Natural Disasters and International Migration from Sub-Saharan Africa

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Abstract

This paper employs a systems GMM model using data on 43 Sub-Saharan African countries from 1960 to 2005 to find that natural disasters have a significant impact on migration from SSA, raising the net out-migration by around 0.37 persons per 1,000. No direct evidence was found that natural disasters lead to further migration through impacting on GDP growth. It is however established that natural disasters is associated with a slightly increased probability that a country will be in conflict in a subsequent period. The frequency of natural disasters will not influence the duration of the conflict. It is concluded that natural disasters is an important determinant of migration from SSA. The findings in this paper imply that global climate change, through leading to more extreme weather events, will contribute to further migration from the continent.

Keywords: natural disasters, international migration, climate change, conflict, Africa

Introduction

Global climate change may result in an increase in international migration, especially from poorer countries who will find it more difficult to adapt to and mitigate its impacts. According to the Stern-Report there could be as much as 200 million 'environmentally forced migrants' by 2050 due to climate change (Stern 2006). Many of these could come from Sub-Saharan Africa (SSA). Being the poorest continent, most of its countries are already suffering from land degradation and freshwater scarcity. Climate change is widely expected to intensify these problems, causing more extreme weather events such as droughts and flooding.

What will be the impact of more extreme weather events and consequent natural disasters on international migration from SSA? There is much anecdotal evidence on the extent and future potential for 'environmentally forced' international migration; however, there is scant empirical evidence on the significance and extent of 'environmental migration', including the extent of migration caused by natural disasters (see e.g. Bogardi, 2007;

In this paper I attempt to provide an assessment of the impact of natural disasters on international migration from SSA. In the next section I briefly sketch the context of international migration from SSA and note the major

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explanations for the extent and patterns of this migration as currently offered in the literature. I note in particular that studies attempting to quantify the impact of natural disasters on migration from SSA is lacking. Then in section 3, I describe my methodology and data. The empirical results are discussed in section 4. Section 5 concludes.

Background and Literature

Migration has been defined as 'the relocation of people within space that involves their permanent or temporary change of residence' (Mafukidze 2006: 103). When an international border is crossed, it constitutes international migration. Recent overviews of the extent and patterns of international migration from SSA are contained in Naudé (2009), Adepoju (2007), Lucas (2006), Hatton and Williamson (2003). From these a number of stylized facts can be drawn.

First, the rate of international migration from SSA is relatively low. In terms of the rate of net migration per 1,000 of its population, SSA's net migration rate of 1.4 (according to World Bank data for 2005) is still the lowest of all developing regions, lagging behind that of the Middle East and North Africa (8 migrants per 1,000), Europe and Central Asia (4 migrants per 1,000), East Asia and the Pacific (2 migrants per 1,000) and South Asia (1.6 migrants per 1,000).

Second, this rate of migration has been increasing very rapidly from 2000, and many expect this to continue (e.g. Naudé, 2008; Hatton and Williamson, 2001; 2003). Between 2000 and 2005 emigration from SSA countries increased by 275 per cent, by far the highest, followed by that of Latin America and the Caribbean (78 per cent).

Third, most migrants from (low wage) SSA move to other (similarly low-wage) SSA countries (ECA 2006; Mafukidze 2006). Reasons that have been noted for this include the costs of migration which can only be borne by few, the artificial and porous nature of many borders in SSA (Adepoju, 2007), and immigration controls in high-wage countries (Hatton and Williamson, 2003).

Fourth, migration from SSA tends to be quite volatile and circular in nature. Reasons for this include seasonal cropping patterns, commodity price cycles, and refugees returning after the cessation of hostilities (Konsiega 2007; Naudé, 2008).

What determine these features? In line with migration theory the literature on migration from SSA makes a distinction between voluntary and forced migration. Voluntary migration takes place when people migration in search of what they perceive to be better economic opportunities – i.e. better wages or better employment or profit opportunities elsewhere (Solimano, 2007). With most migration from SSA destined for SSA, one may therefore expect differences in GDP growth rates to signal differential employment, wage and profit opportunities for potential migrants (Myburgh, 2004). Often,

younger people, being able to capture such better opportunities for a much longer period, more easily become migrants, so that one may expect countries with a higher rate of young people in its population to perhaps have a higher emigration rate (Hatton and Williamson, 2003).

