The effect of drought on internal migration: The case of Brazil

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Abstract

This paper investigates the effect of environmental aspects on internal migration flows in Brazil, focusing specifically on drought. Internal migration in Brazil is analyzed by using bilateral migration rates between states. The palmer drought severity index is used as a measurement of drought. The results show that drought has a significant effect on inter-state migration flows in Brazil. An increase in drought in the state of origin or a decrease in drought in the state of destination increases bilateral migration at a decreasing rate. Two other environmental variables that are analyzed are land degradation and deforestation. Based on the results of two different measures of deforestation, the suggestion was made that in general out-migration decreases with deforestation due to increased work-opportunities. However when only deforestation because of agricultural land expansion is considered, this effect will not exceed the negative effects of deforestation. Concerning land degradation, no clear evidence was found for its expected effect on migration.

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1. Introduction

Migration is a process involving various aspects where different types of determinants influence the migration decision. One of these determinants could be environmental changes. Environmental change is a broad concept covering a variety of disturbances in nature and climate either induced by natural occurrences or human activities. This paper will investigate the role of the environmental aspect drought, as a determinant of inter-state migration in Brazil. Via a panel data study where the palmer drought severity index measures drought, this effect will be analyzed. The paper follows the methodology proposed by Hering and Paillacar (2013), who study the impact of international trade on bilateral migration rates in Brazil for the years 1995 to 2003. The main research question will be as follows: What is the relation between drought and inter-state migration in Brazil and will this result in substantial migration flows? Besides drought as the key variable of interest, two other environmental aspects will be incorporated in the analysis; land degradation and deforestation. The agricultural production value added will be a proxy for land degradation. Deforestation will be measured in two ways, data on temporary crops planted and on annual deforest area in squared kilometers is used.

Environmental aspects are often seen as a determinant of migration. With people being vulnerable to changes in the environment, via their work or their living area, this could lead to out-migration. However the literature showing empirical evidence of the effect of environmental aspects on migration is not that extensive. In addition the empirical studies are specific to a certain country, region or a group of countries and they use different measures of environmental aspects. With these studies showing different results, the effect of environmental changes on migration is not that clear.

There are also a few studies on the relation of environmental changes and migration in Brazil. By looking at different state and municipal level migration scenarios for the northeast of Brazil, Barbieri et al. (2010) investigate the effect of temperature increase on the performance of the primary sector. They model the long term relation with scenarios in the period 2025-2050. Their results suggest that the agricultural sector will be affected by climate change, pushing people out of the region. Another study that looks at the impact of drought on migration in Brazil is conducted by Bastos et al. (2012). They found a significant positive effect of drought on migration for Brazil in the period 1970-2000. In order to measure drought they use data on rainfall and migration is measured by population cover. In this paper the same effect will be analyzed, however a different approach will be taken. First, a panel dataset is used with state-level bilateral migration flows in the period 1992-2006. Second, the Palmer drought severity index will be a measure of drought. The index is calculated using data on precipitation, temperature and soil moisture. This index takes into account not only precipitation but also evapotranspiration, run-off, soil moisture recharge and soil moisture loss (Palmer, 1965). This makes the Palmer drought severity index a richer measurement of drought compared to the amount of rainfall (Couttenier and Soubeyran, 2013). The index has been widely used to study other questions, not linked to migration (See for example Couttenier and Soubeyran, 2013, Landon-Lane et al., 2009).

Brazil is an interesting country to study this impact of environmental aspects on migration. It is a large country counting 27 states, which include one federal district. Internal migration between the states became highly important in the 1940's and the 1950's, when the rapid growth of some states attracted migrants from lower income states (Graham 1970). Despite its long and intense history of internal migration, the country still has considerable migration flows. Migration between the states is an important occurrence as displacement of people in a way redistributes the population. This could result in exodus of certain areas and an increase in population in others. Camarano and Abramovay (1999) explain that this flow in Brazil is responsible for rural exodus and that the intensity of this deruralization remained roughly the same in the last fifty years of the twentieth century. Brazil is a large country with a rich variety in nature and it has different climate zones. The states therefore differ in this respect and if one region's nature is largely affected, it might happen that people will migrate towards another region. This could lead to internal migration in Brazil, where individuals[1] or families out migrate from one state towards another. Understanding the effect that changes in the environment have on migration flows would be of interest to the country. It might lead to better policymaking in order to improve living conditions of the population.

The rest of this paper is organized as follows. First, section 2 goes deeper into Brazil's situation concerning internal migration and Brazil its environment. In section 3 the impact of drought and the additional environmental variables on the population will be briefly discussed. Thereafter theory concerning internal migration and relation between some environmental aspects and migration will be investigated. Section 5 presents related previous empirical studies. Subsequently, the variables included in the panel data study are introduced.

[1] In the rest of the paper the migration decision of an individual is mentioned. This individual decision might in some cases be a decision for a whole household. Think for example of parents taking their children when they migrate.

Section 7 presents the methodology of the empirical analysis and section 8 shows its results. A short discussion will follow and at the end there will be a conclusion.

2. The study area

Brazil has a long history of internal migration. The main focus traditionally is on the rural-urban migration flow, as cities were growing rapidly. The majority of the Brazilian population currently lives in cities, to be more precise in 2011 an urbanization rate of 84.6 percent was measured (World urbanization prospects: The 2011 Revision). Remarkable is that this urbanization process started relatively early and happened quite fast, as was explained by Martine and McGranahan (2010). This development resulted in large cities and metropolitan areas, which on its turn attracted migrants. In the period 1930-1955 the urban population grew substantially. This can be attributed on the industrial development and agricultural modernization (Faria, 1978). From there on economic and social factors were key factors in rural-urban migration flows. Urbanization growth decreased ever since and other migration flows, rural-rural, urban-urban and rural-urban, became important as well (United Nations population division, 2009; Bilsborrow, 2002). Another important migration flow took place from Brazil's northeast states towards its southeast states (Fiess and Verner, 2003). The in 1940-1950 rapid growing southern states attracted migrants from the lower income states (Graham, 1970). Graham (1970) shows that besides the substantial displacement of people from the northern states toward the southern states, most migrants in this period arriving at the southern states came from neighboring lower income states. In the period 1950-1960, Inter-state migration grew intensively. In this decade the percentage of people that moved across states rose from 10 percent toward 18 percent (fischlowitz, 1969). Inter-state migration in Brazil is still quite high. Based on data of the Brazilian household survey from 1992-2002, Kovak (2010) shows that among adults, 29 percent have ever migrated between states. With this increase of inter-state migration the patterns of migration have changed over the years. For example, the former north-south flow of people is not that strong anymore. In recent years a considerable amount of people migrated from the southeast states towards the northeast (Fiess and Verner, 2003). Inter-state migration might also reflect migration flows related to rural and urban areas. These flows occur both within state as well as across states. With the states in Brazil having different shares of rural and urban areas, rural and urban related movements might actually be inter-state migration (Embrapa Monitoramento por Satelite, 2005).

