Land Use and Marriage Timing in Nepal

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Abstract

I examine the relationship between patterns of land use and marriage timing in the Chitwan Valley, a rural area in south-central Nepal. In this setting, I conceptualize a relevant dimension of land use as the portion of land in each neighborhood devoted to agricultural use. Using discrete-time event history methods, I estimate the effects of land devoted to agriculture on the rate of marriage among 1009 never-married individuals. Land devoted to agriculture has a positive effect on the rate of marriage. A portion of this effect, however, may be mediated through measures of neighborhood nonfamily organizations—specifically places of employment. As agricultural land decreases, nonagricultural employment opportunities are likely to increase. Employers are potentially intervening mechanisms between land use and marriage timing because employment outside the home may weaken parental authority while at the same time giving young people more independence.

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Introduction

Changing patterns of land use and its consequences for populations is a growing concern among researchers. This concern is most typically stated as a warning that deforestation or other dramatic consumption of natural resources has accelerated to a pace that is unlikely to be sustainable. These changes in the environment are usually evaluated against changes in population and economic development (Femia, Hinterberger, and Luks 2001).

Although studies have been extremely helpful in describing large-scale shifts in regions and offering rough predictions from current trends, they have been not as useful in explaining important mechanisms at the individual level of human behavior. Aggregate data on land use, population growth, and consumption can provide only a summary or equilibrium description of the untold number of individual human actions that form a population's behavior. This macro view may obscure less visible mechanisms that are important to the relationship between population and environment yet may be subsumed or hidden under the aggregation of population members. Individual or micro-level studies of environment-human interactions are not, of course, a panacea to studying these relationships. By their nature, individual-level approaches can often study only small pieces of the population and environment relationships. These studies, therefore, are a complement to macro-level studies.

In this paper, I examine the relationship between patterns of land use and marriage timing in the Chitwan Valley, a rural yet growing area in Nepal. The data used for this analysis is a combination of two sources: survey data from individuals living in 151 neighborhoods and ground-mapped measures of categories of land use in each of those 151 neighborhoods. I use land use data to predict the rate of marriage among 1009 unmarried individuals.

Theoretical Issues

Micro-level Pieces of Macro-level Relationships

It is clear that changes in human behavior impact the environment, and in turn changes in the environment affect human behavior. The challenge in studying this relationship is to partition this complex relationship into specific hypotheses that can be tested. To attempt to model population and environment relationships as a whole is akin to modeling entire societies and ecological systems. This encompassing, macro-level undertaking is possible yet it requires substantial abstraction, reducing large land areas and scores of individuals into summary measures. While this approach can be useful, it may not be as successful in describing the many micro-level processes that underlie the broad relationships that are apparent at the level of a population or ecological system. As Axinn and Ghimire (2003) note, it is ultimately at the level of the individual that humans and the environment interact.

Increasingly, researchers are turning to micro-level approaches in studying the relationship between populations and their environments. For example, Thapa, Bilsborrow, and Murphy (1996) studied how Ecuadorian women's agricultural labor was affected by both family and land use characteristics. Wilcox, Quisenberry, and Jones (2003) examined how the built environment affected individual's perceptions of crime. And An, Mertig, and Liu (2003) studied how perceptions in resource availability influenced rural Chinese young people's decisions to leave home. To take these micro-level approaches, researchers must identify context-specific mechanisms that are part of the broader population and environment relationships. Having identified a limited number of mechanisms, they can then be tested with micro-level data. The micro relationship I investigate in this paper is the relationship between land use and individual marriage timing in the Chitwan Valley of Nepal. This relationship is by necessity a small part of

broader population and environment trends, yet it is a potentially important piece. To show this specific relationship's place within broader issues requires that land use is related to environmental issues and marriage timing is related to population concerns.

In general, dimensions of environmental quality and land use patterns have been shown to be strongly linked (Awasthi et al. 2002; Perz and Skole 2003). While there are a variety of ways to conceptualize land use patterns, in Chitwan the most relevant categories of land use tend to be divided into agricultural land, non-agricultural floral land, private buildings, public infrastructure, and non-usable land, i.e., geographic areas covered by rivers and ponds (Axinn and Ghimire 2003). As non-agricultural floral land is transformed into agricultural land, there may be increasing pressures on resources such as water, which agricultural land can consume in large quantities. This can result in diversions and disruptions of existing water use patterns, thus leading to environmental degradation. Transforming floral lands into agricultural land also can cause erosion, which can negatively impacts other floral lands, other agricultural lands, and human-inhabited areas (Awasthi et al. 2002).