But it is not just the benefits of migration that is taken into consideration, but also the costs of movement. Thus people will consider the benefits of migration against the costs, and will move or stay based on the outcome of this subjective assessment. Whereas opportunities may include higher wages or better employment or profits, costs include the costs of travel and relocating, of searching for opportunities, as well as meeting or by-passing immigration regulations in destination countries. The existence of these costs has implied a 'migration hump'. As Lucas (2006) explains, at low levels of per capita income, there are fewer people who can afford to overcome the fixed costs required for international migration. However, as the development level increases, people's 'expectations, desire and ability' to migrate start to increase (Adepoju 2007: 14). Thus a positive relationship can be expected between GDP per capita and net migration. At higher levels of per capita income, there are sufficient local opportunities for people to refrain from migrating. Also, the existence of migration costs imply that people with better social networks in destination countries may be more likely to emigrate. This has also been described as the 'friends and relatives' effect (Hatton and Williamson, 2001; Lucas, 2006).

Whereas voluntary migration is based on a calculated decision of a migrant to pursue a better economic opportunity, forced migration is a coping strategy in the face of a hazard, where movement to another physical locality is required. Conflict and natural disasters are two major hazards recognized in theory and empirical literature as having an impact on migration (Naudé, 2009; Reuveny, 2007; Crisp, 2006). In SSA, conflict has been recognized as one of the most important determinants of migration (e.g. Naudé, 2009). It is estimated that Africa accounts for one out of three refugees worldwide and around 13 million internally displaced persons (Black 2004). The number of internally displaced persons in SSA at the end of 2006 stood at over 11 million (IDMC 2007). Hatton and Williamson (2001) investigate the effect of armed conflict on refugees. The authors capture the incidence of coups, guerrilla warfare and civil wars, finding that these generate respectively 45, 30 and 64 refugees per 1,000 inhabitants.

In contrast to the understanding of the role of conflict in international migration and internal displacement in SSA, much less attention has been given to the impact of natural disasters on international migration. In particular, studies attempting to quantify this impact is lacking, consistent with the comment of Lucas (2006) that empirical work into migration from SSA is generally still lacking.

In the remainder of this paper I will try to address this shortcoming, by regression net migration rates from SSA against data on the number of disasters that have occurred, taking as control variables measures of economic

opportunities, costs and conflict into account. The next section explains my approach.

Methodology and Data

To capture the impact on natural disasters on international migration from SSA, I will estimate the following model of migration:

$$\Delta m_{it} = \gamma_t + (\alpha + 1)\Delta m_{it-1} + \Delta d_{it}\delta + \Delta x'_{it}\beta + \Delta u_{it} \quad (1)$$

For i = 1,….N and t = 2,….T and where $\mathbf{m}_{it}$ = net migration from country i over period t; d = the occurrence of a natural disaster in country i period t, and $\mathbf{x}_{it}$ = a 1×K vector of control variables and $\mathbf{u}_{it}$ is an random error term with the usual properties.

The dependent variable is net migration, i.e. the difference between the total number of immigrants and emigrants. This data, made available by the UN Population Division has been taken for 43 SSA countries, and is expressed as an annual average for the 10 five-year periods ending in 1960, 1965, 1970, 1980, 1985, 1985, 1990, 1995, 2000 and 2005.

The variable of interest, 'natural disasters', is taken from the Emergency Disasters database (EM-DAT) of the Centre for Research on the Epidemiology of Disasters (CRED). They define[1] a disaster as 'an unforeseen or often sudden event that causes great damage, destruction and human suffering' and measure a disaster as having occurred if either 10 or more people were killed, and/or100 or more people affected and/or a country or region declared a state of emergency or called for international assistance. They identify various types of natural disasters such as floods, droughts, earthquakes, storms, etc (see Rodriguez et al, 2009).

After Asia, SSA had the largest number of victims from natural disasters between 1974 and 2003, with more than 350 million affected (CRED 2004). Often these are due, or exacerbated by, environmental degradation, including changes in land cover due to human population/activity. Over the period 1974 to 2003, the annual number of natural disasters recorded in SSA increased more than 300 per cent. During this period, the countries most frequently hit by natural disasters included South Africa (56 occurrences), Ethiopia (54), Mozambique (46), Tanzania (38), Madagascar (35), Sudan (32), Nigeria (28) and Kenya (28).

One of the major natural hazards faced by SSA countries is the highly variable and unpredictable climate patterns (Washington, Harrison and Conway 2004). Droughts are a major natural hazard: SSA had the largest concentration of droughts in the world between 1974 and 2003 (CRED 2004: 122), affecting more than 200 million people (Reuveny 2007). The link between natural disasters and migration is stronger than the link between resource degradation and migration because often the unexpected disas-

[1] See http://www.emdat.be/ExplanatoryNotes/glossary.html

ters allow less time for adaptation, thus increasing the likelihood that people will migrate. A natural disaster, such as a sudden drought, can also 'trigger' armed conflict in the battle for the control of natural resources (Hendrix and Glaser 2007), and therefore we will be sensitive for this relationship in the regression analysis in section 4.

