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CHAPTER 1

Introduction

1.1 There's No Such Thing as a Free Lunch

Most economists believe that "free lunches" would be nice, but are too good to be true. Macroeconomists in particular worry about general equilibrium and external effects and so does this dissertation. "Free lunches", such as rents stemming from commodity endowments, the unexpected increase in their value, humanitarian aid, etc., do have effects on societies and their economies. The studies in this dissertation try to make a marginal contribution to the vast literature on these effects. In this chapter, we begin with a literature review, followed by a brief summary of the different chapters. Chapters 2 to 4 present the research conducted for this dissertation.

1.2 Literature

Aid flows and commodity revenues are similar in many ways. Part of the output generated from commodity production represents rents in excess of the costs of production. Aid resembles rents as it is not the outcome of a production function. Maximising income from these sources is therefore not based on basic economic profit maximisation, but on many other factors, including political economy considerations. For example, commodity extraction could be too quick compared to intertemporal welfare maximisation due to a greedy dictator expecting to be in power for a short period. Maximising aid is in itself questionable as the goal of a government should be to make the country independent of international donors.

Aid and commodity production are also similar in other ways. The production of non-renewable commodities is often based on simple technologies, making it accessible to many developing countries, the same countries which can also access aid. With existing deposits and short life expectancies, both streams of resources can be considered infinite by many economic actors. The value of both flows is to a large degree influenced by factors outside of the control of a single country. Humanitarian aid in particular, the focus of one of the studies in this dissertation, is for a large part determined by developments in donor countries. Likewise the world market price for non-renewable resources can hardly be influenced by the countries in our samples.

Nevertheless, aid flows and commodity revenues are conceptually very different and are treated separately in the literature. We therefore discuss them successively in this chapter, first starting with the aid effectiveness literature (Section 1.2.1) and continuing with the literature on resources (Section 1.2.2). The purpose of this chapter is twofold. First, it serves as an extensive literature review, starting from seminal contributions in the wider research to the more specialised articles closer to the studies conducted for this dissertation. Because little research has been done in the field of humanitarian aid, the literature review on this topic covers the aid effectiveness literature more broadly. There is much more literature on the effects of resources as they are studied in chapter 3 and 4, so the literature review on commodities starts from a more narrow perspective (compared to the discussion of the aid effectiveness literature) in order to be able to capture the most important related work.

1.2.1 Aid Effectiveness

The largest part of the aid effectiveness literature is devoted to the aid-growth nexus. Most of the research focuses on this question, but it also illustrates the problems researchers face when investigating the effects of development aid and therefore also demonstrates the problems we face. Chapter 2 focuses on a very specific question, the effects of humanitarian aid on food consumption, life expectancy and government expenditure patterns. The literature on the effects of *humanitarian* aid as well as the literature on the effects of aid on *government spending* is very limited, mainly due to data availability issues.

The literature faces a number of problems, including bad data quality (especially from developing countries), incomplete data (e.g. developing assistance from NGOs often go unaccounted), endogeneity (improving countries could be rewarded with more aid), and the problem that the purpose of aid is often unclear. If the United States of America (USA) gives aid to Pakistan to build a school, is that strategic aid (Pakistan is an important ally for the USA) with a possible effect of aid on political stability, or is it aid to help Pakistan grow in the long run?

A large part of the literature investigates the effects of aid on economic growth. Economic growth is correlated with improving values for many variables from conflict to health and political stability (see e.g. chapter one in Acemoglu (2008)), but these outcomes must take into consideration the fact that disaggregated aid data are scarce. If we cannot isolate aid that is intended to improve human capital in a country, we cannot evaluate if aid achieves this goal.

One of the most prominent (and highly criticised) papers in the field is Burnside & Dollar (2000). Their finding that aid has a positive effect on growth in countries that have good policies in place has influenced academics as well as policy makers (see Easterly (2003) for an early discussion). Dalgaard, Hansen & Tarp (2004) also find a positive effect of aid on growth, but the effect is smaller in countries with tropical climates. This finding is counterintuitive and could result from the fact that legal origins and institutions are highly correlated with settler mortality and bad climates (Acemoglu, Johnson & Robinson (2001)).

Virtually all researchers use an instrumentation strategy to tackle the obvious reverse causality from growth to aid. Brückner (forthcoming) even uses this fact to find the effect of aid on growth by instrumenting growth (instead of aid) and calculating the reverse effect of growth on aid from the OLS estimates of the aid-growth relationship. He uses rainfall data and international commodity prices as instruments for economic growth and finds, calculating the reverse effect, a positive effect of aid on growth.

Most papers use external instruments to tackle the endogeneity issue.[1] Finding instruments that do not directly influence growth is difficult and often colonial relationships and relative (initial) population size are used (Rajan & Subramanian (2008), Kalyvitis, Stengos & Vlachaki (2010), Rajan & Subramanian (2011)). One problem of using a dummy for colonial relationships is that this is correlated with inherited institutions and could have a direct effect on growth in the second stage. Another problem is that, by using these instruments, they actually test for the effect of strategic aid on growth (assuming that aid given to a former colony has a stronger strategic motive than average aid).[2] These three studies find very different effects of aid on growth: Rajan & Subramanian (2008) find no significant effect, whereas Kalyvitis et al. (2010) find a positive effect of aid above a certain threshold.[3] Rajan & Subramanian (2011) find that aid harms the exporting sector through the exchange rate.

Other instruments used in the literature are regional dummies, initial GDP, population, and interaction terms of these values and aid (see e.g. Hansen & Tarp (2001)), but they also have the problem that these instruments might also have a direct effect on growth.

[1] Two exceptions are Headey (2008) and Minoiu & Reddy (2010) who mainly use internal instruments.

[2] This problem returns with any external instrument: the effect measured is actually the effect of aid given on the basis of the assumption underlying the instrumentation strategy (see Arndt, Jones & Tarp (2010) for more problems concerning the instrumentation strategy used by Rajan & Subramanian (2008) and others.).

[3] Kalyvitis et al. (2010) also provide a very good overview of the literature on non-linear effects of aid on growth.

That similar studies result in very different outcomes is a problem that by itself has attracted attention. Roodman (2007) tests some important contributions to the current literature and finds that many findings are not robust to, for example, changes in the time span of the analysis. This could be caused by the "structural break" international assistance experienced around 1990. Headey (2008) for example finds that aid has a positive effect on growth after 1990, but had no significant effect before, which is in line with his hypothesis that pre-1990 aid was mainly given for strategic purposes, but not to help countries grow or develop.