In Brazil environmental aspects might play an considerable role in people's lives as the country has a highly diverse and rich ecosystem and it possesses the world largest rainforest. This could make the environment an important determinant of migration in Brazil. Brazil can be divided into six biomes. A biome is a set of vegetation types that cover large contiguous areas with similar flora and fauna (Portal brasil, 2013).The biomes are: The Amazon, Cerrado, Atlantic Forest, Caatinga, Pampa and Pantanal (Ministério do meio ambiente, 2013). Figure 1 show a map of Brazil where the six biomes are illustrated. Each biome is associated with a different climate and therefore the biomes may faces different types of environmental changes. These changes might be associated with droughts, sea level rise, floods, fires and erosion (EM-DAT, 2013; Szlafsztein, 2012). In Latin America a growing concern related to climate change is the increase in temperature. A rise in temperature might lead to a decrease in soil water which could on its turn result in droughts and crop degradation (IPCC report 2007). Environmental impacts might not only result from climate change but also direct human activities could be a cause. A quite important human activity in Brazil that affects the environment is deforestation. A transformation happens where the forest area is used for other purposes. The main reasons of deforestation relate to cattle ranching and grain production, with in particular production of soybeans and corn (PNMC, 2008; Portal Brasil, 2013). Also timber exploitation is an important cause of deforestation (Portal Brasil, 2013). The loss of forest cover is principally a critical issue in the Cerrado, the Atlantic Forest and in the Amazon which makes deforestation a country wide problem.

In the whole country variation in dryness of areas may occur as precipitation and temperature changes. The intensity and the frequency of drought periods however, may differ among the regions characterized by different climates. A region that is affected quite frequently is the northeast of Brazil. Due to its semiarid climate the region has a long history of severe droughts events (Brant, 2007). Other regions that also faced these more extreme periods of droughts in the past are the Amazon and the southern part of Brazil (Parry, 2007; FBDS).

The government has different programs where the people in the affected areas are supported, financially but also in other ways. There exist programs for farming families such as 'Bolsa Estiagem' a financial support, 'Garantia Safra' a minimum wage guarantee if families lose their crops and 'Venda de milho' which authorizes the selling of corn at subsidized prices. In addition tanker cars are deployed to distribute drinking water, rainwater tanks are installed and water wells are recovered and constructed in the critical areas.

Farmers, merchants, service providers and agro-industrial enterprises in the northeast part of the country that are harmed by droughts can apply for a particular loan. Via its Growth Acceleration Program (PAC), the government also takes care of the water infrastructure by investing substantially in water systems (Portal Brasil, 2013). All these measures help the people in the areas that face periods of drought. The impact drought could have on people's lives could therefore be mitigated. The last few years the government of Brazil is also quite involved in reducing the effects of climate change in general in Brazil. In 2008 they have set up a national plan which objective is to identify, plan and coordinate the actions and measures that can be taken to mitigate the emissions of greenhouse gases generated in Brazil, as well as those necessary to adapt society impacts that occur due to climate change (PNMC, 2008). With climate changes possibly resulting in an increase of droughts, this plan may involve also the ones affected by droughts. If droughts would lead to substantial outmigration of people from certain areas, these programs might indirectly reduce migration rates. This shows the importance of understanding the effect of drought on internal migration.

3. The impact of drought on individuals

Environmental changes will influence migration flows as they might impact the population's living conditions. This could happen via either direct or indirect dependence on environmental aspects in their work or via changes in their living area. The effect of drought on the population could go through both these channels. An increase in drought, affecting agricultural land, will directly affect farming families and people who work in the agricultural sector as they depend on the yield from the land. Also the living conditions of the people working for instance in the retail sector in the cities and villages may change. This could happen either via the supply chain or a decrease in consumer spending of the people working in the agricultural sector. Besides this effect related to the agricultural sector, villages or cities could be affected directly by a period of drought. Extreme droughts for example may result in local fires but also the supply of drinking water may become scarce (FBDS). The affected people could then decide to migrate to another region or are even forced to do so.

The empirical analysis will also look at the effect of land degradation and deforestation. The same way as drought, land degradation might influence the population via the agricultural sector. Deforestation however could affect the people in the region in a negative but also in a positive way. Deforestation resulting in floods, might influence people's lives as it can destroy partially or completely crops, villages and cities. However, there may also be a positive effect present. Some reasons of deforestation, such as agricultural land expansion or timber exploitation will increase labor demand in the area. This could have a direct positive effect on the new workers. Some people will also be affected indirectly as economic activity increases in the area, affecting also the workers in cities and villages in a positive way. The magnitude of this positive impact will depend of course on how labor intensive the plant is.

So in the end events like these might affect a large group of people, either in a direct or in an indirect way, people in rural but also in the urban areas. This might then lead to migration out of the affected region. The next section will look at the related literature on environmental aspects and migration. This will show what is involved in the process of migration when people are affected by changes in the environment.

4. Theoretical background

In this section first some elements from general migration literature that can be linked to environmental aspects affecting migration will be highlighted. Second, related literature on the environment and migration will be discussed. With drought as an environmental change, these different elements in the migration process might also apply when drought affects the people in the area.

4.1 Migration

The migration process of a person may be triggered by various aspects, leading to different types of migration. In the migration literature a variety of ways of classifying migration can be found. A common division that can be made is between decision-based migration and forced migration. Forced migration relates to quite extreme changes in the place of origin of people. They may be forced to migrate because of for example political, economic, social or demographic reasons but also because of natural or human-induced disasters (black et al. 2011). An example of a recent event leading to forced migration in Brazil is the construction of a hydroelectric dam in Pará, a northern state of Brazil part of the Legal Amazon. Because of this large scale project some local people will be forced to leave their houses (RIMA report 2009). Besides forced movements, migration could also be voluntary and the result of an individual decision. Before making this decision different factors are taken into consideration. Also here this may involve political, economic, social, demographic or environmental motives (black et al. 2011).

Migration can also be divided into migration induced by an individual change and migration because of a collective change. In the first case a change happens specifically to the individual himself, only he is affected. Unemployment because of mal performance, family expansion and obtaining a degree are examples of this type of changes in someone's life. Changes might also happen affecting a whole group of people. Either their living situation changes in the place of origin or the potential living condition changes at the possible destination. An example could be a technology change in a specific sector that results in redundancies or an increase in criminality affecting the feeling of safety in a certain area. It affects more people at once. This will also be the case for changes in the environment. An environmental change in the place of origin of a person will not affect only that person but a whole group of individuals. This will trigger more people at once to consider migration.

In a study on migration, Lee (1966) explains that there exist plus factors and minus factors that may influence the migration choice. Plus factors are connected with the potential destination and they form a positive attraction to a person. Minus factors on the contrary are negative factors present in the place of origin. This idea has evolved into a well known model in the migration literature called the push-pull model. This theoretical model points out the determinants of migration in a more general sense. However, it does not take into account personal differences and the variation in the degree of importance of these determinants (Haas, 2008). Some factors are quite important to the majority of the population. It is important to know and to understand them as changes in these factors might trigger more people at once to migrate.

The presence of these pull and push factors alone does not explain why people migrate. People also need to be aware of these factors and to have the ability to migrate as a response (Bilsborrow, 2002). These two aspects help explain why people migrate towards certain places. In the context of this paper, awareness and ability will be involved in the choice of the state of destination. After being aware of a state's pull-factors, a person may be attracted to a specific state. Aside, distance and the availability of resources (transport, money, etc.) could influence the direction of the movement. This shows that an individual might have the ability to migrate but within certain bounds, limiting the choice of destination states.

