Do Remittances Reach Households Living in Unfavorable Climate Areas? Evidence from the Republic of Yemen

George Joseph and Quentin Wodon and Brian Blankespoor

World Bank

June 2014

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This paper is forthcoming in:
Wodon, Q., A. Liverani, G. Joseph and N. Bougnoux, 2014 editors, *Climate Change and Migration: Evidence from the Middle East and North Africa*, Washington, DC: The World Bank.

Abstract

There is evidence in the literature that migration and remittances tend to increase in response to climate shocks, so that both may function as coping mechanisms. It is not clear however whether remittances are likely to be higher in areas that suffer from poor climate in the absence of weather shocks. This chapter uses a nationally representative household survey for Yemen combined with weather data to measure remittance flows, both domestic and international, and assess the likelihood of households receiving remittances as well as the amounts received. We are interested in testing whether households living in less favorable areas in terms of climate (as measured through higher temperatures, lower rainfalls, more variability or seasonality in both, and larger differences in a given year between extreme temperatures) are more likely to benefit from remittances. The results suggest that this does not seem to be the case in Yemen.

1. Introduction

Cross-country and country studies suggest that migration and remittances tend to increase in response to climate and other shocks, with remittances helping households to cope with the effect of the shocks (World Bank, 2006). While private international capital flows tend to dry up after such shocks, remittance flows tend to increase or at least remain stable after natural disasters, as well as macroeconomic or financial crises and armed conflicts (e.g., Clarke and Wallsten, 2004; World Bank, 2006; Weiss, Fagen and Bump, 2005). Yang (2007) provides cross-country evidence on the response of international financial flows to hurricanes, and concludes that for poorer countries, increased hurricane exposure is associated with greater remittance flows. In the Caribbean, a one percent decrease in real gross domestic product may be associated with a three percent increase in migrant remittances with a two-year lag (Mishra 2005).

Evidence from household surveys also indicates that households use both migration and remittances as coping strategies in response to climate shocks. Migration flows increased in the aftermath of disasters in Jamaica in 1989, after hurricane Gilbert and in Central America in 1998, and after hurricane Mitch (Wisner, 2003). In El Salvador, an agricultural shock increases the probability of migration of a household member to the United States by 24.3 percent (Halliday 2006). Studies using household survey data also confirm the consumption smoothing role played by remittances in recipient households (Quartey and Blankson, 2004). Yang and Choi (2006) show for the Philippines that remittances help to compensate for nearly 65 percent of the loss in income due to rainfall shocks. Increased remittances helped to smooth household consumption and compensate for the loss of assets after an earthquake in El Salvador in 2001 (Halliday 2006). A survey of households in four villages in Pakistan after the devastating earthquake in 2005 reveals that migrant remittances were important factors in disaster recovery and reconstruction (Suleri and Savage, 2006). Remittance-receiving households in the Aceh region of Indonesia were found to have recovered faster from the 2004 Tsunami because of immediate relief provided by migrant remittances, although remittance transfers were adversely affected due to the disruption of financial services and informal remittance transfer channels (Wu 2006). Konseiga (2005) finds evidence of migration to Cote d'Ivoire and resulting remittances used as a survival strategy in drought prone areas in North Eastern Burkina Faso.

Despite the emerging consensus in the literature that migration and remittances are indeed part of an overall livelihood strategy by which households try to insure against shocks in disaster prone regions, there is less evidence on whether households use migration and receive remittances as part of a livelihood strategy in regions prone to slow onset disasters, or more generally adverse weather conditions as opposed to specific climate shocks. Said differently, it is not clear whether remittances are likely to be higher in areas that suffer from poor climate in the absence of specific major climate shocks. On the one hand, households in such areas often are poorer and thus need support, which may be an incentive for migrants to remit. But such households also have limited means to send migrants away, especially internationally, and thus may not benefit from as large flows of remittances than households living in regions with better climate. In addition, migrants from unfavorable climate regions are also less likely to be well educated and may thus have lower earning potential, which may in turn limit their ability to remit.

By combining a nationally representative household survey with climate and geographic data, this chapter tests whether in Yemen remittance flows, both domestic and international, benefit more those households located in areas with unfavorable climate than households living in better climate areas. This is done both with and without controls for household characteristics that may affect remittances, but may also be endogenous – a fact that is often brushed aside in empirical work on remittances.