Linking marriage timing to relevant population concerns may seem less straightforward, but in the context of Chitwan this is a potentially important issue. Nepal, like many south Asian countries, has relatively high fertility and population growth. As a small, land-locked, natural-resource poor nation, population growth is of paramount concern.

The determinants of fertility are numerous, but one heuristic model for thinking about fertility is the proximate determinants framework (Davis and Blake 1956; Bongaarts 1978). This framework proposed that there were a relatively limited number of closely linked or "proximate" factors related to fertility. These factors included contraceptive use, abortion, postpartum infecundity, and marriage (Davis and Blake 1956; Bongaarts 1978). Marriage is considered a

proximate determinant only to the extent that marriage is a necessity for childbearing in a society. Although not a biological necessity, there are often strong norms about what kind of relationship is validated for childbearing. Of course the importance of marriage as a proximate determinant varies across societies and time. Chitwan is an area in which nonmarital childbearing is highly discouraged. In our study's survey of 5271 Chitwan individuals, not a single man or woman admitted to premarital childbearing. This is not to say such childbearing does not exist, but there is strong evidence that local norms prohibit such behaviors. Thus in Chitwan marriage is an important proximate determinant of fertility. If marriages are delayed, this is likely to decrease fertility because men and women have fewer of their childbearing years exposed to the risk of having children (Davis and Blake 1956; Bongaarts 1978).

Linking Land Use Patterns to Marriage Timing

Having situated the relationship between land use and marriage timing within broader environment and population concerns, I now describe the theoretical mechanisms that may link land use patterns to marriage timing in the Chitwan Valley of Nepal.

The Chitwan Valley started as an agricultural community. In the 1950s, the government of Nepal with the help of USAID deforested large sections of Chitwan. Where there were once thick jungle, malaria, and animals such as tigers and rhinoceroses became some of the richest and most productive farmland in Nepal a decade later. Thus most of Chitwan is land devoted to agriculture. Of the neighborhood land in our study, 80.18% was agricultural land in 1996. Agricultural land in Chitwan falls into two types: khet, which is used for growing rice, and bari, which is used for growing other crops such as maize and millet. Another major category of land use in Chitwan is also covered with flora, yet is not agricultural land. These kinds of land are public and private grasslands and plantation lands. The last two categories of land use are non-

floral lands: land devoted to private buildings, land devoted to public infrastructure, and a small fraction of unusable land (rivers and ponds).

In Chitwan, the percent of land devoted to agriculture may affect marriage timing because it changes the organization of families. First, as agricultural land decreases, it may increase the proportion of young people who look for work that is nonagricultural labor. As agricultural land decreases and technological farming innovations spread, usually less labor is needed to obtain the same levels of productivity. Nonagricultural employment is usually located away from the family home. Thus individuals have potentially more independence and freedom from family elders, which can make it more difficult for elders to encourage the family patterns they practiced, such as earlier marriage and high fertility (Thornton and Lin 1994).

Second, changes in land devoted to agriculture may affect individuals' perceptions of environmental change. Previous research shows that individuals' perceptions are shaped by physical features of their surrounding environment (Wilcox, Quisenberry, and Jones 2003). Thus even if actual changes in land use patterns are small, a few very visible changes can drastically affect how individuals perceive their environment. If the land devoted to agriculture is relatively small, then individuals may perceive that there are long-term shifts in the future nature of obtaining a livelihood. Instead of focusing on the family formation patterns that are most valuable in agricultural societies, such as marriage and high fertility (Caldwell 1982), individuals may be drawn to other experiences, such as schooling and employment. These are activities that do not require family formation, and schooling's student role is often viewed as incompatible with spouse or parent roles (Thorton, Axinn, and Teachman 1995; Tambashe and Shapiro 1996). Thus perceptions of a decreasing agricultural environment may cause individuals to pursue activities that are likely to delay marriage.