4.2 Environment and migration

Environmental aspects as a determinant of inter-state migration fit into the, in section 4.1 mentioned, general concepts of migration. Changes in the environment might as a collective impact lead to either forced or decision based migration. The push and pull factors view will give a meaning to the migration between combinations of states due to these changes. Bilsborrow (2002) explains that environmental aspects are an element of both factors. He therefore splits the effect of environmental variables on migration into environmental push factors and environmental pull factors. A negative environmental change in the state of origin might push people out of the state. In the possible state of destination this type of change could repel migrants. On the other hand, positive changes in the environment could lead to attracting migrants towards a certain state.

Environmental aspects are generally classified as one of the determinants of migration. Black et al. (2011) developed a framework which presents the factors that could impact the volume, direction and frequency of migration. In this framework five main drivers of migration are identified: political, demographic, economic, social and environmental factor. They explain that migration flows are influenced by actual or perceived differences in these drivers comparing the place of origin with possible places of destination. Aside there is a component, environmental changes, which affects migration via one of the five main drivers. These changes could thus impact migration directly but also indirectly, involving political, demographic, economic or social aspects.

Vulnerability of regions to environmental changes is another aspect interwoven with migration. Not each place in a country is equality vulnerable to these changes. In Brazil for example the Amazon with its tropical rain forest will be different in its vulnerability to certain environment changes than the southern region with its subtropical climate. Smit and Polifosova (2003) discuss the concept of difference in vulnerability to climate changes. They explain that the extent to which certain regions are in danger depends on two elements: exposure and the ability to adapt (Smit and Polifosova, 2003). Concerning exposure to environmental changes, different regions will deal with different kind of changes. Also human induced environmental degradation will be region specific, depending on for example natural resources and existing production plants. Expose thus simply differentiate regions in its occurrence of changes to the environment. The ability to adapt refers to the ability of humans to adapt to the changes in the environment, including adaptations within communities, regions, sectors etc. (Smit and Polifosova, 2003).

McLeman and Smith (2006) elaborate on this concept and they present a model showing the relation of vulnerability, exposure and adaptive capacity. In addition they make a link with migration suggesting that climate induced migration could be a function of exposure and adaptive capacity. The vulnerability aspect subdivided into exposure and adaptation capacity could help explain the difference in volume of outmigration between certain regions. Exposure differentiates regions in possible motives to migrate. The ability to adapt will influence the degree of importance of the change in environment as a push factor. A good ability to adapt will decrease the necessity to migrate. Different regions facing a same type of environmental change might therefore differ in the number of out-migrants because of this adaptation aspect. Vulnerability could also play a role in the destination selecting process. Less vulnerable places, possibly due to good adaptation ability and/or a moderate exposure to negative environmental changes, might be more attractive than highly vulnerable places.

5. Previous studies

The literature showing empirical evidence of the effect of environmental changes on migration is not that extensive. The results of these studies will be country or region specific as different areas cope with different type of environmental problems and changes of different magnitudes. This results in a quite diverged set of studies. Henry et al. (2003), for example, show that rainfall variability and land degradation, at both the origin and destination, influences inter-provincial migration in Burkina Faso. In a cross country panel study on sub-Saharan Africa Marchiori et al. (2011) also look at the effect of rainfall anomalies on migration. They use rainfall and temperature anomalies as a measure of climatic change, and they found that internal and international migration increases with climate changes. Massey et al. (2010) and Feng et al. (2010) investigate the effect of environmentally induced impacts in the agricultural sector on migration. In a study on Nepal, Massey et al. (2010) found that as agricultural productivity declines and the flora share falls, people are more likely to out-migrate. Feng et al. (2010) examine the migration flow from Mexico towards the United States. They show that there is a significant effect of changes in crop yields resulting from climate change on the rate of out-migration from Mexico towards the United States. Instead of focusing on a specific country, region or a group of countries, Beine and Parsons (2012) analyze the effect of environmental changes on international migration via a panel study including 137 origin and 166 destination countries. They found no evidence for the effect of climatic change on international migration in the long run. However concerning internal migration they found that natural disasters result in an increase of urbanization.

Within this set of migration literature there is a subset of studies investigating the effect of drought on migration. A common proxy for drought in these studies is data on precipitation. This is what Bastos et al. (2012) use in their study on short and long-term impacts of drought in Brazil. For the period 1970-2000 they found that in the long-term drought lead to out-migration from these impacted areas. Gray and Mueller (2012) use data on satellite measures of daily rainfall and household self-reports of drought in a study on Ethiopia. They found a positive significant effect of drought on men's labor migration which could indicate that drought reduce living conditions. However marriage related moves by women decreased. Also Henry et al. (2004) also look at the impact of rainfall on out-migration in Burkina Faso. Their results suggest that out-migration towards rural areas is expected to be higher for people living in drier areas compare to people living in wetter regions. In a study on Australia, Hunter and Biddle (2011) found that in the short run the net effect of drought on migration is small or insignificant but in the long run people are very likely to migrate. Again data on rainfall is used.

These studies show no clear picture of the effect of environmental aspects on migration, neither of the impact of drought on migration. Despite the relevance of studying these effects for Brazil, there is little empirical evidence. The following sections will proceed with the empirical analysis of the effect of drought on inter-state migration in Brazil.

6. Data

This section will present the variables that will be used in the panel data study. First the dependent variable, bilateral migration rate and the palmer drought severity index are introduced. Subsequently the additional environmental variables will be presented and the control variables will follow.

6.1 Bilateral migration rate

The dependent variable, migration, is a *bilateral migration rate*, computed from the data from the Brazilian household survey *Pesquisa Nacional por Amostra de Domicilios* (PNAD) that is obtained from the IBGE, the Brazilian Institute of Geography and Statistics. The data set contains data for the years 1992 until 2006 with the exclusion of the years 1994 and 2000. As in Hering and Paillacar (2013), the migration rate is defined as follows: $\ln(s_{ij,t}/s_{ii,t})$. The rate is the log of the number of migrants moving from state i towards state j over the amount of stayers in state i in year t. Here a migrant is defined as an individual who five years ago lived in a different state than his state of residence in year t.

6.2 Palmer drought severity index

The *palmer drought severity index* is an index measuring drought by using data on precipitation temperature and soil moisture (Palmer, 1965). The index is divided into eleven 'types' of wet or dry weather conditions. It ranges from values indicating extremely dry areas up to values pointing out extremely wet areas. In this analysis an adjusted Palmer drought severity index is used. This adjustment has been proposed by Couttenier and Soubeyran (2013). The values of the index have a scale ranging from 0 until 30. The value 15 corresponds to a "normal" climatic situation; an extremely wet climate is now indicated by values below 5 and an extremely dry climate by values above 25. The range of non-extreme index values thus ranges from 5 to 25, instead of the original scale going from -4 to 4. The range of the index values of the dataset goes from 8.82 up to 20.83. The average value is 16.11, which is slightly higher than the value corresponding to a normal climatic situation. The expectation is that an increase in the drought index in the origin state i or a decrease in drought in the destination state j would increase bilateral migration.