Yemen is an interesting case study for such work, given that it is highly vulnerable to the vagaries of weather. This is suggested not only by historical patterns of climatic variability, but also by extreme levels of water scarcity and high economic reliance on water dependent sectors such as agriculture and fisheries. The topography of the country is highly diverse, with coastal plains where the population is concentrated, a mountainous interior, and upland deserts to the north towards the Saudi Arabia border. Annual precipitation in many parts of the country is low, although much higher in the western mountainous highland region. Temperatures are high, with more than occasional extreme values, but they also vary a lot across areas and over the year. While climate models do not all agree on how Yemen's climate is expected to change, there is agreement that temperatures are likely to rise, while rainfall will fall. Due to near complete depletion of groundwater resources, agricultural output is projected to decrease by four percent in the next two decades (World Bank, 2010). For households who will remain in areas with unfavorable climate, the ability to rely on remittances may well therefore be crucial for their livelihoods. Looking at current patterns of remittances is one way to assess whether the hope of steady and substantial remittances flows for households living in 'climate-poor' areas is realistic.

The chapter is structured as follows. Section two presents the data and methodology. Section three presents the estimation of models for the likelihood of receiving remittances and the amounts received, both for domestic and international remittances. A conclusion follows.

2. Data and Methodology

We use the most recently available nationally representative household budget survey implemented in Yemen, whose data were collected in 2005-2006. The survey includes 13,136 households (98,941 individuals) living in 309 of the country's 333 districts. Apart from the location of households, the survey provides information on a wide range of socio-economic characteristics including among others demographics, education, health and anthropometrics, employment and occupation, consumption and assets, and income including remittances. Data are available on both domestic and international remittances.

Beyond the household survey, and based on the location of households proxied through the most populous city in the district in which the household lives, we also use information on the distance between the household/district location and the coast, as well as the distance to the nearest airport. These distances are calculated using an Euclidean distance function in ESRI ArcGIS 9.3 software. We also use measures of travel time to the nearest city with a population of at least 100,000 using a methodology developed from Nelson (2008) with regionally specific information (World Bank, 2011). The percentage of irrigated land is taken from Global Map of Irrigated Areas version 4 (Siebert et al., 2005; Siebert et al., 2006). Weather district level data on annual mean temperature and rainfall and their variability/seasonality are collected from BIOCLIM (Busby, 1991). All weather variables are computed on observations for the period 1990 to 2000. We also include in some specifications governorate dummy variables to control for additional geographic effects operating at a higher level of aggregation than the district.

The estimation method – a standard Heckman (1979) selection model – enables us to look at both the likelihood of receiving remittances, and the amount of remittances received. Estimations are provided for domestic and international remittances separately. The Heckman specification allows to control for potential selectivity in who receives remittances. It is however not easy find a variable that affects the probability of receiving remittances and not their amount. One candidate could be the leave-out-mean likelihood of receiving remittances (domestic or international) in the district in which the household lives, which reflects migration networks. However, while this variable certainly affects the likelihood of migrating, it may also affect the amount of remittances received by households. For example, it could be that larger networks may be associated with better employment opportunities at destination, which can, in turn, influence the amounts of remittances sent by the migrants (Munshi, 2003). On the other hand, it could also be that if more migrants are coming to destination areas, they may compete for the same jobs and thereby benefit from lower wages which might reduce the amounts of remittances they are able to send back home. Also, even if networks only influence migration costs and not wages at destination, they might still influence the demand for remittances in migrant-sending households (Carrington et al., 1996; McKenzie and Rapoport, 2010). For this reason, the leave-out-mean is included in our analysis in both the probit on whether households receive remittances, and in the levels regression for the amount of remittances received by households, with the Heckman model simply identified through the non-linearity in the probit equation.

Table 1 provides summary statistics for the variables used in the estimations. Out of the total number of households (13,136), 12,987 are used for the estimation due to missing values for some variables. The number of households receiving remittances is 5,334 (43.63 percent when using sample weights), of which 4,019 (33.90 percent) receive domestic remittances, and 1,920 (14.10 percent) receive international remittances, and 605 (4.38 percent) receive both. 7,653 households (56.37 percent) do not receive any remittances. The average amount of remittances received among households who receive domestic remittances is YER 46,654 (US$ 252 at the average exchange rate in 2004 of US$ 1 = YER 185), while the average amount for international remittances is as expected significantly higher, at YER 218,786 (US$ 1,183). Given low standards of well-being in the country, these are rather substantial transfers.

