ECONOMIC RESEARCH FORUM

منتدى البحوث الاقتصادية

2017

working paper series

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Working Paper No. 1099

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May 2017

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First published in 2017 by
The Economic Research Forum (ERF)
21 Al-Sad Al-Aaly Street
Dokki, Giza
Egypt
www.erf.org.eg

Abstract

In this study, we examine the effect of extreme weather events on migration among governorates in Egypt using migration gravity models and data from the 1996 and 2006 Population and Housing Census. We find that low or high temperature and precipitation does not affect the migration of people. Instead, people are considering the weather in destination areas to decide where they should migrate. The number of months with temperature below the five percentiles the distribution of monthly temperature of destination governorates strongly increases in-migration. An additional month with low temperature increases the number of in-migrants by 9.98 percent. For the elderly, they also avoid a governorate with more months of high temperatures. One additional month with temperature above the 95 percentile reduces in the destination governorates the number of old migrants by 8.15 percent.

JEL Classification: Q54; O15; R23.

Keywords: Climate change, migration, households, population census, Egypt.

ملخص

في هذه الدراسة، ندرس تأثير الظواهر الجوية المتطرفة على الهجرة بين المحافظات في مصر باستخدام نماذج الجاذبية الهجرة والبيانات من تعداد السكان والمساكن 1996 و2006. نجد أن انخفاض أو ارتفاع درجة الحرارة وهطول الأمطار لا يؤثر على هجرة الناس. وبدلا من ذلك، يفكر الناس في الطقس في مناطق المقصد لتحديد المكان الذي يجب أن يهاجروا إليه. فعدد الأشهر التي تقل فيها درجة الحرارة عن خمسة في المائة، يؤدي توزيع درجة الحرارة الشهرية لمحافظات المقاصد إلى زيادة الهجرة إلى حد كبير. ويزيد شهر إضافي مع انخفاض درجة الحرارة من عدد المهاجرين إلى الداخل بنسبة 9.98 في المائة. وبالنسبة لكبار السن، فإنهم يتجنبون أيضا محافظة ذات أشهر أعلى من درجات الحرارة المرتفعة. ويؤدي شهر إضافي مع درجة حرارة أعلى من 95 في المائة إلى تخفيض عدد المهاجرين القدامى بنسبة 8.15 في المائة في المحافظات المقصودة.

1. Introduction

Migration is an important strategy households in developing countries use to increase income and reduce poverty. Poor households often rely on income from agricultural activities, which can be volatile because of economic and natural risks such as input and output price fluctuations, diseases, and natural disasters (Winters et al., 2004; Easterly and Kraay, 2000). Starting a non-farm business often is not easy due to credit constraints and lack of business knowledge. As an alternative, households can choose migration as a way to increase and stabilize or diversify their income sources. Moving the whole family to a new area is costly, and households often choose one or two family members for migration. The main benefits of migration are increased income and reduced risk of income fluctuation (Stark and Bloom, 1985; Stark and Taylor, 1991; Stark, 1991). Migrants contribute directly to household income mainly through remittances (McKenzie and Sasin, 2007). Remittances sent by migrants are remarkable capital flows for migrant-sending households, which can lead to increased consumption and poverty reduction. Remittances can also fund investments in physical and social assets so that households can increase agricultural productivity or start non-farm businesses.

The literature on the migration decisions of individuals or households has documented a number of determinants. Classical theories reason that individuals relocate to maximize their utility given the prevailing wage and price levels in each location (Molloy, 2011; Valencia, 2008). The migration decisions depend on characteristics of not only migrants but also of their families (Stark and Bloom, 1985; Stark and Taylor, 1991). Community-level characteristics of home and destination areas also play important roles in 'pushing' or 'pulling' migrants (De Haas, 2007; Mayda, 2007; Kim and Cohen, 2010; Filiztekin and Gokhan, 2010; Ackar et al., 2012). Recent literature has pointed out that political conditions of countries can be 'push' and 'pull' factors of international migration (e.g., Hatton and Williamson, 2002; Mayda, 2010; Docquier and Rapoport, 2012).

There is a broad consensus that climate change has been and will be the biggest challenge to humankind. Climate change is caused by both natural and human factors, but the human factors play a more important role in climate change (Goulder and Pizer, 2006; Stern, 2006 and 2008). It is estimated that the mean global temperature was increased by around 0.74°C during the period 1906-2005 (IPPC, 2007). The land temperature has been increased faster, nearly 1°C since 1970 (Brohan et al. 2006). With increasing accumulation of carbon dioxide and other greenhouse gases, the mean global temperature is projected to rise between 2.3°C and 4.1°C in the next 100 years (Khandekar, 2009).

Researchers and policy makers have been increasingly interested in the effect of climate change. An important question is whether migration is a way to cope with climate change. There are several studies which find drought can increase migration out of rural areas (e.g., Findley, 1994; and Erza, 2001). Recently, Groger and Zylberberg (2015) find a positive effect of typhoon in labor migration. Understanding whether climate can attract or reduce migrants, especially highly-educated and skilled migrants, is important for economic development. It can inform policy makers as well as researchers about the adverse effects of climate change and the important role of migration as a way to cope with climate change.

This study aims to examine the push and pull effects of climate change on internal migration between governorates in Egypt using a gravity model. More specifically, the study will evaluate to what extent climate variation measured by variation in temperature and precipitation push and pull internal migration between governorates in Egypt. It also measures whether the effect of climate variation affect different types of migrations such as work and non-work migration, and migration of people with different ages and education level.

For several reasons, Egypt is an interesting case to look at. Firstly, Egypt is the largest country in the Arab world with a high migration rate. In 2009, there were 6.5 million migrants abroad from Egypt (Migration Policy Centre, 2013). The internal migration rate was around 6.5 percent in 2010 (Herrera and Badr, 2012). Egypt is also a country which is vulnerable to global warming (World Bank, 2010). Hassan (2011) predicts that economy of Egypt, especially agricultural sector, will be more like to be affected by climate change. Secondly, although there are a number of studies on migration in Egypt (e.g., Assaad and Arntz, 2005; Zohry, 2007, Zohry, 2009; Assaad, 2010; Wahba, 2012, 2015, Binzel and Assaad, 2011), there have been no studies on climate changes on migration in Egypt. Thirdly, the availability of the Population and Housing Census in 1996 and 2006 allow us to estimate inter-governorate migration overtime.[1]

This study is expected to contribute to the literature of environmental economics as well as development economics as follows. Firstly, it provides empirical findings on the effect of climate change on migration in Egypt – the largest country in the Arab world. Secondly, using a gravity model, this study examines not only the push effect but also the pull effect of climate change on migration. Most studies often focus on the effect of extreme weather events on rural out-migration. In this study, we will examine whether people consider weather issues in choosing destination areas. Thirdly, this study compares the effect of temperature variation and the effect of precipitation variation on different types of migration including overall migration, skilled and unskilled labor migration. Finally, it will investigate the heterogeneous effect of climate change across different characteristics of governorates. Although the empirical analysis focuses on Egypt, the results are expected to be important for a wider group of emerging and developing economies in the Arab world.

This paper is structured into six sections. The second section presents the theoretical framework and literature review of migration and climate change. The third section presents the data set and descriptive analysis of migration and climate variations in Egypt. The fourth and fifth sections present the estimation method and empirical result, respectively. Finally, the sixth section concludes.

2. Theoretical Framework and Literature Review

In the recent decades, there is a growing attention from not only academic researchers but also policy makers to climate change. Especially, there are numerous research studies on the impact of climate change and on the strategies households use to cope with climate change and extreme weather. Relevant climate events include more frequent periods with extreme heat, more frequent periods of reduced precipitation and droughts, floods and storms as well as long-term changes in mean temperature. Household’s strategies to cope with climate change and extreme weather are limited and include using savings, selling assets or livestock or asking for a loan. Migration can also be a strategy to cope with climate change and extreme weather.

[1] There are no data on internal migration at the areas smaller than governorates in the Population and Housing Censuses of Egypt. Thus, we focus on the inter-governorate migration in this study.

