population ($\times 10^{-4}$)	-0.05	-0.05*
	(0.86)	(1.88)
Share of young (aged 15-29) in the population	4.79	-1.12
	(0.35)	(0.49)
t(1995-2004)	0.11***	-0.12***
	(3.3)	(8.8)
District fixed effects	Yes	Yes
Observations	136	136
R-squared	0.58	0.72

Notes: Absolute values of robust t-statistics in the parenthesis. Each column is a regression at the district level. The conflict intensity index is calculated based on data on various measures of conflict collected by Informal Services Center(INSEC). Throughout the period of the conflict, INSEC monitored the number of war casualties, abductions and displacements caused by the conflict in each district. We use the weighted average of cumulative numbers in each of these categories as a measure of conflict intensity experienced by a district. The specific weights we use are as follows: (a) Death- 75%; (b) Abduction - 20% and; (c) Displacement - 5%. We normalize this conflict measure by the district population in 2001. ***$p<0.01$, **$p<0.05$,*$p<0.1$

A Data Appendix

A.1 Data on population

The population data we use in this paper comes from Nepal's population censuses for 1991 and 2001. Our primary analysis, however, is based on a village panel data that we construct from the living standards survey for 1995/96 and 2003/04. In order to get population measures for villages for these years, we perform the following exercise. We start with actual population level for villages in the sample from the 2001 census. If we could observe the population counts for these same villages in 1991, then we could calculate the implied annual rate of population growth and used that to impute what the population for 1995/96 and 2003/04 would be. But this task is made difficult by the fact that the census data for 1991 is available only at a higher level of aggregation, at the district level. To deal with this we start with population counts for the 75 districts in 1991 and 2001. By subtracting the population of any metropolitan area within the district, we restrict attention to rural population in the two years and calculate the annual rate of growth of the rural population. If r_d is the annual growth rate of rural population thus calculated then for each village v_d in district d, $pop_{vd}^{1995} = \frac{pop_{vd}^{2001}}{(1+r_d)^6}$ and $pop_{vd}^{2003} = pop_{vd}^{2001} \times (1 + r_d)^2$. Here, we are implicitly assuming that (a) within each district, rural population grew at the same rate in all villages (b) rural population between 1991 and 2001 grew evenly over the decade and (c) rural population grew between 2001 and 2003 grew at the same rate as it did between 1991 and 2001.

A.2 Rainfall shock

The rainfall shock is currently calculated as the standard deviation from the mean rainfall of the last five years. This data is available at the district level from the District Profile of Nepal published by the Central Bureau for statistics for various years. A refinement of this data that we are working on includes the use of a longer historical rainfall series for about 62 rainfall stations in Nepal to calculate historical rainfall normals. Since we know the geographical location of each rainfall station, we can generate village level rainfall measures using a weighted average from the three nearest stations to the village's geographical center. The weights we use will be the inverse of the squared distance to the village's centroid.