Do climate shocks induce migration? The case of Nepal

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Motivation

- Climate change projections suggest increase in temperatures and higher variability of rainfall

  → agricultural production becomes riskier

- Diversification one strategy to reduce income variation

  → migration = diversification across space (and sector)

- Macro- and micro-level evidence on weather shocks as driver of migration conceptualises migration as reaction not ex-ante strategy (often for methodological reasons)

- Nepal:
  - Highly vulnerable to climate change
  - 80% of population depends on farm income and remittances contribute to around 31% of total GDP

This paper:

- How does climate change affect decision for household member to migrate?
  - Disentangle simultaneous effect of weather variation on agricultural production and migration decision.
  - Differentiate between short-term variation of weather and long-term changes in weather patterns that form expectations

  → Differentiate between *ex-ante* and *ex-post* strategy
- Unique dataset that combines detailed migration information and weather data.

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Data

Household survey representative of five rural districts in Nepal collected in July/August 2017 (*N=1000* households)

- Over-sample migrant households (50% of sample)
- Modules on demographics, migration history, current migration, remittances, agriculture, housing, women's empowerment

Sample: households that engage in farming (98% of sample) and most recent migration in years 2016 or 2017 (= 632 households)

Climate data:

- Rainfall: aggregated to dekadal rain at ward level from 1981-2016 (CHIRPS, daily, 0.05 degrees (~5 x 5km))
- Temperature: aggregated to dekadal average, maximum and minimum at ward level from 1979-2016 (ECMWF, daily, 0.75 degrees)

Methodology: Simultaneous equation model

- Migration:

$$P(M_i = 1) = f(Y_i^a, Y_i^{na}, Y_i^{wage}, W_v^{LR}, X_i) + u_i \quad (1)$$

- Agricultural income:

$$Y_i^a = g(M_i, W_v, I_i, Y_i^{na}, Y_i^{wage}, Z_i) + e_i \quad (2)$$

i = household level

M_i = Household has a migrant

Y_i^a = log(Total value of crop production per hectare)

Y_i^{na}, Y_i^{wage} = income from non-agricultural sources (wage or self-employment)

W_v^{LR} = Change in weather patterns in years preceding migration

W_v = weather in year/season of crop production

I_i = Inputs (expenditure on fertilizers etc., land size)

X_i, Z_i = household characteristics (ecological zone, size, demographics of head, past migration, ethnic network)

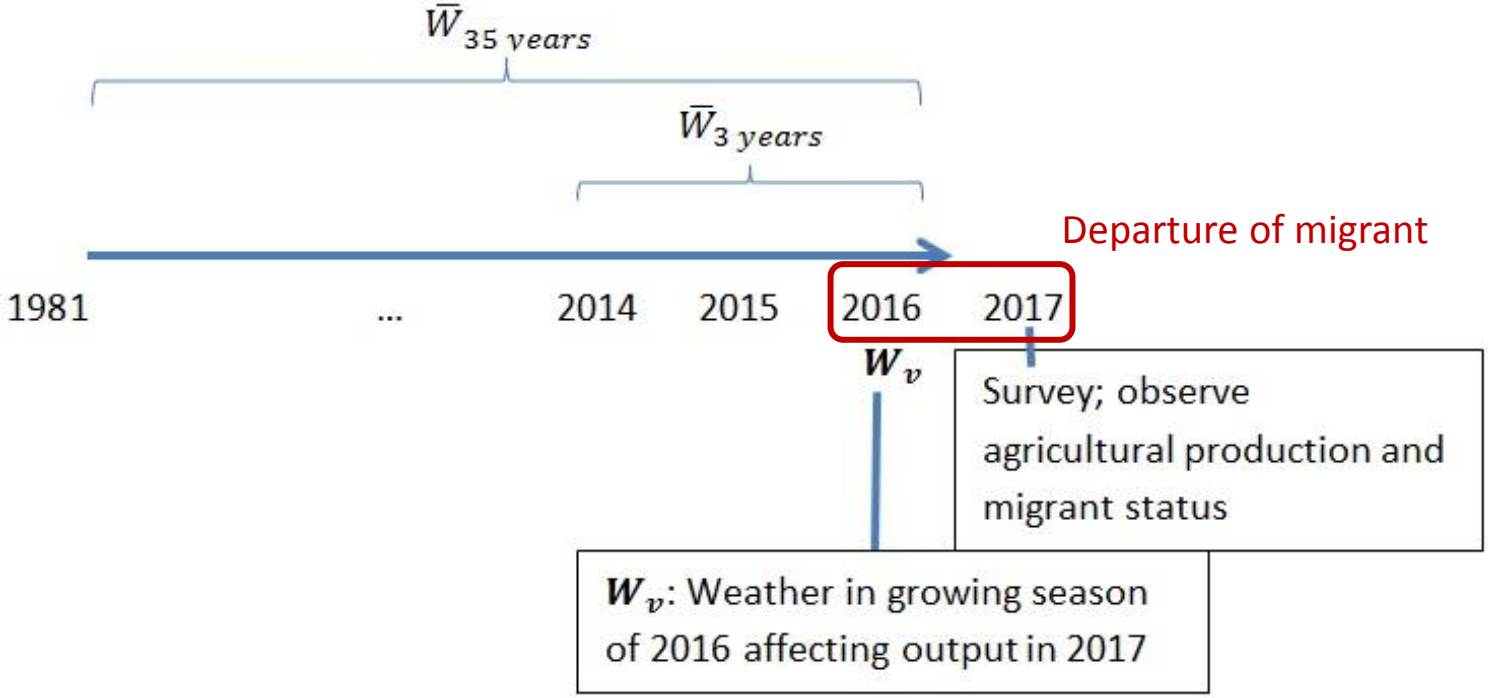
u_i, e_i = error terms, correlated across equations