At the macroeconomic level, Dasgupta et al. (2009) estimate that one meter rise in sea level in 84 coastal developing countries would affect about seven percent of agricultural land and 11 percent of the population of these countries. A one meter rise in sea level can reduce the agriculture sector's GDP by 10 percent. World Bank (2011) concludes that global climate change can decrease household welfare and increase poverty. Dell et al. (2008) show a strong effect of temperature increase on economic growth of poor countries. A 1°C rise in temperature in a year decreases economic growth rate in that year by about 1.1 percentage points.

This suggests that climate change such as extreme heat, reduced precipitation, storms and long-term increases in mean temperature can affect people's living standards and present and future income and be at the origin of migration, i.e. displacement from poor to better climate conditions. Migration can thus be considered as a form of adaptation or a failure of adaption to climate change. However, the push effect as well as the pull effect of climate change on migration is a priori unknown. There are several channels through which climate change can affect migration and labor mobility. Firstly, climate change results in weather shocks which can have a direct effect on health. High temperature results in discomfort and tiredness, thereby reduces productivity and labor supply, especially for outdoor workers (e.g., Zivin and Neidell, 2010; Dunne et al., 2013). Hot temperatures are found to be associated cardiovascular, respiratory, cerebrovascular and blood cholesterol problems (Basu and Samet 2002; Barreca et al. 2012). Health problems can either reduce or increase the probability of migration. Exposure to cold days can also cause health problems (e.g., Deschenes and Moretti 2009). The impact of climate change on migration depends of the intensity of the change and the vulnerability of the person suffers the change. For instance, unhealthy people might be less likely to migrate (e.g., Finney et al., 2011). However, people can migrate from the areas with more extreme wealth to other areas with less extreme wealth.

Secondly, weather extreme can affect human capital and cause problems to labor. For example, Sharon and Yang (2009) estimate the effect of early-life rainfall on the health, education, and socioeconomic outcomes in Indonesian adults. They find that higher early-life rainfall has large positive effects on outcomes of women, but not of men. Through human capital, climate change can affect the propensity of migration. Thirdly, weather extreme can affect economic growth and reduce labor demand and cause high unemployment and push people to migrate. There are several studies which investigate the effect of precipitation extremes on economic growth and they mainly find the adverse effect (e.g., Brown and Lall, 2006, Brown et al. 2011, Brown et al. 2013).

People working in agriculture are expected to be the most affected my climate change and extreme weather. Burgess et al. (2014) establish that excessive heat has reduced agricultural income and increased mortality among the rural population in India. In contrast, the authors show the income effect of climate change is weaker among people employed in the non-agricultural sector. Heal and Park (2013) suggests the excessive heat can lead to decrease in physical and cognitive abilities and thus reduce labor productivity, especially in the agricultural sector. Mueller et al. (2014) suggest that excessive temperature reduces labor productivity not only in agricultural activities but also in other sectors by causing thermal stress to humans. The authors show that in rural Pakistan, excessive temperature reduces agricultural income by one third and non-agricultural income by one sixth. Deryugina and Hsiang (2014) study the US case and reach similar conclusion: excessive temperature reduces non-farm income by one fifth the reduction caused by excessive temperature on farm income. The negative effect of climate change on income and labor productivity may cause internal and international migration. For instance, Barrios et al. (2006) report that in Sub-Saharan African countries, decline in rainfall leads to increases in rural to urban migration

Climate change and extreme weather are major concerns particularly for countries from the MENA region (Wodon et al., 2014). In this region, the threats, that include seasonal temperature variability, lack in rainfall and water stress, deforestation, rise in the sea level, affect in particular agricultural activities. Agriculture employs a large percentage of the labor forces in some MENA countries like Egypt. A reduction in agriculture income and labor productivity may constitute a push factor of migration. Climate change and extreme weather can also play as pull factors: people migrate to urban areas where they will be less vulnerable and less exposed to the impacts of the climate change and where they will have more economic opportunities and better living standards. For instance, Joseph and Wodon (2014) show that climate change play a weak but statistically significant role in the decision to migrate to urban areas in Yémen. Wodon et al. (2014) study the effect of climate change, extreme weather and environmental degradation in some MENA countries including Egypt and show that they exercise a positive effect on temporary and permanent migration.

3. Data Sets and Descriptive Analysis

3.1. Data set

In this study, we will use two main data sets. The first data set which is used to constructed migration variables is the Population and Housing Census of Egypt held by the Central Agency for Mobilization and Statistics (CAPMAS) in 1996 and 2006. The Population and Housing Censuses of Egypt contain individual-level and household-level data. The individual-level module contains data on demography, education, employment, disability and migration of individuals. Regarding migration, there are data on the previous governorate of individuals before living in the current governorate, and year of moving. The household-level module contains data housing condition and facilities, and durables. In this study, we will focus on the internal migration in Egypt. The international migrants are not considered since we do not know the location of migrants in other countries.

The second data source is climate change data. There are different sources of data on monthly temperature and precipitation, for example data from Willmott, C. J. and K. Matsuura (2001) Terrestrial Air Temperature and Precipitation: Monthly and Annual Time Series (1950 - 2012). This data set provides worldwide (terrestrial) monthly mean temperature and precipitation data at high resolution. We can use geospatial software to compute the governorate-level data of monthly temperature and precipitation over the period 1996-2006.

3.2. Climate in Egypt

Egypt is country with a hot desert climate. Most areas are generally dry except the northern Mediterranean coast. Using climatic data from Willmott and Matsuura (2015), we compute the monthly precipitation and temperature at the governorate level of Egypt over 1900-2014. Figure 1 presents the average of monthly precipitation and temperature over the period of 1900 to 2014. Each dot presents the average of monthly precipitation or temperature in one year. It is computed as the average across governorates and months (weighted by the areas of governorates). It shows that temperature is lowest in 1970s and recently increases. In 2014, the average temperature is 23.6. The rainfall is rather low in Egypt, and it tended to decrease in the recent years.

Although the average of the monthly temperature and precipitation is small, there is a high variation in temperature and precipitation within a year. Figure 2 presents the median of temperature and precipitation of months over time. The estimates are averaged across years from 1900 to 2014 and across governorates. The temperature is very high, especially in July and August. In some areas, daytime temperatures are much higher. The average high temperatures can exceed 40°C in cities and places which are located in the deserts of Egypt.

From March to May, hot spring winds from the south or the southwest that are known to Europeans as the sirocco and to Egyptians as the khamsin blow across the country. The winds can carry high volume of sand and dust from the deserts. The winds can increase the temperature to 45°C.[2]

Figure 3 presents the geographic variations in the average monthly precipitation and temperature. The average monthly precipitation and temperature are computed over the period of 1900 to 2014. It shows that there is a relatively large variation in both monthly precipitation and temperature within Egypt. Northern governorates have lower temperatures and higher precipitation than southern governorates.

3.2. Internal migration in Egypt

Migration in Egypt has been studies in different studies such as Zohry (2007, 2009) and Wahba (2014). In this study, we use the Egypt Population and Housing Censuses to estimate the migration flows between governorates. In the 1996 and 2006 Egypt Population and Housing Censuses, there are questions on the migration status of individuals and their current and previous governorates. Figure 4 shows that the percentage of internal migrants was 8.9 percent and 5.9 percent in 1996 and 2006, respectively. The percentage of migrants across governorates is smaller, at 6.3 percent in 1996 and 5.4 percent in 2006. In this study, we will measure the migration flow during the past 10 years so that the estimates of the migration rates are not overlapped between the 1996 and 2006 Egypt Population and Housing Censuses. The percentage of migrants during the past 10 years was lower than the percentage of all the migrants. In the 2006 Egypt Population and Housing Census, there was 2.1 percent of the population who migrated across governorates during the past 10 year.

Figure 5 presents maps of the percentage of inter-governorate out-migration and in-migration population during the past 10 years using data from the 2006 Population and Housing Census. Detailed estimates of the migration rate and the number of migrants are presented in Tables A.1 and A.2 in Appendix. Cairo had the highest out-migration rate, at 5.82%, while Marsa Matroh had the lowest out-migration rate, at 0.89%. Governorates that had the highest in-migration rates are South Sinai, Suez, and Port Said.

Although some governorates such as Cairo had low migration rates, they had high number of migrants since they had large population. Figure 6 presents the number of out-migration and in-migration people during the past 10 years across governorates (estimated from the 2006 Population and Housing Census). It shows that Cairo had the highest number of in-migrants as well as out-migrants.

