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Poverty traps

The causes of poverty traps in sub-Saharan Africa

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Abstract

Poverty traps is a hotly debated topic in the literature, but the evidence on the existence is today still mixed and not that strong. Many possible causes are named, which may drive countries into a poverty trap, or keep them in one.

This thesis studies the possible causes of poverty traps empirically, focusing on the countries in sub-Saharan Africa during the period 1980-2010. A multivariate logistic regression model is used to study the possible causes, but first all variables are tested for significance using a univariate logistic regression. The significant variables are concluded in the final multivariate logistic regression. The results suggest that more freedom, less corruption, more FDI and a higher HIV prevalence rate lowers the chances of a country of being in a poverty trap.

Content

1 Introduction

Sub-Saharan Africa is a unique region in the world. It is the only major region in the world where poverty, in terms of proportion of the poor, has been rising constantly. Sub-Saharan African countries are in need of substantial investments to reverse the current poverty trend. These investments mostly likely need to be external, due to the fact that the sub-Saharan African countries face extreme low per capita GDP and savings rates (SESRTCIC, 2007).

Extreme poverty has been on the international political agenda for quite some time now. Following the adaption of the United Nations Millennium Declaration, the Millennium Summit of the United Nations was held in 2000. The Millennium Development Goals set targets in reducing poverty, hunger, disease and exclusion of groups from society. The goals also advocate basic human rights, the rights of each person on the planet to health, education, shelter and security. All member states committed to help achieve the Millennium Development Goals by 2015 (United Nations).

From various reports and reviews, it can be concluded that Sub-Saharan Africa faces a difficult task to meet some, if not all, of these goals by 2015.

The idea of a poverty trap was already developed in the 1950s. Development economists realized that some poor countries remained poor and that they could not achieve robust growth. The idea emerged that some developing countries, the underdeveloped, were caught into a poverty trap[1].

A poverty trap is "any self-reinforcing mechanism which causes poverty to persist" (Azariadis & Stachurski, 2005:326). A poverty trap is therefore a vicious circle, which makes the poor even poorer. According to Costas Azariadis and John Stachuski (2005), it is important to note that persistent poverty cannot be used as proof for the existence of poverty traps. They argue that something more than persistent poverty is needed to prove that poverty traps exist, due to the fact that poverty traps are supposed to be a dynamical process. Another point made regarding this definition is "that the mechanisms which reinforce poverty may occur at any scale of social and spatial aggregation, from individuals to families, communities, regions, and countries. Traps can arise not just across geographical location such as national boundaries, but also within dispersed collections of individuals affiliated by ethnicity, religious beliefs or clan" (Azariadis & Stachurski, 2005:326). This makes a poverty trap a very difficult concept to grasp and measure.

1.1 Research question

The research question of this paper is: **"What are the causes that drive and/or keep some sub-Saharan countries into a poverty trap?"**

1.2 Relevance

First of all, there are numerous countries in other parts of the world which were confronted with a similar low economic starting point as the sub-Saharan African countries, but who did manage to achieve sustainable economic growth. For this reason it would be very interesting to know why Africa is suffering from this unique development crisis.

The existence of poverty traps is widely discussed among development economists, but the current available empirical evidence is not that strong and mostly mixed. Bloom, Canning and Sevilla (2003) did however find results that support the poverty trap hypothesis. They clearly

1 See for example (Nelson, 1956) and (Lieberstein, 1957).

found a poverty trap model with both high and low equilibria. This research is scientifically relevant because it is not focusing on evidence of the existence of poverty traps, but on the interlinked reasons that could cause some sub-Saharan African countries to be in a poverty trap. It also constructs a poverty trap index, which is a contribution to the existing poverty trap literature.

This study is also of societal relevance; because a large amount of money is spend on foreign aid and international organizations to help fight poverty. The Netherlands alone already invest 3.7 milliard Euros in the development of poor countries (Rijksoverheid). It is however important to know how poverty persists before we can really fight it.

1.3 Structure

In order to answer the research question, a logistic regression model is conducted. The outline of the rest of the paper is as follows: part 2 describes a theoretical model to identify the possible causes of poverty traps. In part 3, the estimation method and variables are described. Part 4 describes the results of the logistic regression model conducted, part 5 describes some robustness checks and a conclusion is found in part 6. The results and limitations will be discussed in part 7.

2 Model and previous literature

To answer the question posed at the end of the last section, I begin with a review of the Solow-Swan model. This model was created after important contributions of Solow (1956) and Swan (1956). Poverty traps theoretically arise with deviations from this model. After the Solow-Swan model review, other literature about possible causes of poverty traps is discussed.

2.1 Model

In the Solow-Swan model the production function $Af(k)$ produces output per capita q. A is the total factor productivity and k is the capital-labor ratio. The national savings rate is denoted by s, the rate of capital depreciation by d and n is denoting the rate of population growth. The rate of capital accumulation follows then from equation 1:

(1) $$dk/dt = sAf(k) - (n+d)k.$$

The *(n+d)* term on the right-hand side of equation 1 is the effective depreciation rate for the capital-labor ratio. If savings were zero, the capital-labor ratio would still decline due to depreciation and population growth. The graphical presentation of this model is displayed in figure 2.1.