Since both internal instruments and the above mentioned external instruments have their shortcomings, some papers apply different sets of instruments. Werker, Ahmed & Cohen (2007) use variation in the oil price as an instrument for aid from OPEC countries to (Muslim) allies. They find a positive, but insignificant effect of aid on growth. Being a good instrumentation strategy, however, it is limited to aid flowing from OPEC countries to their allies.

Roodman (2009) discusses problems related to using Difference and System GMM for instrumentation. Their main shortcomings are based on the fact that statistical software tends to use a large number of instruments when applying these estimators, resulting in a set of instruments that overfit the endogenous variable and bias the results towards the OLS (i.e. uninstrumented) results. An additional problem is that this also weakens widely used tests of instrument validity. System and difference GMM estimators also assume a small number of time periods and result in inconsistent results when applied to datasets with a large number of time periods. Researchers therefore often take averages over several years (which also smoothes out business cycle effects), but in doing so are not able to test for short-term reactions. Averaging over an always arbitrary number of years can result in weak instruments because the time-lag between the instrument and the endogenous variable increases. Averages are also always taken in an arbitrary sequence. Having a different starting year (e.g. averages are taken over 1982-1986 instead of 1980-1984) could change the results.

The problem related to a large number of instruments is not restricted to internal instruments.[4]

Most of the external instruments used in the literature do not vary over time because it is often easier to argue that they are indeed valid instruments. Rajan & Subramanian (2008) for example use a set of variables based on common colonial history and relative population sizes. Some years ago the aid effectiveness debate moved towards scepticism (e.g. Rajan & Subramanian (2008)), but two very recent papers try to improve on (Arndt et al. (2010)) or aggregate (Mekasha & Tarp (2011)) recent contributions to show that aid indeed has a positive effect on growth. The final word on the effect of aid on growth has not yet been spoken.

[4]Two stage least square estimates are biased towards the OLS results if the model is overidentified and this bias increases with the number of instruments used. Only if the model is just identified, the estimator is approximately centred around the true value (see e.g. Angrist & Pischke (2009), p. 206ff).

Disaggregated aid data are rarely available. The most extensive data set on aid is provided by the OECD, but is only available in aggregated format. But the OECD also shares data on aid *commitments*, which are available on a disaggregated scale and are highly correlated (around 0.66) with actual aid disbursements. Clemens, Radelet & Bhavnani (2012) use this data set to estimate the effect of aid that is supposed to have a short-term effect on growth, i.e. they deduct (for example) humanitarian aid from total aid. Focusing on aid that can potentially influence growth rates in the short term, they find that aid indeed has a positive and significant effect on growth. Headey (2008) uses a similar approach and deducts humanitarian aid from total aid to find the effect of aid on growth.

Although the target of aid (and aid-induced economic growth) is often to lift people out of poverty, the effects of aid on *poverty* have hardly been studied, Collier & Dollar (2002) being a notable exception. It is unclear why this is the case: data on different measures of poverty (Gini coefficient, income quintiles, poverty headcounts) are available for many countries over many years (see e.g. Beck, Demirgüc-Kunt & Levine (2007) who use these measures to quantify the effect of financial development on poverty).

But aid has not only the potential to influence growth directly but also to change institutions or policies, and through these channels influence growth. As with the aid-growth literature, however, the sign and significance of the effects is not clear. Whereas Djankov, Montalvo & Reynal-Querol (2008), Knack (2001), and Bräutigam & Knack (2004) find that aid has a negative effect on *rule of law, bureaucratic quality and corruption* (measured by the International Country Risk Guide, Polity IV and the Database of Political Institutions), some papers find that aid significantly decreases (Tavares (2003), Dalgaard & Olsson (2008)) or has no significant effect on corruption (Alesina & Weder (2002)).

The effect of aid on *democracy* is also ambiguous. Whereas Knack (2004) finds that aid does not improve democracy, Blodget-Bermeo (2011) finds that it does if it comes from a democratic donor.

The variables to measure institutions, corruption, rule of law, etc. mainly come from the ICRG and the Polity IV project and are valued for their accuracy. But the most commonly used instruments used to find the causal effect of aid on institutions are problematic (initial values of population and income; geographical values; regional dummies). Small, dysfunctional states are covered to a lesser extent than bigger ones in the ICRG because the former are less interesting for international investors (whom the ICRG is made for) than the latter. This way the ICRG index is correlated with population size in a way that has nothing to do with aid (Knack & Azfar (2003)). Also, as Dalgaard & Olsson (2008) point out, Tavares (2003) uses population as a control and finds it to be significant, which shows that this variable should not be used as an instrument. Geographical values are also not as innocent as they seem. If trade is prone to corruption and larger countries trade relatively less, then corruption and country size are correlated (Shleifer & Vishny (1993)). Regional dummies can be correlated with colonial relationships and (inherited) institutions.

The second large field of studies on the effect of development assistance is concerned with the effects of aid on *conflict*. Again, this is partly due to the importance of the question at hand (conflicts have a direct negative effect on people's lives, but also reduce economic growth), and partly due to data availability (conflicts are easy to observe). Most of the studies use the UCDP/PRIO dataset on conflict incidence. This dataset is also easily transformed to test for the effects on conflict onset or conflict duration. Most people use the binary version of the dataset in which a conflict is assigned to a country-year if that country experienced a conflict with at least 25 casualties and if at least one of the actors was a state.

De Ree & Nillesen (2009) use this dataset and find that aid (instrumented by donor countries GDP) decreases the duration of civil war but does not influence the probability of the onset of a civil war. Collier & Hoeffler (2002) investigate the channel through which aid influences conflict. They find that aid reduces conflict through its effects on economic growth and the structure of the economy (the economy diversifies away from commodities). As with the aid-growth literature, endogeneity is also a problem in the aid-conflict literature. Balla & Reinhardt (2008) show that donor countries condition aid on the proximity of conflict.[5] Donor countries often increase the amount they give after a country has experienced a conflict. Collier & Hoeffler (2004*a*) investigate how this should be done and recommend a phasing in of post-conflict aid because the absorptive capacity of a country is limited.[6]

There is far less literature on the effects of aid on more specific outcomes. For example, Mishra & Newhouse (2007), Boone (1996) and Masud & Yontcheva (2005), are, to our knowledge, the only papers on the effects of aid on health outcomes. Mishra & Newhouse (2007) find a significant effect of health aid on infant mortality (which is an indicator that quickly responds to changes in the health system of a developing country). They use the disaggregated OECD aid commitment data and internal instruments (GMM) to overcome reverse causality.