[2] "Egypt Climate and Weather". Tour Egypt. http://www.touregypt.net/climate.htm, accessed on April 20, 2016.

In the next figures, we examine the correlation between the migration rate and climate. In this figures, the migration rate is computed for migrants across governorate during the period 1997-2006. The climate is measured by the average rainfall and temperature during the same period. The correlation between migration and climate during the period 1987-1996 is very similar to the period 1997-2006 and this correlation is presented in Figures A.1 and A.2 in Appendix.

Figure 7 shows a positive correlation between out-migration as well as in-migration and precipitation. Governorates with higher precipitation experienced higher population movement than those with lower precipitation.

Regarding temperature, there is a small and not significant correlation between out-migration and temperature of governorates (Figure 8). However, there is a negative correlation between in-migration and temperature. People tend to move to areas with lower temperature.

4. Econometric Method

A large number of economic and econometric models have been developed to examine the factors determining migrations. Gravity models of migration are widely used to model the flow of migration between geographic areas (Karemera et al., 2000; Grogger and Hanson, 2011; Hatton and Williamson, 2000; Volger and Rotte, 2000; Ortega and Peri, 2013; Bunea, 2012; Kim and Cohen, 2010). The gravity model was initially inspired by the Newton's law of universal gravitation which states that any two objects attract each other with a force that is proportional to their masses and inversely proportional to the squared distance between them. By extension, the gravity model of migration posits that the migration flow between two distinct geographic locations is positively associated with their population size, geographic area, or GDP, and negatively associated with the distance between them. The basic gravity model can be expressed in terms of the following equation:

$$M_{ij} = g\frac{P_{it}^{\alpha}P_{jt}^{\beta}}{D_{ij}^{\gamma}} \qquad (1)$$

where M_{ijt} is the out-migration flow from governorate i to governorate j in year t (i and j can be any two geographic areas, but in our study they are governorates); P_{it} and P_{jt} are the sizes of the populations of governorates i and j in year t, respectively; D_{ij} is the distance between the two governorates. Taking the log of both sides of equation (1), we get:

$$\log(M_{ijt}) = \log(g) + \alpha\log(P_{it}) + \beta\log(P_{jt}) - \gamma\log(D_{ij}). \qquad (2)$$

In this study, we will extend the basic model to include variables that represent public administration and public services in governorates i and j. We also include the time dummies and governorate dummies. The full econometric model can be expressed as follows:

$$\log(M_{ijt}) = \alpha + \beta_1\log(C_{it}) + \beta_2\log(C_{jt}) + \gamma\log(D_{ij}) + X_{it}'\theta_1 + X_{jt}'\theta_2 + T_t\delta + u_{ij} + \varepsilon_{ijt}, \qquad (3)$$

where C_{it} and C_{jt} are the variables of climate change of governorates i and j in year t, respectively; X is a vector of control variables including the logarithms of population sizes, areas, and other exogenous variables which can affect the migration flows; T_t is the time dummies corresponding to the year of migration flow from governorate i to governorates j; errors includes time-invariant, u_{ij}, and time-variant, ε_{ijt}. The time-invariant error term includes dummies of home governorates and destination governorates.

The push and pull effects of climate changes are measured by the coefficients β_1 and β_2. We expect that people tend to move from governorates with extreme weather events to those without extreme weather events, so we expect $\beta_1>0$ that $\beta_2<0$.

It should be noted that there are no questions on the previous districts (the smaller administrative unit than governorates). Thus, we are not able to examine the migration between districts. In this study, we will measure the effect of climate change on overall migration, and migration of different types. Thus, the dependent variable will be measured in different ways: the outflow of all migrants, the outflow of migrants by different purposes, and the outflow of only high-education migrants, and the outflow of migrants by age and gender.

One empirical problem that we anticipate is that the dependent variable can be zero whenever there is no migration between governorate pairs, so the logarithm cannot be taken. In our study, 37.7% of the pairwise governorates did not have inter-governorate migration. This is a technical issue which is treated in the literature. In this study, we will use a two-part model which is often used to model a variable with a large number of zero values (Duan et al., 1983; Manning et al., 1987). In the first part, we will model the dummy variable, denoted by $I\{M_{ijt}>0\}$, indicating whether migration happens between governorates:

$$\log\{M_{ijt} > 0\} = \alpha + \beta_1 \log(C_{it}) + \beta_2 \log(C_{jt}) + \gamma \log(D_{ij}) + X_{it}'\theta_1 + X_{jt}'\theta_2 + T_t\delta + u_{ij} + \varepsilon_{ijt}, \quad (4)$$

In the second part, we will apply the model (3) to only governorates which have between-migration.[3] An advantage of the two-part model is that it allows us to estimate the effect of climate change on the decision to migrate (in the first-part of the model) as well as the effect on the quantity of migration (in the second part of the model).

In empirical studies, climate change is measured by several ways. In this study, we also measure the climate change by different ways to examine the sensitivity of the impact estimates to the measurement of climate change variables. Firstly, since our dependent variables are measured in annual basis, we can simply use the annual average of temperature and precipitation. We simply compute the annual mean by averaging monthly temperature and precipitation data. Secondly, we can measure the climate change by the monthly variation within a year. It reflects unusually high or low amounts of precipitation and temperature in the district-year-month (e.g., Deschenes et al., 2009; Deschenes and Greenstone, 2011; Brown et al., 2013). It is measured by the number of months (in the year of interest) which have temperature or precipitation below or above the average monthly temperature during a period of time. Since our climate change is defined as a wealth shock, it is expected to be exogenous. In addition, we will estimate model (3) and (4) using fixed-effects regression. Time-invariant unobserved variables are eliminated by fixed-effects transformation. Thus, it is expected that we can estimate the impact of climate events on inter-governorate migration unbiasedly.

[3] There are other ways to deal with zero or missing values of dependent variables such as sample selection model. However, this method requires exclusion restrict, which is difficult to find. We can consider zero values of dependent variable as censored values and apply Tobit model. However, the Tobit model requires an assumption on error term normality for consistency, and this assumption is strongly rejected in our data sets. Another method is to transform equation (3) into exponential function, and apply a Poisson pseudo-maximum likelihood (Gourieroux et al., 1984; Santos and Tenreyro, 2006). However, this model does not estimate the same function as model (3), and as a result the interpretation is not the same as the original gravidity model.

5. Empirical Results

Tables from 1 to 3 present two-part model regressions of migration between governorates on climate variables. For each migration type, there are two dependent variables. The first is the dummy variable indicating whether there is a flow of migration from an origin governorate to a destination governorate in a given year. The second is log of the migration flow – the number of migrants – from an origin governorate to a destination governorate in this year. In this section, we use the results from two-part model for interpretation.

The climate variables include yearly temperature and precipitation of the original and destination governorates, and the variation in monthly climate variables. The yearly climate variables can be endogenous. For example, people in hot or cold areas can have different livelihood strategies to adapt to temperature. However, temperature or rainfall in a year can be different from the average trend. Thus, we will focus on the effect of the variation in monthly climate variables, which is more exogenous. More specifically, we measure the climate shocks by the number of months (in the year of interest) which have temperature or precipitation below the five percentiles and above 95 percentage of the distribution of monthly temperature or precipitation during the period 1900-2006. The number of months with very high or low temperature and precipitation in a given year cannot be predicted by individuals.

In addition to climate variables, the explanatory variables include basic variables of gravity models including log of distance between governorates, log of population of governorates, and year dummies. We do not use many control variables, since variables that might be affected by the climate events should not be used. In impact evaluation, endogenous variables which are caused by treatment variables are not controlled (e.g., Heckman et al., 1999; Angrist and Pischke, 2008). For example, although pre-migration income can strongly affect migration decision, it should not be controlled since it is also affected by climate events.

Table 1 presents regression of inter-governorate migration of all people and high education people. The distance between governorates affects negatively the migration flows. This is consistent with the prediction of gravity models. If the distance between two governorates increases by 1 percent, the probability of migration happening between them decreases by 0.2 percent. The inter-governorate migration flow is also strongly affected by distance between governorates. A one percent increase in the distance between two governorates leads to a 0.88 percent decrease in the number of migrants between the two governorates.