The palmer drought severity index will enter ones more in the analysis but this time as the *palmer drought severity index squared*. As explained by Landon-Lane et al. (2009) this will indicate whether extreme weather conditions have a non-linear effect on migration. Within the range of the index values of the dataset, this will show possible non-linearity for the outmost values. It is plausible that the effect on out-migration is smaller when a quite dry area faces a reasonable drought period, compared to when an area not experiencing any drought is suddenly confronted with drought. This has to do with the, in section 4.2 mentioned, ability of humans to adapt to changes in the environment. This non-linearity together with the expected relation between the index and migration would imply that migration increases at a decreasing rate as drought increases in the state of origin.

6.3 Additional environmental variables

The variable *value added of agricultural production* is the value of total agricultural production in constant 2000 Real as a percentage of GDP and is obtained from Ipeadata[2], the

[2]Ipeadata is a database containing macroeconomic, social and regional data of Brazil maintained by The Brazilian Institute of Applied Economic Research (IPEA). Available at http://www.ipeadata.gov.br/

Brazilian Institute of Applied Economic Research. Guillaumont and chauvet (2001) use this variable as a proxy for the size of climate shocks. However, the value added of agricultural production will be affected by environmental aspects that affect agricultural land in particular. The damage of crops that are growing on the land will result in lower output of agricultural production. Therefore this broad view of Guillaumont and chauvet (2001) will be narrowed by using this variable as a proxy of land degradation specifically. Agricultural production value added captures, besides the quantity change, also the quality change of the production as it is a monetary variable. This way, situations where the quality of the agricultural output has decreased because of (partial) damage to crops are also incorporated. The expectation here is that a decrease in the value added in the origin state or an increase of this variable in the state of destination increases bilateral migration.

The variable temporary crops planted as a share of total crops planted will be a proxy for deforestation. As defined by the IBGE, temporary crops are crops that are planted for a short term, usually less than one year and that after each harvesting new seeding is required. The variable that is used here is the amount of *temporary crops planted* measured in hectares, and is obtained from the IBGE. The data on the total crops planted, also expressed in hectares, is obtained from Ipeadata. In his study about tropical deforestation, Scrieciu (2007) used arable land area to measure deforestation. He mentions that the main source of deforestation is the acquisition of new land for agricultural purposes. This is also the case for Brazil where, as explained in section 2, a main reason for deforestation is grain production with in particular the production of soybeans and corn. These two grains are the largest and second largest temporary crop products and take both a substantial share of total temporary crop production in Brazil (See Figure 2). Therefore, instead of using agricultural land area in general to measure deforestation a more specified variable will be used, temporary crops planted. This is also done by Angelsen et al. (1999). They argue that the temporary crops are more likely to expand as a response to market forces than permanent crops. In addition different studies show that there is a significant relation between temporary corps and deforestation (Brum et al., 2011; Marchand, 2010; Diniz et al, 2009). By using the variable temporary crops planted as a share of total crop planted, the expectation is that as ceteris paribus temporary plantation increases, this land was acquired by deforesting the area. Expecting a negative effect of deforestation on the population, an increase in this variable in the state of origin or a decrease in the state of destination is expected to increase bilateral migration.

Also included in the analysis is the annual *deforest* area in squared kilometers. The data for this variable is obtained from the IBGE and it covers only the nine states making part of the Legal Amazon (see Table 1 for the corresponding states). This will thus be a more direct way of studying the effect of deforestation on the bilateral migration rate.

6.4 Control variables

Besides these five environmental variables, additional variables are included in order to control for some other possible determinants of migration. These variables are all, to a certain extent, correlated with some of the variables of interest (See Table 2). This makes them relevant as control variables in this analysis.

The (potential) *wage* of a person, in the state of origin and in the state of destination, could influence the migration decision. Because of geographical or sector-related wage differentials this variable is important to include. As in Hering and Paillacar (2013) for each pair of state two wage variables are calculated; one for the state of origin and one for the state of destination. The wage variable for the state of origin i, for all combination of states, is the log of the average of predicted wages that individuals who lived in state i five years ago would potentially earn in state i, in year t. The wage variable for the state of destination j is the log of the average of predicted wages in period t that individuals would potentially earn in state j coming from state i. The data that is used comes from the household survey PNAD from the IBGE.

The *unemployment rate* is another possible determinant of migration. Correlation between this variable and the environmental variables could originate from the reasoning that there exist higher labor market competition in the attractive less vulnerable places. As Hering and Paillacar (2013) the unemployment rates are computed with the data from the household survey PNAD from the IBGE. The variable is defined as the log of the share of people, aged 16 to 65, who are unemployed in state i in year t.

In order to control for healthcare a variable measuring the number of *active health professionals* per 1000 inhabitants in state i in year t is included. The data is acquired from the IBGE. With the notion that healthcare (hospitals, doctors, etc.) is possibly more established in certain areas this variable is added to the analysis.

Another control variable is the number of *homicides* and it will be used as a proxy for criminality in the Brazilian states. The data is obtained from Ipeadata. Including this variable will control for the effect of differences in criminality rates between certain areas.

The presence of other migrants in a possible state of destination could also influence the migration decision. In some places the number of former migrants might be higher than in other areas. The variable *bilateral stock of migrants* is computed with the data from the household survey PNAD from the IBGE. The variable is defined as the number of former migrants present in state j originating from state i in year t.

The last control variable is *population density*. It could be expected that states with a high population density consist of more urban areas and are larger cities less vulnerable to environmental aspects, compared to states with a small population density. This variable is constructed by dividing the population of state i in year t by the size of the state in squared kilometers. The data on population is the number of inhabitants obtained from Ipeadata whereas the information on the size of the states comes from the IBGE.

7. Methodology

In this section a model will be set up in order to study the effect of drought, and the additional environmental variables, on inter-state migration. A panel data study will be conducted. The analysis starts with 27 states with 522 couples of states for the period 1992 until 2006 leading to a total number of 3742 observations. Because of inclusion of the palmer drought severity index this will be reduced to 21 states, 342 couples of states and 2541 number of observations. See Table 1 for a list of the corresponding states.

As discussed up to now, migration is a process involving different factors. The actual migration of a person does not take place immediately after a change of one of these factors, excluding some cases of forced migration. Therefore all independent variables will be lagged one year. Lagging these variables will also serve another purpose. The fixed effects estimates may suffer from the endogeneity bias, reverse causality. Besides that an independent variable has an effect on the bilateral migration rate, the bilateral migration rate could also have an effect on some of the independent variables. An increase in the migration from state i towards state j might for example increase deforestation, the amount of temporary crops planted and the agricultural production value added in state j. This problem of endogeneity is taken care of by lagging the independent variables as it is unlikely that migration in year t influences a certain independent variable in year t-1. All variables, both dependent and independent variables, are expressed in logs. This log transformation reduces the impact of present outliers and the interpretation of the results will be facilitated as the coefficients can be interpreted as elasticities.

The dependent variable is a bilateral migration rate between two states. In the dataset all 27 Brazilian states are therefore paired. This results in combination of states that consist of a state of origin and a state of destination, where the combination of for example origin state Acre and destination state Bahia differs from the combination of origin state Bahia and destination state Acre. For each independent variable a rate will be constructed containing both the value for the corresponding state of origin and for the corresponding destination state. This rate will be as follows:

$$'variable'\,ratio = ln\frac{'variable'_{j,t-1}}{'variable'_{i,t-1}}$$

Where j denotes the destination state and i denotes the state of origin. The variable bilateral migration rate is an exception here. Just as the dependent variable it is a bilateral variable for couples of states. Therefore no rate will be created for this variable.