Table 1: Summary Statistics

	National		Domestic		Int’l		None		Both	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Dependent variables										
Household receiving remittances (%)	43.63	49.6	100	0	0	0	0	0	100	0
Household receiving domestic remittances (%)	33.9	47.3	100	0	31.05	46.28	0	0	100	0
Household receiving international remittances (%)	14.1	34.8	12.91	33.54	0	0	0	0	100	0
Amount of domestic remittances (YER)	15,818	48,255	46,654	73,691	40,761	45,983	0	0	40,761	75,305
Amount of international remittances (YER)	30,851	199,821	148,055	233,514	218,786	492,082	0	0	148,055	635,426
Independent variables – household level										
Rural location (%)	71.7	45.05	78.46	41.11	72.48	44.68	67.61	67.61	74.07	43.86
Household head with no education (%)	55.77	49.67	61.35	48.70	59.73	49.06	51.37	51.37	54.96	49.79
Household head with primary education (%)	12.04	32.55	11.6	32.03	9.87	29.84	12.83	12.83	11.7	32.16
Household head with middle school education (%)	11.3	31.66	9.69	29.59	12.07	32.59	12.32	12.32	14.61	35.35
Household head with high school education (%)	9.34	29.10	8.04	27.19	7.13	25.74	10.54	10.54	7.61	26.55
Household head with tertiary education (%)	8.9	28.48	5.99	23.74	7.25	25.94	10.91	10.91	6.9	25.37
Household members above 21 with middle school (%)	10.65	20.88	8.83	19.43	10.87	20.15	11.71	11.71	11.09	20.48
Household members above 21 with high school (%)	8.82	18.62	7.81	17.90	8.86	18.74	9.48	9.48	9.63	20.94
Household members above 21 with tertiary (%)	6.27	17.33	4.64	14.92	5.35	16.33	7.41	7.41	5.42	17.46
Cultivating household with land (%)	52.1	49.96	58.48	49.28	50.48	50.01	48.63	48.63	51.57	50.02
Household owns livestock (%)	60.6	48.87	64.4	47.89	61.01	48.79	58.16	58.16	59.93	49.05
Indebted household (%)	53.96	49.85	61.58	48.65	46.66	49.90	51.34	51.34	55.74	49.71
Independent variables – district level										
Leave-out-mean international migrants (%)	0.14	0.14	0.15	0.15	0.27	0.20	0.12	0.12	0.29	0.21
Leave-out-mean domestic migrants (%)	0.34	0.28	0.56	0.31	0.36	0.26	0.21	0.21	0.53	0.30
Percentage of irrigated land in the district (%)	4.29	6.40	3.96	7.03	3.1	5.20	4.71	4.71	3.4	6.63
Annual mean temperature (°C)	22.24	4.63	21.61	4.22	22.16	4.35	22.6	22.60	21.66	4.32
Annual mean temperature squared (°C)	516.23	209.39	484.78	188.87	509.84	196.71	534.54	534.54	487.88	193.77
Temperature seasonality (standard deviation*100)	27.85	2.85	27.32	2.63	27.65	2.67	28.19	28.19	27.43	2.57
Temperature seasonality squared	783.85	172.31	753.42	157.17	771.47	155.19	803.34	803.34	759.19	149.39
Annual precipitation (mm)	24.15	13.25	28.25	12.33	24.62	13.99	21.65	21.65	25.21	13.78
Annual precipitation squared (mm)	758.88	680.50	950.23	663.27	801.64	701.48	638.22	638.22	824.78	669.45
Precipitation seasonality (coefficient of variation)	8.4	1.69	8.52	1.50	8.66	1.87	8.29	8.29	8.78	1.73
Precipitation seasonality squared	73.4	29.08	74.83	26.23	78.55	33.26	71.76	71.76	80.11	31.08
Temperature annual range (max-min, °C)	21.53	2.91	22.05	2.67	21.28	2.77	21.28	21.28	21.71	2.91
Travel time to nearest city of 100,000 (minutes)	375.79	334.25	432.94	353.01	441.72	375.32	333.8	333.80	490	420.33
Travel time to the nearest airport (minutes)	348.15	299.67	414.44	327.13	393.7	313.36	303.61	303.61	434.7	344.89
Travel time to the nearest port (minutes)	480.81	337.25	556.04	348.77	537.83	384.56	430.86	430.86	603.87	432.19
Selected other variables not used in the regressions										
Age of the household head (years)	44.71	14.86	45.63	16.20	45.9	15.57	43.96	43.96	46.09	16.62

Number of males above age 15	2.05	1.46	1.83	1.41	2.13	1.51	2.16	2.16	2.08	1.53
Number of children below age 5	1.08	1.15	1.02	1.14	1.02	1.13	1.12	1.12	0.99	1.12
Number of members above 65	0.21	0.49	0.26	0.54	0.22	0.49	0.18	0.18	0.27	0.54
Household size	7.5	3.87	7.03	3.74	7.78	3.88	7.71	7.71	7.41	3.97
Poverty headcount (%)	35.4	45.75	33.88	45.33	31.05	44.05	36.99	31.00	30.76	44.33
Poverty gap (%)	9.73	15.69	9.1	15.19	8.26	15.21	10.39	8.53	9.14	16.48
Squared poverty gap (%)	3.82	8.04	3.53	7.69	3.24	8.18	4.12	3.33	3.74	8.93

Source: Authors' estimation.