In the models which do not include the dummies of governorates and years, the sign of population of bother origins and destination governorates are positive.[4] However, when years and governorates fixed-effects are controlled, the population size of the origin governorate has a negative sign, while the population size of the destination governorate has a positive size. It means that people move from governorates with low population to those with high population.

Regarding the climate variables, the yearly temperature and precipitation level of origin governorates are not significant. The yearly temperature of destination governorates is positive and significant at the one percent level, and the yearly precipitation of destination

[4] We do not present the regression results of the models without dummies of governorates and years in this paper, since we do not use these results for interpretation. Readers who are interested in these results can contact the authors to obtain.

governorates is negative and significant at the 10 percent level. It means that people tend to migrate to governorates with a high average temperature and low average precipitation.

It shows that there are few shock climate variables affecting the migration between governorates. Climate variables of the origin governorates have very small and insignificant effects on the probability of out-migration. However, the number of months with high temperature tends to push migration. An increase of one month with temperature above the 95 percentile of temperature distribution increases the number of out-migrant by 3.31 percent.

High precipitation of destination has a positive effect on the probability of in-migration. An increase of one month with precipitation above 95 percentile of precipitation distribution increases the probability of in-migration by 0.0187. It means that high precipitation attracts the probability of in-migration. The number of months with temperature below the five percentiles the distribution of monthly temperature of destination governorates strongly increases in-migration. People prefer to move to a low temperature area. An additional month with low temperature increases the number of in-migrants by 9.98 percent.

Other dependent variables are the probability and the log of migrant flows of migration of different purposes. It shows a consistent effect of low temperature of destination governorates in pulling migration. The effect is similar for migration of work, family and marriage.

In the migration literature, high educated people tend to have better information and employment opportunity and they are more likely to migrate than low educated people (e.g., Levy and Wadycki, 1974; Greenwood, 1975; Ritsilä and Ovaskainen, 2001; Faggian, et al. 2007). For the case of Egypt, Herrera and Badr (2012) shows that people with high secondary education are most likely to migrate, then follow by those with post-secondary education. The next two columns of Table 1 present the impact of climate events on migration of high education individuals, who are defined as those completing college or university and above 22. The effect of climate events on high education people is very similar to the effect of overall people. People tend to move from high temperature governorates to low temperature governorates.

Table 2 reports the estimates of the weather events on different types of migration by purposes. There are not large differences in the effect of weather events on different type of migration. Low temperatures of governorates attract more work migration, family migration and marriage migration. People with work and family migration purpose also tend to move to governorates with high precipitation.

Table 3 presents the regression of migration on climate events by age. The propensity of migration differs by age. For instance, the migration literature shows that migration is more common among the younger than the older, since the older have a shorter period to obtain returns or benefit from migration. The shorter payoff period decreases the net gains to migration and thereby reduces the migration probability (Borjas, 2005). Table 3 shows a consistent effect of low temperature of destination governorates in pulling migration of children (aged below 15), young (aged from 16 to 30), middle-age people (aged from 31 to 60) and elderly (aged above 60). For the elderly, hot weather of destination governorate reduces the in-migration. One additional month with temperature above the 95 percentile reduces in the destination governorates the number of old migrants by 8.15 percent. High precipitation on destination governorates tends to reduce in-migration of children and elderly, but to increase in-migration of young and middle-age people. Possibly, children and elderly are more concerned about health and high precipitation does not pull their movement.

6. Conclusion

There is a growing concern about the climate change and extreme weather events. How people cope with the climate change and extreme weather events receive a great deal attention from researchers as well as policy makers. In this study, we examine the effect of extreme weather events on migration in Egypt using migration gravity models. We find that low or high temperature and precipitation does not affect the migration of people. Instead, people are considering the weather in destination areas to decide where they should move in. The number of months with temperature below the five percentiles the distribution of monthly temperature of destination governorates strongly increases in-migration. An additional month with low temperature increases the number of in-migrants by 9.98 percent. For the elderly, they also avoid a governorate with more months of high temperatures. One additional month with temperature above the 95 percentile reduces in the destination governorates the number of old migrants by 8.15 percent. High precipitation on destination governorates tends to reduce in-migration of children and elderly, but to increase in-migration of young and middle-age people. Possibly, children and elderly are more concerned about health and high precipitation does not pull their movement.

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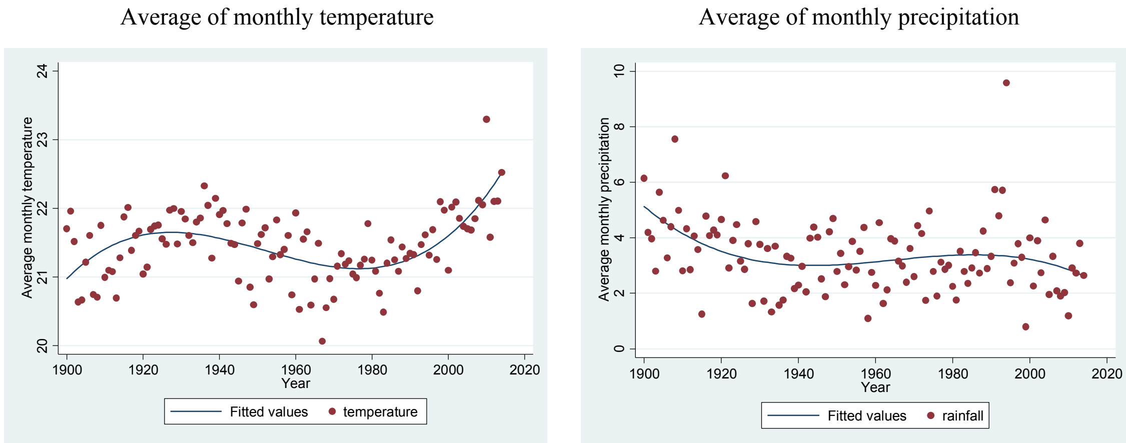
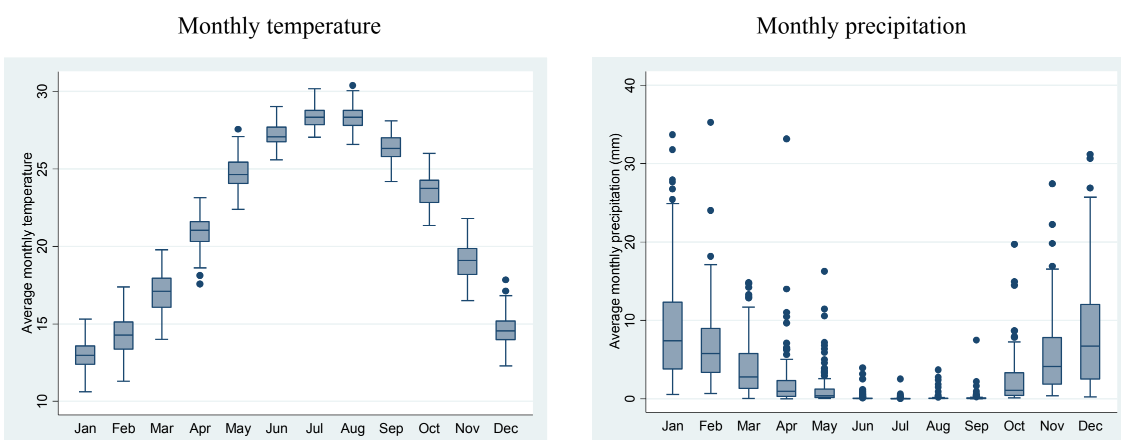
Figure 1: Average of Monthly Temperature and Precipitation Over Time



Source: author's estimation using climatic data from Willmott and Matsuura (2015)