The literature on the effects of *humanitarian* aid is small as well. There are studies focusing on single countries (Levinsohn & McMillan (2005) and Quisumbing (2003) on Ethiopia; Uvin (1999) on Rwanda), but cross-country studies face a data-availability problem.

Neanidis (2011) uses the OECD aid commitment data and applies a GMM estimation strategy to estimate the effect of humanitarian aid on fertility and economic growth. He does not find any significant effect of humanitarian aid on these variables. Nunn & Qian (2010*a*) use the FAO dataset on food aid to estimate the effect of food aid from the USA on conflicts in African countries. They use weather shocks in the USA as an instrument for food aid from that country. Due to several laws, the US government is in fact obliged to buy some of the (weather-induced) overproduction and to give it to developing countries. Using this instrument, they find that food aid significantly increases the likelihood of an incident of civil war in a receiving country. The problem with their instrumentation strategy is

[5] Hegre & Sambanis (2006) provide a good overview of the problems this literature faces.

[6] Excellent surveys on the aid-conflict literature are Blattman & Miguel (2010) and Collier & Hoeffler (2007*a*).

that it is based on donor-country characteristics and measures the effect of randomly (i.e. caused by a weather shock in the USA) given food aid. This way Nunn & Qian (2010*a*) measure the effect of food aid given to a country that does not necessarily need it (which is an important research question since food aid is often given because donor countries need to get rid of overproduction). This study, on the other hand, tests for the effects of humanitarian aid given to countries that actually need it. Both lines of reasoning are valid and important given that both approaches result in strong instruments.

When studying the effects of aid, fungibility is an important aspect. Fungibility means that a government uses the resources it gets directly for other means or that, by using aid for the purposes intended, it relaxes the government's budget constraint and enables it to increase spending for other purposes. Whether foreign aid is fungible has been investigated by, for example, Feyzioglu, Swaroop & Zhu (1998), Pack & Rothenberg Pack (1993) and Van de Sijpe (2010). Their results are mixed. Whereas Feyzioglu et al. (1998) find that aid is fungible in some sectors (e.g. agriculture), it is not in others (e.g. transport). Van de Sijpe (2010) finds that aid given for educational and health purposes is rarely fungible.

Tschirley & Howard (2003) discuss to what extent humanitarian aid is and should be monetized. Around 90% of US food aid (average 2006-2009) is provided under Title II of the Food for Peace Programme, which can be monetized. Monetization makes it easier for the government of a receiving country to divert money to other means. But even if food aid is not monetized, it can still be diverted to feed soldiers or the government can put a company in charge of the distribution of food aid that has close links with the ruling elite.

In addition to the question of fungibility, aid can also have other (external) effects. Svensson (2000), for example, shows that aid disbursements create incentives for receiving governments not to fight poverty.

1.2.2 Natural Resources

One of chapter's 3 foundations lies in a debate that took place in the 1950s and 1960s, discussing the (economic) expectations of the colonies in the wake of decolonization. Independence movements in many African countries fuelled the masses' expectations about the gains of independence. Blessed with vast amounts of natural resources and cheap labour, these countries were expected to flourish with independence, a feeling that got additional support from charismatic leaders promising economic and political development. Together with the rise of revolutionary Soviet-sponsored Marxist movements, this motivated scholars to study the preconditions of revolutions.

Based on the views of Marxism (revolution as the result of the relative income decline of the working class compared to capitalists) and Alexis de Tocqueville (revolution following an actual improvement of the living standards of the masses, see de Tocqueville (1955)), the most prominent paper in this

debate is probably Davies (1962). His theory of revolution is also based on a behavioural view of people (like Marx and Tocqueville), suggesting that they start a revolution if, after a time of improvement, economic conditions start to flatten out, or even decline. Because they were expecting past growth rates to persist, this stagnation or decline creates an "intolerable gap between what people want and what they get" (Davies (1962)).

Our study distinguishes itself from this line of research in several ways. First, it assumes rational actors (as does almost all of the current literature, see below). Second, it uses expectations as the precondition of a revolution. Davies (1962) does not have forward-looking actors and neither do Marx nor Tocqueville. They all think of revolutions arising from people looking at their current situation and maybe comparing it with expectations they *had*. It was probably due to this fact that this literature could not help explain the political situation in the pre-decolonised world. The expectations these people had in the 1950s were not based on current or former economic conditions but on the future they were expecting to happen.

Revolutions, institutional change, and political systems have lost the attention of most economic researchers until very recently (one exception in the tradition of the new approach being Grossman & Noh (1994)). Only in recent years are we observing a growing literature on weakly institutionalized states that focuses on political systems, institutional change, etc.

Although no workhorse model to illustrate weakly institutionalized states has emerged so far, the current literature shares some common features. There is, obviously, the distinction between countries with good and strong institutions and countries with weak institutions. But what constitutes weak institutions is still disputed. Some papers focus on the (in)ability of a government to tax its citizen (Acemoglu (2005*a*), Besley & Persson (2010)), others on the way of succession of the leader (Acemoglu, Robinson & Verdier (2004), Shen (2007)), and some on using force to achieve their goals as a property of weak states (Caselli & Coleman II (2006), Chou & Khan (2004), Besley & Persson (2011)). Another feature we observe is the importance of public goods (e.g. Oechslin (2010), Acemoglu (2005*b*), Caselli (2006)).

Our study focuses on the rules of the political game, i.e. the checks and balances of the political system and was inspired by the theoretical model of Acemoglu et al. (2004). Their model is simplified and amended in several ways: our model does not include taxes or an elastic supply of labour; it abstracts from foreign aid and the possibility that the productive groups have heterogeneous productivity. Whereas labour is the only factor of production (other than technology) in Acemoglu et al. (2004), we introduce *state capacity* in the spirit of Besley & Persson (2010) as a factor of production.[7] The model also introduces changes in the flow of natural resource rents. Natural resources are only of secondary interest for Acemoglu et al. (2004) as they affect the optimal level of taxes and the value of democracy.

[7] Besley & Persson (2010) define *state capacity* as "The wider range of competencies that the state acquires in the development process, which includes the power to enforce contracts and support markets through regulation or otherwise".

In our model they have a prominent role as they determine the stability of the equilibrium, i.e. they are the driving force behind a regime change towards democracy.

