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# MIGRATION AND THE ENVIRONMENT: THE CASE OF PHILIPPINE UPLANDS

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## INTRODUCTION

The typical migration pattern world-wide has been from rural to urban areas, and rural emigration has been a cause of degradation of the urban environment. This pattern has reversed in the 1980s, particularly in Southeast Asia and the Amazon, as migrants began leaving impoverished cities to settle in sparsely inhabited upland and forest frontiers. The rural poor have added to the upland migrant stream migration as they, too, search for uninhabited land and better agricultural opportunities. Government resettlement policies and policies that favor capital over labor, particularly in the industrial sector, often induce disemployment and migration to the frontier where the open access nature of existing land tenure regimes provide not only opportunity but also increased the likelihood of environmental degradation.

Philippine migration in the 1980s was an example of this phenomenon. There are other examples — such as Indonesia's experience with transmigration, the migration to Thailand's northeast after the army built roads for military movement and national security, the migration to Nepal's *tarai* after malaria was eradicated in that region, or migration to the unsettled reaches of the Amazon from various South American countries —but the Philippines may be the best example. Manufacturing, employment, and per capita income

* Forestry Department, Virginia Tech. Eric Jensen of The College of William and Mary recommended some of the analysis, Wilfrido Cruz of the World Bank lent data and his personal insights, but the findings in this paper are the authors'. A variation of their analysis appears in *Land Economics* 74(1):

actually decreased in the Philippines in the 1980s, and many urban and landless rural families migrated to the uplands where agricultural land conversion has destroyed 200,000 hectares of native forest annually for the last 20 years (NRAP 1991).

This study uses a multinomial discrete choice model, together with census data on migration flows, and socioeconomic and environmental data from the late 1980s to assess the factors that influence 1) the people's decision to migrate, and 2) the migrates' choices among upland destinations. This approach allows us to estimate the relative importance of population factors, environ-mental resources, government policy, and economic opportunity at both the origin and the destination as elements in the final decision to migrate. We will find little to distinguish non-migrants from migrants. Once the decision to migrate is made, those who do migrate are responsive to local income opportunity, but less responsive to population factors. The availability of upland natural resources and insecure land tenure are strong and statistically significant attractants. This means that migration is greatest to regions where upland environmental pressure could accumulate on the largest scale. These results argue that it is difficult to predict the long-run effects of policies targeting employment, income, or property rights. Similarly, predictions of the effects of trade and industrial policies that reduce the welfare of the urban poor would be incomplete without taking into consideration the degrading impacts of these policies on the upland environment.

## MIGRATION AND DEFORESTATION

Local measures of poverty grew steadily from the 1970s through 1980s until they reached 50 and 60 percent in rural and urban areas, respectively in 1988 (World Bank 1988). The Philippine recession of the 1980s, coupled with government incentives for capital- and energy-intensive industries, and disincentives for commercial agriculture, reinforced this disappointing trend. Displaced urban workers and landless agricultural workers migrated to the upland frontier in search of better opportunities, converting upland forests to subsistence agricultural production. Forest policy, and the difficulties inherent in its enforcement, reinforced the migrants' impact on the uplands. Lands with slopes greater than 18 percent are officially classified as public lands, but the government has difficulty enforcing use rights to these lands. As a result, these lands are effectively open to deforestation by

improper logging and illegal homesteading. This is a common problem for the forested frontier of many (developed and developing) countries where the best land, the settled population, and the government authority are all so dispersed.

For the Philippines, the results have been an upland population growing at 3 percent annually since 1950, and settlement mostly on previously uninhabited open access forest (Cruz *et al.* 1988). Total forest cover has decreased by 24 percent since 1970. By the early 1990s, 72 percent of the total upland area was cultivated, more than double the area of upland cultivation in 1950 (NRAP 1991, FAO 1983).

Without secure private claims to the land, the new upland farmers tend to favor extensive cultivation practices and short-term production maximization. The general environmental results tend to be unsustainable agriculture on land that is poorly suited for agriculture in any event, erosion and degradation of the upland forest, and downstream losses due to heavy sediment deposition on commercial agricultural land, in water catchments intended for hydroelectric power production, and in the coastal fisheries.