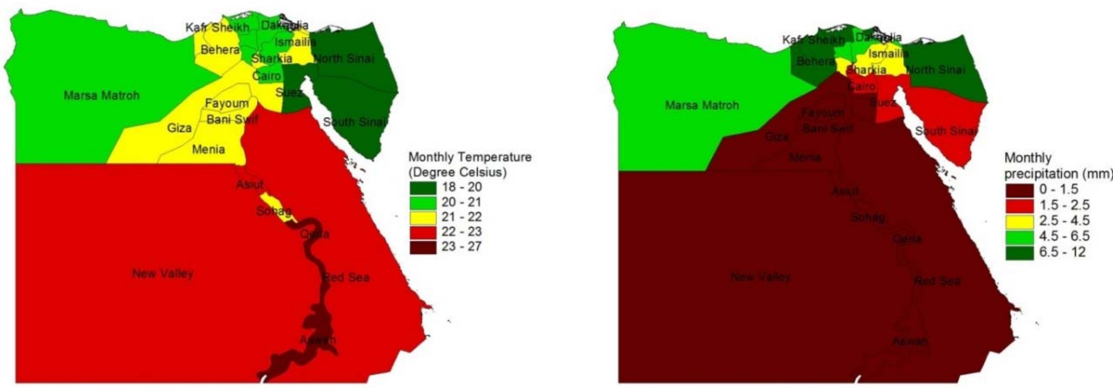
Figure 2: Monthly Temperature and Precipitation



Source: author's estimation using climatic data from Willmott and Matsuura (2015)

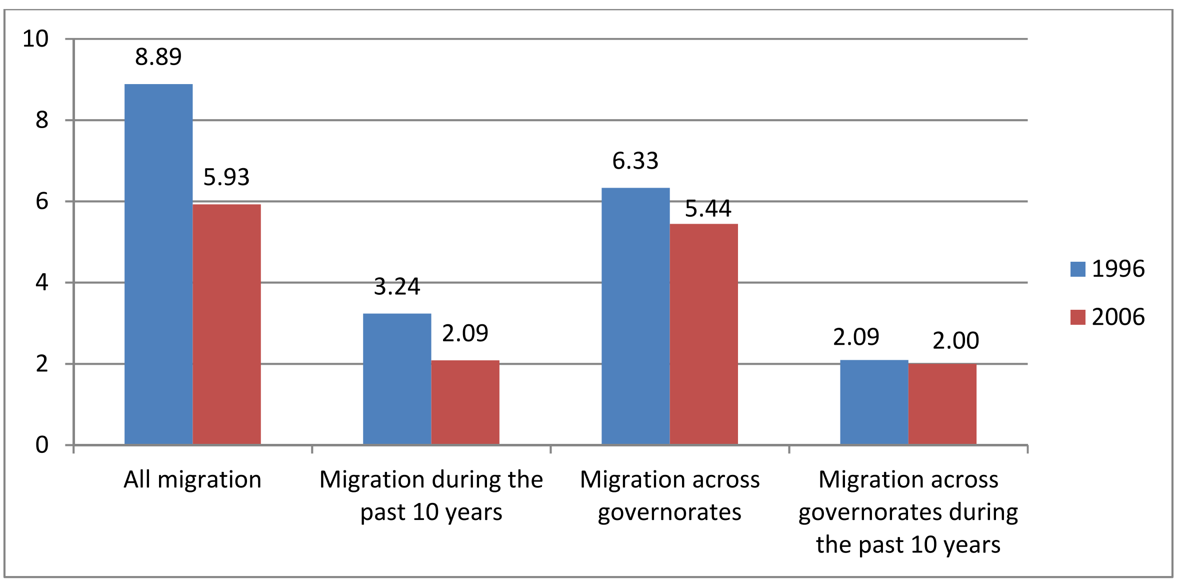
Figure 3: Temperature and Rainfall of Governorates

Average of monthly temperature | Average of monthly precipitation



Source: author's estimation using climatic data from Willmott and Matsuura (2015)

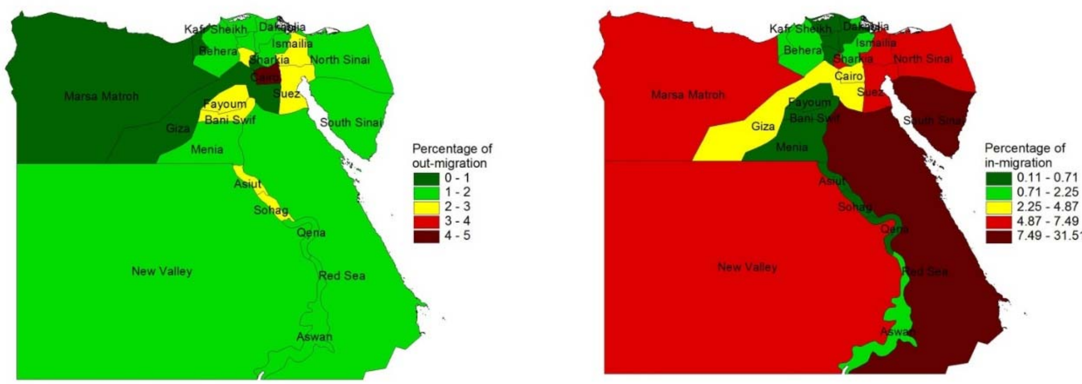
Figure 4: Migration rate in Egypt



Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses

Figure 5: Percentage of Out-Migration and In-Migration Population During the Past 10 Years Across Governorates in the 2006 Population Census

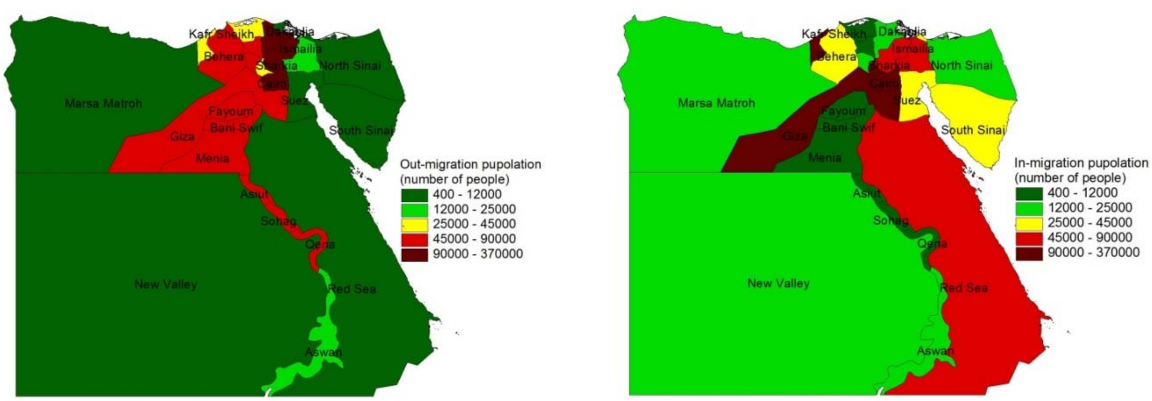
Percentage of out-migration population   Percentage of in-migration population



Source: Authors' estimation from the 2006 Egypt Population and Housing Censuses

Figure 6: The Number of Out-Migration and In-Migration People During the Past 10 Years Across Governorates in the 2006 Population Census