The present study is closely related to Chaturvedi & Münster (2005), who model an ongoing contest of political power. They find that dictators have an incentive to use bad policies even if they expect to stay in power for a long time. While similar in their results to the present study, their model differs in several aspects: for example, they model a contest between two dictators, one incumbent and one contestant, do not take natural resources into account and do not test their results empirically.

Some papers highlight the importance of the duration of the dictator being in power and how changes in the discount rate can influence policy decisions (Oechslin (2010), Sarr, Bulte, Meissner & Swanson (2011)). If a dictator faces a shorter (expected) time in office, he has less incentive to engage in growth-enhancing strategies (Wrigth (2008)). Our study abstracts from this effect as the dictator can stay in power indefinitely and has the same discount rate and preferences as all other agents in the economy.

Other important aspects that we abstract from in this chapter are technology adaptation (Oechslin (2010)), private capital (Shen (2007)), international capital markets (Sarr et al. (2011)), an endogenous rate of extraction of natural resources (Robinson, Torvik & Verdier (2006)), ethnic differences (Caselli & Coleman II (2006), Padro-I-Miquel (2007), Fearon & Laitin (2003)), corruption (Fjelde (2009), Brollo, Nannicini, Perotti & Tabellini (2010), Dalgaard & Olsson (2008), Vicente (2010), Arezki & Brückner (2011*b*)), and the duration of conflicts (Fearon (2004), Collier, Hoeffler & Söderbom (2004)). We also abstract from all forms of violence or repression from the government towards its people. The quantitative literature on state repression is reviewed in Davenport (2007), who comes to the conclusion that only a few theories are robustly supported by the data. Repressions by governments come in many forms, but they typically include actual or threatened physical sanctions with the purpose of deterring specific activities that challenge the government (Goldstein (1978)). One of the few findings that is supported by many studies is the relationship between threats to the foundations of states and repression (e.g. Davis (2007), Regan & Henderson (2001)). Throughout centuries, governments react to threats to their institutions, the lives of their personnel, and the territorial integrity of the state by repression. The second stable finding that robustly gets supported by the data is the relationship between democracy and repression. Although the findings are mixed for countries that have a mixed democratic-autocratic regime, at least full democracies seem to engage significantly less in repressive behaviour (e.g. Davenport & Armstrong (2004), Bueno de Mesquita, Cherrif, Downs & Smith (2005)).

A recent empirical contribution to the above mentioned literature is Brückner & Ciccone (2010). Although their work is similar to our study in aim, there are a number of distinguishing features that eventually lead to very different outcomes and interpretations. Brückner & Ciccone (2010) find that civil wars in Sub-Saharan Africa are more likely after a downturn in the price of a country‘s main export commodities, whereas we find the opposite effect. The first difference between Brückner &

Ciccone (2010) and our approach is that we focus on non-renewable, capital-intensive commodities to abstract from indirect wage effects. Distinguishing between labour- and capital-intensive commodities is important as Dube & Vargas (2007) show. The second important difference is that we look at the level of civil freedom and its interaction term with our commodity export index. This variable as well as the non-linear specification is important in capturing the effects and neglecting them qualitatively changes the results, bringing them closer to the results in Brückner & Ciccone (2010). A third important difference is that Brückner & Ciccone (2010) use the UCDP/PRIO data on the onset of civil war, whereas we have chosen to focus on a different dataset to capture political stability on a finer scale. The UCDP/PRIO data on the onset of civil war is used as a robust check and confirms the main findings. Caselli & Michaels (2009) use a somewhat similar approach as we do. They use windfalls in oil revenues of Brazilian municipalities as a natural experiment to investigate the impact of such windfalls on GDP composition, corruption, social transfers, public good provisions, etc. They show that oil revenues have little impact on local living standards, despite an increase in local spending, but increase illegal activities by mayors.

The idea behind the "dynamic resource curse" can already be found in papers such as Van der Ploeg & Poelhekke (2008) and Cavalcanti, Mohaddes & Raissi (2011). They study the effect of resource revenue volatility on economic growth and find that, although there is a positive direct effect of resource revenues on growth, there are larger negative indirect effects of the volatility of resource revenues on growth. Cavalcanti et al. (2011) show that this negative effect works through decreased investments in physical capital. Their study demonstrates that volatility of resource revenues hampers not only growth but it also affects political stability of a country, even after controlling for economic growth. Using micro data from Zimbabwe, Elbers, Gunning & Kinsey (2007) show that risk substantially reduces capital stocks (by about 46%) and decreases economic growth.

For important contributions and surveys regarding the resource curse see Mehlum, Moene & Torvik (2006), Brunnschweiler & Bulte (2008), Frankel (2010*b*), Van der Ploeg (2011) and Collier & Venables (2010), and regarding conflicts related to resources, see Ross (2004), Humphreys (2005), Ross (2006), Collier & Hoeffler (2004*b*) and Besley & Persson (2008). Recent summaries of the literature on the causes and consequences of civil war are Blattman & Miguel (2010) and Collier & Hoeffler (2007*a*).

Chapter 4 is fundamentally a country study. The body of literature focusing on single countries is small and often either does not make use of an econometrical assessment or deduct their country-specific recommendations based on cross-country analysis One reason for this phenomenon is that data availability for within-country studies is often not available, making it difficult for researchers to address the specific problems a country that produces natural resources faces. Examples for such country-focused studies are Iimi (2006), Weinthal & Jones Luong (2001), and Gelb & Majerowicz (2011).Our first approach (comparing Mauritius with Trinidad) is similar to Vicente (2010), but his research is (a) based on microdata (we use macro data) and (b) looks at the short-term macroeconomic

effect of natural resource *discoveries* on corruption, whereas this chapter looks at the long-term effects of natural resource *deposits* on governance, sugarcane production, public debt, etc.

In Section 4.4.1 we see that Trinidad scores significantly worse than Mauritius on measures for corruption and rule of law. Apparently public officials or politicians try to grab some of the resource rents. This finding is in line with Arezki & Brückner (2011*b*) who find that countries with larger oil rents have higher corruption. Arezki & Brückner (2011*b*) use fixed effects panel estimation techniques and cover 31 oil-exporting countries between 1992 and 2005. They use a unique dataset on the quality of oil of the different countries (which is mainly determined by geological factors and is exogenous to corruption) to estimate oil rents.