In sum, the amount of agricultural land is likely to affect marriage timing because it alters the organization of individuals' families. In general, I expect a positive relationship between the amount of agricultural land and the rate of young people's marriages. An important intervening link between land use and individual marriage decisions may be the presence of nonfamily organizations and services, which may give children independence from family elders. As described below, I test this model of land use and marriage timing with data from the Chitwan Valley Family Study.

Data and Methods

The Chitwan Valley Family Study is a multifaceted data collection that began in 1996. Several components comprise the data, each with a separate focus. Using a probability sample of neighborhoods, the individual interview in 1996 measured 5271 individuals in 171 neighborhoods between the ages of 15 and 59. The respondents' spouses were also interviewed, regardless of age. The individual interview collected a variety of social demographic, life history, and attitudinal questions. Upon completion of the individual interview, a household registry system began. This registry system is ongoing and collects monthly data on vital and life events, such as births, marriages, deaths, and migration. The registry system involved a subset of 151 of the 171 original neighborhoods (the selection of the 151 was random).

A second component of the data is the land use mapping. In 1996, field workers mapped the entire area of neighborhoods and classified its use into various categories. The main land use categories are agricultural, non-agricultural floral, private buildings, and public infrastructure. These categories can be further broken down into specific classes. For example, agricultural land includes rain fed khet, irrigated khet, and bariland. For the purposes of this paper, however, I focus on the aggregated categories. Neighborhoods were defined as free-standing clusters of 5

to 15 households. Neighborhood land boundaries were created by bisecting the land areas between neighborhoods.

A third component of the data is the neighborhood history calendars. This data source measures how far, in minutes walking distance, each neighborhood was from various nonfamily organizations and services that reflect daily social life, such as schools, health posts, bus stops, cinemas, markets, employers, and police stations. These are important organizations in a setting such as Chitwan, which is undergoing rapid social change—many activities that once were the exclusive domain of the family are increasing performed outside the family within nonfamily organizations.

Marriage Timing. Marriage timing is the independent outcome of interest. Because this is an event that may be censored—i.e., not all respondents may have experiences the event—event history analysis is appropriate. I use discrete-time event history to estimate the effect of covariates on the rate of marriage among people who were never married as of late 1996. The person-period of risk is the person-month. For every month in which the individual is single, the dependent variable is coded 0. When an individual marries, the dependent variable is coded 1, and the individual no longer contributes person-months of exposure. Individuals who do not marry are censored after 4.5 years (the registry system, which began in late 1996, has 4.5 years of data available).

Percent agricultural land. Although there are many ways to categorize of land use, the dimension most likely to influence marriage timing in Chitwan is the percent of land devoted to agriculture. This measure is calculated as the amount of khet and bariland divided by the total land in the neighborhood. Because this measure was skewed, with many individuals living in neighborhoods clustered in the high percentages of land devoted to agriculture, a logarithmic

transformation was applied. This transformation accentuates the differences in percent agricultural for the neighborhoods with a low percentage of agricultural land, which is justifiable: the difference between 70% and 90% of agricultural land is likely to be less important than the difference between 5% and 25%. While the former two cases would both be considered largely agricultural, the latter two cases may be different: one which is virtually nonagricultural (5%) and one which is moderately agricultural (30%). The economies of scale involved with agriculture also point to substantial, fundamental differences in land use when comparing neighborhoods that are 90% and 70% as opposed to 5% and 30%.

Nonfamily Organizations. Because neighborhood nonfamily organizations may be important intervening links between land use and marriage timing, I incorporate measures of how far away, in terms of minutes walking distance, are various nonfamily organizations and services. I focus on schools, health posts, markets, bus stops, and employers. Schools are defined as any place of instruction for youth. Health posts are any places of care and healing, such as hospitals, clinics, or doctor's offices. A market was defined as any place of at least two continuous stores or places offering goods for sale. Bus stops were any places an individual could ride a vehicle for pay, which included buses, cars, or even tractors that were regularly operated for transportation. An employer was defined as a place that paid 10 or more people for work. The distance to the nearest of each of these nonfamily organizations or services was measured with the neighborhood history calendars.

Controls. Important controls in the analyses include gender, age, and ethnic group. Gender is coded as a dichotomous variable where females are coded 1, males are coded 0. Age is simply the respondent's age at the beginning of the registry data collection in 1996. Because there is often a quadratic age-pattern to marriage, age-squared is also included in the models.