Out-migration population   In-migration population

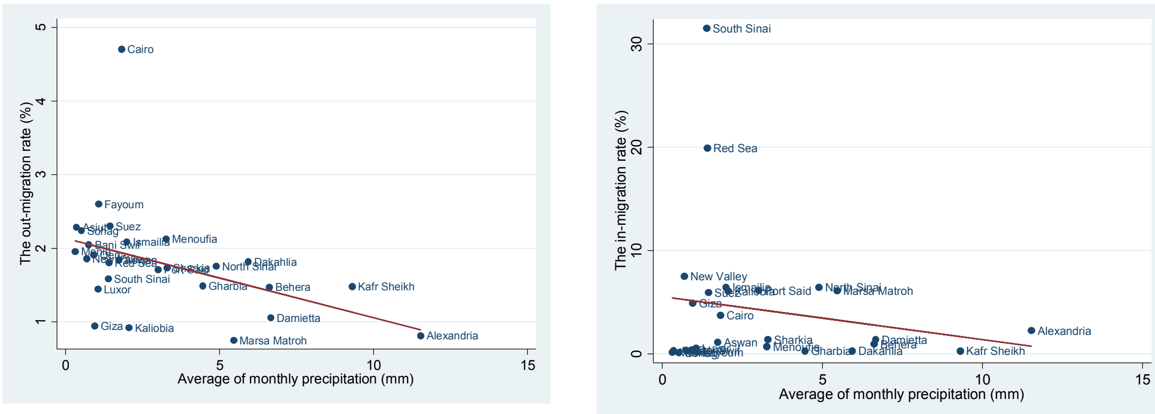


Source: Authors' estimation from the 2006 Egypt Population and Housing Censuses

Figure 7: Inter-Governorate Migration and Average Monthly Precipitation in 2006

Out-migration rate and precipitation

In-migration rate and precipitation

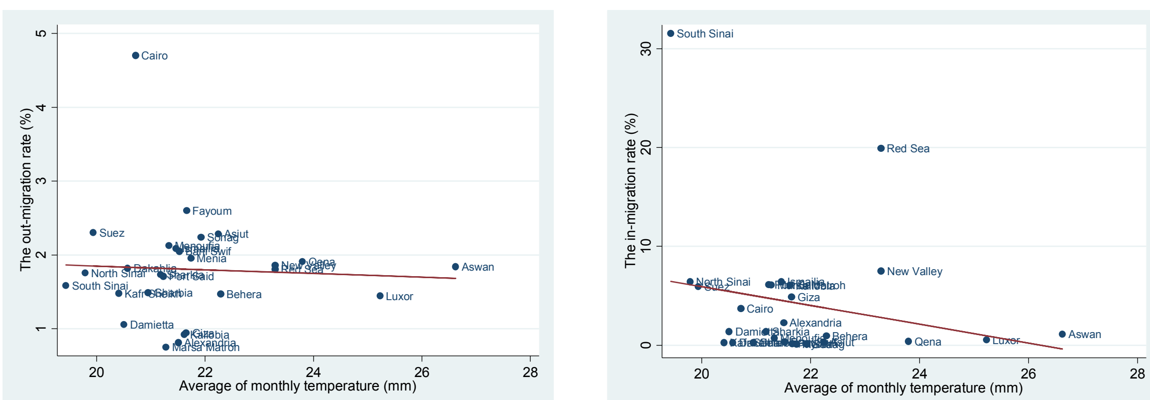


Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses, climatic data from Willmott and Matsuura (2015)

Figure 8: Inter-Governorate Migration and Average Monthly Temperature in 2006

Out-migration rate and temperature

In-migration rate and temperature



Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses, climatic data from Willmott and Matsuura (2015)

Table 1: Regression of Migration Flows by Migration Purposes

Explanatory variables	Having migration	Log of migration flow	Having high education migration	Log of high education migration flow
Log of distance	-0.2011***	-0.8842***	-0.2137***	-0.5829***
	(0.0054)	(0.0201)	(0.0064)	(0.0198)
Log of population of origin governorates	-0.1040***	-0.1654	-0.1149***	0.8667***
	(0.0264)	(0.1576)	(0.0251)	(0.1791)
Log of population of destination governorates	0.1383***	0.3976***	0.2783***	0.4560***
	(0.0280)	(0.1023)	(0.0320)	(0.1007)
Yearly temperature of origin governorates	-0.0063	0.0412	0.0011	0.1124**
	(0.0161)	(0.0543)	(0.0163)	(0.0556)
Yearly precipitation of origin governorates	-0.0017	0.0098	0.0006	0.0116*
	(0.0019)	(0.0063)	(0.0020)	(0.0059)
Yearly temperature of destination governorates	0.0594***	0.2828***	0.0354**	0.1677***
	(0.0162)	(0.0548)	(0.0162)	(0.0562)
Yearly precipitation of destination governorates	-0.0034*	0.0055	-0.0045**	0.0032
	(0.0019)	(0.0065)	(0.0020)	(0.0063)
Origin: Number of months with low temperature	0.0181	0.0193	0.0092	0.0676
	(0.0169)	(0.0235)	(0.0071)	(0.0435)
Origin: Number of months with high temperature	-0.0062	0.0331*	-0.0034	0.0382**
	(0.0053)	(0.0178)	(0.0053)	(0.0185)
Origin: Number of months with low precipitation	-0.0026	-0.0058	-0.0040	0.0065
	(0.0026)	(0.0086)	(0.0027)	(0.0086)
Origin: Number of months with high precipitation	0.0085	0.0184	0.0077	-0.0041
	(0.0054)	(0.0174)	(0.0056)	(0.0173)
Destination: Number of months with low temperature	0.0047	0.0998***	0.0160**	0.0660***
	(0.0069)	(0.0231)	(0.0070)	(0.0233)
Destination: Number of months with high temperature	0.0062	-0.0140	0.0024	-0.0039
	(0.0053)	(0.0182)	(0.0053)	(0.0190)
Destination: Number of months with low precipitation	-0.0007	0.0052	0.0028	-0.0079
	(0.0025)	(0.0087)	(0.0026)	(0.0086)
Destination: Number of months with high precipitation	0.0187***	-0.0062	0.0183***	-0.0171
	(0.0053)	(0.0181)	(0.0056)	(0.0176)
Year dummies	Yes	Yes	Yes	Yes
Constant	0.6891*	1.8590	-0.8957**	-17.486***
	(0.4077)	(1.7885)	(0.4165)	(1.9793)
Observations	14,040	8,754	14,040	5,690
R-squared	0.433	0.583	0.411	0.561

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses and Climate Data.

Table 2: Regression of Migration Flows by Migration Purposes

Explanatory variables	Having work migration	Log of work migration flow	Having family migration	Log of family migration flow	Having marriage migration	Log of marriage migration flow	Having other-type migration	Log of other-type migration flow
Log of distance	-0.1734***	-0.5506***	-0.1975***	-0.6463***	-0.2535***	-0.7559***	-0.1908***	-0.5928***
	(0.0063)	(0.0207)	(0.0064)	(0.0245)	(0.0059)	(0.0200)	(0.0065)	(0.0260)
Log of population of origin governorates	-0.0976***	-0.0417	-0.0875***	0.4894**	-0.0959***	0.0429	-0.1617***	-0.3491
	(0.0248)	(0.1696)	(0.0251)	(0.1958)	(0.0238)	(0.1778)	(0.0231)	(0.2214)
Log of population of destination governorates	0.1829***	0.3755***	0.1441***	-0.0559	0.2273***	0.0901	0.3416***	0.2502
	(0.0307)	(0.1034)	(0.0318)	(0.1124)	(0.0300)	(0.1227)	(0.0265)	(0.2042)
Yearly temperature of origin governorates	0.0041	0.1368**	0.0007	0.1369**	-0.0140	0.0712	0.0044	-0.0912
	(0.0160)	(0.0569)	(0.0164)	(0.0662)	(0.0165)	(0.0538)	(0.0156)	(0.0677)
Yearly precipitation of origin governorates	-0.0011	0.0184***	-0.0021	0.0133*	-0.0003	0.0082	0.0032*	0.0091
	(0.0020)	(0.0065)	(0.0020)	(0.0076)	(0.0019)	(0.0056)	(0.0019)	(0.0073)
Yearly temperature of destination governorates	0.0528***	0.1973***	0.0531***	0.0970	0.0394**	0.0760	0.0700***	0.3416***
	(0.0159)	(0.0583)	(0.0162)	(0.0675)	(0.0164)	(0.0545)	(0.0152)	(0.0687)
Yearly precipitation of destination governorates	-0.0038*	0.0061	-0.0019	0.0124	-0.0005	-0.0022	0.0035*	0.0151*
	(0.0020)	(0.0066)	(0.0019)	(0.0080)	(0.0019)	(0.0062)	(0.0019)	(0.0078)
Origin: Number of months with low temperature	0.0101	0.0346	0.0018	0.0616	0.0182	0.0339	0.0143	-0.0192
	(0.0070)	(0.0240)	(0.0070)	(0.0486)	(0.0170)	(0.0230)	(0.0164)	(0.0317)
Origin: Number of months with high temperature	0.0029	0.0009	-0.0093*	0.0204	-0.0016	-0.0141	0.0045	0.0593**
	(0.0053)	(0.0181)	(0.0053)	(0.0219)	(0.0053)	(0.0179)	(0.0050)	(0.0233)
Origin: Number of months with low precipitation	-0.0017	-0.0067	-0.0012	-0.0134	-0.0020	0.0038	-0.0035	-0.0007
	(0.0026)	(0.0089)	(0.0026)	(0.0105)	(0.0026)	(0.0085)	(0.0025)	(0.0109)
Origin: Number of months with high precipitation	0.0107*	0.0012	0.0124**	0.0023	0.0082	0.0221	0.0032	-0.0116
	(0.0056)	(0.0180)	(0.0056)	(0.0216)	(0.0054)	(0.0171)	(0.0053)	(0.0218)
Destination: Number of months with low temperature	0.0246***	0.0614***	0.0222***	0.0519*	0.0164**	0.0548**	-0.0011	0.0019
	(0.0069)	(0.0236)	(0.0068)	(0.0284)	(0.0069)	(0.0224)	(0.0064)	(0.0312)
Destination: Number of months with high temperature	0.0027	-0.0050	0.0103*	-0.0024	-0.0018	-0.0051	-0.0000	-0.0498**
	(0.0052)	(0.0189)	(0.0053)	(0.0220)	(0.0053)	(0.0179)	(0.0049)	(0.0243)
Destination: Number of months with low precipitation	-0.0021	-0.0004	-0.0027	0.0000	0.0015	-0.0084	0.0068***	0.0103
	(0.0025)	(0.0089)	(0.0026)	(0.0108)	(0.0026)	(0.0084)	(0.0025)	(0.0103)
Destination: Number of months with high precipitation	0.0080	-0.0398**	0.0130**	-0.0430*	0.0083	0.0271	-0.0010	-0.0702***
	(0.0055)	(0.0184)	(0.0055)	(0.0222)	(0.0055)	(0.0178)	(0.0052)	(0.0230)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.3517	-3.3243*	0.2973	-2.1015	0.0159	4.9170***	-2.1636***	4.7622*
	(0.4102)	(1.9134)	(0.4155)	(2.2590)	(0.4013)	(1.8309)	(0.3702)	(2.4396)
Observations	14,040	6,271	14,040	6,125	14,040	6,041	14,040	4,253
R-squared	0.439	0.510	0.431	0.443	0.427	0.605	0.380	0.449