Based on the basic statistics provided in table 1, a few facts are worth pointing out. First, the differences in the characteristics of households receiving domestic and international remittances are smaller than one might have expected based on experience in other low income countries (see for example Hildebrandt and McKenzie, 2005). Households receiving international remittances are 'better off' in many dimensions (such as poverty status, education of the household head, land cultivation status, etc.), but not by a whole lot. For example, poverty measures are lower among households receiving international remittances, but the differences are smaller than one might have expected. In general, the fact that poverty measures are relatively high among both domestic and international migrants suggests that migration is likely for the most part to be unskilled (this is related to the relatively low skills employment opportunities that are available for international migrants in nearby oil producing countries of the Gulf region, and especially neighboring Saudi Arabia). In terms of weather variables characterizing the areas in which households live, the differences between households receiving remittances, whether domestic or international, and the national sample are also small.

Turning to the regression methodology, it is important to start by pointing out that in many papers on the determinants of remittances using household survey data, a number of household level variables are included in the correlates. This is however often problematic, because most of the household level correlates are at risk of being endogenous. Consider the correlates included in tables 2 and 3. Whether the household head has a given level of education depends on who the household head is. When households receive remittances, it is typically because they have one or more migrants, and this may well include the household head. This is the case when the husband or father has left the family either temporarily or for a longer period of time in order to increase his earnings through better employment, and thereby help the family members back at home through remittances. In that case, if the wife is then considered as the household head at home in the survey, given that her level of education is often likely to be lower, the level of education of the head depends on the decision of the husband to migrate and send remittances, and is thus endogenous.

The same problem arises, albeit probably in a more diluted way, with the shares of household members above the age of 21 that have various levels of education. But more generally, the type of occupation of the household members at home, and whether they cultivate land, own livestock, or have debts, may all be endogenous. If one were to include additional variables (as is often done) such as poverty status or quintiles of well-being based on consumption, this would clearly depend on the remittances received (or lack thereof). Even if this often ignored in the applied survey-based literature in the drivers of migration and remittances, it is in general difficult to find household socio-economic characteristics that are truly exogenous to the decision of some household members to migrate and send remittances. And while some of these problems are alleviated when the household survey has information on members that were part of the household but have left (see for example Binzel and Assaad, 2011), this is not the case for most surveys, and such information is not available in our data.

This being said, in this chapter our main interest is less on how household level correlates affect whether they receive remittances or not, than on whether remittances reach households that are located in areas with comparatively unfavorable climate. This is why we include in the correlates a large number of district-level variables that were merged with the household survey data and that account for weather (temperature and rainfall), irrigated land characteristics, and location of the districts in which households live. We have quite a few district level variables, and much more so than is typically found in the literature, as well as higher level governorate dummies. Therefore we have the possibility of estimating at least somewhat meaningful models even without household characteristics, even though it must be clear that one could argue that it is problematic to try to explain household level variations with mostly geographic variables. If one considers the models without household level variables as a test for robustness of the results obtained with the model with household controls, then the procedure enables us to test whether the partial correlations observed between remittances and district-level characteristics are indeed robust to the inclusion of household controls or not. To the extent that the results are robust, we can be more confident in the results obtained for the geographic effects. As we will show, the fact that the sign, magnitude, and statistical significance of most of the district-level variables do not change much whether we include household level correlates or not is a good sign of the validity of the estimates for the district-level variables which are the focus of this chapter.

3. Results

Tables 2 and 3 provide the regression estimates (Heckman model) for the likelihood of receiving domestic and international remittances, respectively, as well as the amounts received. This is done with and without regional (governorate) variables as additional controls. The coefficients of the regional dummies are not reported here to save space, but they are available upon request and many of them are statistically significant. Differences in results in the specifications with and without governorate dummies tend to be small.

Consider first the results for domestic remittances without the household level controls in order to focus on the district-level variables. Districts with more irrigated land are less likely to receive remittances. Apart from the migration network variable which has a strong effect on the probability of receiving remittances and several regional dummies that are not shown in the table, this is the only variable for which a statistically significant effect is observed in the probit when no household controls are included[1]. One explanation might be that there is less need for households to send migrants away when more land is available for cultivation, which would reduce remittances. As for the amounts of domestic remittances received, the coefficients of the many of the weather variables are statistically significant either in the specifications with or without regional dummies, and in several cases in both specifications. The coefficients for three of the five weather variables (and their squared values when applicable) suggest that domestic remittances are lower in districts with unfavorable climate. This is the case for higher temperatures (negative impact with regional dummies), higher levels of precipitation (positive impact without regional dummies), and larger differences between minimum and maximum temperatures (negative impact without regional dummies). The coefficients for precipitation seasonality are not statistically significant. The only weather variable which suggests more remittances in climate poor areas is temperature seasonality, for which a higher value is associated with higher remittances. But one could argue that this is counteracted to some extent through the negative correlation between the amount of domestic remittances received and the difference between the maximum and minimum temperature.