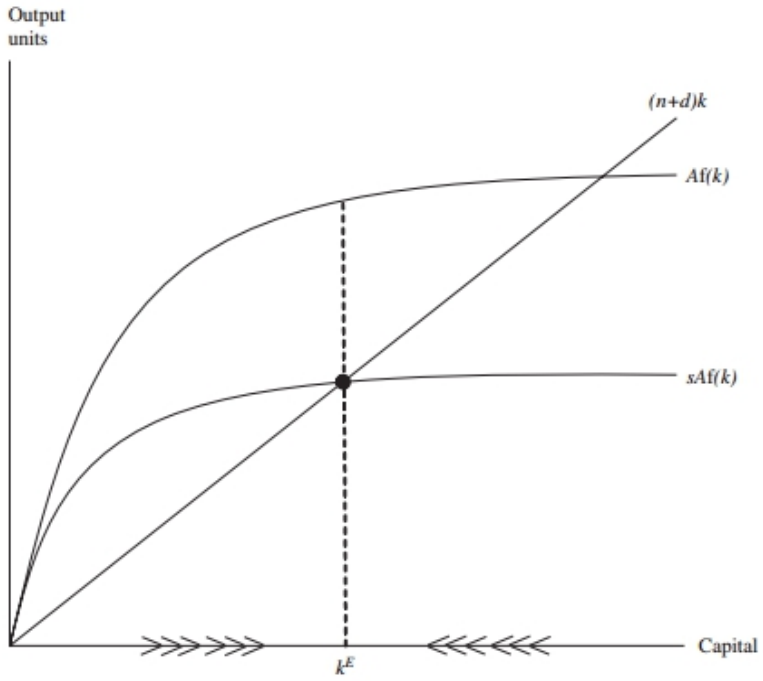

Figure 2.1 The Solow-Swan model (Sachs, et al., 2004:124).

"A steady state is a situation in which the various quantities grow at constant rates" (Barro & Sala-I-Martin, 1995:19). This corresponds to $dk/dt = 0$ in equation 1 and to the intersection of the *sAf(k)*- and *(n+d)k*-curve in figure 2.1. The corresponding steady state capital-labor ratio is denoted by k^E. An upward shift of the production function or the savings rate will shift the *sAf(k)*-curve upwards, which

will lead to an increase in k^E. An increase in the population growth rate or the depreciation rate will lead to an upward shift of the *(n+d)k*-curve and this leads to a decline in k^E.

2.2 Previous literature

2.2.1 Capital

In terms of the Solow-Swan model, poverty traps can be thought of as a stable steady state with low levels of per capita output and capital stock. This steady state is a poverty trap, because with small deviations from this steady state, the economy has a tendency to return to this low-level steady state (Barro & Sala-I-Martin, 1995). A poverty trap is displayed in figure 2.2.

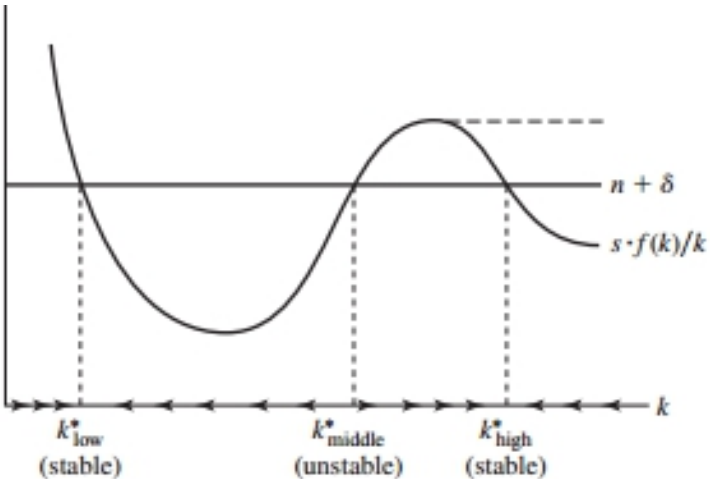

Figure 2.2 Poverty trap (Barro & Sala-I-Martin, 1995:50)

The production function *Af(k)* features diminishing returns when *k* is low, increasing returns for a middle range of *k* and either constant or, again, diminishing returns when *k* is high. The curve *sAf(k)* is therefore downward sloping in the low-middle range of *k*, is upward sloping for the middle-high range of *k* and again downward sloping for high values of *k*. The steady state value k^*_{low} is stable and this leads to a poverty trap for countries starting with levels of *k* between zero and middle. This is the first theoretical deviation of the Solow-Swan model that leads to a poverty trap and this is called a capital trap. The concept of a capital trap was developed by multiple economists; they argued that a country can only achieve economic growth if a minimum capital threshold is in place. Rosenstein-Rodan (1943) argues that the underdeveloped countries have not adopted the needed technology yet, because the fixed costs are too large to adopt this technology. The poor essentially cannot afford the needed investments.

2.2.2 Credit

Moreover, the low capital levels of the poor leads them to being credit constraint. This is because lenders require collateral from their borrowers, but due to their low levels of capital the poor do not have any collateral to insure the lenders. This lacking access to credit markets restricts the range of possible income generating activities by the poor[2].

2.2.3 Population growth

Rapid population growth can push a country into a poverty trap as well. As mentioned earlier: an increase in the population growth rate will lead to an upward shift of the $(n+d)k$-curve and this leads to a decline in k^E in figure 2.1. This explains the democratic trap, where high population growth leads to a poverty trap. The poorest people in the world have the highest fertility rates (Sachs, et al., 2004). There are several reasons for this phenomenon. First children are seen as financial assets by their parents. They start working at a very young age and therefore help to generate income for the family. Second, children in poor countries are more likely to die than in developed countries. It can be reasoned that parents therefore have a large number of children to compensate for this risk. It is however also true that families in underdeveloped countries lack access and knowledge of contraceptive methods to simply avoid a pregnancy (Ross & Winfrey, 2002). And lastly, in the absence of any private or public old-age scheme, children can be the only old-age securities some people have (Sachs, et al., 2004).

2.2.4 Savings

There is a lot of theoretical and empirical evidence to support the claim that multiple equilibria may arise due to a saving trap. This means that the savings rate is very low at low income levels and rises as income rises above the stagnant steady state equilibrium level[3,4].

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2 See for example (Kiyotaki & Moore, 1997) and (McKay & Perge, 2011).

3 Norman Loayza, Klaus Schmidt-Hebbel and Luís Servén (2000) find that in developing countries, a doubling of private income raises the long-run private saving rate by 10 percent.

4

Another example is the case study of Ugandan households, where only 23.8 percent indicated that they had undertaken any saving. The most mentioned reason was low income, but poor access to financial institutions was named as well (Musinguzi & Smith, 2000).