## MIGRATION DECISION

In earlier but related studies, Todaro (1976) reviewed economic models of migration, Cruz *et al.* (1988) computed changes in upland forest populations and informally tied population growth to the decrease in forest area, and Cruz and Francisco (1993) reviewed the relation between migration and the environment.

This study will combine economic characteristics with the geographic and demographic characteristics common to those previous assessments of migration, but it will seek revised focus on the formal definition of the migrants' choices: first the choice of whether or not to migrate; and second, the selection of an upland destination. An individual's decision to migrate involves a complex comparison of the known utility received at the site of current occupation with the utilities expected at various potential destinations. Once an individual chooses to emigrate, the potential destinations form a discrete set of alternatives. Each emigrant faces the same set of alternatives, and the group of individuals from one origin who make the same choice of destination among alternative possibilities defines a migration stream.

## Empirical specification

Let the indirect utility for any individual at province $m$ be given by

$$V(X_m;\Omega,\beta) + \varepsilon_m \qquad \text{for all } m \qquad (1)$$

where $X_m$ is a vector of variables affecting prices and income in the province, $\beta$ is a vector of estimable parameters, and $\varepsilon_m$ is an error term. The number $m$ is equal to the number of provinces. Moving costs incurred by the migrant are implicitly present in the indirect utility functions for the destination provinces because moving costs affect income.

The probability that an individual migrates from origin province $i$ to destination province $j$ is

$$P_{ij} = pr\{V(X_j;\Omega,\beta) + \varepsilon_j > V(X_m;\Omega,\beta) + \varepsilon_m\} \quad \neq j. \qquad (2)$$

This probability can be estimated with individual data (where choices are binary variables), or with sample proportions (Ben-Akiva and Lerman 1988). Sample proportions are especially well-suited for large population studies where data on individuals are unavailable and where individual migration decisions can be aggregated as migration streams.

Migration streams can be defined if the individuals who make similar migration choices are themselves similar. A migration stream $M_{ij}$ is the total number of individuals in origin province $i$ making the identical choice to migrate to destination province $j$. If all observations of migration are contained within one time period, then the economic, environmental, and demographic attributes only vary across provinces.

Sample proportions define the frequency distributions of migration patterns. The sample proportion for each origin $i$ and destination $j$ is

$$P_{ij} = \frac{M_{ij}}{\sum_j M_{ij}} \qquad (3)$$

The $p_{ij}$ substitute for the $P_{ij}$ in equation (2) and the choices in equation (2) become frequencies in equation (3). These frequencies sum up to one when they are aggregated over all migration streams from each origin province—or, a $p_{ij}$ of one indicates that all who chose to emigrate from province $i$ also chose to immigrate to province $j$.

The error term in equation (2) has an extreme value distribution (Fomby *et al.* 1984). Therefore, we can use a maximum likelihood procedure to determine how the probability that a migration stream occurs depends on the vector of explanatory variables in the utility function. Following Ben-Akiva and Lerman (1988), a maximum likelihood procedure follows from defining the probability of migration between origin $i$ and destination $j$ as:

$$P_{ij} = \frac{exp\,(X^T_{ij}\beta)}{\mathcal{R}_m exp(x^T_{ij}\beta)} \qquad \text{for all } i, j \qquad (4)$$

where $x_{ij}$ is the vector of explanatory variables for origin province $i$ and destination province $j$ that are known to migrants from origin province $i$. The denominator is the vector sum over all potential destination alternatives. The probability $p_{ij}$ is computed for all provinces, $m = 1,2,...,i,j,..,N$, where $N$ is the total number of provinces.

This multinomial discrete choice specification provides consistent estimates of the effects of province specific attributes on the migration streams. If we assume a Cobb-Douglas form for the representative individual's utility function, equation (1), then the specification of equation (4) will be logarithmic. We will follow Pudney's (1988) recommendation of linear attachments for nonprice and nonincome variables (environmental and demographic variables, in this case).

Finally, we are also interested in identifying these broad categories of explanatory variables with greatest relevance to migration. For example, we would like to know whether expected personal welfare, population and social infrastructure, or natural resource availability; or whether economic or demographic characteristics as a group; or whether upland, lowland, or province-wide characteristics serve as greater inducements for migration. This suggests grouping the explanatory variables and completing the analysis with hypothesis tests that examine the importance of these groups of variables.