The equation that will be studied is the following:

$$\ln migr_{ijt} = \beta_0 + \beta_1 \ln wage_{ij,t-1} + \beta_2 \ln unempl_{ij,t-1} + \beta_3 \ln health_{ij,t-1} + \beta_4 \ln hom_{ij,t-1} + \beta_5 \ln migrstock_{ij,t-1} + \beta_6 \ln popdens_{ij,t-1} + \beta_7 \ln palmer_{ij,t-1} + \beta_8 \ln palmer^2_{ij,t-1} + \beta_9 \ln tempcrop_{ij,t-1} + \beta_{10} \ln prod_{ij,t-1} + \alpha_{ij} + \alpha_t + \varepsilon_{ijt} \quad (1)$$

Where i denotes the state of origin, j the state of destination and t denotes the year. *migr* is the bilateral migration rate as explained in section 6.1, representing the migration flow from state i to state j in year t. *wage*, *unempl*, *health*, *hom*, *migrstock* and *popdens* represent the control variables potential wage, the unemployment rate, the number of active health professionals, the number of homicides, the stock of migrants and the population density. *palmer, palmer*^{2}, *tempcrop* and *prod* are the environmental variables palmer drought severity index, the palmer drought severity index squared, temporary crops planted as a share of total crop planted and the agricultural production value added as a share of GDP respectively. α_{ij} is the bilateral fixed effect that is included to control for the time-invariant characteristics of the combination of states. This will capture variables that might influence migration but are constant over time, for example the presence of a common boarder and distance between the couple of states. The year fixed effect α_t is used to control for the effect of macro-wide shocks that impact bilateral migration in all states at the same time. By capturing these unobservables, the country and year fixed effects will by a large extent reduce the omitted variable bias. The last term in equation (1) is the residual ε_{ijt}. Table 3 presents the descriptive statistics of the variables used in the empirical model.

This equation is analyzed by five models. The first model regresses migration on the standard migration determinants. The variable Palmer drought severity index is then included to study the effect of drought on the bilateral migration rate. Thereafter the other two environmental variables, temporary crops planted and agricultural production value added are added stepwise. In order to look in a more direct way at the effect of deforestation on migration an additional model will be considered. Here the variable temporary crops planted, a proxy for deforestation, will be replaced by the variable deforestation, leading to the following equation:

$$\ln migr_{ijt} = \beta_0 + \beta_1 \ln wage_{ij,t-1} + \beta_2 \ln unempl_{ij,t-1} + \beta_3 \ln health_{ij,t-1} + \beta_4 \ln hom_{ij,t-1} + \beta_5 \ln migrstock_{ij,t-1} + \beta_6 \ln popdens_{ij,t-1} + \beta_7 \ln palmer_{ij,t-1} + \beta_8 \ln palmer^2_{ij,t-1} + \beta_9 \ln prod_{ij,t-1} + \beta_{10} \ln def_{ij,t-1} + \alpha_{ij} + \alpha_t + \varepsilon_{ijt} \quad (2)$$

As explained in section 6.3, this variable *def* gives the amount of deforest area in the Legal Amazon states only. This will narrow the number of observations from 2541 to 351 observations. Keeping this in mind the effect this model will be analyzed briefly.

All six models are fixed effects models. This type of model is preferred when cluster correlation is present and when the dataset is unbalanced, as is the case here (Wooldridge 2nd ed.). In the fixed effects model it is assumed that ε_{ijt} is uncorrelated over the state couples and time. However presence of autocorrelation and heteroskedasticity might invalidate the standard errors and resulting tests (Verbeek, 2012). The wooldridge tests for autocorrelation indicate that the models[3] suffer from autocorrelation. In all regressions the standard errors will be clustered at the couple of states, this will take care of non-independence of observations within the couples of states. These standard errors are also robust against both heteroskedasticity and autocorrelation.

8. Results

The empirical results are reported in Table 4. First migration is regressed on the six control variables, which is shown in column 1. Here the variables unemployment, health and population density have a significant effect on the bilateral migration rate. Column 2 presents results of the same regression, however the number of observations is this time restricted to the number of observations corresponding to the models presented in column 3 up to 5. The

[3] Autocorrelation is present in the models of Table 4 and 5.

number of observations in these models reduces because the variable palmer drought severity index is included. In addition to the previous significant variables, the variable wage is significant as well. The sign of unemployment and population density is as would be expected. Wage and health on the contrary show a different sign than its general prediction.

Columns 3 to 5 present the results of adding stepwise the environmental variables to the model. First the Palmer drought severity index is added together with its squared term. Both these two introduced variables are significant and show its expected sign. The estimated coefficient of the palmer drought severity index indicates that a one percent increase in the ratio of this index leads to a 0.261 percentage decrease in the bilateral migration rate. This negative relation means that ceteris paribus either an increase in drought in the state of origin or a decrease in the destination state (a decrease of the palmer index ratio) leads to an increase of migration between these two states. The palmer drought severity index squared shows a positive relation with the bilateral migration rate, as was expected in section 6.2. Together with the negative relation of the palmer drought severity index ratio and migration this would imply that the bilateral migration rate increases at a decreasing rate, either due to a ceteris paribus increase in drought in the origin state or a decrease in the state of destination. To explore whether the level of drought is a push or a pull factor, the bilateral migration rate will be regressed upon the origin and destination variables separately. The results are presented in Table 5, and it shows the effect of the variables as a push and as a pull factor on the bilateral migration rate. Both the variables palmer drought severity index for the state of origin and the state of destination are significant and show their expected sign. The results indicate that as drought increases in the state of origin outmigration increases. In addition, a decrease in drought in the state of destination increases migration towards this state. The level of drought thus has an effect on the bilateral migration rate as both a push and a pull factor.

In column 4 of Table 4 the variable temporary crops is added. As a proxy for deforestation this variable shows to have a significant effect on the bilateral migration rate. A one percentage increase in the temporary crops ratio means a 0.211 percentage decrease in the bilateral migration rate. This negative relation follows the expectation explained in section 6.3. Ceteris paribus either an increase in temporary crops planted relative to total crops planted in the origin state, which would mean that deforestation has increased, or a decrease in the state of destination results in an increase of migration.

The last step is adding the variable value added of agricultural production. In column 5 of Table 4 this model is presented which shows that the variables health and temporary crops are not significant anymore. The coefficient of the value added agricultural production variable, measuring land degradation, shows a significant negative relation to the migration rate. A one percentage increase in this variable's ratio, decreases migration by 0.087 percent. The results in Table 5 indicated that this effect is due to its effect on migration in the state of origin. If ceteris paribus the agricultural production value added as a share of GDP in the origin state increases, out-migration would increase. This result does not follow the prediction stated in section 6.3. Because the bilateral migration rate that is used here consists of movements of all migrants active in all sectors the negative effect could be attributed to the GDP term in the variable. A decrease in the value added in other sectors than the agricultural sector could increase outmigration of workers active in these sectors. In order to explore this further, the regressions of the five models discussed up to now will be repeated but this time the dependent variable will be the bilateral migration rate in the agricultural sector[4]. The results are presented in Table 6. It should be noticed that the number of observations is reduced. Also here the variables unemployment population density and the palmer drought severity index are significant in most models. The coefficient of the variable value added agricultural production is still negative but not significant anymore. This is in line with the sector explanation of this effect in Table 4. The effect of a ceteris paribus increase in the agricultural production value added as a share of GDP increasing out-migration, is only significant if migrants active in all sectors are considered. However it is likely this is attributed to the GDP term and not to the value added of agricultural production. There thus seems to be no effect of land degradation on the bilateral migration rate, either including all migrants or only migrants working in the agricultural sector.