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses and Climate Data.

Table 3: Regression of Migration Flows by Age

Explanatory variables	Having child migration	Log of child migration flow	Having young migration	Log of young migration flow	Having middle-age migration	Log of middle-age migration flow	Having elderly migration	Log of elderly migration flow
Log of distance	-0.1960***	-0.5849***	-0.2164***	-0.8167***	-0.2037***	-0.5730***	-0.0758***	-0.2857***
	(0.0065)	(0.0247)	(0.0056)	(0.0191)	(0.0064)	(0.0206)	(0.0047)	(0.0344)
Log of population of origin governorates	-0.0521**	0.0045	-0.1093***	-0.1542	-0.0966***	0.1678	-0.0244*	-0.1292
	(0.0239)	(0.1931)	(0.0259)	(0.1509)	(0.0255)	(0.1624)	(0.0140)	(0.2852)
Log of population of destination	0.1746***	0.1649	0.1541***	0.4004***	0.2033***	0.0833	0.0588***	-0.0548
governorates	(0.0319)	(0.1136)	(0.0304)	(0.0980)	(0.0323)	(0.0966)	(0.0154)	(0.2542)
Yearly temperature of origin	0.0101	0.0198	-0.0148	0.0025	0.0543***	0.0830	0.0023	0.0890
governorates	(0.0164)	(0.0647)	(0.0165)	(0.0508)	(0.0163)	(0.0561)	(0.0109)	(0.0815)
Yearly precipitation of origin	-0.0008	0.0064	-0.0022	0.0165***	0.0006	0.0150**	0.0002	0.0083
governorates	(0.0021)	(0.0078)	(0.0020)	(0.0058)	(0.0021)	(0.0064)	(0.0014)	(0.0092)
Yearly temperature of destination	0.0245	0.1960***	0.0677***	0.2769***	0.0139	0.1892***	0.0354***	0.1205
governorates	(0.0160)	(0.0672)	(0.0166)	(0.0514)	(0.0162)	(0.0570)	(0.0109)	(0.0874)
Yearly precipitation of destination	0.0011	0.0057	-0.0050***	0.0044	0.0004	0.0086	0.0048***	-0.0063
governorates	(0.0019)	(0.0079)	(0.0019)	(0.0061)	(0.0020)	(0.0064)	(0.0015)	(0.0082)
Origin: Number of months with low	0.0035	0.0248	0.0128	0.0164	0.0258	0.0367	0.0050	0.1134
temperature	(0.0070)	(0.0284)	(0.0171)	(0.0219)	(0.0171)	(0.0242)	(0.0045)	(0.0797)
Origin: Number of months with high	-0.0041	0.0219	0.0004	0.0206	-0.0037	0.0259	0.0030	0.0851***
temperature	(0.0053)	(0.0220)	(0.0054)	(0.0166)	(0.0053)	(0.0191)	(0.0035)	(0.0312)
Origin: Number of months with low	-0.0028	-0.0029	-0.0036	-0.0021	-0.0053**	0.0023	0.0010	0.0061
precipitation	(0.0026)	(0.0104)	(0.0026)	(0.0081)	(0.0027)	(0.0088)	(0.0017)	(0.0149)
Origin: Number of months with high	0.0114**	0.0117	0.0138**	0.0063	0.0020	-0.0079	0.0022	-0.0222
precipitation	(0.0056)	(0.0216)	(0.0055)	(0.0164)	(0.0056)	(0.0180)	(0.0038)	(0.0269)
Destination: Number of months with	0.0146**	0.0824***	0.0118*	0.0720***	0.0040	0.0889***	0.0099**	-0.0503
low temperature	(0.0068)	(0.0283)	(0.0070)	(0.0216)	(0.0069)	(0.0241)	(0.0044)	(0.0397)
Destination: Number of months with	0.0132	-0.0076	0.0020	-0.0181	0.0049	-0.0306	-0.0028	-0.0815**
high temperature	(0.0152)	(0.0221)	(0.0054)	(0.0171)	(0.0053)	(0.0193)	(0.0035)	(0.0333)
Destination: Number of months with	0.0011	-0.0139	0.0008	0.0080	-0.0000	-0.0148	-0.0007	-0.0331**
low precipitation	(0.0026)	(0.0106)	(0.0026)	(0.0081)	(0.0026)	(0.0091)	(0.0018)	(0.0142)
Destination: Number of months with	0.0034	-0.0389*	0.0202***	-0.0063	0.0096*	-0.0236	-0.0165***	0.0009
high precipitation	(0.0055)	(0.0224)	(0.0054)	(0.0169)	(0.0056)	(0.0187)	(0.0040)	(0.0269)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.3521	1.7068	0.6180	1.3802	-0.7534*	-0.5436	-0.1165	4.0572
	(0.4111)	(2.2087)	(0.4147)	(1.7162)	(0.4181)	(1.8615)	(0.2394)	(2.9701)
Observations	14,040	5,439	14,040	7,972	14,040	5,847	14,040	1,545
R-squared	0.403	0.420	0.430	0.586	0.414	0.530	0.287	0.302

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses and Climate Data.