This can be seen in figure 2.1 as well, a downward shift of the savings rate will shift the *sAf(k)*-curve downwards, which will lead to a decrease in k^E. The poor have a low savings rate because poor people use all (or more than all) of their income just to meet their basic needs (Kuznets, 1966) and (Ogaki, Ostry, & Reinhart, 1996). The situation of Africa's true savings rate might even be worse than is believed, according to the World Bank, Africa's savings rate is substantially overestimated (Sachs, et al., 2004). The last decades Africa has been living of its natural capital, but is counting this resource depletion as income. The World Bank takes this resource depletion into account and this leads tropical sub-Saharan Africa to a savings rate of just 3.0 percent of GNI, instead of the unadjusted 11.1 percent. This is significantly lower than in other world regions, the Middle East and North Africa for example have a savings rate of 9.1 percent and East Asia and the Pacific 29.3 percent.

2.2.5 Foreign direct investments

Africa is besides capital accumulation and savings also dependent on foreign aid from donor countries and/or international organizations. This foreign aid can in some situations be counterproductive for some policy reform goals and it can even crowd out private investments as it is competing for scarce domestic resources, as was shown in a case study on Ghana (Younger, 1992). Policy reforms, but mostly investments, are necessary for a poor country to achieve economic growth, so foreign aid might be keeping countries poor.

2.2.6 Technology trap (productivity and geography constraints)

According to Fofack (2008) sub-Saharan Africa suffers from a technology trap and this is largely responsible for the overall poverty trap. This result is supported by empirical evidence which suggests that if sub-Saharan African countries were using the same technology levels as industrialized countries, income levels in sub-Saharan Africa would be higher (Fofack, 2008). Some economists think that the link between the technology trap and the poverty trap can be attributed to the productivity channel[5,6]. But others[7] think the link between the technology and

5 See for example (Kraay & Raddatz, 2007).

6

Existing empirical studies indicate that most African countries operate below their production possibility frontier (Bloom, Canning, & Chan, 2005).

7

the poverty trap is due to geographical constraints. Unfortunately there is not enough data on research and development expenditures, so the technological trap itself will not be examined. But the relationships between poverty traps and low production and geographical constraints will be examined in this paper.

For low production, food productivity will be a good proxy, because Africa is still very reliant on the export of raw materials and primary products. The food productivity is still very low in sub-Saharan Africa; during 1980-2000 there has even been a decline in productivity. This makes sub-Saharan Africa the only major developing region that experienced a decline in productivity during this period (Sachs, et al., 2004).

The geographic constraints can be seen in different aspects. Some African countries are landlocked, which means that they do not have easy access to a seaport and this is one of the causes of high transport costs. But countries with access to a seaport face high transport costs as well. Due to history, Africans live in the interior of their continent, which increases the distance to a port. Furthermore, African countries are relatively remote from the world trade routes and they face high transport costs due to transport across mountainous lands (Sachs, et al., 2004).

2.2.7 Climate

Empirical evidence shows that a cool and coastal region, which has high rainfall all year, has a higher probability of being in a high-level steady state (Bloom, Canning, & Sevilla, 2003). Africa is known for its dry and warm climate, this is because Africa is closer to the equator, and has therefore a higher probability of being in a low-level steady state and endure a poverty trap. Even within Africa poverty rates are notably higher in countries closer to the equator, as can be seen in figure 2.3.

[] See for example (Sachs & Warner, 1997) and (Gallup, Sachs, & Mellinger, 1999).

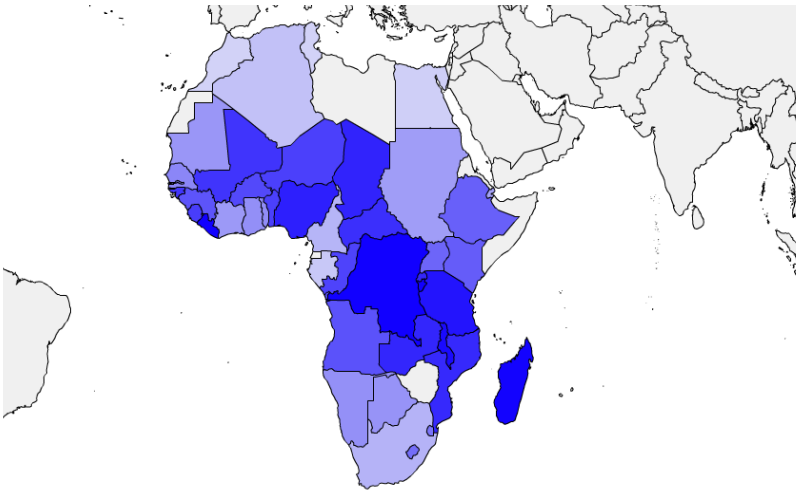

Figure 2.3 Population living in multidimensional poverty

2.2.8 Education

Education is one of the import ways to accumulate human capital and therefore an escape from poverty. From a case study in South Africa there is clear empirical evidence that low initial education is one of the causes of poverty traps (May & Woolard, 2007). Poverty is found to have a negative effect on both the quantity and quality of education, therefore contributing to a poverty trap (Knight, Quheng, & Quheng, 2009).

2.2.9 Corruption

There is a general belief that corruption is one of the major causes of poverty. Corruption tends to lower economic growth and induce poverty in multiple ways. First, corruption increases uncertainty and reduces profits, therefore discouraging foreign investments. Second, corruption discourages entrepreneurship. Entrepreneurs are required to get licenses and permits to start their businesses. But they have to pay bribes to get the licenses and permits, which will reduce their profits (de Soto, 1989) and (Murphy, Shleifer, & Vishny, 1993). And third, empirical evidence shows that corruption lowers the quality of the public infrastructure, making transportation more difficult. Corruption also decreases tax revenues and hence the resource base of the government (Chetwynd, Chetwynd, & Spector, 2003). There are a number of empirical studies that demonstrate that high levels of corruption are associated with

low levels of investment and low levels of aggregate economic growth[8]. Corruption might therefore induce the existence of a poverty trap.