## Data

The fundamental migration data were processed from 1990 national census observations of individuals who moved within the

1985-1990 period. These observations were based on a stratified random sampling scheme designed to capture variation in lowland and upland socioeconomic factors. The original sample included 5,476 migration streams involving 74 provinces. A 1990 survey of the Philippine Bureau of Census provided general income, employment and demographic data. Data distinguishing upland areas within a province were taken from a University of the Philippines Los Baños survey of 8,935 households.[1] Annual Philippine Statistical Yearbooks provided data on agricultural and forest lands.

Two modifications were made to the data and two more were made to the analysis. First, three provinces contain no upland forests. These provinces failed to attract any immigrants and we dropped them as potential destinations. (They remain as origins for migration streams.) Second, attribute data (income, employment, or demographic data) were missing for three provinces from which there also were no emigrants. Dropping the provinces with missing attribute data left 74 origin and 52 destination provinces, for a total of 3,848 observations on migration streams. This means that the model represents fewer choices, but the study sample is still large. Dropping a few observations should not have a serious effect on the analysis because multinomial discrete choice models implicitly assume the independence of irrelevant alternatives (IIA) (Amemiya 1986).[2]

The full sample of migration streams separates into three approximately equal groups of origin-destination pairs. There are no observations for the first group. The second group includes streams with less than half the migrants from an origin province. The third includes streams in which more than half of all migrants from one particular origin province emigrate to one particular destination. The largest migration sources were the provinces of Central Luzon. Many movements were local, within the province of origin. The destinations of the largest longer distance migration streams were the 22 provinces in Mindanao.

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1. These migration data are the key to the analysis. M.C. Cruz is the source of basic research idea. She directed the migration survey of more than 815,000 individuals commissioned by the Philippine Department of Agrarian Reform and conducted by the Institute of Agrarian Studies and the University of the Philippines, Los Baños (Cruz *et al.* 1988).

2. IIA was tested by removing three of the largest provinces and computing the appropriate test statistic (Hausman and McFadden 1984). The hypothesis of independent destination choices could not be rejected.

Tables 1 and 2 summarize the descriptive statistics for the origin and destination attributes, respectively. Approximately one of every 400 individuals nationwide migrated (line 1) both from and to a large variety of destinations, but it is difficult to distinguish among either origins or destinations from the raw data on their attributes. Various attribute measures might be used. The measures in Tables 1 and 2 were selected to include measures of income and employment opportunity,

**TABLE 1: Descriptive Statistics for Migration Attributes: Provinces of Origin**

| Attribute | Mean | Standard Deviation | Minimum Value | Maximum Value |
|---|---|---|---|---|
| Emigration (% of 1980 origin population) | 0.03 | 0.086 | 0.0006 | 0.095 |
| Average household income (pesos/yr in 1990) | 32,002 | 8,857 | 16,000 | 55,390 |
| Average upland household income (pesos/yr in 1990) | 11,920 | 1,940 | 0 | 61,950 |
| Unemployment rate (% in 1990) | 9.24 | 4.6 | 6.9 | 9.8 |
| Households in bottom 30% of income profile (1990) | 12,723 | 3,383 | 7,165 | 23,150 |
| Population (1980) | 660,920 | 409,330 | 83,230 | 1,930,000 |

**TABLE 2: Descriptive Statistics for Migration Attributes: Provinces of Destination**

| Attribute | Mean | Standard Deviation | Minimum Value | Maximum Value |
|---|---|---|---|---|
| Emigration (% of 1980 origin population) | 0.03 | 0.086 | 0.0006 | 0.095 |
| Immigration (% of 1980 origin population) | 0.023 | 0.017 | 0.004 | 0.079 |
| Average household income (pesos/yr in 1990) | 31,591 | 8,808 | 16,000 | 55,390 |
| Average upland household income (pesos/yr in 1990) | 11,676 | 20,296 | 9,999 | 61,950 |
| Unemployment rate (% in 1990) | 6.16 | 2.75 | 2.0 | 11.9 |
| Population in bottom 30% of income profile (1990) | 12,728 | 3,517 | 7,165 | 23,150 |
| Population (1980) | 222,710 | 144,190 | 9,009 | 707,000 |
| Upland population density (1980) | 38.41 | 6.74 | 6.60 | 73.96 |
| Arable land ($km^2$) | 1,148.44 | 467.25 | 247 | 2363 |
| Road density in arable uplands ($mi/km^2$) | 1.46 | 1.54 | 0.39 | 11.66 |
| Forest land area (ha) | 263,360 | 214,630 | 28,200 | 1,042,000 |
| Forest land area classified as public (ha) | 328.1 | 216.1 | 40.4 | 1041.8 |
| Share of forest land area with > 18% slope (%) | 50.32 | 16.46 | 18.64 | 82.40 |