The control variables are based on the basic literature on international migration, which based on the briefly literature discussion in the previous section will include

- Lagged net migration rates to capture the potential effect of 'friends and relatives' (networks) in migration.
- GDP per capita and GDP per capita squared in order to capture the 'migration hump', if relevant.
- GDP growth rates in the sending country as well as the destination country as proxies for differences in perceived economic opportunities. I will use average GDP growth rates for SSA as that of the destination country, given that most migration in SSA is inter-country.
- The proportion of the population that is young, here measured by the percentage of the population between 15 and 25 years of age.
- The incidence of violent conflict in a country, measured as the number of years during a 5-year period when there was civil war or conflict in a country. The data is taken from the well known UCDP PRIO Armed Conflict dataset where conflict is deemed to have taken place if at least 25 battle-deaths occurred.

Table 1 summarises the variables and sources of data used.

In order to estimate (1) I use a 'system GMM' estimator. This makes it possible to address three issues which complicate estimation with typical linear estimators such as OLS and 2SLS. First, in the present case one can expect important country-specific effects to operate, which may cause omitted variable bias. Second, the relationship between net migration and some of its expected determinants are complex, with the possibility of reverse causality. For instance, net migration may affect economic opportunities by influencing GDP growth through changes in skilled labour. Third, migration is a dynamic process. Thus past levels of migration may influence current levels due to either persistence effects (networks, or 'family and friends') or instability (returning migrants). To allow for these lagged values of net migration and GDP growth will be included in (1).

Regression Results

Table 2 contains the 'system GMM' regression results using three specifications. It can be seen from the diagnostics that all the specifications are sound. The regressions are significant, there is no sign of autocorrelation, the number of instruments does not exceed the number of groups, and the

Sargan tests cannot reject the null that the over-identifying restrictions are valid.

Table 1: Summary of Main Variables and Data Sources

Variable	Measures	Description	Sources of data
Dependent variable (m_{it})			
Migration	Net migration per 1,000 population	Difference between emigration and immigration per 1,000 of a population. Provided as annual average over five year periods 1960-1965, 1965-70, 1970-75,. 1975-80, 1980-85, 1985-90, 1990-95, 1995-2000, 2000-2005	United Nations Population Division. (http://esa.un.org/unpp)
Explanatory variables			
Natural Hazards	Natural Disasters	The total number of natural disasters in a country in a five-year period between 1974 and 2003. Time varying.	Centre for Research on the Epidemiology of Disasters (http://www.emdat.be)
Control variables			
Economic opportunities and costs of migration	GDP per capita GDP growth in sending and destination countries (SSA)	Obtained as average GDP in constant 2000 international $ divided by total population per year over five-year intervals, 1960 to 2005. Time varying. Average annual growth in real GDP for sending countries and the SSA average over five year intervals 1960 to 2005. Time varying.	World Development Indicators Online. World Development Indicators Online
Demographic pressures	Young population	Proportion of population aged 15 to 24. Time varying.	United Nations Population Division.
Political instability and conflict	Armed conflict	The number of years during a five year period when there was civil war in a country, defined as at least 25 battle-deaths. Time varying.	UCDP PRIO Armed Conflict dataset (http://www.prio.no/CSCW/Datasets/Armed-Conflict/UCDP-PRIO/)

I have run two specifications of (1) given that the discussion in the previous sections suggested that there may be relationships between the variables, specifically between disasters and economic growth, and between disasters, economic growth and conflict. Thus one may conceive of the possibility that a natural disaster leads to lower GDP growth, and through this channel foster emigration. Or that a decline in GDP growth leads to conflict which fosters emigration on both accounts. And finally, there is the possibility that a disaster may induce conflict and in this manner stoke emigration. In order to investigate these interdependencies, I first calculated the pair wise correlations between the variables in Table 2. These are shown in the Appendix. They indicate that disasters are not significantly correlated with contemporaneous or lagged GDP growth in the country where it occurs.

This lack of correlation is general consistent with the literature on the impacts of natural disasters on economic growth, which 'remains inconclusive about the effects of natural disasters on growth' (Loayza et al., 2009:2).

Natural disasters are however positively and significantly correlated with the incidence of armed conflict as can be seen from the Appendix, although the degree of correlation is low. I therefore first ran (1) with armed conflict included, and second, as reported in specification 2, without armed conflict.