2.2.10 Inequality

Earlier research shows that inequality has a negative effect on growth; this relationship is highly significant (Tiah You, 2013). Inequality can thus keep a poor country into poverty. Inequality is said to have a negative impact on economic growth through the following channels: politics, imperfect capital market, and institutions. It is suggested that politics might increase the redistribution movement which will lower economic growth[9]. The imperfect capital market prevents the poor to make long term profitable investments due to short term credit constraints[10]. According to Engerman and Sokoloff (1997) and (2002) structural inequality causes bad institutions, which eventually will lower growth.

2.2.11 High disease burden

Africa has furthermore a disease burden unique to the world, which is directly seen in the high malaria and HIV/AIDS death rates. The high disease burden immediately translates into a low life-expectancy at birth. The high disease burden contributes to a classic poverty trap. Most diseases in sub-Saharan Africa could be easily controlled with the technologies of today, but Africa is too poor for such investments. "Thus Africa is too poor to control diseases, and meanwhile diseases reduces productivity, frustrates foreign investment, and (by contributing to very high child mortality rates) delays or stops the demographic transition, thereby helping to keep Africa poor" (Sachs, et al., 2004: 134). Malnutrition also raises the disease burden substantially.

2.2.12 Governance

And at last, sub-Saharan Africa is said to suffer from bad governance which keeps them locked into poverty. There are numerous examples of countries being so poor that it leaves the

8 See for example (Rose-Ackerman, 1999) and (Heidenheimer & Johnston, 2002).

9 See for example (Galor & Zeira, 1993) and (Galor & Maov, 2006).

10 See for example (Alesina & Rodrik, 1994) and (Persson & Tabellini, 1994).

population desperate and the government unable to change any of it. Poverty raises the chances of a violent conflict; some groups eventually may start helping themselves on the costs of others (Kahl, 2006). Somalia is a good example of this phenomenon. This will only leave a country poorer and thus induce a poverty trap.

3 Data and methodology

In the previous part a theoretical model is constructed with indicators that could result in a country being trapped into poverty. The following chapter will describe the dataset used and where this data comes from. Furthermore, it will explain the estimation method and the variables used.

3.1 Data

Most of the data comes from the database Africa Development Indicators provided by the World Bank. The World Bank was established in 1944 and is a vital source of financial and technical assistance to developing countries. The Africa Development Indicators dataset is a collection of development indicators on Africa, which the World Bank compiled from officially-recognized international sources. The database contains all African countries. The data is available per country, per year or by topic and it covers the period 1960-2012.

Furthermore, some information from the CIA the World Factbook is used as well. The World Factbook contains information on the history, people, government, economy, geography, military and transnational issues for 267 countries. Data is available for all African countries and the Factbook is updated annually.

And The Freedom in the World 2014 index, the Polity IV Project and the Corruption perceptions index 2013 are also used in this research.
The Polity IV Project is done by the Center for Systemic Peace, which was founded in 1997. The Center for Systemic Peace is engaged in research on the problem of political violence. The Polity IV Project is one of the constructed projects of the Center of Systemic Peace; it codes authority characteristics of states for the purpose of comparative, quantitative analysis. The Polity IV dataset covers all major independent states over the period 1800-2013. The Center for Systemic Peace identifies a major independent state as a state with a total population of at least 500,000 in the recent year; which are currently 167 countries.

The Freedom in the World 2014 Index is published by the Freedom House, which is an independent organization dedicated to the expansion of freedom around the world. The Freedom in the World index is the comparative assessment of global political rights and civil liberties. This index is published annually since 1972 and has survey ratings and reports on 195 countries.
The Corruption Perceptions Index (CPI) is published by the Transparency International organization, which consists of more than 100 independent locally organizations that fight corruption in their respective countries. The CPI scores and ranks countries/regions based on how corrupt a country's public sector is perceived to be and is published annually. The index is a combination of surveys and assessments of corruption.

3.2 Sample

This research has a focus on sub-Saharan Africa and therefore only 48 countries will be used in the analysis. The list of countries used can be found in Appendix A. The time-span used in this research is the period 1980-2010. The following variables are used in the analysis: 'poverty headcount ratio at $2 a day (PPP)', 'GDP per capita growth (annual %)', 'current GDP (US$)', 'Population Level', 'Corruption Perceptions Index 2013 score', 'Total area (in sq km)', 'Polity IV Index score', 'Freedom in the World 2014 score', 'Prevalence of HIV (% of population 15-49)', 'Ginicoefficient index score', 'Latitude (distance from the equator in degrees)', 'Life expectancy at birth (years)', 'Roads, paved (% of total roads)', 'Food production index (2004-2006=100)', 'Population growth (annual %)', 'Domestic credit to private sector (% of GDP)', 'FDI (% of GDP)', 'Gross domestic savings (% of GDP)', 'Gross capital formation (% of GDP)', 'Public spending on education (% of GDP)', 'Expected years of schooling' and 'School enrollment, primary (% net)'.

3.3 Constructing variables

Some variables have been transformed and some new variables have been constructed as well.
First of all, the dependent variable 'Poverty trap' is constructed. Because the poverty trap process is a dynamical process and it is very hard to model a dynamic process, this research uses a static measurement of poverty traps. Because a poverty trap is more than 'just' being in poverty, two conditions are formulated for a country being in a poverty trap. Countries are defined to be in a poverty trap if they have more than 50% of the population living in multidimensional poverty [living on $2 a day (PPP)] and have a mean negative per capita GDP growth five years before and five years after the poverty measurement (so eleven years in total). If a county fulfills both of these two conditions it will be given the value 1 and

otherwise the value 0. The variable 'Poverty trap' is therefore a binary variable. A logistic regression model will be used to model this binary dependent variable. Due to the binary dependent variable, all the variable averages are taken for the 30 years. So instead of 30 values, each country has one mean value for every variable and each variable has 48 values.
Second, the dummy variable 'Land trapped' is constructed. If a country is landlocked according to the CIA World Factbook, it gets the value 1 and the value 0 otherwise.