population pressure, and resource availability. Larger total populations and larger total land area available are suggestive of more information available to migrants and more migrant confidence about the perceived opportunity, but average measures of income, unemployment, and population density also indicate levels of opportunity. Therefore, it is important to use both totals and averages—and not to normalize all attributes for either population or area. We will discuss our expectations of the effects of each attribute in the discussion of empirical results.

Many of the data distinguish upland from province-wide attributes. Province-wide information is summary information that represents the origins well. It may also be the most available destination information for long-distance migrants. Nevertheless, the uplands tend to be the final destinations of these migrants. Therefore, several of the agriculture and forest data sets were selected for their implicit indications of upland land tenure, a critical issue for migrants and for natural resource and environmental policy. Price data for selective upland agriculture and forest resources were unavailable.

## Political unrest and distance as migration deterrents

We added a political unrest variable and a travel cost variable to these data. Some 14 provinces in Central Visayas and Mindanao suffered a level of political unrest that may have made these areas less attractive for immigration. The Philippine Embassy in Washington identified these provinces.[3] They were marked with a dummy variable in the analysis. A negative and significant coefficient on this dummy will imply that political unrest restrained immigration.

Travel costs also deter migration. Distance alone, however, does not satisfactorily incorporate the mix of time costs for overland travel and financial costs for ferry passage characteristic of migration in the Philippines. Time costs may be especially important for poorer migrants who cannot afford commercial travel. For them, the financial cost of ferry passage may be overwhelming. On the other hand, the strongest felt cost of migration is probably its deterrent on family communication during holidays. Therefore, the threshold which makes periodic return visits unlikely is critical. This threshold may be approximated by overland travel beyond the boundary of the province of origin or by ferry travel of any distance.

3. L.Q. Del Rosario, personal communication, October 11, 1995.

Two alternative systems were developed to incorporate these market and nonmarket features of migration costs. The first is a system of weights that assigns two points to migration streams contained within the origin province, another point to migration out of a province but within the administrative region, a fourth point to migration to a new administrative region, a fifth to any movement across water (or ferry travel), and a final point to additional overland movement inland and upland once the ferry travel component of migration is complete. Some, but not all, migration out of the province includes ferry travel. Some ferry travel is followed by additional overland migration. The second system for incorporating travel costs uses migration within a province as the standard and assigns a new dummy variable for any travel beyond this threshold. Both systems were examined in the empirical analysis.

## Results

The results emphasize the importance of the destination variables. No origin variable was significant, and the entire regression was insignificant when origin variables were included. The signs on some origin variables were different for different origin provinces. For example, it is not unreasonable that a high unemployment rate might have been a significant inducement for emigration from one province but a significant deterrent to emigration from another. In any event, no single origin variable was a significant determinant of emigration across the full range of origins and migration streams.

Perhaps this is not a surprising finding. Economic and demographic averages are generally poor predictors of emigration. Migrants tend to be a select subset of the population: young and able males, not well off but also not so poor that they have nothing to venture. Province-wide income and unemployment averages are not indicative of these characteristics.

Table 3 shows the empirical results after eliminating the origin variables and correcting for generalized heteroskedasticity. The first column reports the destination variable coefficients associated with scaled index of travel costs. The second column reports the coefficients associated with the distance dummy distinguishing emigration out of the province of origin. Except for this travel cost variable, all destination attributes are the same in both regressions, and all destination attributes are in log form. The table describes the anticipated signs and the statistical significance for each attribute, as well as the estimated