The findings in Section 4.4.2 support the hypotheses that the resource curse is not (only) driven by the level of resources, but mainly by the volatility of income resource-based economies often experience. Van der Ploeg & Poelhekke (2008) find a positive direct effect of natural resources on economic growth but also a negative indirect effect through macroeconomic volatility that is much larger. Economies that are highly dependent on the extraction of a small number of natural resources often experience boom-bust cycles that follow the world-market prices of these commodities. This is also the case for Trinidad & Tobago. The findings of Elbers et al. (2007) suggest that this negative effect is based on risk-averse households accumulating smaller capital stocks when income is risky. There could also be an effect of natural resources on growth through conflicts as studied by Besley & Persson (2010) and Collier & Hoeffler (1998).

Cavalcanti et al. (2011) find similar results: natural resources have a positive direct effect on economic growth but a negative indirect effect through macroeconomic volatility. They show that this indirect effect is larger than the direct effect and that it works through lower investments in physical capital.[8]

1.3 Summary of the Studies

Chapter 2 studies the intended and unintended effects of humanitarian aid. As is argued above, the literature on the effects of humanitarian aid is very limited, and this study is, to our knowledge, the first one trying to estimate the effects of humanitarian aid on life expectancy, food consumption and public expenditure patterns. Using a novel instrument to circumvent the issue of endogeneity in the data, we estimate these effects and find that a 1% increase of humanitarian aid increases life expectancy by over 6 years and that there also exists a significant and positive effect of humanitarian aid on calorie intake. But the inflow of humanitarian aid also seems to change spending patterns of governments. Humanitarian aid reduces public spending for education, and there is some indication that it reduces public spending on health and increases military spending.

[8] Survey articles about the resource curse are Collier & Venables (2010) and Frankel (2010*b*)

Chapter 3 investigates the effects of relative changes of resource revenues on political stability and the probability of an outbreak of a conflict. Both a theoretical model and an empirical analysis show that a relative increase in the value of commodity exports increases political stability in countries that grant their citizens a lot of freedom, but much less so in countries that grant their citizens less freedom. As indicated by the theory, the effects are non-linear, and not taking this non-linearity into account qualitatively changes the results, as some previous literature suggested. The results show that there are non-linear effects of commodity export revenues on political stability, but we did not try to investigate empirically how these additional revenues affect political stability. It would also be interesting to extend the analysis to longer time periods or beyond Sub-Saharan Africa.

Chapter 4 focuses on Trinidad and Tobago and finds that the production of natural resources (oil and natural gas) has a negative effect on the control of corruption and on the rule of law in the country. It also investigates the effects of the production of oil on the production of sugarcane. We conclude that the production of oil has crowded out the production of sugarcane through the exchange rate. As this study focuses on one sector of one small country, data availability is a problem. With more detailed data, the effects of natural resources on the economy of Trinidad and Tobago could be investigated in more detail, especially the effects on other sectors of the economy, such as manufacturing.

Overall, the results of the different chapters suggest that "free lunches" are indeed not free and can have negative unintended consequences. Humanitarian aid, even though it achieves its goal of an increase of food consumption and an increase of life expectancy, has adverse effects on public expenditures. Commodity exports can negatively influence political stability and can crowd out other economic activities. But if properly managed, such windfalls can improve economic conditions. When it comes to (humanitarian) aid, the donor community can condition their support to prevent the negative consequences from materialising, but the international community has much less influence on how a country uses its commodity exports. More research is needed on the question how such negative consequences can be avoided.

CHAPTER 2

Humanitarian Aid
When Feeding the Hungry Comes with an Aftertaste

"We know [World Food Programme] contractors have been diverting food to the Shabab," said one official close to the [United Nations] investigation, who was not allowed to speak publicly. "And we're talking about millions of dollars of food."

(The New York Times, October 1, 2009)

2.1 Introduction

Humanitarian aid, like any other form of aid, can be diverted, stolen, or used for other purposes than intended by the donor. This chapter investigates if humanitarian aid helps increase life expectancy and improve calorie intake[1], as is often the intention of the donors. It also studies the effects of an inflow of humanitarian aid on public spending patterns. We find that humanitarian aid has a strong and significant effect on both food consumption and life expectancy, with the latter likely to be positively influenced by the former. Increasing humanitarian aid by 1% increases food consumption by over 100 kilocalories and life expectancy by over 6 years. These numbers are likely to be lower bounds of the effect as they are averages over whole countries that include people who did not suffer from a humanitarian crisis and were also not targeted by the aid inflow. Humanitarian aid on average achieves one of its goals of feeding people in immediate need. We also find that humanitarian aid has a negative effect

[1] Throughout the chapter we use both the correct "kilocalorie" as well as the more commonly used term "calorie" interchangeable.

on educational spending (a 1% increase in humanitarian aid reduces public spending on education by 0.5%) and (with a lag of one year) on public spending on health (a 1% increase in humanitarian aid reduces public spending on health by 0.47%). Increasing humanitarian aid by 1% increases military spending by 0.26%, but the effect is not robust to the inclusion of food production as a control variable.

Because we use data on governmental expenditures, we cannot test for leakage of aid into non-governmental groups, such as the Shabab mentioned in the quote preceding this text. Due to data limitations, we cannot investigate the full scope of effects humanitarian aid has on, for example, military expenditure of all governmental and non-governmental actors. But as the quote indicates, there are likely to be effects unaccounted for in our analysis.

The main challenge in coming to these conclusions is to overcome the problem of (expected) endogeneity in the data. To estimate the causal effect from humanitarian aid to the different variables of interest, we apply an instrumental variable strategy. We use the Palmer Drought Severity Index to construct a weather index to be used as the instrument, which we argue to be a valid and strong one. There is no effect of the variables of interest on weather patterns. The instrument also has a strong effect on the endogenous variable of interest, which is shown using the Kleibergen-Paap Wald rk F Statistic[2]. To have a strong effect of weather patterns on food production, one has to focus on an area where irrigation is uncommon. For this reason we restrict our dataset to all countries in Sub-Saharan Africa. That the exclusion restriction holds is supported by the fact that a large number of control variables have been included in the regressions, but by using the test proposed by Kraay (2012), we also show that the results are very insensitive to even a strong weakening of the exclusion restriction.