Third, the variable 'Institutions' is constructed to test whether the governance of country would have an effect on creating a poverty trap. The variables 'Corruption perceptions index (score)', 'Polity IV Index score' and 'Freedom in the World 2014 score' were combined for this variable. The three variables were first normalized to values between 0 and 1 according to the min-max method, then the weighted average of the three variables were taken to compute the 'Institutions' variable. The min-max method uses the following equation to compute the normalized values:

$$Normalized(e_i) = \frac{e_i - E_{min}}{E_{max} - E_{min}}.$$

In this equation, E_{min} is the minimum value of the variable and E_{max} is the maximum value of the variable.
At last, the variable 'Schooling' is constructed because it can be argued that the education variables combined have an effect and the combination would have less missing values. For this variable the three variables 'Public spending on education (% of GDP)', 'Expected years of schooling' and 'School enrollment, primary (% net)' were used. The primary school enrollment rate was chosen instead of the secondary enrollment rate, because if people lack primary education they will not follow secondary education. The same methodology was used to construct this variable as for the 'Institutions' variable.

3.4 Variables

3.4.1 Dependent variable

Because the possible causes of a poverty trap will be examined, the self-constructed variable 'Poverty trap' will be used as the dependent variable. However, there is one shortcoming with this measurement. Being in a poverty trap is a dynamic process and measuring a dynamic process with a static variable will always not capture the full effects. This needs to be kept in mind when interpreting the results.

3.4.2 Independent variables

The possible causes of a poverty trap were determined in part 2: climate, low accessibility to trade, a high disease burden, inequality, low levels of credit, low productivity, high population growth, foreign direct investments, low levels of savings, low levels of capital, governance and low initial education.

Climate could have an impact on poverty traps in the sense that it is more difficult to grow crops in a dry and hot country. Africa is in general warmer than other places across the earth, but it might be a bigger problem near the equator. It is generally warmer near the equator, simply due to the geometry of the earth's curvature. 'Latitude (distance from the equator in degrees)' is therefore seen as good proxy for climate. The further away from the equator, the cooler it will be.

As mentioned before, accessibility to trade could have an impact on poverty traps as well. Two variables are used as a proxy to measure this effect, the dummy for being land trapped and 'Roads, paved (% of total roads)'. If a country is being land trapped it is shut in completely, or almost completely, by land which results in having no direct access to the sea. It becomes then much more expensive to export goods, because the distance to a port is larger. But transport costs are also determined by the other variable. When there is a low percentage of the total road network paved, it is more difficult and time consuming to transport goods. Again, this is resulting in higher transport costs.

The high disease burden is measured with the help of two proxies as well, namely 'Life expectancy at birth (years)' and the 'Prevalence of HIV (% of population 15-49)'. A higher disease burden results in a lower life expectancy at birth, there is a higher chance to get a disease in sub-Saharan Africa and there is not enough technology and money to provide the accurate ways of treating these diseases and this will result in an earlier death in sub-Saharan Africa than in other world regions. HIV has been the most prominent disease in sub-Saharan Africa and the prevalence rate of HIV has also been higher in sub-Saharan Africa than in any other world region. In 2001 it was 7.3% for sub-Saharan Africa and below 1% in every other world region (Sachs, et al., 2004).

The 'Ginicoefficient index score' is used as a proxy for inequality; this variable is internationally used most to measure inequality.

Productivity is measured through the 'Food production index (2004-2006=100)', because, as mentioned in part 2, Africa is still very reliant on the export of raw materials and primary products.

The effect of credit on poverty traps is measured through the variable 'Domestic credit to private sector (% of GDP)', the effect of foreign direct investments with 'FDI (% of GDP)', the effect of savings with 'Gross domestic savings (% of GDP)', population growth is measured with the variable 'Population growth (annual %)', the effect of capital with the variable 'Gross capital formation (% of GDP)', the effect of governance with the variables 'Corruption Perceptions Index 2013 score', 'Freedom in the World 2014 score', 'Polity IV Index score' and their combination in the self-constructed variable 'Institutions'. The effect of education is measured with the variables 'Public spending on education (% of GDP)', 'Expected years of schooling', 'School enrollment, primary (% net)' and the combination in the self-constructed variable 'Education'.

3.4.3 Control variables

In the constructed model, 'current GDP (US$)', 'Population Level' and 'Total area (in sq km)' are added to control for country size. Transport and good governance might be harder to achieve in a large African country. These effects are accounted for by controlling for country size.

3.5 Estimation method

In order to answer the main question "What are the causes that drive and/or keep some sub-Saharan countries into a poverty trap?" a logistic regression analysis is conducted.

3.5.1 Logistic regression

Because the variable 'Poverty trap' is a binary variable (it only has two possible outcomes, 1 if a country is in a poverty trap and 0 if it is not) a logistic regression model is used. A logistic regression model is an extension of the regression model. Instead of predicting the value of the dependent variable, it predicts the probability of the dependent variable occurring, given known values of the independent variables. The model can be expressed in the following way:

$$\ln\left(\frac{prob(event)}{1-prob(event)}\right)=\beta_0+\beta_{1X_1}+\beta_{2X_2}+\ldots+\beta_k X_k.$$

The left side of the equation is called the logit, it is the logarithm of the odds than an event occurs. The odds is the change of an event occurring divided by the change of the event not occurring:

$$odds = \frac{P(event)}{P(no\,event)} \quad .$$

The coefficients on the right side of the equation show how the independent variables affect the logit. The intercept sets the ‘baseline’ event rate through the following equation:

$$odd = \frac{e^{\beta_0}}{1+e^{\beta_0}} \quad .$$

The other parameters can be interpreted with the odds ratio. The odds ratio for a unit change in *X*, or for a change of *z* units, can be expressed in the following way:

$$odds\,ratio = e^{z\beta_i} \quad .$$

If the odds ratio is less than 1, then more of that covariate makes the outcome event less likely to happen (ceteris paribus). And if the odds ratio is more than 1, then more of that covariate makes the outcome event more likely to happen (ceteris paribus).

