Labor adaptation to agricultural risk and shocks

Ashenafi Ayenew
Department of Economics
University of Copenhagen

WIDER Conference on Migration and Mobility

Accra, Ghana

October 6, 2017

UNIVERSITY OF COPENHAGEN

Outline

1. Introduction
2. Data
3. Risk and Shock Measures
4. Empirical Strategies
5. Descriptive Statistics
6. Results
7. Robustness Checks
8. Conclusions

1. Introduction

- Labor market activity in SSA is dominated by a highly vulnerable smallholder agriculture
- Formal crop insurance and credit markets are thin in the region (Dercon et al. (2005), Clarke and Dercon (2009))
- Informal risk sharing schemes cannot be relied upon to deal with covariate shocks

- Hence, households rely mainly on *ex ante* and *ex post* self-insurance schemes
  - On-farm adaptations and other mechanisms
- How households adapt family labor has not been well documented in the literature
- To shed light on this, I address two questions:
  1. Do farm households adapt family labor to agricultural risk and shocks? (Occupational adaptation)
  2. If they do so, do they do it locally or elsewhere? (Locational adaptation)

2. Data

I merged two datasets:

- Mozambican National Agricultural Survey (*Trabalho de Inquérito Agrícola* (TIA)) on small and medium-sized farms:
  - Collected by the Ministry of Agriculture of Mozambique in collaboration with Michigan State University
  - A two wave panel survey (2001/2 and 2004/5)
  - Nationally representative of small and medium-sized farm households
  - I constructed a balanced panel of **2936** households living in **407 villages** in all 10 rural provinces of the country for which village centroid GPS coordinates are available

- Gridded **monthly** climate data from Climate Research Unit, University of East Angelia
  - Precipitation (P) and potential evapotranspiration (PET)
  - Has a spatial resolution of 0.5 degrees lat & long
  - Data is available from 1901 to near present, but the actual years used in this study span from **1971 to 2005**

3. Risk and Shock Measures

- Weather risk and shock are used to proxy agricultural risk and shock, respectively
- Weather is defined by monthly water balance **(P-PET)**
- PET is calculated based on monthly maximum, minimum and average temperature, wind speed, vapor pressure and cloud cover (Harris *et al.* (2014))
- WB not only provides a better proxy for agricultural income (Rose(2001), Vicente-Serrano *et al.*(2010)), but also improves the identification of effects (Auffhammer *et al.* (2013))

- Measures are defined over the main growing period
- Which runs from **October to March** in the south and from November to March in the center and north (Silva *et al.* (2015))
- For consistency purposes, I used values from October through March
- Weather risk**:** Coefficient of variation (CV) of water balance in the period 1971 to 2005

- Weather shock: Defined based on the Standardized Precipitation Evapotranspiration Index (SPEI) from the climatology literature on a six months scale

- Construction:

  - Fitting the WB data for each village into a log-logistic distribution

  - Transforming it into a standard normal distribution with **zero** mean and standard deviation of **unity**

- The resulting value, WB shock, is the number of SDs of current WB from the long-term mean

4. Empirical strategies

- *Ex ante* labor adaptation: RE specification:

$$Y_{hvt} = \alpha + \beta CV_v + \delta X_{hvt} + YR_t + C_{hv} + \varepsilon_{hvt} \quad \ldots.(1)$$

- Exogeneous unobserved individual hetrogeneity! Instead, I use the Mundlak's correction (Mundlak(1978), Wooldridge (2010)):

$$C_{hv} = \eta + \theta \bar{X}_{hv} + \alpha_{hv}, \qquad \alpha_{hv} \quad /X_{hv} \sim N(0, \sigma_\alpha^2) \ldots (2)$$

- Variant of RE, Correlated Random Effects (CRE) model

- *Ex post* labor adaptation: Household FE specification:

$$Y_{hvt} = \alpha + \beta W_{vt} + \delta X_{hvt} + YR_t + C_{hv} + \varepsilon_{hvt} \quad \ldots . (3)$$

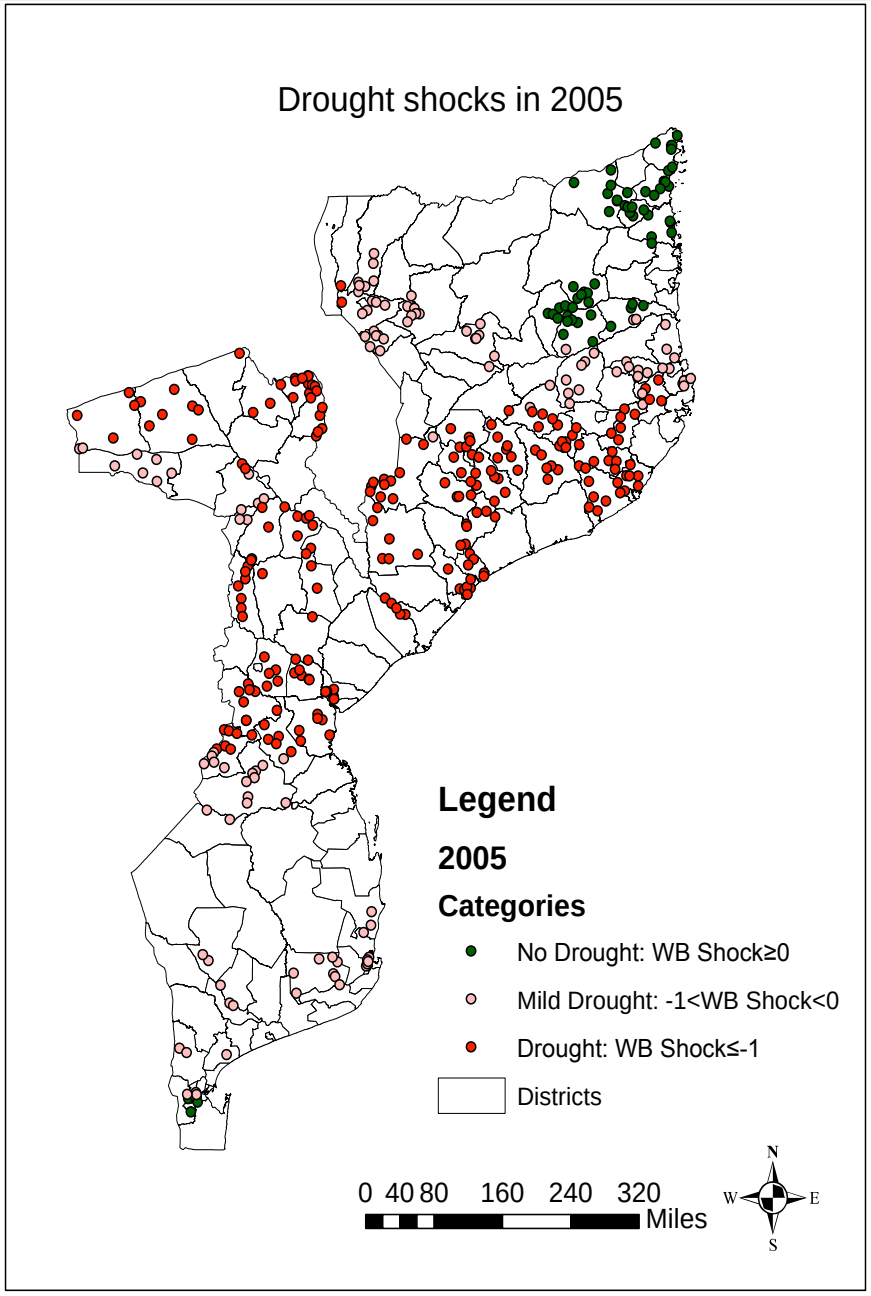
- Once time and location FEs are controlled for, I assume WB shocks are random
- Potential cross-sectional correlations in the two decisions (occupational and locational) within a village
- I clustered the standard errors at the village level. Sufficient number of clusters (Bertrand *et al.* (2004), Wooldridge (2010))