[1] As pointed out to us by a referee, it could in theory be that the mean share of the land that is irrigated, as an aggregate outcome of farming decisions taken at the household-level, depends on remittances. This could happen if such remittances were invested in irrigation, or inversely if the receipt of remittances were to worsen the incentives to undertake productive investments. Yet the level of remittances is small and most remittances tend to be used for consumption purpose, with little positive or negative impact on investments. In addition, investments in irrigation tend to be low in general for a range of terrain as well as cultural and agricultural reasons that have little to do with remittances. Finally, the mean irrigated land variable is computed over all households in a given district, as opposed to a Primary Sampling Unit, so that the risk of endogeneity is further reduced.

Table 2: Heckman Selection Model for Domestic Remittances, 2006

	With household level variables				Without household level variables			
	Without regional dummies		With regional dummies (not shown)		Without regional dummies		With regional dummies (not shown)	
	Second Stage: Amounts	First Stage: Probit	Second Stage: Amounts	First Stage: Probit	Second Stage: Amounts	First Stage: Probit	Second Stage: Amounts	First Stage: Probit
Rural	-0.092	0.011	-0.108*	0.020	-0.130***	0.012	-0.114**	0.022
Head with primary education	-0.294***	-0.094	-0.217***	-0.105*				
Head with middle school education	-0.262***	-0.107*	-0.281***	-0.114**				
Head with high school education	-0.247***	-0.174***	-0.270***	-0.176***				
Head with technical education	-0.627***	-0.309**	-0.607***	-0.329**				
Head with tertiary education	-0.303**	-0.319***	-0.268**	-0.322***				
Share of household members above 21 with primary	0.007	-0.166*	-0.087	-0.158*				
Share of household members above 21 with middle school	0.052	-0.235***	0.026	-0.253***				
Share of household members above 21 with high school	0.316**	-0.122	0.260*	-0.125				
Share of household members above 21 with tertiary	0.635***	-0.071	0.465**	-0.081				
Cultivating household with land	-0.001	-0.113***	0.051	-0.110***				
Household owns livestock	-0.052	-0.037	-0.063	-0.042				
Indebted household	-0.208***	0.127***	-0.170***	0.131***				
(Mean) irrigated land (percent)	0.000	-0.007***	-0.003	-0.010***	0.001	-0.006***	-0.002	-0.008***
Annual mean temperature	-0.064	-0.017	-0.248***	-0.017	-0.105	-0.027	-0.280***	-0.016
Annual mean temperature squared	-0.001	0.001	0.006***	0.001	-0.000	0.001	0.007***	0.001
Temperature seasonality (standard deviation*100)	0.568***	-0.003	0.511***	0.021	0.569***	-0.025	0.533***	0.016
Temperature seasonality squared	-0.008***	-0.000	-0.008***	-0.001	-0.008***	0.000	-0.008***	-0.001
Annual precipitation	0.060***	-0.011	-0.015	-0.012	0.065***	-0.007	-0.014	-0.009
Annual precipitation squared	-0.001***	0.000	0.000	0.000	-0.001***	0.000	0.000	0.000
Precipitation seasonality (coefficient of variation)	0.144	0.120	0.116	0.085	0.154	0.114	0.175	0.056
Precipitation seasonality squared	-0.010	-0.006	-0.006	-0.005	-0.011	-0.006	-0.009	-0.003
Temperature annual range (max-min)	-0.335***	0.023	0.008	0.055	-0.344***	0.030	0.007	0.056
Travel time to nearest city of more than 100,000 pop.	-0.002***	-0.000	-0.001**	-0.000	-0.002***	0.000	-0.001**	-0.000
Travel time to the nearest airport	0.000***	0.000	0.001***	0.000	0.000***	0.000	0.001***	0.000
Travel time to the nearest port	0.002***	0.000	0.000	0.000	0.002***	-0.000	0.000	0.000
Leave-out mean migration rate	-1.254***	3.076***	-1.189***	2.963***	-1.330***	3.058***	-1.206***	2.950***
Constant	9.408***	-1.889	5.239*	-2.539	9.891***	-1.915	4.737*	-2.537
Rho	-0.158		-0.062		-0.155		-0.048	
Sigma	1.231		1.177		1.247		1.19	
Lambda	-0.195		-0.074		-0.193		-0.057	
Number of observations	4004	12953	4004	12953	4004	12953	4004	12953

Source: Authors' estimation.