Whereas the expected outcomes of the regressions of food consumption and life expectancy on humanitarian aid are straightforward (we expect humanitarian aid to improve these measures), the effects of humanitarian aid on public spending patterns are not. Aid could leak into other forms of spending, resulting in an increase in spending. Aid could also be supplemented by reducing other forms of government spending. But humanitarian aid could also not effect public spending, especially if it is disbursed by non-governmental organisations. Because there are several possible effects and hardly any literature, we do not preempt any results by modeling the different possible effects. Section 2.2 presents the empirical results and Section 2.3 the conclusions.

[2]Because the errors are likely to be clustered and/or heteroskedastic, we report the Kleibergen-Paap Wald rk F statistic (Kleibergen & Paap (2006)) to test for the weakness of the instrument.

2.2 Empirical Analysis

2.2.1 Data Description and Identification Strategy

All variables that are used in the analysis are summarized in Table 2.1. Our main variables of interest are the different forms of public expenditures, food consumption, life expectancy, and humanitarian aid. Public expenditures are measured in the log of total government spending on the different areas (education, health and military) in constant prices. Food consumption is measured as the average calorie intake of a person in a given year and country. Life expectancy is measured as the average life expectancy at birth in a given year and country. The humanitarian aid dataset is based on the aid commitment data of the OECD. It is measured as the log of total humanitarian aid in constant USD. For a detailed description of all variables see Appendix 2.3.

The countries in our sample suffer repeatedly from weather shocks. The mean of food consumption shows that calorie intake is just enough to survive. Food production and consumption are also problematic with low minimum values and high standard deviations. In general, Sub-Saharan African countries suffer from conflicts, low economic growth, and short life expectancy. We clearly face a problem of endogeneity in our analysis. Countries that are facing a humanitarian crisis get more humanitarian aid than countries that do not face one. To get the exogenous effect of humanitarian aid on the variables of interest, we use an instrumental variable approach. To instrument for humanitarian aid, we use a self-constructed weather index that is based on the Palmer Drought Severity Index (PDSI). We use PDSI data instead of rainfall shocks because the former take local soil characteristics into account. The weather index is based on the (updated) PDSI dataset by Dai, Trenberth & Qian (2004). The PDSI is an index of relative dryness and is only based on readily available data such as precipitation and temperature (see Palmer (1965) for a detailed description of the model). Its simplicity and wide reach (the series starts in 1870 and is available for the entire landmass of our planet, except Antarctica and Greenland) have contributed to its prominence in meteorology. The PDSI goes from around -10 to +10, with zero depicting weather conditions equal to the long-run average of a region. Negative numbers indicate relative dryness, positive numbers relative wet conditions. We have PDSI data on a monthly basis at a 2.5° grid, so larger countries have a larger number of PDSI values. We calculate the weather index we use in the estimations by taking the average of all *absolute* PDSI values of a country for a given year.[3] A country that is on its long-run average for 10 out of 12 months (PDSI = 0) and scores -3 on the PDSI scale in the remaining months gets a weather index value of 0.5 (=(10*0+2*3)/12). As we see from the summary statistics in Table 2.1, the weather index has a mean of 3.7. This is a very high value, given that Dai et al. (2004) define a value of the PDSI above 3 as very dry and very wet (the weather index is the average of the absolute value of the PDSI, so the two values can be easily compared). A

[3] By taking absolute values we treat dryness and wetness symmetrically.

Table 2.1: Summary Statistics

Variable	Observations	Mean	St. Dev.†	Minimum	Maximum
age	422	83.61	9.37	49.28	103.56
conflict	422	0.16	0.37	0	1
conflict onset	422	0.06	0.23	0	1
economic growth	422	0.008	0.05	-0.40	0.26
log(educational spending)	422	2.58	1.20	-0.93	5.88
food consumption	422	2195	281.36	1508	2965
food production	422	98.73	12.62	52	143
log(health spending)	422	1.71	1.16	-0.33	5.20
HIV	422	6.35	7.12	0.1	26.5
log(humanitarian aid)	422	1.10	0.66	0.01	2.57
inflation	422	33.00	266.20	-5.55	5400
life expectancy	422	51.16	5.94	38.17	64.09
log(military spending)	454	2.04	0.59	0.23	3.71
log(military spending of enemies)	454	0.09	0.47	0.01	3.10
log(military spending of potential enemies)	454	0.35	0.88	0.01	3.71
log(military spending of security web)	454	3.05	0.68	0.30	3.87
m2	422	23.75	18.67	0.92	154.17
polity4	422	0.54	5.56	-10	9
log(population)	422	15.53	1.40	12.83	18.77
urbanisation	422	32.35	13.03	11.6	83.60
weather index	422	3.70	1.85	0.76	9.71

† within-country standard deviations

The summary statistics are based on the sample that is used for the regressions of food-consumption and life expectancy. The summary statistics of the military expenditures are based on the sample that is used for the regressions concerning military spending.

simple scatterplot of the food production index and the weather index (Figure 2.1) indicates that there is a linear relationship. A detailed description of the weather index is given in the Appendix. As a robust test, we have replicated all regressions using a modified weather index. The modified weather index only takes dry spells into account. It is constructed in the same way as the weather index, but wet periods are not included. The results using the modified version of the weather index are virtually the same as the results using the original weather index.