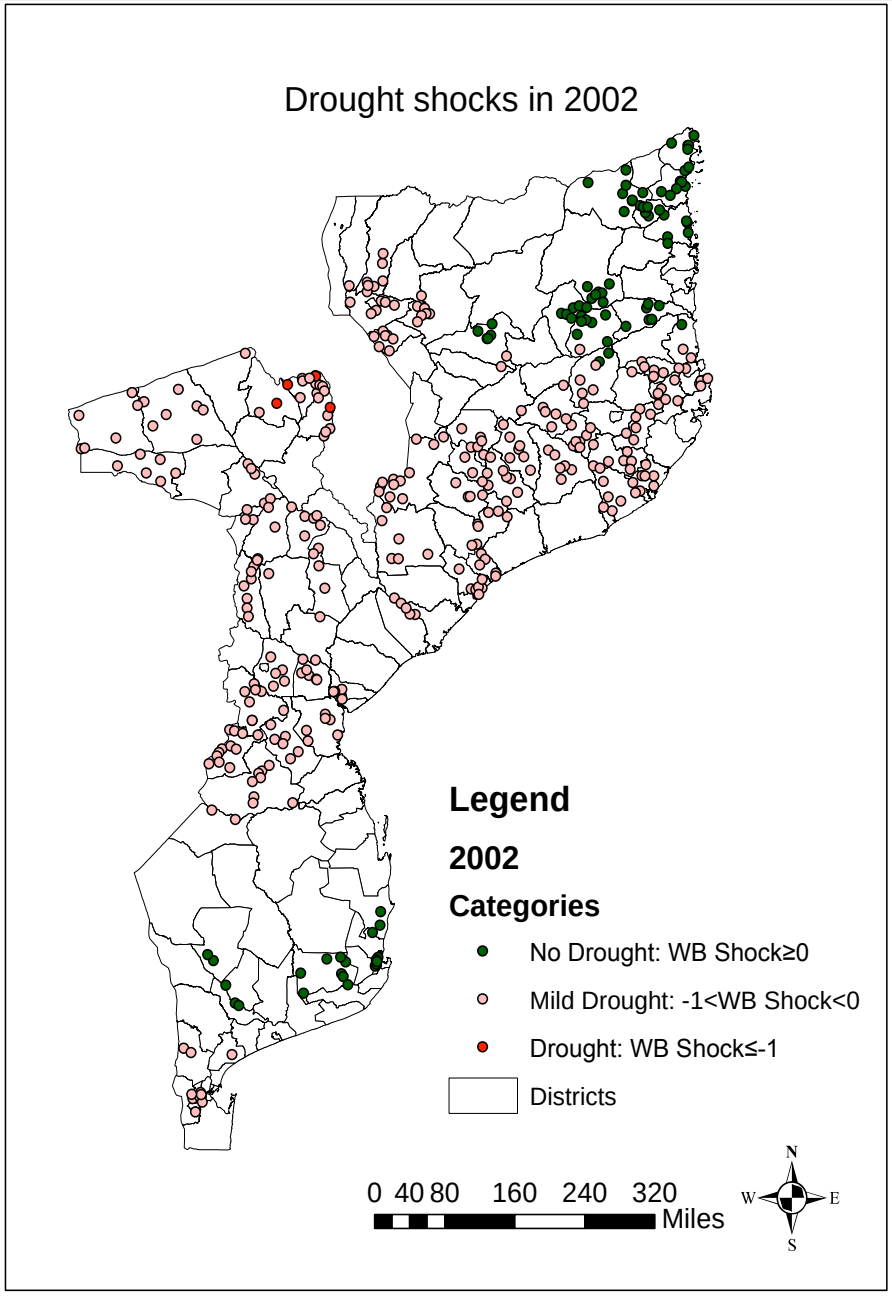
5. Descriptives by survey year

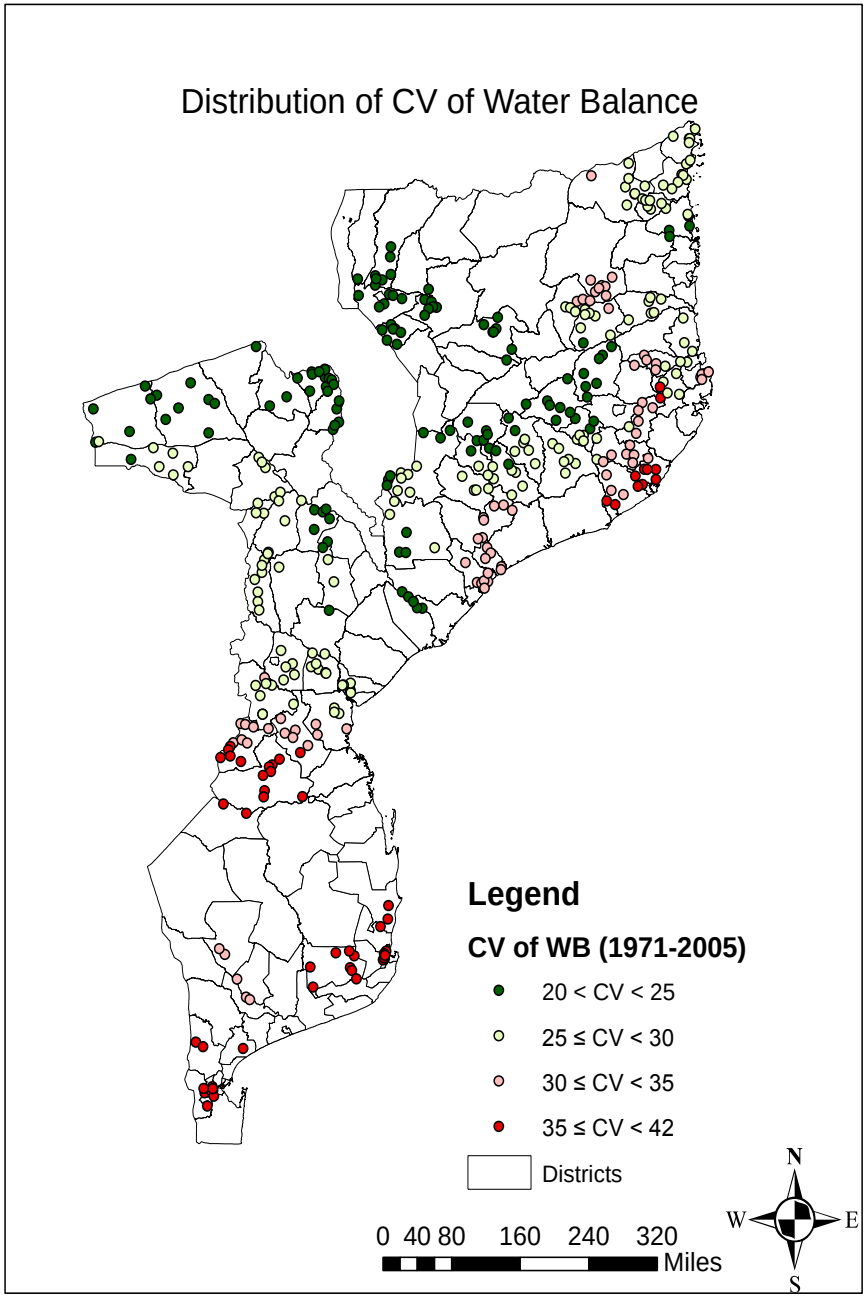
	Survey Year					
	2001/2			2004/5		
Panel (a): Outcome Variables	N	Mean	SD	N	Mean	SD
Self-Employment (SE) in Agriculture (Ag)	2,936	0.990	0.097	2,936	0.995	0.069
Wage Employment (WE) in Ag	2,936	0.073	0.259	2,936	0.177	0.382
Local	2,936	0.050	0.219	2,936	0.146	0.353
Domestic	2,936	0.018	0.134	2,936	0.032	0.175
International	2,936	0.005	0.069	2,936	0.002	0.045
Wage Employment (WE) in Non-Ag	2,936	0.118	0.322	2,936	0.156	0.363
Local	2,936	0.035	0.184	2,936	0.058	0.234
Domestic	2,936	0.066	0.248	2,936	0.078	0.268
International	2,936	0.022	0.148	2,936	0.026	0.160
SE in non-farm businesses	2,936	0.291	0.454	2,936	0.421	0.494
Local	2,936	0.235	0.424	2,936	0.371	0.483
Domestic	2,936	0.058	0.234	2,936	0.065	0.247
International	2,936	0.009	0.095	2,936	0.006	0.076
SE in forestry, fishery and fauna activities	2,936	0.946	0.226	2,936	0.799	0.401
Net crop income	2,936	4650.641	9754.359	2,936	5107.146	11365.830