Lastly, dummy indicators for ethnic group are also included as controls. There are many diverse ethnic groups in the Chitwan Valley, but they can be categorized into five main groups. Upper Caste Hindus, Lower Caste Hindus, Newars, Terai Tibetoburmise, and Hill Tibetoburmise.

Another concern in the analysis is how to parameterize the duration of the hazard. In contrast to a Cox proportional hazards model, in a discrete-time event history model it is necessary to specify the functional form of the hazard. If individuals are observed for a relatively long period of time, then a smooth function, such as a quadratic, often describes family behaviors such as marriage and childbearing. In the current analysis, however, about four years are observed. Because Hindus view some months as more auspicious than others for marriage, one pattern that may be expected is monthly variations in marriage timing. Thus I include 11 dummy indicators to include the twelve calendar months, which allows for periodic month effects in the shape of the hazard. An alternative form that allowed a separate parameter for each month of the 4.5 year period was also estimated, but it provided no substantive difference from the 11 month dummies. Thus I take this more parsimonious approach.

Results

Table 1 presents descriptive statistics for the measures used in the analysis. Of the 1009 unmarried individuals in 1996, almost half (44%) married during the following 4 years. The sample was also nearly equally divided by sex, with slightly more men than women (54% male, 46% female). In terms of ethnic composition, the largest group was the High Caste Hindus at slightly more than half the sample (55%). They were followed by the Terai Tibeoburmise at 16% of the sample.

(Table 1)

In terms of land use, respondents lived in neighborhoods in which 69% of the total land area of the neighborhood was devoted to agricultural land, on average. Recall that this land includes rain-fed khet, irrigated khet, and bariland. This indicates that most respondents lived in largely agricultural areas of the Chitwan Valley.

The distance to neighborhood nonfamily organizations and services showed variation in accessibility by the type of organizations. Schools were the most accessible organizations, and respondents averaged less than a ten minute walk the nearest school. Bus stops and markets were also nearby, with these organizations averaging about 12 minutes away. Health posts and employers were the next farthest away; these organizations averaged a 20 minute walk by foot. Few individuals own automobiles in Chitwan, and walking or biking is the most popular form of transportation. Thus minutes walking distance is an ideal conceptualization of the geographic constraints in the access to these organizations. Note that it is not necessarily the nearest organization that is hypothesized to influence individual behavior. If a neighborhood is only 15 minutes from the nearest employer of 10 people or more, then there is a good chance there are also employers within 20, 25, and 30 minutes. Contrast that neighborhood to a neighborhood whose nearest employer is 50 minutes away by foot. Thus the distance to the nearest organization is simply a way to measure the respondent's neighborhood's general relationship to nonfamily organizations and not one particular organization.

(Table 2)

Table 2 presents the discrete-time estimates of the effects of agricultural land use on marriage timing. The results are presented as odds ratios, which are the exponentiated coefficients of the logistic regression model used to estimate the discrete-time hazard. An odds ratio greater than one represents a positive effect on the marriage rate: it is an effect that causes

individuals to marry sooner. In contrast, an odds ratio less than one is a negative effect on the marriage rate, something that delays individuals' marriages. An odds ratio of 1.00 is null effect.

In model 1, the only predictors are agricultural land used (logged) plus an intercept and monthly dummies for the parameterization of the hazard, which are not shown. Model 1 indicates a significant effect of agricultural land use on the rate of marriage. When more land in a respondent's neighborhood is devoted to agricultural use, unmarried respondents tend to marry more quickly.

Model 1, however, is a simple "zero-order" model in which no other variables are estimated. In model 2 I include some simple sociodemographic controls: gender, ethnicity, and age. As expected, the coefficient for female (which is coded as female=1, male=0) is positive, indicating that women marry more quickly than men. In fact, women marry at a rate that is 98.6% higher than men (1.986-1.00 = .986). This is expected because women tend to marry men who are older than themselves. There were few ethnic differences in marriage rates compared to the reference group (High Caste Hindu). One exception was the Newar group, which married at rates lower than High Caste Hindu. Newars, like Upper Caste Hindus, are one of the more advantaged groups in Chitwan. Newars tend to have high education and they often are business owners. Thus it is not surprising to see that Newars have the lowest rates of marriage among the five ethnic groups in Chitwan. Lastly in model 1, the age coefficients indicate a quadratic trend in the age pattern of marriage. A positive effect for age and a negative effect for age-squared means that age has a positive effect on marriage until it reaches a peak, after which it decreases.