Table 2: System GMM estimates of the Determinants of Net Migration in SSA (dependent variable net migration), 1965 – 2005

Variable	**Specification 1**	**Specification 2**
Intercept	3.19 (0.17)	2.75 (0.14)
Natural disasters	**-0.37** (-1.74)*	**-0.40** (-1.80)**
Control variables		
Lagged net migration	-0.06 (-0.89)	-0.05 (-0.64)
GDP per capita	-0.02 (-1.63)	-0.02 (-1.42)
GDP per capita squared	**0.00** (1.84)*	0.00 (1.64)
GDP growth sending	**0.76** (2.81)**	**0.88** (3.64)***
GDP growth sending (lag)	**0.46** (2.30)*	**0.56** (2.69)**
GDP growth SSA	0.08 (0.12)	0.05 (0.07)
GDP growth SSA (lag)	-0.04 (-0.10)	0.17 (0.38)
Young population	0.17 (0.19)	0.02 (0.02)
Incidence of violent conflict	**-1.31** (-2.68)**	-
Diagnostics	No. of obs : 188 No. of countries: 43 No. of instruments: 24 χ^2 (10) = 75 *** Arellano-Bond test for second-order autocorrelation prob > Z = 0.56 Sargan test of overidentifying restrictions: χ^2 (15) = 15.09 p =0.44	No. of obs : 188 No. of countries: 43 No. of instruments: 25 χ^2 (10) = 30.81*** Arellano-Bond test for second-order autocorrelation prob > Z = 0.40 Sargan test of overidentifying restrictions: χ^2 (15) = 17.27 p =0.73

*(z-ratio's in brackets based on robust standard errors. A * and ** indicates statistical significance at the 10 and 5 per cent level, respectively)*

The results in Table 2 show that natural disasters are indeed a significant determinant of net migration in SSA, even if we control for the standard explanations of migration. To be precise, an additional natural disaster per year would on average lead to a net outflow of 0.37 persons per 1,000, given that the sign on the coefficient is negative. That natural disasters lead to emigration through conflict is confirmed when armed conflict is dropped as in specification 2, which results in the size of the coefficient on natural disasters increasing. Specification 2 also shows that if we omit violent con-

flict from the regression, that we might be overestimating the impact of GDP growth in migration.

The remainder of the results in Table 2 is fairly consistent with prior expectations given the discussion in section 2. Thus we can see that violent conflict and economic growth in the home country has the largest impacts on net migration, with the expected signs. A 1 per cent increase in GDP growth lead to a reduction (inflow) of net migration of 1.2 persons per 1,000, with the lag also being significant. This illustrates the appropriateness of using a dynamic panel to estimate the determinants of migration as earlier researchers such as Hatton and Williamson (2001) using static method found the coefficient on GDP growth to be around 0.80 (very similar to the coefficient found here). Specification 1 is also consistent with the migration hump, although the effects are very weak. Finally there is no evidence that networks (friends and relatives) have a significant impact on net migration from SSA, as the coefficient on lagged net migration is insignificant.

Given that Table 2 and the correlations in the Appendix hints at the possibility that natural disasters may affect emigration through conflict, Table 3 reports results of a probit regression for the determinants of whether a country will experience conflict in a given year or not. The dependent variable was constructed as a dummy variable which is equal to 1 if a country experienced violent conflict in a particular year, and equal to 0 if otherwise.

Table 3 shows that if a natural disaster occurs in an SSA country, there is a significant (albeit somewhat low) probability that conflict could break out the next year. I control for GDP, growth, ethnic divisions and environmental vulnerability. Calculating the elasticity from Table 3 indicates that an additional disaster per annum (the average in the sample was 3.6) raises the probability that the country can fall into civil conflict by 1.75 per cent. Countries with a higher GDP per capita will have less probability of being at civil war; conversely countries with higher degree of ethnic fractionalization have a higher probability.

Table 3: Probit regression results for the likelihood of armed conflict in SSA

(1) **Variable**	**(2)** **Coefficient**
Net migration	-0.020 (-1.03)
Natural Disasters	**0.05** (1.86)*
GDP per capita	-0.0003 (-1.83)*
GDP growth	0.01 (0.35)
Ethnic Fractionalization	0.91 (1.78)*
Environmental Vulnerability Index	0.002 (0.82)
Pseudo R^2	0.06

*(z-ratio's in brackets. A * and ** indicates statistical significance at the 10 and 5 per cent level, respectively)*

Thus, a natural disaster could be associated with a slightly higher probability that violent conflict could break out. But what about the duration of conflict? It is well known that the longer conflicts lasts, the greater will be the pressures on out-migration. Table 4 contains system-GMM results of the determinants of the number of years of conflict (intensity) in SSA. The independent variables in this regression are taken from the conflict in SSA literature which posits 'greed and grievance' as causes of conflict. A full discussion of this literature falls outside the scope of the present paper; readers are referred to e.g. Collier and Hoeffler, 1998 and more recently Welsch (2008). Thus these regression include, in addition to natural disasters, variables such as GDP, GDP growth, ethnic fractionalization (using the index of Alesina et al, 2003) and in the case of the probit regression, the Environmental Vulnerability Index (EVI) of a country (alternatively the proportion of land under irrigation was also used, but turned out to be insignificant as in the system GMM estimation). Moreover, the rate of net migration is included to control for the possibility that migration may influence conflict in a country.