Modeling the variable temporary crops planted as a share of total crops planted is a quite indirect way of measuring deforestation. Therefore this variable will be replaced by the direct deforestation variable. The results are presented in Table 4 column 6. It has to be noticed that one should be careful with drawing conclusions from these results since only the states in the Legal Amazon are being analyzed here, restricting the number of observations. The positive coefficient of the deforestation variable is significant, indicating that as the deforestation ratio increases by one percent, the bilateral migration rate increases by 0.168 percent. This effect is not in line with the expectation explained in section 6.3 and the negative coefficient of the variable temporary crop planted. An explanation of this positive coefficient could be the in section 3 discussed positive effect of deforestation on the population in the region. With the acquisition of new land, demand for labor might increase

[4] The bilateral migration rate in the agricultural sector is computed with the data from the household survey PNAD from the IBGE.

which could result in less people migrating out of the region and even attracting more people towards the area. However, if this would be the case one would expect the effect of the variable temporary crops planted to be positive as well. The explanation of the positive effect of the variable deforestation could then be that the other motives of deforestation will benefit the people in the region. Deforestation for example because of wood production might attract workers leading to less out-migration and an increasing receipt of migrants. In addition, the result for the variable deforestation in Table 5 indicate that the deforestation as a push factor affect migration. The results of both variables together could then suggest that overall, deforestation decreases out-migration as the effect on labor demand surpasses the effect of people being harmed by deforestation. However in the case of agricultural land acquisition this is not the case as the negative impact on the population in the region is stronger than the positive labor effect.

9. Discussion

The results of this paper show that bilateral migration between two states increases at a decreasing rate as ceteris paribus either the origin state becomes drier or the destination state becomes less dry. The bilateral approach that is used here has the advantage that the effect of drought on migration both as a push and as a pull factor can be analyzed simultaneously. The findings for the variable palmer drought severity index show that the level of drought is a push and also a pull factor. Thus both drought in the state of origin and in the state of destination are important in the migration process.

Based on the results the suggestion was made that in general out-migration decreases with deforestation, because of the positive effect of increased work-opportunities on the people in the region. However when only deforestation because of agricultural land expansion is considered, this effect will not exceed the negative effects of deforestation. This suggestion should however be considered with care since both measures of deforestation used have their limitations. The number of observations is quite small in the model including variable deforest area and the variable temporary crops planted is a rough proxy of deforestation.

No clear effect was found between land degradation and the bilateral migration rate. Also here a quite rough proxy for land degradation was used. A more direct measure of land degradation would be preferred. However value added of agricultural production as a share of GDP seems to be the best proxy available due to a lack of data on land degradation.

The results of this study show the importance of more direct measures of environmental aspects. The lack of data on these aspects, especially on a more micro-scale level, restricts analysis that try to capture the effect of certain environmental changes on migration. Another limitation here is the incomplete data on palmer drought severity index for the whole panel dataset, which reduces the studied sample. It would be preferred to look at the effect of drought on the bilateral migration rate for all 27 states on Brazil. These limitations leave room for further research in terms of finding more direct measures and complete data of environmental aspects.

10. Conclusion

This paper investigated the effect of environmental aspects on inter-state migration in Brazil in a panel data study. The theoretical literature has emphasized that environmental aspects play an important role as a determinant of migration. However, the literature showing empirical evidence of this effect is not that extensive and no clear picture has emerged. The same holds for the effect of drought on migration. It is important to understand the effect that changes in the environment have on migration flows. It might lead to better policymaking in order to improve living conditions of the population. Future migration flows might be better anticipated. This way the government can help mitigating the environmental impacts on the population in the origin state. Also the living conditions of migrants in the state of destination can be improved.

The main focus of this paper was on drought, in addition land degradation and deforestation were analyzed. What was found was that drought has a significant impact on migration flows in Brazil. An increase in drought in the state of origin increases outmigration whereas increases in drought in the state of destination decreases migration towards this state. In addition the results show a non-linear relation between drought and migration. The results concerning deforestation were less strong. A suggestion was made between the relation of deforestation and migration however, because of limitations of the variables and the data one should be careful in drawing conclusions from these results. No clear evidence was found for the expected effect of land degradation on migration.