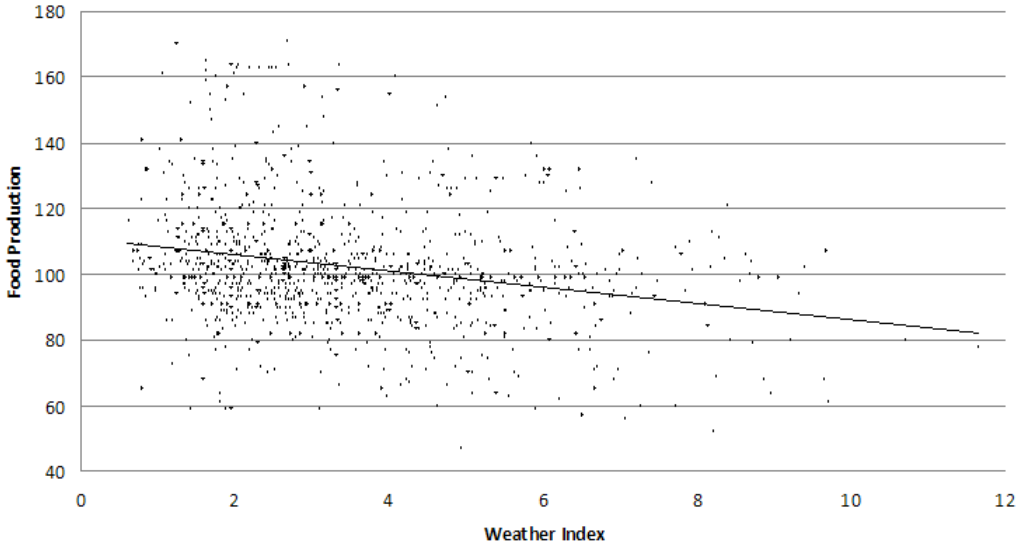

Figure 2.1: Scatterplot Food Production Index and Weather Index

Our approach is closely related to the literature using rain data as instruments. Miguel, Satyanath & Sergenti (2004) use rainfall variation as an instrument for economic growth and find a strong negative relationship between economic growth and civil conflict (although the results are questioned by Ciccone (2010)[4]). They can use rainfall variation as an instrument for growth in Sub-Saharan Africa, because these economies have relatively large agricultural sectors that highly depend on rainfall (irrigation is uncommon). This study focuses on Sub-Saharan Africa for the same reason. The dataset on rainfall variation has a number of shortcomings. First, it only goes back to 1979. Second, it measures rainfall shocks as the "proportional change in rainfall from the previous year", which results in uninformative data points if a drought continues for several years (and the return to normal conditions would be another shock). They define rainfall shocks that way because it prevents them from having to define rainfall shock *thresholds* for every region. Another problem is that a two litre increase in rainfall has different interpretations in a desert compared to a wetland. Third, it produces a weak instrument (the F-test of the instruments, which should in general be above 10, in one of their estimations is 4.5; the corresponding values of the other regressions are not reported).

[4]In Miguel & Satyanath (2010), the authors of Miguel et al. (2004) reply to this critique and argue that their initial results are valid and that the results from Ciccone (2010) rely on, inter alia, a wrong Stata code.

The basic idea we apply in our instrumentation strategy is that a weather-induced shock to domestic food production leads to an increase in humanitarian aid given to a country. This idea is supported by the findings of Lavy (1992) and Nunn & Qian (2010*b*). Using a recipient-based instrument, we can include humanitarian aid from all OECD countries whereas Nunn & Qian (2010*a*) focus on aid coming from the USA.

A good instrument has to meet a number of criteria. It has to be exogenous to the variable of interest, i.e. there should be no effect of the variable of interest on weather conditions. The instrument clearly meets this criterion: food production does not influence temporary shocks to regional weather conditions.

The instrument should also have a strong influence on the endogenous variable. The value of the F-test of the instrument in the first-stage regression indicates that the instrument has indeed a strong influence on the endogenous variable.[5] The Kleibergen-Paap Wald rk F Statistic of the instrument is in all (but one) regressions exceeding both the rule of thumb (that it should be larger than 10) of Staiger & Stock (1997) as well as the critical values in Stock & Yogo (2005).[6]

To have a valid instrument, we need to assume the exclusion restriction. This restriction assumes that there is no direct effect of the instrument on the variable of interest. We add a large number of variables to control for possible direct effects of the instrument on the variable of interest. But because the exclusion restriction cannot be tested, we apply the Kraay test (Kraay (2012)) to investigate the sensitivity of our results to a weakening of the exclusion restriction.[7] In all cases the Kraay test indicates that our results are robust up to a very strong weakening of the exclusion restriction. The results of the test are given in Subsection 2.2.3.

All regressions are fixed effects estimations with a single instrumental variable and are done using the Stata code xtivreg2 by Schaffer (2005). All regressions include country-specific fixed effects and time dummies. Correlation matrices for all estimations are given in the Appendix.

[5] We also tried instrumenting other forms of aid by weather shocks but did not find any correlation (the same holds for instrumenting humanitarian aid by the lagged value of the weather index). This shows the limitations of our instrumental strategy but at the same time supports our argument that weather shocks influence humanitarian aid.

[6] As recommended by Baum, Schaffer & Stillman (2007), we compare the statistic to the rule of thumb as well as the Stock-Yogo critical values because critical values for the Kleibergen-Paap Wald rk F Statistic have not yet been calculated. Stock & Yogo (2005) show that the rule of thumb provided in Staiger & Stock (1997) is too low for most applications, except for cases when the number of instruments is very low. When the number of instruments increases (which is the case in most of the related literature), the threshold value of the F-test increases as well. In our case with only one endogenous variable, the Kleibergen-Paap Wald rk F Statistic equals the F-statistic (and therefore the square t-statistic) of the instrument in the first stage.

[7] We apply the Kraay test, instead of the test proposed by Conley, Hansen & Rossi (2012), mainly because the former paper applies the test to a number of papers that have a somewhat similar approach as in our analysis. This enables us to interpret the main parameter of the Kraay test (which has no direct interpretation) by comparing it to the results of his applications.

2.2.2 Estimation

All variables have been tested for the presence of unit roots using the tests by Maddala & Wu (1999) and Pesaran (2007). The hypothesis of a unit root could not be rejected for the log of military spending of enemies and the log of military spending of potential enemies. These variable have therefore been dropped from the main regressions. We estimate a fixed effects model using one instrument to control for the endogeneity of the variable of interest:

$$z_{i,t} = a_{1,i} + b_1 x_{i,t} + b_2 w_{i,t} + c_{1,i}\, year_t + u_{1,t} \quad (2.1)$$

$$y_{i,t} = a_{2,i} + b_3 x_{i,t} + b_4 z_{i,t} + c_{2,i}\, year_t + u_{2,t} \quad (2.2)$$

Equation (2.1) is the first and equation (2.2) is the second stage of our regression. $z_{i,t}$ is the endogenous regressor (humanitarian aid), $y_{i,t}$ is the dependent variable of interest (food consumption, life expectancy, etc.), $x_{i,t}$ are country-specific characteristics, $w_{i,t}$ is the instrument, $a_{1,i}$ and $a_{2,i}$ are country fixed effects, $year_t$ are time dummies, $u_{1,t}$ and $u_{2,t}$ are error terms and b_1, b_2, b_3, b_4, $c_{1,i}$ and $c_{2,i}$ are coefficients.

Tables 2 and 3 summarize the regression results. In all but one case, the Kleibergen-Paap Wald rk F statistic exceeds the rule of thumb (that it should be larger than 10) of Staiger & Stock (1997) and the critical values in Stock & Yogo (2005). All estimations include time dummies, country-specific fixed effects, and robust standard errors. Estimations I-VI use log(humanitarian aid) as the independent variable of interest, instrumented by the weather index. Estimations VII-XI use log(humanitarian aid) lagged one period, instrumented by the weather index, also lagged one period.