Net non-crop income	2,936	6529.019	35063.630	2,936	8267.188	32936.540

Panel (b): Risk and Shock Variables

	Survey Year					
	2001/2			2004/5		
	N	Mean	SD	N	Mean	SD
Drought shock (t)	407	0.405	0.301	407	0.905	0.566
Drought shock (t-1)	407	0.009	0.063	407	0.609	0.428
Drought shock (t-2)	407	0.205	0.368	407	0.263	0.374
CV of WB	407	28.386	5.282	407	28.386	5.282


Drought shocks in 2005
Legend
2005
Categories
No Drought: WB Shock≥0
Mild Drought: -1<WB Shock<0
Drought: WB Shock≤-1
Districts
0 40 80 160 240 320
Miles
N
W
E
S


Drought shocks in 2002
Legend
2002
Categories
No Drought: WB Shock≥0
Mild Drought: -1<WB Shock<0
Drought: WB Shock≤-1
Districts
0 40 80 160 240 320
Miles
N
W
E
S


Distribution of CV of Water Balance
Legend
CV of WB (1971-2005)
20 < CV < 25
25 ≤ CV < 30
30 ≤ CV < 35
35 ≤ CV < 42
Districts
0 40 80 160 240 320
Miles
N
W
E
S

6. Results

- Two steps:
  - How good are WB risk and shocks to proxy agriculture?
  - Labor adaptation responses