11. References

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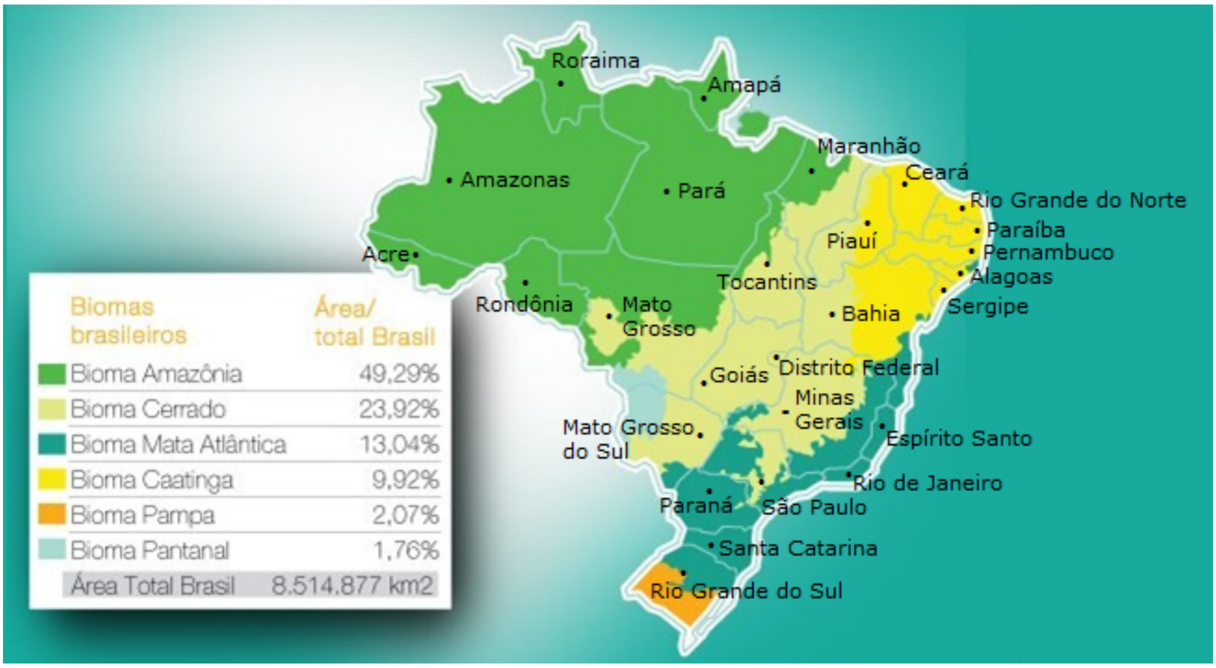
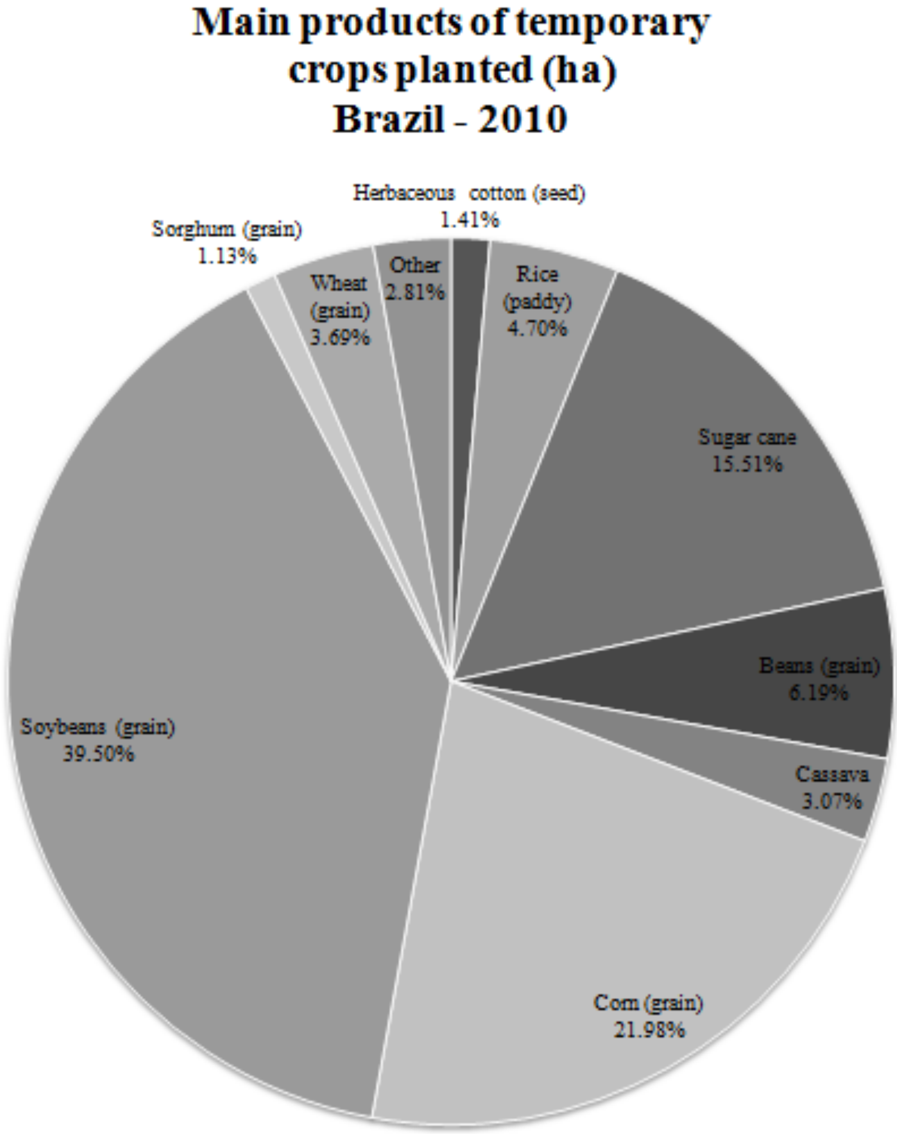
12. Appendix

Figure 1 – Map of Brazil showing the countries six biomes



Source: Portal Brasil

Figure 2 – Share of the main temporary crops production plants of the total



Source: Data from the IBGE Produção Agrícola Municipal 2010

Table 1 – List of the 27 Brazilian states

State code	State
12	Acre*[1]
27	Alagoas
13	Amazonas*[1]
16	Amapá*[1]
29	Bahia[1]
23	Ceará[1]
53	Distrito Federal
32	Espírito Santo
52	Goiás[1]
21	Maranhão*[1]
31	Minas Gerais[1]
50	Mato Grosso do Sul[1]
51	Mato Grosso*[1]
15	Pará*[1]
25	Paraíba
26	Pernambuco[1]
22	Piauí[1]
41	Paraná[1]
33	Rio de Janeiro[1]
24	Rio Grande do Norte[1]
11	Rondônia*[1]
14	Roraima*[1]
43	Rio Grande do Sul[1]
42	Santa Catarina
28	Sergipe
35	São Paulo[1]
17	Tocantins*[1]

States marked by * are part of the Legal Amazon and the variable *deforestation* only covers these 9 states. The variable *palmer drought severity index* contains data on the 21 states marked by [1]. Source: IBGE

Table 2 – Correlation matrix

	Production	Temporary crops	Palmer index	Palmer index²	Wage	Unemployment	Health professionals	Homicides	Migration stock	Population density
Production	1.0000									
Temporary crops	0.3552	1.0000								
Palmer index	-0.1099	0.1494	1.0000							
Palmer index²	0.0142	0.0431	0.0627	1.0000						
Wage	-0.2320	0.0215	0.0230	0.0004	1.0000					
Unemployment	-0.5330	-0.5242	-0.0755	-0.0191	0.1355	1.0000				
Health professionals	-0.4197	0.2082	0.1490	0.0123	0.3475	0.1725	1.0000			
Homicides	-0.4097	-0.0531	0.1206	0.0188	0.3549	0.4051	0.6702	1.0000		
Migration stock	0.0373	0.0628	0.0767	-0.0750	0.1822	-0.0878	-0.0005	0.0580	1.0000	
Population density	-0.5340	-0.1231	0.0190	0.0017	0.1595	0.3130	0.6889	0.7622	-0.0975	1.0000

Table 3 – Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Obs
Bilateral migration rate	overall	-6.78993	1.299978	-9.89091	-2.95001	5583
	between		1.134839	-9.60601	-3.52788	
	within		0.543627	-9.46045	-4.6315	
Unemployment ratio	overall	-0.0244	0.621852	-2.28573	2.028306	4470
	between		0.612223	-1.49965	1.856529	
	within		0.243751	-1.35552	1.306727	
Health professionals ratio	overall	-0.01454	0.806119	-4.31749	4.317488	5870
	between		0.76507	-2.40493	2.609887	
	within		0.254653	-2.09668	2.068668	
Homicides ratio	overall	-0.09367	1.640665	-5.22564	5.038337	5934
	between		1.641661	-4.76744	4.852631	
	within		0.26456	-1.21085	1.023515	
Migration stock ratio	overall	3.814133	1.589719	0	7.768533	4100
	between		1.709727	0	7.706204	
	within		0.367886	1.431974	5.374367	
Population density ratio	overall	-0.16133	2.030364	-5.66746	5.667457	5077
	between		2.162834	-5.52441	5.530541	
	within		0.045659	-0.45867	0.089397	
Palmer index ratio	overall	-0.00057	0.161323	-0.80041	0.738043	3950
	between		0.109027	-0.48679	0.342011	
	within		0.131821	-0.51649	0.513556	
Palmer index² ratio	overall	0.026019	0.052128	0	0.640659	3950
	between		0.032111	0	0.335325	
	within		0.045316	-0.27932	0.447766	
Temporary crops ratio	overall	0.008728	0.360389	-1.63861	1.633824	5934
	between		0.387208	-1.57392	1.588966	
	within		0.125812	-0.70456	0.722017	
Value added production ratio	overall	0.003937	1.415439	-4.80981	4.859436	5934
	between		1.333014	-4.08528	4.134872	
	within		0.335252	-1.97757	1.666159	
Deforestation ratio	overall	-0.14927	2.036617	-6.77041	6.770407	654
	between		2.330821	-5.23061	5.548399	
	within		0.46578	-3.15856	2.86002	