**TABLE 3: Multinomial Discrete Choice Estimates for Destination Attributes**

| Attributes | | Regression Coefficients[a] | | | |
|---|---|---|---|---|---|
| Average household income (pesos/yr) | (+) | 3.310 | *** | 4.005 | *** |
| | | (3.708) | | (4.486) | |
| Average upland household income (pesos/yr) | (+) | −0.011 | | −0.0453 | |
| | | (−0.282) | | (−1.169) | |
| Share of households in bottom 30% of income profile | (−) | −2.867 | *** | −2.448 | *** |
| | | (−3.280) | | (−2.810) | |
| Unemployment rate (%) | (−) | 5.551 | *** | 8.003 | *** |
| | | (2.342) | | (3.384) | |
| Population (1980) | (+) | 1.741 | *** | 1.340 | |
| | | (2.932) | | (1.991) | |
| Upland population density (1980) | (+/−) | −0.343 | | 0.505 | |
| | | (−0.508) | | (0.855) | |
| Arable land ($km^2$) | (+/−) | 0.753 | *** | 0.384 | |
| | | (1.964) | | (1.002) | |
| Forest land area (ha) | (+) | 0.577 | * | 0.154 | |
| | | (1.786) | | (0.477) | |
| Road density in arable uplands ($mi/km^2$) | (−) | −0.690 | *** | −0.915 | *** |
| | | (−2.806) | | (−3.726) | |
| Share of forest land area classified as public (%) | (+) | 0.796 | *** | 0.925 | *** |
| | | (3.719) | | (4.320) | |
| Share of forest land area with > 18% slope (%) | (+) | 1.307 | *** | 1.414 | *** |
| | | (2.860) | | (3.093) | |
| Political unrest dummy (1 for provinces showing political unrest during 1985-90, 0 otherwise) | (−) | −0.0310 | | | |
| | | (−0.101) | | | |
| Travel cost dummy (0 for moves within province of origin, 1 otherwise) | (−) | | | −54.586 | *** |
| | | | | (−54.057) | |
| Travel cost index | (−) | −3.246 | *** | | |
| | | −21.913) | | | |
| Log likelihood | | −292.39 | | −292.39 | |

[a] Expected signs and t statistics in parentheses. ***, **, and * indicate significance at the 0.01, 0.05, and 0.10 level, respectively.

coefficients. Twelve of 13 attributes display expected signs—in both models. Ten are statistically significant in the first regression and eight are significant in the second. A Chow test rejected the hypothesis that the two regressions are significantly different.

The first group of destination attributes refers to income and employment. Average household income is a predictor of expected migrant income at the destination and, as such, is a powerful migration attractant. The uplands are the destination of most migrants, but average upland income is an insignificant predictor, probably because it represents a much smaller population and because most migrants have

less well-formed perceptions of this measure than of the province-wide average household income. The income status of poorer households is also important. Since migrants themselves are not generally well-off, it is reasonable that they would be concerned with the income opportunity of the province's poorer inhabitants. The proportion of households earning less than 30 percent of average provincial household income is a measure of the opportunity of poorer households. A larger proportion earning less than 30 percent reflects poorly on migrant expectations, and deters immigration. Finally, the positive sign on unemployment is surprising. Perhaps higher unemployment rates reflect only the influx of migrants who become engaged in subsistence agricultural activities but who would prefer some market employment.

The second group of destination attributes refers to population. A larger provincial population probably translates into better information held by migrants as they prepare to move. For the upland areas which tend to be the migrants' final destinations, however, population density may be a more important attribute. Higher population density may indicate greater social support, an attractant, or it may indicate less available land, a detractant to immigration. The expected sign on upland population density is uncertain and our empirical results do not improve on the uncertainty.

Agricultural and forest attributes are indicators of resource availability. A larger area of arable land may suggest greater land availability, which may attract migrants, or it may indicate that more land has already been settled, which might detract them. Both regressions indicate that the former argument must dominate. Our expectations for a larger forest land area are unambiguously positive. Larger forest area implies more land available for settlement, and greater opportunity for deforestation and conversion to upland agriculture. The regression coefficients support these expectations.

The remaining agricultural and forest attributes all reflect on the security of claims to the land. Less secure existing claims serve as migration attractants because they indicate greater opportunity for immigrants to extract some claim for themselves. The resulting new claim, however, cannot be very secure, and short-term management and environmental destruction will probably accompany settlement. Lower road densities suggest a larger unroaded and undeveloped interior and greater susceptibility to new settlement. Therefore, the public share of the forest land base is also a migration attractant. Officially, these forest lands with steeper slopes are all public land. The

availability of these public lands is an attractant for migration and an indicator of likely off-site environmental damage that is made more certain by the insecurity of a settler's tenure on forest lands that are nominally public.