Table 2:Income effects of weather risk

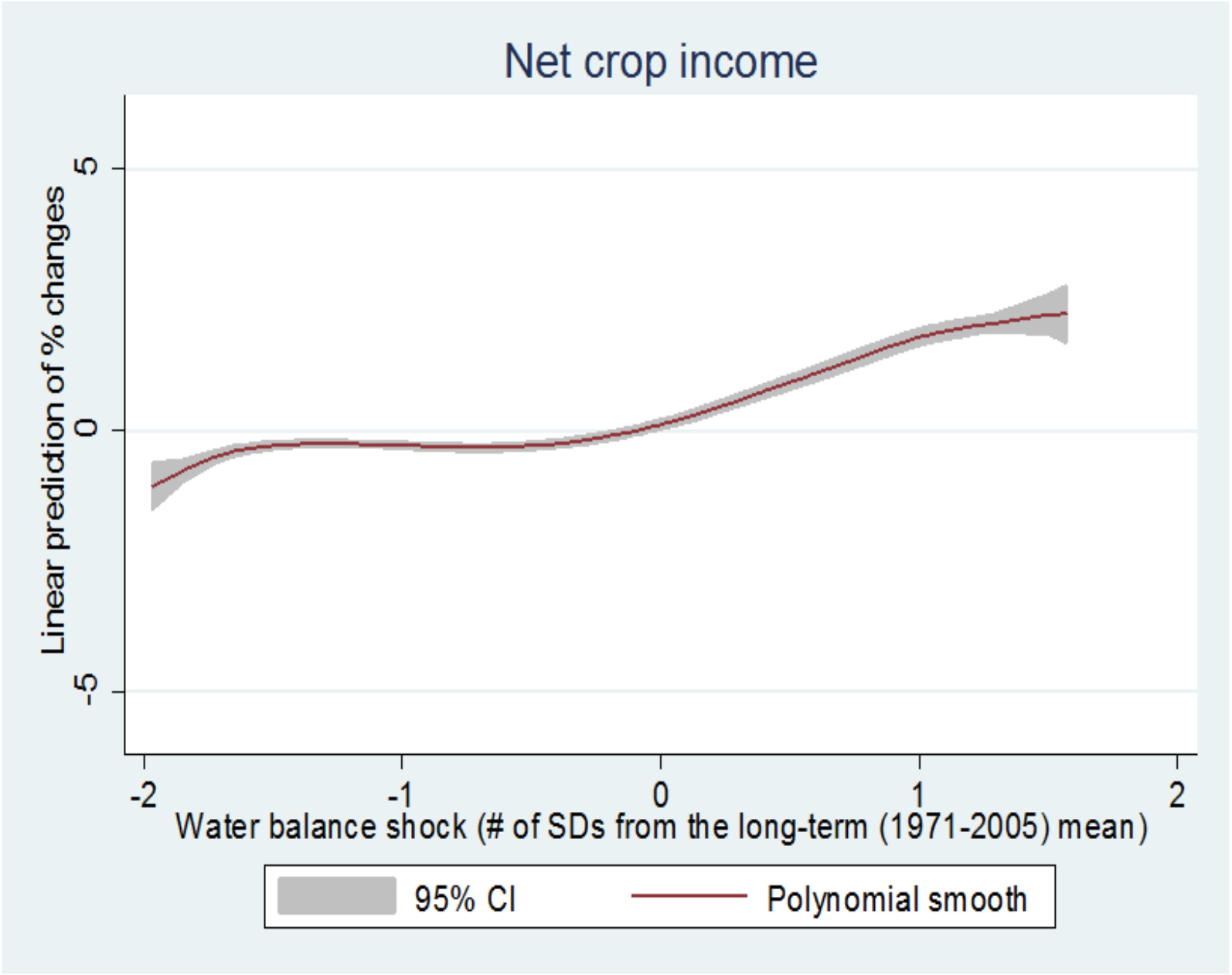
	(1)	(2)	(3)	(1)	(2)	(3)
	log (Crop income)			log (Non-crop income)		
CV of WB	-0.070***	-0.064***	-0.059***	0.082***	0.046***	0.030***
	(0.009)	(0.009)	(0.009)	(0.016)	(0.012)	(0.011)
Constant	9.716***	8.900***	8.528***	3.182***	1.957***	2.172***
	(0.265)	(0.297)	(0.273)	(0.454)	(0.399)	(0.375)
Demog Controls	No	Yes	Yes	No	Yes	Yes
Other Controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.03	0.026	0.059	0.021	0.036	0.07
# of villages	407	406	396	407	406	396
N	5872	5764	5626	5872	5764	5626

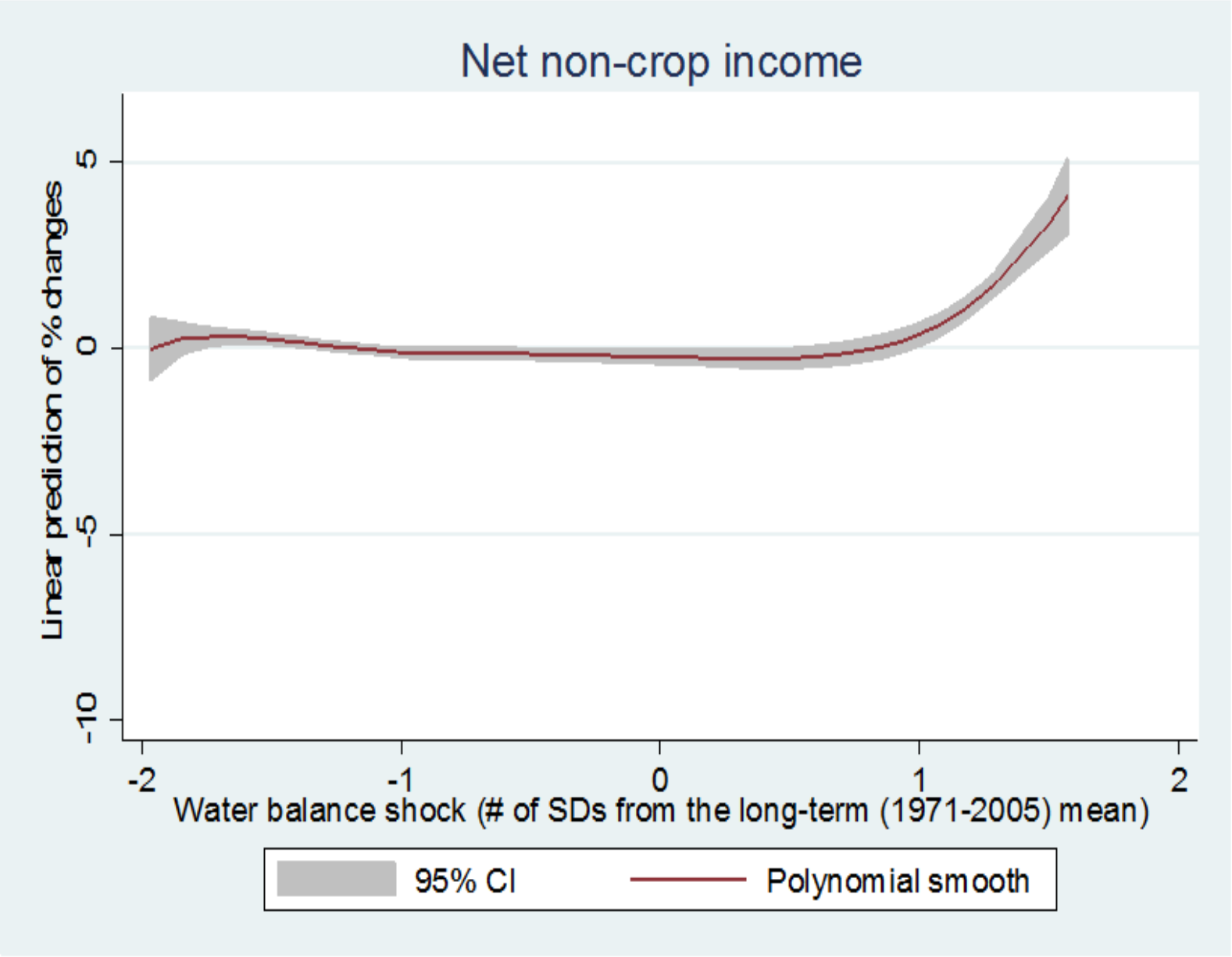
Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 3:The impact of water balance shock on household incomes

	(1)	(2)	(3)	(1)	(2)	(3)
	log (Crop income)			log (Non-crop income)		
WB Shock	0.295*	0.368**	0.304**	-0.132	-0.156	-0.151
	(0.168)	(0.169)	(0.151)	(0.203)	(0.204)	(0.201)
Constant	7.790***	7.379***	7.139***	5.488***	3.740***	3.052***
	(0.064)	(0.377)	(0.352)	(0.075)	(0.687)	(0.679)
Demog Controls	No	Yes	Yes	No	Yes	Yes
Other Controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.033	0.032	0.052	0.021	0.037	0.07
# of Villages	407	406	396	407	406	396
N	5872	5764	5626	5872	5764	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.