An important note in model 2 is that the effect of agricultural land remains significant, but the magnitude of the coefficient has decreased (it has become closer to 1.00). This would suggest that a portion of the relationship between land use and marriage timing is explained by

the additional predictors in model 2. Further investigation (tables not shown) revealed that it was the ethic group dummies that are largely behind this decrease in the effect of agricultural land. Thus some of the effect of agricultural land may be spurious, resulting simply from the fact that ethnic groups tend to have different marriage rates, and these groups are distributed unequally onto different kinds of neighborhoods. Nevertheless, agricultural land still positively affects the rate of marriage in model 2.

In models 3 through 7 I introduce measures of neighborhood nonfamily organizations. Recall that the organization of the family may be an important intervening link between agricultural land use and marriage timing. When there are few agricultural opportunities nearby, individuals may be more likely to participate in nonagricultural activities, such as paid wage labor. Markets represent consumption opportunities outside of home production, and bus stops allow individuals to participate in nonfamily organizations that may be geographically distant. Schools are opportunities to invest in human capital that is valued outside agricultural work. And health posts are yet another indicator of nonfamily control of activities that once took place entirely within the family. Thus there is good theoretical reason to expect that the effect of agricultural land use may be explained by the opportunity to participate in these other organizations.

In model 3, however, there is little effect of walking distance to schools on marriage timing. The hypotheses predicted that when these kinds of organizations were close, marriage rates would decrease. Or stated in the opposite, when these organizations are far, marriage rates would increase. The effect of the measure is in the predicted direction—the distance to the nearest school has a positive effect on the rate—but the effect is not significant. Similarly,

models 4 through 6 show no significant effect of health posts, bus stops, or markets on the rate of marriage. Again, these effects are in the hypothesized direction, but they are not significant.

Model 7, however, shows that the distance to the nearest employer has a significant, positive effect on the rate of marriage. The odds ratio of 1.008 means that for each minute of walking distance to the nearest employer of 10 or more people, the rate of marriage is predicted to increase by 0.8%. This may not appear to be a sizable effect, but it must be remembered that odds ratios are multiplicative; thus the effects are multiplied for each one-unit change. As an example, compare two individuals, one who lives in a neighborhood that has an employer (0 minutes walk) and one who lives 40 minutes from the nearest employer. The values of 0 and 40 minutes are about 1 standard deviation below and above the mean; thus these are reasonable values for the data. The difference in marriage rates between these two individuals is 37.5%: the individual who lives 40 minutes away from the employer is predicted to marry at a rate that is 37.5% higher than the individual who lives in the neighborhood with an employer (1.008 raised to the power of 40 equals 1.375).

In addition to the significant effect of employers in model 7, also of note is the change in the effect of agricultural land. Although the effect of agricultural land is still positive, it is no longer significant. It has decreased from 1.102 in model 2 to only 1.062 in model 7. Although the effect is not reduced to null (1.00), it appear that a sizable amount of the effect of agricultural land might be attributed to the presence of nearby employers.

Lastly, in model 8 all neighborhood nonfamily organizations are estimated in the same model. The effects of predictors in model 8 are similar to what they were in previous models. The effect of agricultural land remains insignificant, most likely to the continued presence of neighborhood employers in the model. The effect of neighborhood employers also remains

similar to the effect in model 7, despite the additional neighborhood organizations in model 8. This is evidence that the effect of employers is independent from the other nonfamily organizations.

Discussion

It is clear that patterns of land use and subsequent human behavior are linked, yet how to make this linkage on the micro-level is not always clear. In this paper, I have examined how the portion of a neighborhood's land used in agriculture is related to individual behavior in marriage. After finding a relationship between agricultural land use and marriage timing, I attempted to explain this relationship with measures of neighborhood nonfamily organization. One kind of organization was a mediator of these effects: nearby employers of 10 people or more.