The distance and political unrest dummy variables performed as anticipated. Distance and political unrest both detract from migration streams, although the detraction due to political unrest is statistically insignificant and small in magnitude. The first column of results in Table 3 reports the coefficient for travel cost index. It is negative and highly significant—as expected. The regression with one distance dummy indicating a critical threshold at the border of the province of origin performed similarly (column two). The larger coefficient on this distance dummy is due to the dummy's smaller value. An additional regression (not shown) with dummy variables for each distinction in the travel cost index (column 1) displayed no significant difference between distances beyond the boundary of the origin province. This final result lends support to the argument that the strongest felt cost of migration is its deterrent to family communication during holidays.

## Hypothesis tests

A series of hypothesis tests can identify which broad sets of attributes are most important to large-scale migration patterns. Travel cost is clearly a key variable, but the greater interest of this paper is in the relative importance of the various destination attributes. The relative contributions of sets of attributes can be examined by dropping a set, re-estimating the model, and conducting a likelihood ratio test on the difference in parameters between the initial and re-estimated model. Likelihood ratio tests reject the null hypothesis that attributes in the set are unimportant if the value of the likelihood ratio test statistic is large.

Table 4 reports the Chi-square test statistics when each of several attribute sets is removed from the first regression in Table 3. We cannot reject the null hypothesis for the sets of income, population, and general resource availability attributes could not be rejected. The Chi-square test statistic supports the importance of the two poverty attributes (households in the bottom 30 percent of income, and unemployment rate) and of the attributes that reflect upland characteristics alone (upland income, upland population density, roaded arable uplands, government forest land). The Chi-square test statistic for the poverty attributes supports the expectation that the status of poorer households reflects closely on migrants' expectations for their

TABLE 4: Hypothesis Tests (Values of the Chi-square Test Statistic)

| Attribute Set | Destination Attributes Dropped from Model | Test Statistic |
|---|---|---|
| Income | (average income, average upland income) | 0.036 |
| Population | (population, upland pop. density) | 0.036 |
| Poverty | (bottom 30% of income profile, unemployment) | 20.05 * |
| General resource availability | (arable land, total forest land) | 1.88 |
| Upland resource availability | (upland pop. density, roads in arable uplands, public share of forest land) | 67.84 * |

* Indicates significance at the 0.05 level or better.

own potential opportunities. The test statistic on upland attributes (not shown in Table 4) argues that, while general province-wide income, population, and general resource availability attributes are unimportant, more selective upland attributes are important for the choice of a migration destination.

Indeed, the insignificant coefficient on upland income in Table 3, together with the first (income) and fifth (upland) hypothesis tests, encourage a variant on the latter with upland income removed. (The last row of Table 4 reports this Chi-square test statistic.) Altogether, these observations seem to argue that upland resource availability is a more important migration attractant than expected income. This would be a most reasonable finding for immigrants whose subsistence agricultural opportunities are more important than their participation in the cash economy. This last hypothesis test is critical. It confirms our initial expectations that it is the uplands that are attracting migrants, and that regions which display lower population density and larger areas of insecurely tenured lands are especially attractive.

## FINAL JUDGMENTS

We have examined the attributes of alternative destinations in order to learn how they affect choices for migrating populations. Empirical results confirm the expectations that attributes associated with the migrants' expected opportunities determine their choices among alternative destinations, and they highlight the importance of accessible natural resources. Upland income and employment opportunities may be attractive, but the availability of undeveloped land like forests and (developed or undeveloped) land with insecure rights to the existing tenure is particularly important.

This is a crucial insight for policy analysis. Land at the frontier tends to be more fragile and more susceptible to environmental destruction. This is certainly the case for steep upland frontiers. The combination of fragile lands and insecure tenure should raise grave concern for excessive deforestation and for downstream damage to reservoir catchments, prime agricultural land, and the in-shore fisheries. Policies to correct the tenure problem at the frontier will have important positive environmental impacts, especially where the immigration flow is substantial. Policies designed to encourage capital, subsidize energy, or support commercial agriculture or international trade often unintentionally increase unemployment. Therefore, they unintentionally encourage migration and expand environmental damage at the frontier. The proponents of these policies seldom consider their indirect impacts at the frontier, but our results suggest that those impacts can be great where the migration streams are large.

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