Net crop income
Linear prediction of % changes
5
0
-5
-2
-1
0
1
2
Water balance shock (# of SDs from the long-term (1971-2005) mean)
95% CI
Polynomial smooth


Net non-crop income
Linear prediction of % changes
5
0
-5
-10
-2
-1
0
1
2
Water balance shock (# of SDs from the long-term (1971-2005) mean)
95% CI
Polynomial smooth

- Vicente-Serrano *et al.* (2010) and Beguería *et al.* (2014) define **negative water balance shocks** as **droughts**
    - Mckee *et al.* (1993, 1995) use the same definition based on precipitation

Ex ante labor adaptation responses

Table 4: *Ex ante* labor adaptation to water balance risk

	(1)	(2)	(3)	(4)
	WE_Ag	WE_NAg	SE_NFB	SE_FFF
CV of WB	-0.002**	0.006***	0.002	0.002
	(0.001)	(0.001)	(0.002)	(0.001)
Constant	0.217***	-0.228***	0.178***	0.958***
	(0.037)	(0.041)	(0.058)	(0.047)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R-squared	0.061	0.046	0.073	0.115
# of villages	396	396	396	396
N	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 5:Locational differences in households' *ex ante* labor adaptation to water balance risk

	WE_Ag		WE_NAg		SE_NFB	
	L	M	L	M	L	M
CV of WB	-0.003***	0.001	0.001	0.005***	0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Constant	0.195***	0.019	-0.028	-0.215***	0.123**	0.075***
	(0.031)	(0.018)	(0.020)	(0.037)"	(0.057)	(0.026)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.062	0.006	0.023	0.033	0.075	0.012
# of villages	396	396	396	396	396	396
N	5626	5626	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 6:Locational differences in households' *ex ante* labor adaptation trough migration

	WE_Ag_M		WE_NAg_M		SE_NFB_M	
	D	I	D	I	D	I
CV of WB	0.000	0.001**	0.001	0.004***	-0.001*	0.000
	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Constant	0.022	-0.003	-0.091***	-0.129***	0.081***	-0.005
	(0.017)	(0.007)	(0.028)	(0.027)	(0.025)	(0.008)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.007	0.008	0.024	0.017	0.01	0.007
# of villages	396	396	396	396	396	396
N	5626	5626	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Ex post labor adaptation responses

Table 7:Labor adaptation to drought shock

	(1)	(2)	(3)	(4)
	WE_Ag	WE_NAg	SE_NFB	SE_FFF
Drought	-0.026	0.062***	0.002	-0.230***
	(0.027)	(0.021)	(0.032)	(0.045)
Constant	0.067	-0.048	0.249***	1.029***
	(0.070)	(0.074)	(0.091)	(0.073)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
R-squared	0.062	0.05	0.073	0.151
# of villages	396	396	396	396
N	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 8:Locational differences in households' *ex post* labor adaptation

	WE_Ag		WE_NAg		SE_NFB	
	L	M	L	M	L	M
Drought	-0.021	-0.007	0.011	0.056***	0.008	-0.007
	(0.026)	(0.011)	(0.015)	(0.015)	(0.031)	(0.014)
Constant	0.049	0.014	-0.047	-0.024	0.186**	0.035
	(0.059)	(0.040)	(0.045)	(0.068)	(0.085)	(0.057)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.062	0.006	0.023	0.038	0.075	0.012
# of villages	396	396	396	396	396	396
N	5626	5626	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 9:Locational differences in hhs' *ex post* labor adaptation through migration

	WE_Ag_M		WE_NAg_M		SE_NFB_M	
	D	I	D	I	D	I
Drought	-0.011	0.003	0.035**	0.023***	-0.011	0.004
	(0.012)	(0.003)"	(0.014)	(0.008)	(0.013)	(0.004)
Constant	0.023	-0.009	-0.026	-0.012	0.032	0.005
	(0.038)	(0.011)	(0.056)	(0.042)	(0.055)	(0.014)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.007	0.008	0.026	0.019	0.009	0.008
# of villages	396	396	396	396	396	396
N	5626	5626	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Medium term *ex post* labor adaptation?

Table 10: *Ex post* labor adaptation to medium term drought shocks

	(1)	(2)	(3)	(4)
	WE_Ag	WE_NAg	SE_NFB	SE_FFF
Drought (t)	-0.048	0.063***	0.032	-0.271***
	(0.030)	(0.023)	(0.035)	(0.052)
Drought (t-1)	-0.006	0.003	-0.004	-0.119***
	(0.024)	(0.021)	(0.031)	(0.035)
Drought (t-2)	-0.053***	0.002	0.084***	-0.034
	(0.016)	(0.012)	(0.021)	(0.023)
Constant	0.098	-0.049	0.198**	1.040***
	(0.071)	(0.074)	(0.091)	(0.071)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
R-squared	0.066	0.05	0.079	0.162
# of villages	396	396	396	396
N	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 11: Locational differences in *ex post* labor adaptation to medium term drought shocks

	WE_Ag		WE_NAg		SE_NFB	
	L	M	L	M	L	M
Drought (t)	-0.041	-0.008	0.016	0.054***	0.036	-0.002
	(0.029)	(0.012)	(0.017)	(0.017)	(0.034)	(0.015)
Drought (t-1)	-0.007	0.003	0.025*	-0.018	-0.01	0.004
	(0.024)	(0.010)	(0.014)	(0.016)	(0.029)	(0.017)
Drought (t-2)	-0.048***	-0.003	-0.004	0.005	0.078***	0.011
	(0.016)	(0.006)	(0.008)	(0.010)	(0.020)	(0.011)
Constant	0.077	0.016	-0.043	-0.029	0.138	0.029
	(0.059)	(0.040)	(0.045)	(0.068)	(0.084)	(0.057)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.066	0.006	0.025	0.039	0.081	0.013
# of villages	396	396	396	396	396	396
N	5626	5626	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