Table 4: Systems GMM regression results for the determinants of the intensity of armed conflict in SSA (dependent variable = number of years of civil conflict)

(1) **Variable**	**(2)** **Coefficient (Robust SE)**
Intercept	-7.7 (-1.57)
Incidence of armed conflict (lag)	**0.75** (3.30)**
Natural disasters	0.02 (0.31)
GDP per capita	-0.0005 (-0.82)
GDP growth	**-0.08** (-4.08)**
Ethnic fractionalization	9.04 (1.45)
Net migration rate (lag)	-0.006 (-0.22)
Land under irrigation	0.12 (1.21)
Landlocked	**4.55** (2.31)*
Diagnostics	*No. observations = 154, No. groups = 41* *No. instruments = 17* *Arellano-Bond test for second-order autocorrelation prob > Z = 0.85 (accept null of no autocorrelation)*

*(z-ratio's in brackets. A * and ** indicates statistical significance at the 10 and 5 per cent level, respectively)*

Table 4 confirms a central finding in the literature on conflict in SSA, namely that conflict tend to be persistent, that reductions in GDP growth will be associated with longer duration of conflict, and that landlocked countries may be more prone to conflict (Arezki and Van der Ploeg 2007, Miguel et al., 2004). Migration is insignificant suggesting that migrations do not contribute to the duration of conflict in SSA. Finally, regarding our variable of

interest, table 4 shows that natural disasters are insignificant – the number of disasters thus does not affect the duration/intensity of conflict. Having thus found that natural disasters may slightly increase the probability of conflict, but not its duration, the tentative conclusion is that natural disasters may act as a 'trigger' for conflict, in line with the recent discussion in Hendrix and Glaser (2007). This trigger effect will increase emigration from SSA.

Conclusion

The contribution of this paper was to provide the first quantitative estimates of the impact of the frequency of natural disasters on net migration from Sub-Saharan Africa (SSA). Using a dynamic panel data model (system GMM) I found that natural disasters have a significant impact on migration from SSA, raising the net out-migration by around 0.37 persons per 1,000. While no direct evidence was found that natural disasters lead to further migration through impacting on GDP growth (further research is required in this regard) I did find that natural disasters is associated with a slightly increased probability that a country will be in conflict in a subsequent period. The frequency of natural disasters will not however influence the duration of the conflict.

In conclusion, natural disasters are an important determinant of migration from SSA. The findings here imply that global climate change, through leading to more extreme weather events, will contribute to further migration from the continent. If there are concerns about what this out migration will mean for the continent's development or for global security (as e.g. in Clemens and Pettersson 2008; Smith 2007; or Reuveny 2007) one needs to keep in mind that the magnitudes of the impact of violent conflict and economic opportunities (proxied by GDP growth) are larger. Ending conflicts and stimulating economic growth are appropriate ways of not only for reducing migration from SSA, but also necessary requirements for SSA to limit the degree to which natural hazards can become natural disasters.

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Appendix: Pair Wise Correlations between Independent Variables

	Net migration	Disasters	GDP per capita	GDP growth sending	GDP growth sending lagged	GDP growth SSA	GDP growth SSA lagged	Population Young	Violent Conflict
Net migration	1.00								
Disasters	-0.00	1.00							
GDP per capita	0.11	0.03	1.00						
GDP growth sending	0.41*	0.08	0.07	1.00					
GDP growth sending lagged	-0.06	0.07	0.17*	0.04	1.00				
GDP growth SSA	0.05	0.41*	-0.03	0.25*	0.08	1.00			
GDP growth SSA lagged	-0.01	0.12	-0.04	0.08	0.25*	0.46*	1.00		
Population Young	-0.07	0.13	-0.01	0.03	0.01	-0.12*	-0.28*	1.00	
Violent Conflict	-0.16*	0.18*	-0.07	-0.15*	-0.13*	-0.08	-0.11*	0.02	1.00

(indicates significance at 5 per cent level)*

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