Table 3: Heckman Selection Model for International Remittances, 2006

	With household level variables				Without household level variables			
	Without regional dummies		With regional dummies (not shown)		Without regional dummies		With regional dummies (not shown)	
	Second Stage: Amounts	First Stage: Probit	Second Stage: Amounts	First Stage: Probit	Second Stage: Amounts	First Stage: Probit	Second Stage: Amounts	First Stage: Probit
Rural	-0.128	-0.086**	-0.105	-0.082*	-0.204*	-0.059*	-0.143*	-0.044
Head with primary education	-0.314**	-0.240***	-0.259*	-0.242***				
Head with middle school education	-0.547***	-0.101	-0.448***	-0.107*				
Head with high school education	0.023	-0.400***	0.114	-0.416***				
Head with technical education	-0.408	-0.325*	-0.364	-0.356**				
Head with tertiary education	-0.424**	-0.200**	-0.408*	-0.201**				
Share of household members above 21 with primary	0.042	0.031	-0.110	0.034				
Share of household members above 21 with middle school	0.205	-0.294***	0.093	-0.322***				
Share of household members above 21 with high school	-0.186	0.160	-0.292	0.155				
Share of household members above 21 with tertiary	0.299	-0.141	0.176	-0.173				
Cultivating household with land	0.151*	-0.007	0.204**	0.013				
Household owns livestock	-0.191**	-0.052	-0.183**	-0.052				
Indebted household	-0.484***	-0.118***	-0.373***	-0.117***				
(Mean) irrigated land (percent)	-0.008	-0.009***	-0.003	-0.008***	-0.012	-0.007**	-0.008	-0.006*
Annual mean temperature	0.135	-0.017	0.131	-0.147**	0.093	-0.044	0.011	-0.147**
Annual mean temperature squared	-0.005*	0.000	-0.004	0.004**	-0.004*	0.001	-0.001	0.004**
Temperature seasonality (standard deviation*100)	0.260	0.092	0.438	0.122	0.183	0.078	0.613**	0.126
Temperature seasonality squared	-0.004	-0.002	-0.006	-0.002	-0.002	-0.001	-0.008*	-0.002
Annual precipitation	0.031	-0.017**	-0.019	0.010	0.031	-0.011	0.001	0.014
Annual precipitation squared	-0.000	0.000**	0.000	0.000	-0.000	0.000*	0.001	0.000
Precipitation seasonality (coefficient of variation)	-0.732***	0.007	-0.219	0.060	-0.849***	0.005	-0.436*	0.017
Precipitation seasonality squared	0.034***	0.002	0.013	-0.003	0.041***	0.001	0.026*	-0.000
Temperature annual range (max-min)	-0.050	-0.010	0.004	-0.044	-0.071	-0.018	-0.069	-0.050
Travel time to nearest city of more than 100,000 pop.	0.000	-0.000	0.001	-0.000	0.001	-0.000	0.001	-0.000
Travel time to the nearest airport	-0.000	0.000	0.000	0.000	-0.000*	0.000	0.000	0.000
Travel time to the nearest port	-0.000	0.000	-0.001	0.000	-0.001	0.000	-0.001	0.000
Leave-out mean migration rate	-1.774**	3.140***	-2.183***	2.860***	0.070	3.216***	0.196	2.973***
Constant	14.263***	-2.340*	6.506	-1.783	14.855***	-2.039	3.360	-1.883
Rho	-0.767		-0.804		-0.351		-0.109	
Sigma	1.713		1.721		1.419		1.306	
Lambda	-1.313		-1.384		-0.498		-0.143	
Number of observations	1920	12987	1920	12987	1920	12987	1920	12987

Source: Authors' estimation.

This suggests that unfavorable climate is associated with lower amounts of domestic remittances. We are of course not claiming that climate itself necessarily influences the amounts of remittances received. The mechanisms at work may be much more complex, and are likely to be related in part to the fact that households living in districts with unfavorable climate may be poorer and less educated. In that case, even when households are able to afford the cost of sending migrants (the weather variables where not statistically significant in the probits), the migrants may not be able to send back as large remittances as is the case for migrants from other areas. This is only a speculation, but whatever the reasons for the findings, the fact is that districts with structural disadvantages in terms of their climate receive less domestic remittances. The fact that many of the effects vanish when including regional dummies is not too surprising, given that weather patterns differ between regions, so this does not invalidate the results.