3.5.2 Model

The following odds can be specified to determine the causes of poverty traps:

$$odds = \frac{prob(¿a\,poverty\,trap)}{prob(not \in a\,poverty\,trap)} \quad .$$

And the following model can be specified:

$$\ln(Poverty\,trap) = \beta_0 + \beta_1 GDP + \beta_2 Population + \beta_3 Corruption + \beta_4 Total\,area + \beta_5 Polity + \beta_6 Freedom + \beta_7 HIV$$

$$\ln(Poverty\,trap) = \beta_0 + \beta_1 GDP + \beta_2 Population + \beta_3 Corruption + \beta_4 Total\,area + \beta_5 Polity + \beta_6 Freedom + \beta_7 HIV$$

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$$\ln(Poverty\,trap) = \beta_0 + \beta_1 GDP + \beta_2 Population + \beta_3 Corruption + \beta_4 Total\,area + \beta_5 Polity + \beta_6 Freedom + \beta_7 HIV$$

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The hypotheses are:

H_0: $\beta_1 = \beta_2 = \beta_3 = \ldots = \beta_{20} = \beta_{21} = \beta_{22} = 0$

H_1: $\beta_1 = \beta_2 = \beta_3 = \ldots = \beta_{20} = \beta_{21} = \beta_{22} \neq 0$

Because of the large amount of variables, first a univariate logistic regression is conducted for every variable. And only the significant variables will be included in the multivariate logistic regression.

4 Results

In this part the results of the univariate logistic regressions and final multivariate logistic regression will be presented. First, the parameter estimates will be given and the final multivariate logistic model will be formulated. Second, the usefulness of the model will be tested. This will be done through goodness-of-fit tests and some other model fitting information. And lastly, the assumptions of a logistic regression model will be tested.

4.1 Parameter estimates

4.1.1 Univariate logistic regressions

Because of the large amount of univariate logistic regressions, only one univariate logistic regression will be displayed. The rest of the regressions are summarized in table 4.1:

$$\ln(\textit{Poverty trap}) = -2.460471 + 0.0136769\,\textit{Life expectancy}.$$

The 'Life expectancy' variable is not significant (P-value = 0.814) and this variable will thus not be in the final multivariate logistic regression.

	Coefficient	**P-value**
GDP	-2.39e^{-11}	0.640
Population	-3.71e^{-09}	0.874
Corruption	-0.2478384	0.011**
Total area	-1.81e^{-06}	0.175
Polity	-3.419857	0.153
Freedom	-3.615624	0.061*
HIV	-0.1102362	0.019**
GINI	0.0173175	0.586
Life expectancy	0.0136769	0.814
Roads	-0.0459128	0.159

Food production	0.0018669	0.950
Population growth	-0.1890512	0.795
FDI	-0.1543672	0.033**
Savings	0.0059515	0.848
Capital	-0.0241977	0.440
Education spending	-0.0031885	0.918
Years of school	-0.0128393	0.673
School enrollment	-0.0326471	0.302
Land trapped	0.3313571	0.691
Institutions	-2.868048	0.228
Schooling	0.0119554	0.744
Latitude	0.0156071	0.769
Credit	-0.0203351	0.509
* significant at a 90% significance level ** significant at a 95% significance level		

Table 4.1 Univariate logistic regressions

According to the univariate logistic regressions, only the variables 'Corruption', 'HIV', 'FDI' and 'Freedom' will be included in the multivariate logistic regression.

4.1.2 Multivariate logistic regression

The multivariate logistic regression is as follows:

$$\log(Poverty\ trap) = 20.0688 - 2.06859\,Freedom - 0.207198\,FDI - 0.1814301\,HIV - 0.6580911\,Corruption.$$

A robust regression is used to get cleaner results. All variables in this regression are significant; see the P-values in table 4.2. Each estimated coefficient is the expected change in the log odds of being in a poverty trap for a one unit increase in the corresponding independent variable, holding all other independent variables constant at a certain value. All four variables have a negative sign, which means that if a variable increases, it will have a negative effect on the log odds of being in a poverty trap.

The odds ratio of the 'Freedom' variable is: $e^{-2.06859} = 0.12636$**.** This means that if all other variables are held at a fixed value, the odds of getting in a poverty trap for a one unit increase in 'Freedom' is 0.12636. In percentage change, the odds of being in a poverty trap for a unit

increase in 'Freedom' is 87.4% lower. This result coincides with the existing literature; more freedom leads to a lower chance of a poverty trap.

The odds ratio of the 'Corruption' variable is: $e^{-0.6580911} = 0.517839$, so the odds of getting in a poverty trap for a one unit increase in 'Corruption' (less corruption) is 0.517839, ceteris paribus. This can also be expressed in percentage change, the odds of being in a poverty trap for a unit increase in 'Corruption' (less corruption) is 48.2% lower. This result also coincides with the existing literature; less corruption lowers the chance of being stuck in poverty.

The odds ratio of the 'HIV' variable is: $e^{-0.1814301} = 0.834077$, so the odds of being in a poverty trap for a one unit increase in 'HIV' (higher prevalence rate of HIV in the population) is 0.834077, holding all other variables fixed. In percentage change, the odds of being in a poverty trap for a unit increase in 'HIV' is 16.6% lower. This result is counterintuitive as it states that more HIV in the population will lead to a lower chance of a poverty trap. It can be argued that the poorest have the highest chance of getting infected with HIV, therefore leaving the relatively wealthier people healthier and more productive.

The odds ratio for the variable 'FDI' is: $e^{-0.207198} = 0.812859$, which means that the odds of being in a poverty trap for a one unit increase in 'FDI' is 0.812859, ceteris paribus. In percentage change the odds of being in a poverty trap for a unit increase in 'FDI' is 18.7% lower. This result, again, coincides with the existing literature. More FDI in a country leads to a lower chance of being in a poverty trap.

The odds ratio for a poverty trap, if all variables are set to zero is: $\frac{e^{20.0688}}{1+e^{20.0688}} = 0.9999$. But all other variables will never be zero in the real world and so the intercept does not have much explanatory power.