Appendix

Table A1: The Migration Rate of Migrants Across Governorates

Governorate	1996		2006		1996		2006	
	Out-migration during the past 10 years	**In-migration during the past 10 years**	**Out-migration during the past 10 years**	**In-migration during the past 10 years**	**Out-migration during the past years**	**In-migration during the past years**	**Out-migration during the past years**	**In-migration during the past years**
Cairo	5.82	3.16	4.70	3.71	12.69	12.00	10.72	11.51
Alexandria	1.12	1.95	0.81	2.25	3.29	8.37	2.44	6.80
Port Said	1.71	4.61	1.71	6.12	7.36	45.22	5.97	36.16
Suez	3.41	5.47	2.30	5.91	12.88	45.95	8.54	38.85
Damietta	1.11	1.30	1.06	1.39	8.09	3.02	5.74	2.84
Dakahlia	1.55	0.42	1.82	0.27	6.73	1.02	6.26	0.69
Sharkia	1.57	0.96	1.73	1.36	6.40	1.78	5.98	2.43
Kaliobia	1.17	6.02	0.92	6.05	4.07	13.25	3.00	12.62
Kafr Sheikh	1.08	0.51	1.48	0.27	3.06	1.63	3.21	1.08
Gharbia	1.38	0.48	1.49	0.26	5.47	1.71	4.70	0.91
Menoufia	2.15	0.82	2.13	0.71	8.73	1.48	7.31	1.33
Behera	1.06	0.90	1.47	0.95	3.13	2.35	3.61	2.29
Ismailia	1.88	5.86	2.09	6.44	6.08	31.20	5.56	28.73
Giza	1.31	6.87	0.94	4.87	3.09	16.60	2.46	11.93
Bani Swif	1.46	0.36	2.05	0.33	4.51	1.01	4.64	0.80
Fayoum	1.94	0.25	2.60	0.16	4.73	0.60	5.23	0.32
Menia	1.32	0.24	1.96	0.13	3.32	0.67	4.03	0.34
Asiut	2.20	0.51	2.28	0.29	6.80	0.89	6.25	0.59
Sohag	2.15	0.35	2.24	0.11	7.72	0.78	6.97	0.28
Qena	1.75	0.35	1.91	0.38	6.37	0.74	5.57	0.83
Aswan	1.78	1.44	1.84	1.11	5.73	5.35	4.88	3.36
Luxor	1.54	0.39	1.44	0.54	6.03	1.13	4.37	1.19
Red Sea	2.03	14.71	1.80	19.91	5.18	30.03	4.38	35.75
New Valley	2.61	6.40	1.86	7.49	6.94	11.61	5.43	14.72
Marsa Matroh	0.89	8.85	0.75	6.10	2.06	14.35	1.64	13.18
North Sinai	1.07	8.75	1.75	6.42	2.84	13.96	3.57	14.46
South Sinai	1.21	28.11	1.58	31.51	3.08	38.54	3.75	48.23
Total	2.09	2.09	2.00	2.00	6.16	6.16	5.42	5.42

Source: Authors' estimation from the 196 and 2006 Egypt Population and Housing Censuses

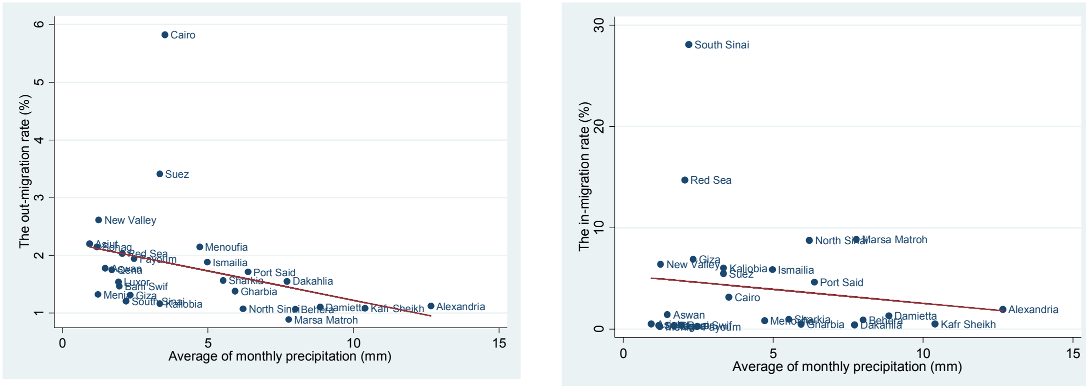
Table A2: The Number of Migrants Across Governorates

Governorate	1996		2006		1996		2006	
	Out-migration during the past 10 years	In-migration during the past 10 years	Out-migration during the past 10 years	In-migration during the past 10 years	Out-migration during the past years	In-migration during the past years	Out-migration during the past years	In-migration during the past years
Cairo	396,749	213,383	361,540	287,940	864,469	810,987	823,730	892,890
Alexandria	35,387	64,886	31,840	92,310	103,792	278,766	95,620	278,860
Port Said	4,766	21,715	6,440	34,000	20,477	212,805	22,490	200,780
Suez	8,815	22,771	7,780	29,930	33,307	191,441	28,880	196,600
Damietta	10,663	11,833	11,860	15,100	77,898	27,596	64,490	30,920
Dakahlia	69,543	17,751	95,770	13,230	301,524	43,085	329,540	34,300
Sharkia	70,412	41,195	96,060	72,740	287,165	76,248	331,430	129,660
Kaliobia	34,777	198,707	34,990	255,750	121,333	437,079	114,260	533,670
Kafr Sheikh	24,460	11,264	39,590	7,080	69,037	36,295	85,820	28,190
Gharbia	48,757	16,393	61,940	10,520	193,391	58,160	195,580	36,340
Menoufia	63,962	22,554	73,790	23,110	259,696	40,710	253,700	43,470
Behera	42,854	35,875	70,690	44,960	126,197	93,646	173,640	108,580
Ismailia	9,790	41,724	14,840	60,650	31,692	222,000	39,540	270,700
Giza	53,723	327,468	52,990	303,540	126,530	791,148	138,480	743,040
Bani Swif	28,189	6,770	48,540	7,620	86,814	18,718	109,820	18,110
Fayoum	40,265	4,928	68,590	4,040	98,086	11,911	138,060	8,140
Menia	44,935	8,066	84,260	5,410	113,034	22,172	173,460	14,040
Asiut	65,614	14,396	83,050	9,800	202,550	24,924	227,130	20,290
Sohag	72,048	10,831	89,740	4,130	259,144	24,513	279,540	10,620
Qena	45,342	8,494	59,820	11,250	164,980	18,081	174,740	24,890
Aswan	17,373	13,982	22,030	13,130	55,945	52,096	58,350	39,610
Luxor	5,837	1,401	6,650	2,410	22,901	4,064	20,120	5,290
Red Sea	2,351	23,051	2,810	46,160	5,992	47,064	6,830	82,860
New Valley	3,515	9,064	3,060	13,670	9,336	16,453	8,930	26,850
Marsa Matroh	1,644	18,738	2,110	19,470	3,808	30,409	4,610	42,090
North Sinai	2,389	22,021	5,290	21,840	6,331	35,120	10,780	49,170
South Sinai	417	15,318	730	27,010	1,065	21,006	1,730	41,340
Total	1,204,578	1,204,578	1,436,800	1,436,800	3,646,492	3,646,492	3,911,300	3,911,300

Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses

Figure A1: Inter-Governorate Migration and Average Monthly Precipitation in 1996

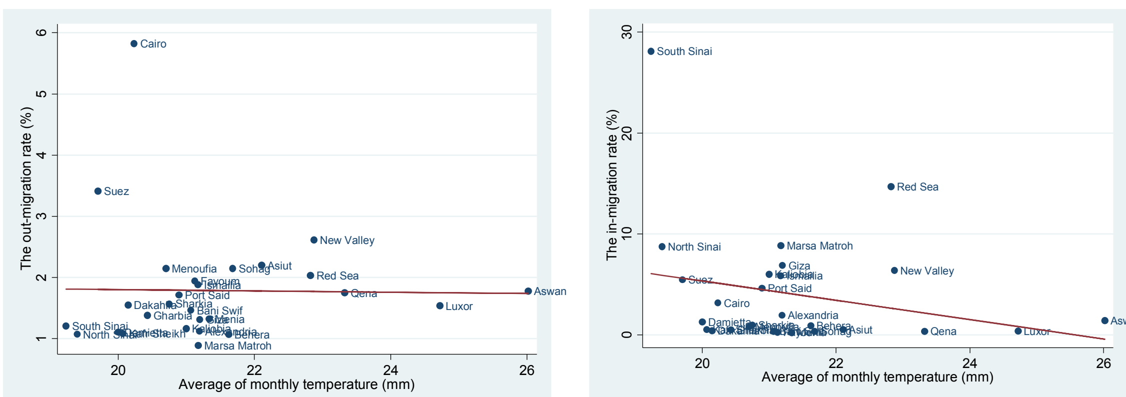
Out-migration rate and precipitation | In-migration rate and precipitation



Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses, climatic data from Willmott and Matsuura (2015)

Figure A2: Inter-Governorate Migration and Average Monthly Temperature in 1996

Out-migration rate and temperature | In-migration rate and temperature



Source: Authors' estimation from the 1996 and 2006 Egypt Population and Housing Censuses, climatic data from Willmott and Matsuura (2015)