Consider next international remittances. The likelihood of receiving remittances is again lower in districts with a higher share of irrigated land, probably for the same reason as mentioned before. Higher temperatures are also associated with a lower probability of receiving international remittances (this is observed with regional dummies and the positive sign for the quadratic term does not affect the overall sign of the effect.) There is a positive effect on the probability of receiving remittances for the squared value of precipitation but this is only marginally statistically significant. Turning to the amounts received, two of the weather variables have a negative impact: higher temperatures lead to lower amounts received in the specification without regional dummies, and more precipitation seasonality reduces the amounts of remittances in the two specifications with and without regional dummies. In the case of the specification with regional dummies, temperature seasonality is associated with more remittances, but this is the only case where indicators of poorer weather lead to more remittances. The upshot is that overall, households in districts with less favorable climate also tend to be less likely to receive international remittances, and when they do, the amounts received tend to be lower, as observed with domestic remittances.

Do these results remain when adding household level controls? They do, and remarkably so, not only in terms of sign and magnitude, but also in terms of statistical significance. In the case of domestic remittances, all results for the weather variables remain virtually the same when household level controls are added. In the case of international remittances, stability is also observed in most cases, with two exceptions. First, the effect of temperature seasonality on the amounts received in the specification with regional dummies vanishes when household controls are added. Second, the effect of precipitation on the probability of receiving remittances becomes statistically significant in the specification without regional dummies when household controls are added. These two changes both go in the way of our conclusion, which is that climate poor areas are less likely to receive remittances and when they do, receive less of them.

Beyond climatic variables, the other district variables (apart from the leave-out-means) which measure isolation of the districts also have an impact on domestic remittances, but not on international remittances, and the effects are robust to the inclusion of household controls. For domestic remittances, being further away from an airport increases the likelihood of receiving domestic remittances, perhaps because international travel is more difficult. Being further away from an airport or a port also increases the amount of remittances received, possibly for the same reason. But being away from a large city reduces domestic remittances, perhaps because of fewer well paying employment opportunities for domestic migrants in nearby districts.

Finally, for the sake of completeness, it is worth briefly discussing the results for the household controls, even if they must be treated with caution due to the risk of endogeneity. Households in rural areas are as likely to receive remittances as households in urban areas in most cases, but they tend to receive lower amounts, as expected. A higher level of education is associated with both a lower likelihood of receiving remittances, and a lower amount of remittances received – the effects tend to be more often statistically significant for the household head than for the share of household members above the age of 21. The effect on the probability to migrate may reflect the fact that much of Yemen's migration is unskilled, and the effects on the amounts of remittances received may be linked to the fact that households whose members have higher education levels may need remittances less. Households cultivating land are less likely to receive domestic remittances, probably because there is less of a need for members to leave, but are more likely to receive international remittances, perhaps because of a higher ability to pay for the cost of international migration. Households with debts are more likely to benefit from domestic remittances, but the reverse is observed for international remittances. As to the correlation between indebtedness and amounts, it is negative for both forms of remittances. Different rationale might be provided for such results, but again endogeneity may be an issue. As for network effects, when the effects are statistically significant they tend as already mentioned to increase the probability of receiving remittances, but they are negatively correlated with the amount of remittances received for both domestic and international remittances. This would be consistent with a story emphasizing the competition between a larger number of migrants for limited job opportunities (especially in a context of substantial unemployment), which would then reduce the amounts of remittances that they are able to send back home.

4. Conclusion

The literature suggests that migrant remittance flows increase in the aftermath of natural disasters, macroeconomic or financial crises, and act as a safety net for households that have migrants either within or outside the country. Furthermore, there is an emerging consensus that migration and remittances are part of an overall livelihood strategy by which households try to insure against shocks in regions which are prone to natural disasters and adverse weather conditions. Less is known however on whether remittances are likely to be higher in areas that suffer from poor climate more generally, in the absence of specific weather shocks. Assessing whether this is the case is however difficult, because data from household surveys are rarely combined with weather data in order to test the impact of climate on remittance patterns.

Using Yemen's latest nationally representative multi-purpose household survey as well as detailed district-level weather and other data, we have tried to assess whether households living in areas with higher temperatures and lower rainfalls, as well as more variability or seasonality in both, are more likely to benefit from remittances than households living in districts with more favorable climate. The results suggest that in Yemen, both the likelihood of receiving remittances and the amounts of remittances received tend to be lower in districts with unfavorable climate. The effects are especially strong for domestic remittances. This suggests in turn that in areas with unfavorable climate, the ability of household to rely on remittances for their livelihoods or to cope with shocks may be more limited than one might have hoped.