	Coefficient	**P-value**
Corruption	-0.6580911	0.011**
HIV	-0.1814301	0.007**
FDI	-0.207198	0.066*
Freedom	-2.06859	0.023**
Constant	20.0688	0.010**

* significant at 90% level	N = 47	Pseudo R^2 = 0.6351
** significant at a 95% level	Prob > chi^2 = 0.0241	

Table 4.2 Multivariate logistic regression

4.2 Model fit

Now some checks will be done to see if the model is a good fit of the data.

4.2.1 Model fitting information

The most important model fit test is the Chi-square test; this test compares the estimated model with a model that only consists of a constant. The Wald Chi-square of our model is 11.23 and is significant at a 95% confidence level (P-value = 0.02). The estimated model is therefore a better fit of the data than a model with only a constant.

4.2.2. Goodness-of-fit

A logistic regression model does not give an R-squared, because we cannot really speak of explained variance with a binary dependent variable. But a few pseudo-R-squared fits exist for logistic regressions that are comparable to the R-squared in a linear regression model. The pseudo-R-squared of our final multivariate logistic regression is equal to 0.635. A pseudo-R-squared only has meaning compared to other pseudo-R-squared of other estimated models. But the pseudo-R-squared of the final estimated multivariate logistic regression is pretty high and we can assume that the model is a good fit with our data.

4.2 Assumptions

To draw conclusions based on a logistic regression analysis, some assumptions must hold. Logistic regression does not make any assumptions of normality, linearity, and homogeneity of variance for the independent variables. The assumptions of logistic regression are: linearity, exogeneity and no multicollinearity (the independent variables should not be too highly correlated) (Field, 2009). Logistic regression further requires that the minimum number of cases per independent variable is ten (Hosmer & Lemeshow, 2004). This requirement is fulfilled, because each variable has 48 observations.

4.2.1 Linearity

The assumption of linearity in logistic regression assumes that there is a linear relationship between a linear combination of the independent variables and the logit of the dependent variable. If this is not the case, there is a chance the model has a specification error. This

assumption can be tested by looking at whether the interaction term between the predictor and its log transformation is significant. This can be down with the linktest command in Stata, which is used after the logit command. Linktest uses the linear predicted value (_hat) and linear predicted value squared (_hatsq) as the predictors to rebuild the model. The variable _hat should be a statistically significant variable, since it is the predicted value from the model. If the variable _hatsq is significance, there will be a specification error. Table 4.3 shows the outcomes of the test on linearity. The variable _hatsq is not significant in this model, which indicates that the assumption of linearity is satisfied.

Poverty trap	**Coefficient**	**P>|z|**
_hat	1.036849	0.051
_hatsq	-0.0908817	0.562
_constant	0.2074662	0.800

Table 4.3 Test on linearity

4.2.2 Exogeneity

There should be no endogeneity in the model, a variable is said to be endogenous if there is correlation between the variable and the error term. The assumption of no endogeneity can be tested with the ivreg command in Stata, which is used instead of the logit command. This test tells us that the model does not include any endogenous regressors. The assumption of exogeneity is therefore satisfied.

4.2.3 No multicollinearity

There should be no perfect linear relationship between two or more of the independent variables. Therefore, they should not correlate too highly. If there is perfect collinearity between independent variables, it becomes impossible to obtain unique estimates of the regression coefficient. One way to indentify multicollinearity is to run a correlation matrix of all the independent variables and see if any correlate highly. Table 4.4 shows the correlation matrix.

	Poverty trap	Corruption	HIV	FDI	Freedom
Poverty trap	1.0000				
Corruption	-0.4357	1.0000			
HIV	-0.3914	-0.0397	1.0000		

FDI	-0.3861	0.3947	0.0202	1.0000	
Freedom	0.2945	0.7543	0.1191	-0.4886	1.0000

Table 4.4 Correlation matrix

The assumption of no multicollinearity holds, because there are no correlations above 0.8 or 0.9 (Field, 2009). The assumption of no multicollinearity can also be tested with the tolerance statistic, which is the reciprocal of the VIF statistic (1/VIF). According to Menard (1995) values below 0.2 indicate that there is multicollinearity. The tolerance statistic is displayed in figure Table 4.5.

	1/VIF
Freedom	0.483582
Corruption	0.581108
FDI	0.734567
HIV	0.980960

Table 4.5 Test on multicollinearity

As there are no values below 0.2, the assumption of no multicollinearity is satisfied.

5 Robustness

Because the dependent variable 'Poverty trap' is a self-constructed variable, some robustness tests will be done to see whether the results depend on the definition of the dependent variable.

5.1 Poverty trap measurement

Three other 'Poverty trap' measures are constructed to test the poverty trap measurement, countries are defined to be in a poverty trap if:
More than 75% of the population is living in multidimensional poverty [(living on $2 a day (PPP)] and have a mean negative per capita GDP growth five years before and five years after the poverty measurement. This variable will be called 'Poverty trap $2 75%'.

More than 50% of the population is living in multidimensional poverty [(living on $1.25 a day (PPP)] and have a mean negative per capita GDP growth five years before and five years after the poverty measurement. This variable will be called 'Poverty trap $1.25 50%'.

More than 75% of the population is living in multidimensional poverty [(living on $1.25 a day (PPP)] and have a mean negative per capita GDP growth five years before and five years after the poverty measurement. This variable will be called ‘Poverty trap $1.25 75%’.

The results of the multivariate logistic regressions with these three poverty trap measures are summarized in table 4.6.