Table 12:Locational differences in hhs' *ex post* labor adaptation through migration

	WE_Ag_M		WE_NAg_M		SE_NFB_M	
	D	I	D	I	D	I
Drought (t)	-0.012	0.004	0.037**	0.018*	-0.004	0.003
	(0.014)	(0.004)	(0.015)	(0.009)	(0.014)	(0.005)
Drought (t-1)	-0.001	0.004	0.002	-0.026	0.013	-0.007
	(0.011)	(0.005)	(0.013)	(0.016)	(0.015)	(0.008)
Drought (t-2)	-0.003	0.000	0.003	0.004	0.01	0.002
	(0.006)	(0.002)	(0.008)	(0.006)	(0.010)	(0.004)
Constant	0.024	-0.009	-0.028	-0.017	0.027	0.004
	(0.038)	(0.011)	(0.056)	(0.043)	(0.055)	(0.014)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.007	0.009	0.026	0.023	0.01	0.008
# of villages	396	396	396	396	396	396
N	5626	5626	5626	5626	5626	5626

Notes: Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. Standard errors are clustered at the village level and reported in parenthesis.

- Local WE_Ag?

- World bank (2006; 2008) explain that ***Ganho-Ganho*** *serves* as an insurance to poorer households during shocks

- Specifically, World Bank (2008, p.49) writes:

  - In rural areas (of Mozambique), coping usually includes casual day labor—often referred locally as *ganho-ganho*—on someone's farm in exchange for food or money. Although *ganho-ganho* is also practiced in normal times, it takes on particular importance as a coping strategy in times of shocks and stress, when few regular activities are available to the poor.

Table 13:Households' labor adaptation in local salaried agricultural activities

	WE_Ag_L		
	Unskilled	Unskilled	Skilled
	HH farms	Commercial Farms	
Drought (t)	-0.032	0.000	-0.009
	(0.026)	(0.009)	(0.006)
Drought (t-1)	0.007	-0.008	-0.006
	(0.022)	(0.007)	(0.005)
Drought (t-2)	-0.043***	-0.003	0.000
	(0.015)	(0.003)	(0.003)
Constant	0.086*	-0.017	0.002
	(0.050)	(0.018)	(0.025)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Household FE	Yes	Yes	Yes
R-squared	0.065	0.006	0.007
# of villages	396	396	396
N	5626	5626	5626

Notes: Skilled labor refers to labor employed by the government, NGOs, factories, etc. Standard errors are clustered at the village level and reported in parenthesis. Asterisks: *, ** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.

7. Robustness Checks

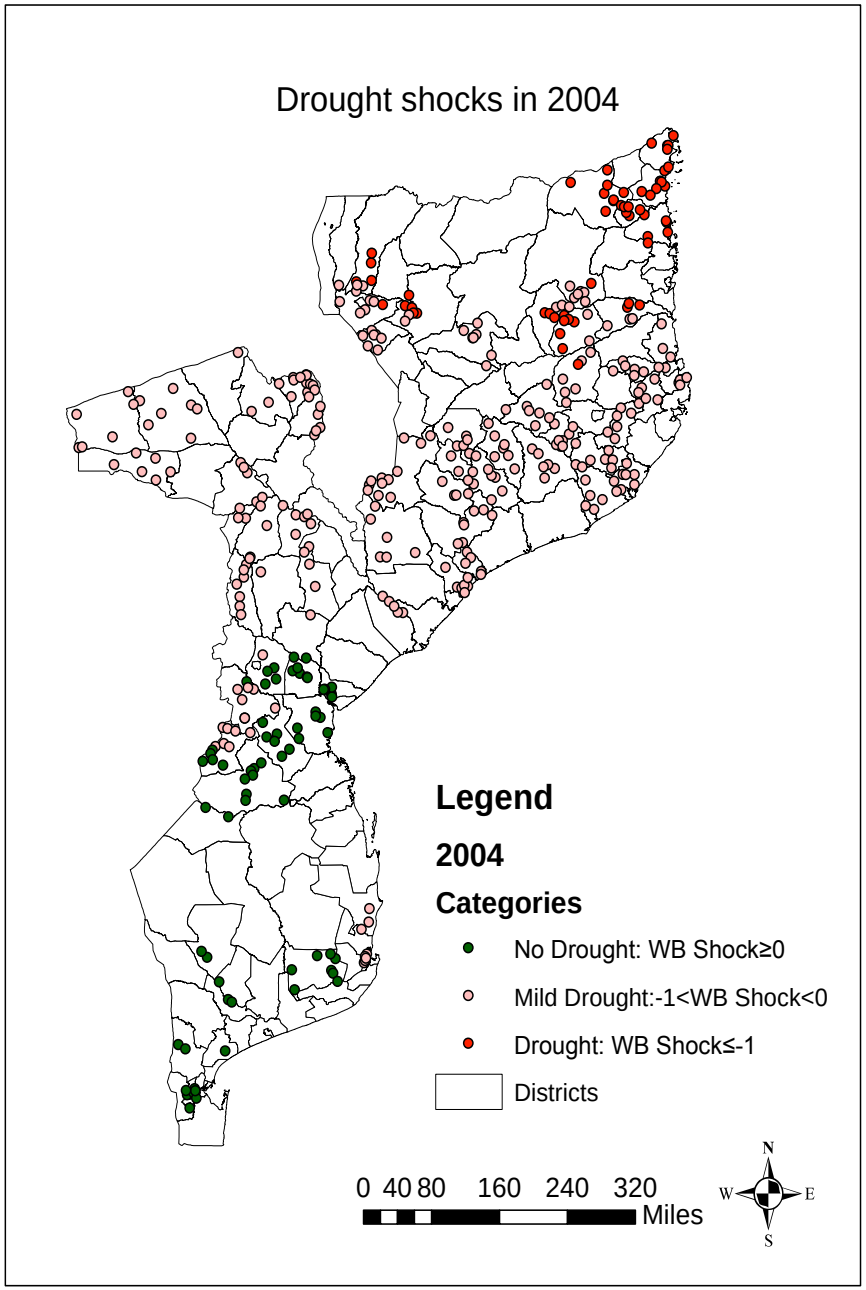
1. Likely endogeneous covariates
2. Nonlinear Models (CREP and Conditional logit)
3. Alternative definition of the growing period: October through March in the south and November through March in the north, and used (1) and (2) aswell