References

Binzel, C. and R. Assaad, 2011, Egyptian Men Working Abroad: Labor Supply Responses by the Women Left Behind, IZA Discussion Papers No. 5589, Institute for the Study of Labor, Bonn.

Busby, J. R., 1991, BIOCLIM—A bioclimate analysis and prediction system, *Plant Prot. Q.* 6:8–9.

Carrington, W. J., E. Detragiache, and T. Vishwanath, 1996, Migration with Endogenous Moving Costs, *American Economic Review* 86(4): 909–930.

Clarke, G. and S. Wallsten, 2004, Do Remittances Protect Household in Developing Countries against Shocks? Evidence from a Natural Disaster in Jamaica, Mimeo, Washington, DC: The World Bank.

Halliday, T., 2006, Migration, risk, and liquidity constraints in El Salvador, *Economic Development and Cultural Change* 54(4): 893–925.

Heckman, J., 1979, Sample selection bias as a specification error, *Econometrica* 47(1): 153–61.

Hildebrandt, N., and D. McKenzie, 2005, The Effects of Migration on Child Health in Mexico, World Bank Policy Research Working Paper 3573, Washington, DC: The World Bank.

Ishra, P., 2005, Macroeconomic Impact of Remittances in the Caribbean, mimeo, Washington, DC: International Monetary Fund.

Konseiga, A., 2007, Household Migration Decisions as Survival Strategy: The Case of Burkina Faso, *Journal of African Economies* 16(2): 198-233.

McKenzie, D., and H. Rapoport, 2010, Self-Selection Patterns in Mexico–U.S. Migration: The Role of Migration Networks, *Review of Economics and Statistics* 92(4): 811–21.

Mishra, P., 2005, Emigration and Brain Drain: Evidence from the Caribbean, IMF Working Paper No. WP/06/25, International Monetary Fund, Washington, DC.

Munshi, K., 2003, Networks in the Modern Economy: Mexican Migrants in the US Labor Market, *Quarterly Journal of Economics* 118(2): 549–599.

Nelson, A., 2008, Travel time to major cities: A global map of Accessibility, Global Environment Monitoring Unit – Joint Research Centre of the European commission, Ispra, Italy. Available at: http://gem.jrc.ec.europa.eu

Quartey, P., and T. Blankson, 2004, Do Migrant Remittances Minimize the Impact of Macro-volatility on the Poor in Ghana, Report prepared for the Global Development Network, Washington, DC: International Monetary Fund.

Siebert, S., P. Döll, J. Hoogeveen, J.-M. Faurès, K. Frenken, and S. Feick, 2005, Development and validation of the global map of irrigation areas, *Hydrology and Earth System Sciences* 9:535-547.

Siebert, S., J. Hoogeveen, and K. Frenken, 2006, Irrigation in Africa, Europe and Latin America - Update of the Digital Global Map of Irrigation Areas to Version 4, Frankfurt Hydrology Paper 05, Institute of Physical Geography, University of Frankfurt, Frankfurt am Main, Germany and Food and Agriculture Organization of the United Nations, Rome, Italy.

Suleri, A. Q., and K. Savage, 2006, Remittances in Crisis: A Case Study of Pakistan, London: Overseas Development Institute.

Weiss-Fagen, P. and M. N. Bump, 2005, Remittances in Conflict and Crises: How Remittances Sustain Livelihoods in War, Crises, and Transitions to Peace, The Security-Development Nexus Program Policy Paper, New York, NY: International Peace Academy.

Wisner, B., 2003, Sustainable Suffering? Reflections on Development and Disaster Vulnerability in the Post-Johannesburg World, *Regional Development Dialogue* 24(1): 135-48.

World Bank, 2006, *Global Economic Prospects: Economic Implications of Remittances and Migration*, Washington DC: The World Bank.

World Bank, 2010, *Yemen: Assessing the Impacts of Climate Change and Variability on the Water and Agricultural Sectors and the Policy Implications*, Washington, DC: The World Bank.

World Bank, 2011, *Poor Places, Thriving People: How the Middle East and North Africa Can Rise Above Spatial Disparities*, MENA Development Report, Washington, DC: The World Bank.

Wu, T., 2006, The Role of Remittances in Crisis: An Aceh Research Study, London: Overseas Development Institute.

Yang, D., 2007, Coping with Disaster: The Impact of Hurricanes on International Financial Flows, 1970-2002, Mimeo, Department of Economics, University of Michigan, Ann-Harbor.

Yang, D. and H. Choi, 2007, Are Remittances Insurance? Evidence from Rainfall Shocks in the Philippines, *World Bank Economic Review* 21(2): 219-48.