	Corruption	HIV	FDI	Freedom	Constant	N	Prob > chi^2	Pseudo R-squared
Poverty trap $2 75%	-0.3491311 (0.074)*	-0.0961494 (0.064)*	-0.0749183 (0.271)	-0.4321204 (0.552)	6.110826 (1.18)	47	0.0002	0.5103
Poverty trap $1.25 50%	-0.1683961 (0.196)	-0.0742752 (0.057)*	-0.0929882 (0.140)	-0.2073533 (0.723)	3.844172 (0.373)	47	0.0023	0.3884
Poverty trap $1.25 75%	-0.1911326 (0.378)	-0.1074323 (0.071)*	-0.2056436 (0.173)	0.0858148 (0.923)	2.54382 (0.690)	47	0.0017	0.5425
* significant at a 90% significance level ** significant at a 95% significance level								

Table 4.6 Multivariate logistic regression with three poverty trap measurements

The three models all have a significant Wald Chi-square (all P-values are 0.00). The estimated models are therefore a better fit of the data than a model with only a constant. The pseudo-R-squared is lower for all three the models than the initial model, respectively: 0.51, 0.39 and

0.54. This means that the initial model is a better fit of the model than the models with the other poverty trap measurements.
The variables ‘Corruption’, ‘HIV’ and ‘FDI’ stay negative with all three measurements, ‘Freedom’ is positive in the last model, but this value is insignificant (P-value = 0.92). Only the variable ‘HIV’ is significant in all models, all other variables become less significant with each harsher poverty trap measurement.
In conclusion, with the significant variables and higher pseudo R-squared in the model, the initial model is a better model for the data. It can therefore be concluded that the results are robust for the poverty trap measurement.

5.2 OLS

To test if the results depend on the statistical model used, an OLS regression will be conducted as well. The initial poverty trap measurement (population in poverty ≥ 50% and negative mean growth) is transformed into a continuous variable. The variables ‘poverty headcount ratio at $2 a day (PPP)’ and ‘GDP per capita growth (annual %)’ were first normalized using the min-max method and the weighted average of these variables was taken. The following regression is the OLS regression:

$$Poverty\,trap = 0.8409666 - 0.0115871\,Corruption + 0.0025607\,HIV + 0.0033584\,FDI - 0.0381456\,Freedom.$$

Only the variable ‘HIV’ is insignificant (P-value = 0.192), but the estimated effects of all variables became much smaller. The variables ‘HIV’ and ‘FDI’ even have small positive coefficients. The OLS regression is significant (P-value of 0.02), but has a lower R-squared than the initial model (R-squared = 0.2377).
Because of the lower R-squared and less significant variables, compared to the initial multivariate logistic regression model, it can be concluded that the initial model is a better model for the data and the results are therefore robust.

6 Conclusion

This paper tried to find the causes that drive and/or keep some countries into a poverty trap. A lot of possible causes that are thought to induce a poverty trap are named in the existing literature. By combining this literature and empirical data, this paper seeks to see if the relationship between these causes and a poverty trap empirically holds. The data sample consists of countries in sub-Saharan Africa and data over the period 1980-2010.

First, a univariate logistic regression model was estimated for every variable. Only the significant variables, 'Freedom', 'HIV', 'FDI' and 'Corruption' were concluded in the multivariate logistic regression model. Second, using a multivariate logistic regression, this paper found that more freedom, less corruption, a higher prevalence of HIV and more FDI as a percentage of GDP lowers the chances of a country being stuck in a poverty trap. 'Freedom' has the largest effect on the chance of being in a poverty trap. The effects are all statistically significant, but it should be kept in mind that the static modeling of poverty traps will not show all possible causes. The found effects of freedom, corruption and FDI coincide with the existing theory. The effects of HIV are counterintuitive; it could be argued that the poorest have the highest chance of being infected with HIV. Therefore leaving the relatively wealthier people more healthy and productive. But this relationship should be investigated. Other poverty trap measures show that the found results are robust.

To answer the main question, what are the causes that drive and/or keep some countries into a poverty trap, it can be concluded that more freedom, less corruption and more HIV and FDI have a negative impact on the chances of being in a poverty trap.

7 Discussion

This study has several limitations which should be taken into account. First of all, a poverty trap is a trap because countries are stuck at the low-level equilibrium and if they try to break out there are forces that will lead them back to this low-level equilibrium. A poverty trap is therefore a dynamical process and the biggest limitation of this research is the fact that there is no widely agreed upon poverty trap measure. In this research a static poverty trap measure was used, which is for sure not able to capture the full dynamical effects and causes of a poverty trap. More research is needed to find an appropriate poverty trap measurement.

Second, research on countries in sub-Saharan Africa faces a serious data problem. For some variables data was not available for the whole research period, 1980-2010. For example, the 'Corruption' variable consists of only one value and this value was somewhere in the 2000s. It therefore makes important assumptions about the corruption pattern twenty years before this value, but this corruption pattern could have made important changes. Some data was missing altogether. South Sudan has for example no data available for several variables. These data inconsistencies should be taken into account in concluding from this research.

It is also important to note that due to data availability the period 1980-2010 was chosen, but the last couple of years countries in sub-Saharan Africa have been doing relatively well. For example, The GNP per capita, life expectancy at birth and primary education completion rate have all been rising in the last decade. Further research is needed to test the consequences for poverty traps.

Third, the true causality of poverty traps should be further investigated. The fact that a county is stuck in a poverty trap might influence the suggested causes of poverty traps in turn. Reversed causality could lead to false inferences of causation and even possible to false conclusions. Further research is needed to make statements about the true causality.

Fourth, there might be other causes, which are not taken into account in this research due to missing data or no current knowledge, that have an effect on poverty traps. Further and more comprehensive research is needed to fully identify and examine all of the possible causes.

And at last, the economic significance of the results can be debated; especially because of the use of a statistical poverty trap measurement while it is a dynamical process. But most effects are also not very large. As noted before, more freedom has the largest effect on the chances of

being in a poverty trap. But it is very hard to ‘just’ increase the freedom in a country; it will take some time for these chances to take place.

Appendix A. List of countries used

Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Cape Verde
Central African Republic
Chad
Comoros
Congo, Democratic Republic
Congo, Republic
Cote d’Ivoire
Equatorial Guinea
Eritrea
Ethiopia
Gabon
Gambia, The
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Nigeria
Rwanda
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
Somalia
South Africa
South Sudan
Sudan
Swaziland
Tanzania
Togo
Uganda
Zambia
Zimbabwe

Liberia

Madagascar

Malawi

Mali

Mauritania

Mauritius

Mozambique

Namibia

Niger

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