Data structure and timing

- Weather data: Dekadal *panel* at ward level (1981-2016)
- Household data: *cross-section* in 2017, with retrospective information about year of migration

Changes in more recent years compared to long run weather patterns:

$$W_v^{LR} = \frac{\bar{W}_{3\ years}}{\bar{W}_{35\ years}}$$



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Weather and climate variables

Variables constructed at ward level:

- *Short-term weather (W_v)*: total monsoon rainfall, percentage deviation of monsoon rainfall from long-run average (positive and negative)
- *Long-term changes (W_v^{LR}):* positive and negative percentage deviation of seasonal rainfall or temperature measure in 3-years prior to migration relative to long run (35 years)
  Measures:
  Coefficient of Variation (CoV) of winter/monsoon rainfall, seasonality index, average winter/monsoon rainfall, maximum winter/monsoon temperature

Descriptive statistics: Diversification

Table 1: Summary statistics of main variables in migrant and non-migrant households

	Migrant hhs.	Non-Migrant hhs.	Mean Difference
Non-ag. self-employment income	0.10	0.22	-0.12***
Non-ag. self-employment *share of income*, excluding remittances	0.06	0.13	-0.08***
Non-ag. wage work income	0.19	0.28	-0.09***
Non-ag. wage work *share of income*, excluding remittances	0.12	0.18	-0.05***
No. of observations	470	494	

note: .01 - ***; .05 - **; .1 - *;

Point estimates are sample means. Asterisks represent level of statistical significance of t-test/chi-squared test of difference in means.

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Results: Simultaneous estimation
Part I: Crop production

log(Value of total crop production per hectare)

	coeff.	std.er.
Total rainfall in monsoon, ward	0.176**	(0.084)
squared (Total rainfall in monsoon season, ward)	-0.005*	(0.003)
Percentage deviation of monsoon rainfall from long run monsoon average:		
Positive	0.013*	(0.008)
Negative	0.022	(0.201)
Log(total land cultivated in hectare)	-0.302***	(0.053)
Crop diversity index, count	0.069***	(0.012)
Log(Expenses in 100 rupees per hectare) for:		
Chemical fertilizers, pesticides and herbicides	0.061***	(0.020)
Organic fertilizers	0.009	(0.017)
Hired labor	0.025**	(0.011)
Ecological zone (Hills=1, Terai=0)	-0.043	(0.092)
Number of working-age hh members	0.046**	(0.020)
Member of dominant ethnic group in district	0.102	(0.065)
Constant	10.001***	(0.770)

Results: Simultaneous estimation
Part II: Migration

	Prob(Migrant=1)	
	coeff.	std.er.
Deviation of 3-year average from long run of rain CoV winter		
Absolute positive % deviation	0.033*	(0.017)
Absolute negative % deviation	-0.012*	(0.006)
Non-ag self-employment income, dummy	-0.177	(0.156)
Non-ag wage work income, dummy	-0.275**	(0.128)
Migration of relative of household	0.271**	(0.113)
Asset index (housing characteristics, electricity, water and mode of transport)	0.186	(0.727)
Constant	0.291	(2.052)
coefficient of ag. prod. in migration function	-0.397	(0.245)
coefficient of migrant dummy in ag. prod. function	-0.013	(0.062)
Correlation coefficient between error terms	0.294	(0.199)
Observations	632	
chi2	301.008	

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Results: Part II, Migration
Other weather variables

	Prob(Migrant=1)				
Deviation of 3-year average from long run of:	Seasonality index	avg. rain		avg. max. temp.	
		winter	monsoon	winter	monsoon
Positive % deviation	-0.111***	0.011**	-0.042***	-0.510***	0.567***
	(0.042)	(0.004)	(0.008)	(0.144)	(0.157)
Absolute negative % deviation	0.134***	-0.097***	0.061*	-0.233***	0.000
	(0.025)	(0.016)	(0.036)	(0.055)	(.)
coefficient of ag. prod. in migration function	-0.405*	-0.327	-0.602***	-0.589***	-0.249
coefficient of migrant dummy in ag. prod. function	-0.033	-0.004	-0.048	-0.099	0.041
Correlation coefficient between error terms	0.355**	0.229	0.504***	0.585***	0.101
Other controls	Yes	Yes	Yes	Yes	Yes
Observations	632	632	632	632	632
chi2	478.357	406.911	385.849	335.276	384.856

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Heterogeneity and robustness of results

Heterogeneity:

- Effect of climatic variables is independent of non-agricultural income share
- More income sources dampen the migration probability under climatic change
- Wealth (asset index) dampens the effects of changing weather patterns on migration

Results robust to:

- 5-year instead of 3-year climatic variables

Conclusions

- Migration is used as diversification strategy in response to changing weather patterns, such as increasing variability of rainfall and thus riskier agricultural production.
- Migration seems to be a substitute for non-agricultural income generation, such as self-employment or wage work. This could point at lack of such opportunities where farmers live.
- Temperature increases are much more likely in all climate models as opposed to rainfall changes. Therefore, we can expect increasing rural out-migration in Nepal if no alternative adaptation strategies are found.

Thank you!

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