Theoretically, it makes sense that employers would have the strongest mediating effects. Although there are good reasons for schools, health posts, markets, and clinics to be intervening mechanisms, the clearest relationships between agricultural land and marriage timing involve the alternatives individuals take if agricultural work is not a possibility. In these cases, it is likely nonagricultural paid employment that individuals participate in. The family modes of organization framework suggests that when individuals participate nonfamily organizations, such as nonfamily employers, it weakens parental authority and gives more independence to young people (Thornton and Lin 1994). In Chitwan, this is likely to lead to delayed ages of marriage.

In a more complete version of this paper I hope to strengthen several areas. First, I will build a stronger theoretical framework for linking land use patterns and marriage timing. Although I have made an initial argument, this argument would benefit from additional literature from others settings that have studied land use and family formation. Second, I plan to incorporate further measures in the analytical models. I controlled for only the most basic

individual-level sociodemographic measures. Other measures, such as the respondents' own educational and employment experiences may be further important. These measures have been collected, and adding them to the models is straightforward. These two additions will likely improve the paper and make it a stronger contribution.

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Table 1: Descriptive Statistics for N=1009 Individuals

	Mean	St. Dev.
% Respondents Marrying	.44	.50
% Land Agricultural	.69	.24
Minutes by Foot to Nearest:		
School	8.84	6.44
Health Post	19.31	17.45
Bus Stop	11.87	13.80
Market	12.46	17.91
Employer	20.10	19.58
Female	.46	.50
Ethnicity		
Upper Caste Hindu	.55	.50
Lower Caste Hindu	.08	.28
Newar	.08	.26
Hill Tibetoburmise	.13	.33
Terai Tibetoburmise	.16	.37
Age	18.60	4.30

Table 2: Effects of Agricultural Land Use and Nonfamily Organizations on Rate of Marriage

	1	2	3	4	5	6	7	8
% Land Agricultural (logged)	1.130**	1.102*	1.100*	1.097*	1.088	1.091*	1.062	1.063
	(2.390)	(1.882)	(1.829)	(1.723)	(1.594)	(1.652)	(1.131)	(1.115)
Minutes by Foot to Nearest:								
School			1.003					0.999
			(0.369)					(0.096)
Health Post				1.001				0.997
				(0.387)				(0.895)
Bus Stop					1.005			1.003
					(1.267)			(0.845)
Market						1.003		1.001
						(1.168)		(0.304)
Employer							1.008***	1.008***
							(3.282)	(3.101)
Female		1.986***	1.986***	1.987***	1.989***	1.996***	1.979***	1.978***
		(6.949)	(6.952)	(6.953)	(6.962)	(6.988)	(6.906)	(6.892)
Ethnicity								
Lower Caste Hindu †		1.132	1.131	1.135	1.131	1.143	1.137	1.13
		(0.686)	(0.681)	(0.699)	(0.681)	(0.736)	(0.71)	(0.674)
Newar †		0.700*	0.702*	0.707	0.712	0.695*	0.716	0.705*
		(1.698)	(1.685)	(1.633)	(1.613)	(1.729)	(1.585)	(1.648)
Hill Tibetoburmise †		1.234	1.233	1.243	1.261	1.234	1.188	1.179
		(1.446)	(1.443)	(1.483)	(1.585)	(1.445)	(1.178)	(1.108)
Terai Tibetoburmise †		0.999	0.995	0.997	0.972	1.010	0.945	0.940
		(0.005)	(0.039)	(0.025)	(0.211)	(0.076)	(0.415)	(0.450)
Age		1.986***	1.982***	1.988***	1.99***	1.992***	2.015***	2.017***
		(6.066)	(6.039)	(6.078)	(6.091)	(6.093)	(6.087)	(6.074)
Age-squared		0.987***	0.987***	0.987***	0.987***	0.987***	0.987***	0.987***
		(5.369)	(5.343)	(5.379)	(5.385)	(5.393)	(5.383)	(5.370)
N (Person-Months)	42786	42786	42786	42786	42786	42786	42786	42786

Coefficients are odds ratios, with z-statistics in parentheses
*p<.05, **p<.01, ***p<.001, one-tailed tests
† Upper Caste Hindu is reference group
Note: Intercept and monthly dummies for parameterization of the baseline hazard were estimated, but are not displayed here