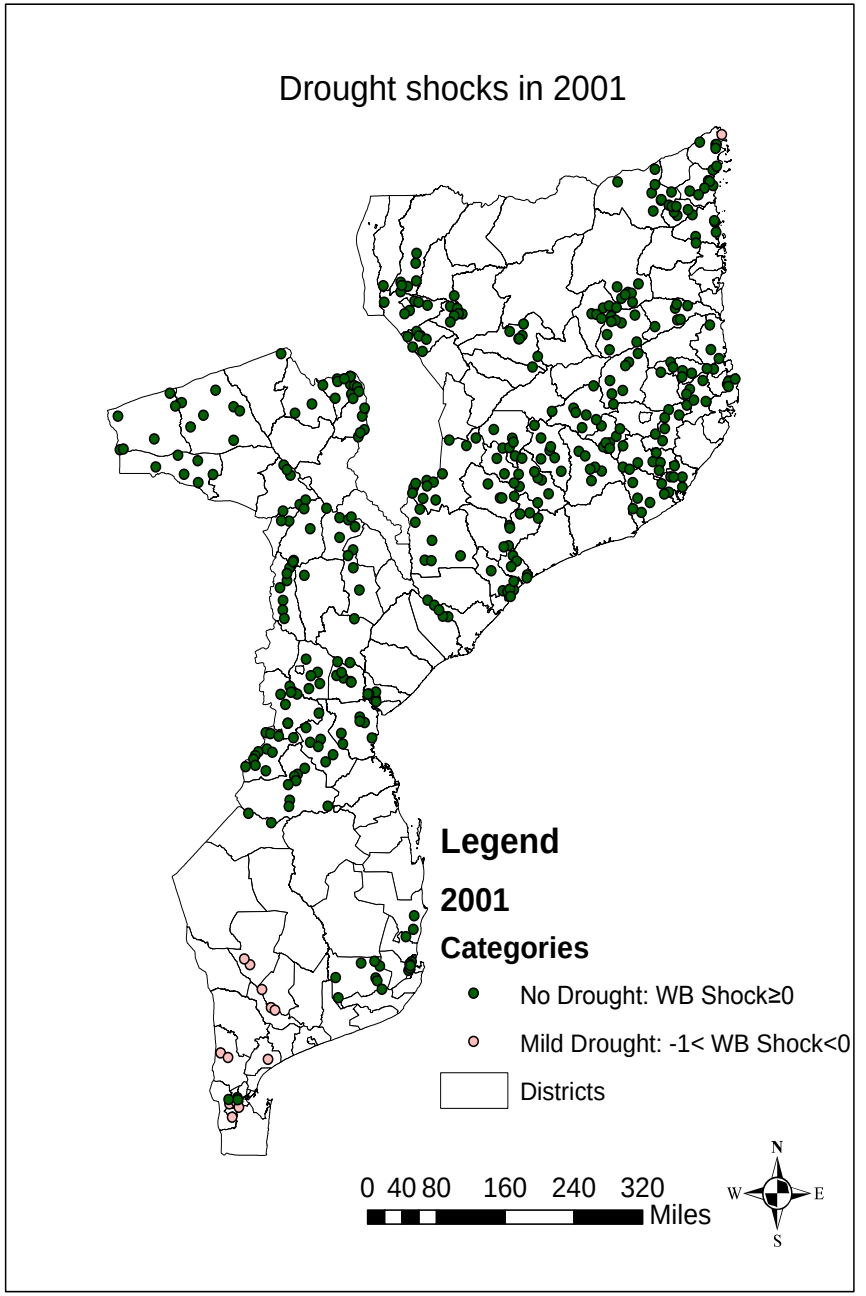
8. Conclusions

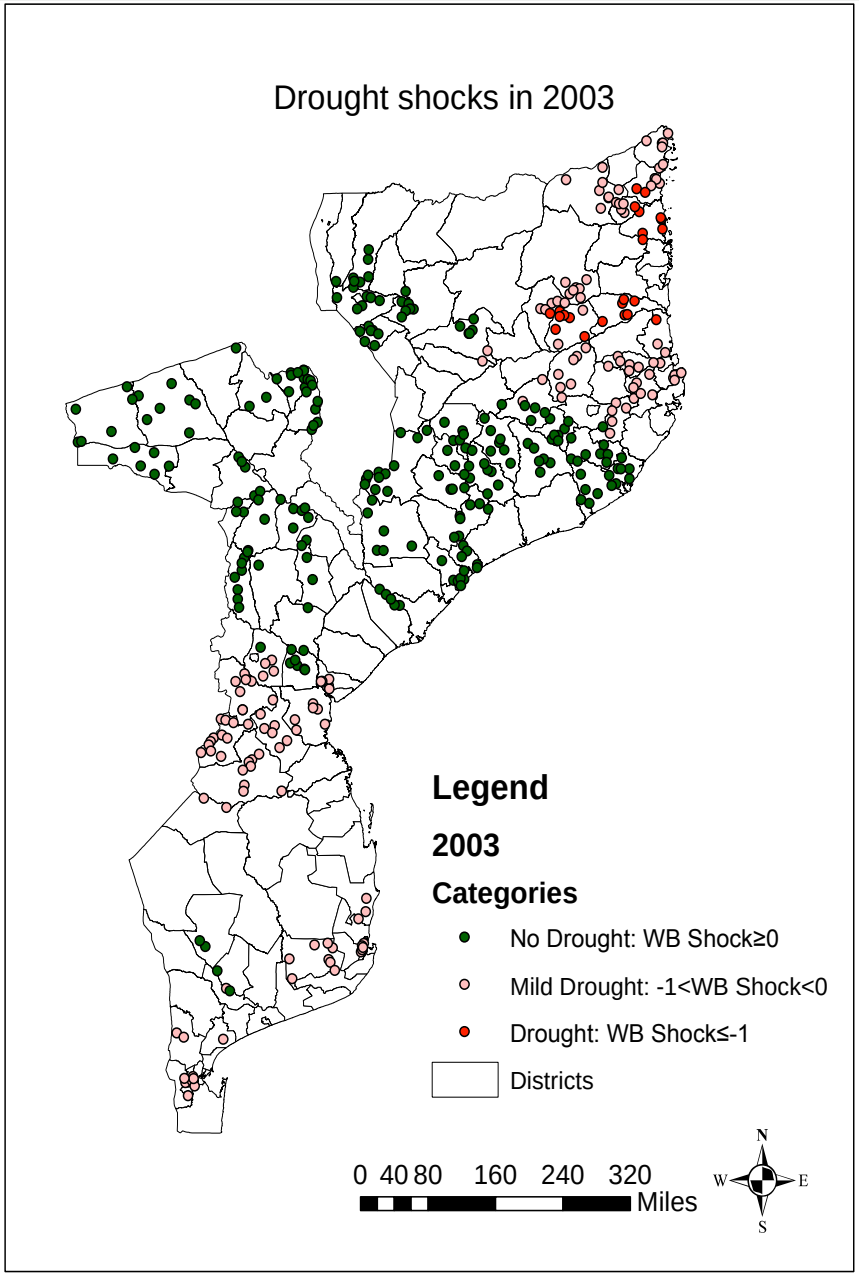
- Suggestive evidence that households engage in *ex ante* labor adaptation by sending out members internationally
- *Ex post* labor adaptation involves both domestic and international migration contemporaneously
- However, it takes place locally after one and two periods after agricultural income shocks