Table 4 – Panel data regression

	Bilateral migration rate					
	M1	M2	M3	M4	M5	M6
Wage	0.019	0.068*	0.046	0.046	0.053	0.027
	(0.029)	(0.038)	(0.038)	(0.038)	(0.038)	(0.06)
Unempl	-0.119***	-0.145***	-0.140***	-0.139***	-0.132**	-0.047
	(0.043)	(0.051)	(0.051)	(0.051)	(0.051)	(0.1)
Health	-0.096*	-0.120**	-0.109**	-0.091*	-0.084	0.048
	(0.049)	(0.053)	(0.052)	(0.052)	(0.052)	(0.072)
Hom	-0.005	-0.029	-0.024	-0.028	-0.024	-0.115
	(0.041)	(0.049)	(0.049)	(0.049)	(0.049)	(0.1)
Migrstock	-0.005	0.012	0.011	0.009	0.007	0.190
	(0.036)	(0.044)	(0.043)	(0.044)	(0.043)	(0.127)
Popdens	1.026***	1.468***	1.543***	1.555***	1.678***	1.552**
	(0.344)	(0.409)	(0.408)	(0.405)	(0.418)	(0.617)
Palmer			-0.261***	-0.266***	-0.250***	-0.278
			(0.081)	(0.081)	(0.081)	(0.279)
Palmer²			0.538***	0.535**	0.532**	-0.644
			(0.202)	(0.209)	(0.213)	(1.312)
Tempcrop				-0.211*	-0.155	
				(0.123)	(0.121)	
Prod					-0.087*	-0.224**
					(0.047)	(0.106)
Deforest						0.168**
						(0.074)
Observations	3742	2541	2541	2541	2541	351
R^2	0.04	0.05	0.056	0.057	0.06	0.187

The heteroskedasticity-robust standard errors, clustered at the couple of states, are presented under each estimated coefficient in parentheses. * represents significance at a 10 percent level, ** at a 5 percent level and *** at a 1 percent level.

Table 5 – Panel data regression

	Bilateral migration rate					
	M1	M2	M3	M4	M5	M6
$Wage_i$	-0.005	-0.023	-0.003	-0.002	-0.014	0.005
	(0.042)	(0.055)	(0.055)	(0.055)	(0.056)	(0.098)
$Wage_j$	0.024	0.104*	0.082	0.083	0.083	0.066
	(0.042)	(0.056)	(0.058)	(0.058)	(0.056)	(0.096)
$Unempl_i$	0.129**	0.117*	0.114*	0.113	0.101	0.061
	(0.058)	(0.068)	(0.068)	(0.069)	(0.07)	(0.145)
$Unempl_j$	-0.091	-0.143**	-0.136**	-0.134**	-0.132**	0.033
	(0.058)	(0.066)	(0.066)	(0.067)	(0.067)	(0.124)
$Health_i$	0.219***	0.246***	0.233***	0.210***	0.203***	0.129
	(0.066)	(0.071)	(0.069)	(0.069)	(0.068)	(0.121)
$Health_j$	0.014	-0.015	-0.005	0.009	0.017	0.214*
	(0.071)	(0.074)	(0.073)	(0.073)	(0.073)	(0.119)
Hom_i	0.024	0.06	0.057	0.064	0.059	0.341*
	(0.063)	(0.075)	(0.075)	(0.075)	(0.075)	(0.175)
Hom_j	0.016	0.013	0.018	0.015	0.019	0.171
	(0.058)	(0.07)	(0.07)	(0.07)	(0.07)	(0.155)
$Migrstock_{ij}$	0.023	0.045	0.044	0.042	0.042	0.248*
	(0.037)	(0.046)	(0.046)	(0.046)	(0.045)	(0.135)
$Popdens_i$	-2.325***	-2.924***	-3.025***	-3.038***	-3.218***	-2.365*
	(0.484)	(0.611)	(0.608)	(0.601)	(0.616)	(1.362)
$Popdens_j$	0.037	0.49	0.576	0.58	0.693	0.807
	(0.473)	(0.553)	(0.557)	(0.553)	(0.558)	(1.229)
$Palmer_i$			0.230*	0.242**	0.208*	0.840*
			(0.118)	(0.121)	(0.12)	(0.483)
$Palmer_j$			-0.285**	-0.285**	-0.290**	0.264
			(0.118)	(0.118)	(0.118)	(0.337)
$Tempcrop_i$				0.268	0.181	
				(0.176)	(0.166)	
$Tempcrop_j$				-0.163	-0.125	
				(0.161)	(0.163)	
$Prod_i$					0.131*	0.435***
					(0.068)	(0.142)
$Prod_j$					-0.06	-0.083
					(0.056)	(0.144)
Def_i						-0.221*
						(0.127)
Def_j						0.127
						(0.098)
Observations	3742	2541	2541	2541	2541	351
R^2	0.049	0.062	0.065	0.067	0.07	0.24

The heteroskedasticity-robust standard errors, clustered at the couple of states, are presented under each estimated coefficient in parentheses. * represents significance at a 10 percent level, ** at a 5 percent level and *** at a 1 percent level.

Table 6 – Panel data regression

	Bilateral migration rate agricultural sector				
	M1	M2	M3	M4	M5
Wage	-0.149**	-0.098	-0.136	-0.135	-0.133
	(0.074)	(0.092)	(0.095)	(0.096)	(0.097)
Unempl	-0.435***	-0.554***	-0.539***	-0.541***	-0.538***
	(0.1)	(0.11)	(0.108)	(0.108)	(0.108)
Health	-0.014	-0.07	-0.04	-0.025	-0.008
	(0.153)	(0.152)	(0.151)	(0.158)	(0.153)
Hom	0.131	0.118	0.104	0.098	0.11
	(0.08)	(0.093)	(0.093)	(0.096)	(0.093)
Migrstock	0.045	0.062	0.068	0.065	0.068
	(0.127)	(0.139)	(0.137)	(0.138)	(0.133)
Popdens	0.149	2.666**	3.005**	3.020**	3.262**
	(1.046)	(1.225)	(1.193)	(1.194)	(1.259)
Palmer			-0.603***	-0.627***	-0.622***
			(0.227)	(0.225)	(0.223)
$Palmer^2$			-0.145	-0.215	-0.185
			(0.714)	(0.744)	(0.754)
Tempcrop				-0.164	-0.08
				(0.384)	(0.346)
Prod					-0.115
					(0.121)
Observations	1028	724	724	724	724
R^2	0.055	0.086	0.097	0.097	0.099

The heteroskedasticity-robust standard errors, clustered at the couple of states, are presented under each estimated coefficient in parentheses. * represents significance at a 10 percent level, ** at a 5 percent level and *** at a 1 percent level.