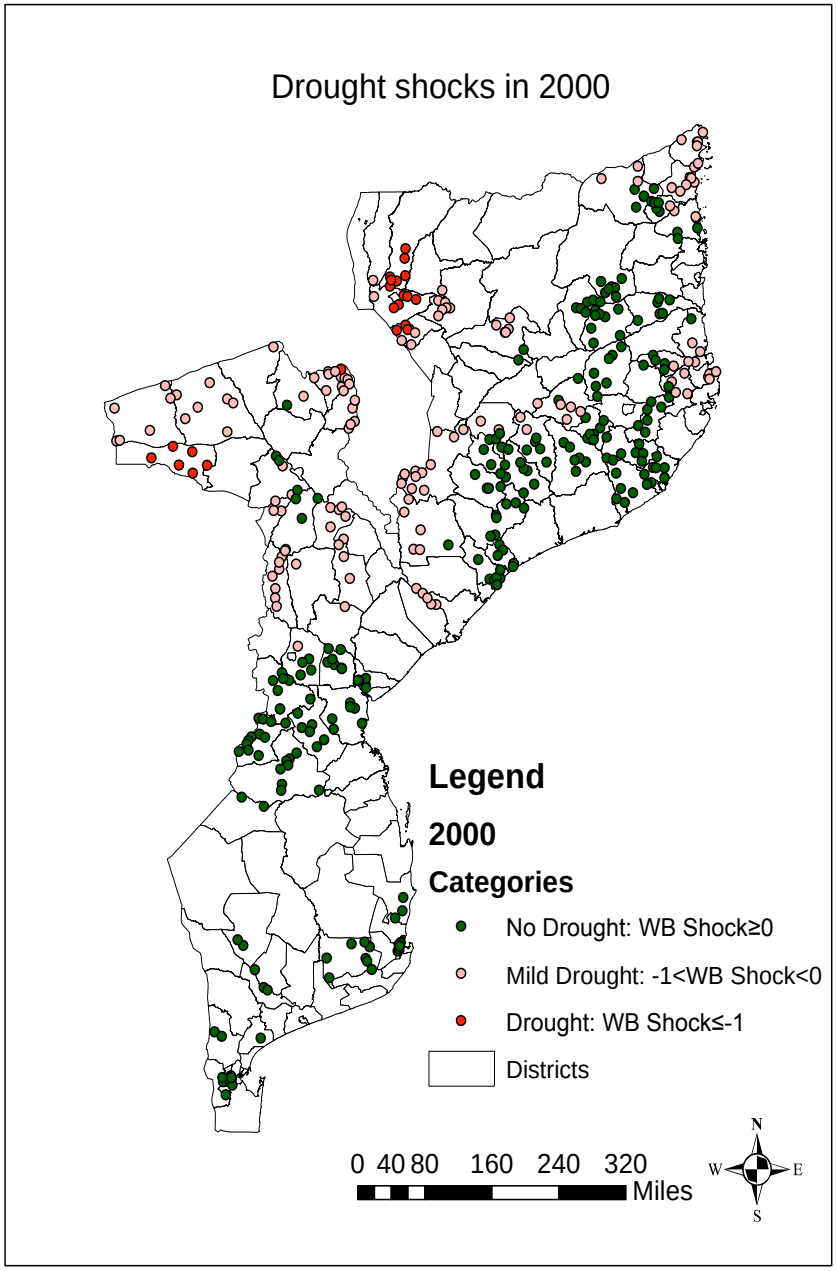
- Good news, that households adapt family labor
- Help them smooth income (potential consumption)
- With potential increases in agricultural risk and shocks (IPCC (2014)), the results suggest increased local movement out of agriculture and migration could result as households adapt family labor
- This may eventually stress the existing limited rural resources and urban labor market opportunities

Thank you!


Drought shocks in 2004
Legend
2004
Categories
No Drought: WB Shock≥0
Mild Drought:-1<WB Shock<0
Drought: WB Shock≤-1
Districts
0 40 80 160 240 320
Miles
N
W
E
S


Drought shocks in 2001
Legend
2001
Categories
No Drought: WB Shock≥0
Mild Drought: -1< WB Shock<0
Districts
0 40 80 160 240 320
Miles
N
W
E
S


Drought shocks in 2003
Legend
2003
Categories
No Drought: WB Shock≥0
Mild Drought: -1<WB Shock<0
Drought: WB Shock≤-1
Districts
0 40 80 160 240 320
Miles
N
W
E
S


Drought shocks in 2000
Legend
2000
Categories
No Drought: WB Shock≥0
Mild Drought: -1<WB Shock<0
Drought: WB Shock≤-1
Districts
0 40 80 160 240 320
Miles
N
W
E
S

Panel (C): Control Variables

	Survey Year					
	2001/2			2004/5		
	N	Mean	SD	N	Mean	SD
=1 Male Head	2,936	0.783	0.412	2,936	0.753	0.431
Head Age	2,934	42.878	14.527	2,935	45.276	14.482
Head Education	2,932	2.223	2.406	2,936	2.630	2.626
Household Size	2,936	5.503	3.140	2,936	5.902	3.488
Young Dependents	2,934	2.628	2.109	2,935	2.805	2.240
Elderly Dependents	2,934	0.146	0.406	2,935	0.663	1.186
Land Size	2,936	2.329	3.999	2,888	2.425	2.783
Asset Index	2,936	0.447	0.316	2,936	0.465	0.330
=1 HH Owns Bicycle	2,936	0.286	0.452	2,928	0.369	0.482
=1 HH Used Animal Traction	2,936	0.162	0.369	2,928	0.003	0.052
=1 HH Received Extension Service	2,936	0.158	0.365	2,928	0.178	0.382
=1 HH is Farmers' Association Member	2,936	0.047	0.212	2,928	0.080	0.272
=1 Village has Electricity	407	0.081	0.273	397	0.194	0.396

Notes: Incomes in panel (a) are all expressed (in real terms) in 2005 *Meticais da Nova Familia* (MTN).