We have argued above that the literature does not give a lot of guidance in the choice of covariates. Stasavage (2005) includes GDP, the share of rural population and the share of young people in the population in his regressions of educational expenditure. He includes GDP to control for the fact that richer countries can spend more on education. Higher shares of urban population and young people could result in higher demand for education. If there are more young people, there is more pressure to provide them with education. An urban population could also demand more education, especially more higher education.

Dunne & Perlo-Freeman (2003) investigate the determinants of military spending. They include the log of population as a control variable to capture size effects. Larger countries can spend relatively less on the military due to economies of scale but also have a larger population to draw soldiers from in case of a conflict. They also include several measures for conflict to capture the effect of an ongoing or starting conflict on military expenditures. They also argue that democratic countries spend less on the military than non-democracies and include the Polity variable to capture this effect (based on the same reasoning, Collier & Hoeffler (2007*b*) also include variables for population size and the Polity variable). M2 and inflation are included as they control for the overall state of the economy. HIV prevalence is

included since it could influence public spending on health care. Food production is included as it is likely to have a strong impact on food consumption, given that transportation or storage of food is uncommon in our sample, and food markets are very localised. In general, we have taken an agnostic approach and included as many of these covariates in all regressions.

Humanitarian aid has a positive and significant positive effect on food consumption in the current period (I) but not one period ahead (VII). Increasing humanitarian aid by 1% increases food consumption by over 100 calories in the same period. This is a large amount, given the sample mean of food consumption, which is 2195 calories. Also, 100 calories is the average effect on calorie intake of people in a given country in a given year. The effect on people that actually receive humanitarian aid is likely to be much larger.[8] Humanitarian aid is on average highly effective in raising people's calorie intake. Humanitarian aid given in one period does not influence food consumption one period ahead. This indicates that humanitarian aid is quickly disbursed. Of the control variables, food consumption is highly correlated with the age dependency ratio (more young people reduce the average food intake), food production, HIV prevalence, the PolityIV score, the rate of urbanisation and, to a lesser degree, with educational spending. These effects are subject to possible endogeneity and should not be interpreted beyond the fact that they are correlations.

Humanitarian aid also has a large and significant effect on life expectancy at birth (II). As we can see from estimation II, increasing humanitarian aid by 1% increases life expectancy by over 6 years. Although this seems like a large effect, it is probably driven by changes in child mortality. When humanitarian aid is focused on very young children and results in these children surviving and gaining the same life expectancy as the older generation, humanitarian aid can have large effects on life expectancy.[9] Unfortunately this reasoning cannot be tested since yearly data on child mortality is not available for the sample period.

Whereas the positive effect of humanitarian aid on food consumption disappears after one year (the food probably got eaten), the positive effect on life expectancy persists (estimation VIII). The control variables in estimation II (and VIII) are virtually the same as for estimation I. The results concerning the control variables are not surprising: conflicts and HIV prevalence are bad for life expectancy, while food consumption, the development of the financial sector (measured by M2/GDP), and urbanisation are positively correlated with life expectancy.

[8] The World Bank provides data for the percentage of people that are undernourished in the developing countries of Sub-Saharan Africa for the years 1992, 1997, 2002 and 2007. The average over those years is around 30%, i.e. in every of these years, around 30% of the people in Sub-Saharan Africa were undernourished (the World Bank defines undernourished as being "below minimum level of dietary energy consumption"). At this order of magnitude, the actual effect could be around 3 times larger. The coefficient should be interpreted as a lower bound of this effect.

[9] In a population that normally has a life expectancy of 50 years, humanitarian aid that is given to very young children that make up 10% of the population and results in these children not starving but having a life expectancy of 50 years as well, average life expectancy (for the whole population) increases by around 5 years.

Humanitarian aid does not influence military spending. Both the contemporaneous (estimation III) and the lagged effect (estimation IX) are positive, but not significant. This indicates that there are neither leaks of humanitarian aid into (official) public spending on the military, nor that the government reduces military spending to supplement the aid inflow. The control variables indicate that countries with relatively many young people, more economic growth, a larger HIV prevalence and a higher urbanisation rate spend more on the military, and that countries experiencing high inflation spend significantly less. Estimation IV includes data on military spending of enemies and potential enemies that were found to exhibit unit roots. Including these variables does not change the results.

In estimation V we see that humanitarian aid significantly decreases public spending on education, which is in line with the findings by Stasavage (2005).[10] An increase in humanitarian aid by 1% decreases educational spending by 0.5%. This indicates that governments receiving humanitarian aid supplement this inflow with funds formerly spend on education. This finding is in line with Stasavage (2005). He finds that (total) aid is negatively correlated (and significant in some specifications) with public spending on education. His results are robust to focusing on aid from a single donor (the World Bank) and to instrumenting for aid. Stasavage (2005) does not argue why there is such a negative relationship between aid and educational spending but suggests that it could be based on the fact that governments that have the (financial) means to spend on popular services can reduce (also popular) spending on education. According to estimation X, the effect of humanitarian aid on educational spending fades after one period. A large proportion of young people, economic growth, HIV prevalence, the Polity IV index, and the rate of urbanisation are positively correlated with educational spending.

Public spending on health is not significantly influenced in estimation VI, but the lagged effect is significant (at 10%) and negative. Whereas there seems to be no contemporaneous effect of humanitarian aid on health spending, there seems to be a negative lagged effect. The control indicators show that the proportion of young people, economic growth and the rate of urbanisation are positively correlated with the log of health expenditures by governments.

The regressions in Table 2 use a weather index that is constructed as the average absolute PDSI value of a given country in a given year. By averaging over absolute values, we take both dryspells and wet spells into account and treat them symmetrically. One could argue that dry spells have a different impact on the variables of interest than wet spells. To test this assumption, we have replicated the regressions using a modified version of the weather index that only takes dry spells into account. This

[10] In his analysis, Stasavage (2005) finds that aid has a significant and negative effect on educational spending and that the percentage of population under age 15 has a negative and significant effect on overall government spending on education. There could be more reasons for this. Governments could be forced to match aid inflows with public funds, resulting in spending cuts on education. It could also be that governments receiving humanitarian aid do not have to prove that they spend their funds wisely (on, for example, education), but are free to allocate resources in their own interest as aid flows in anyhow.

His discussion of these findings is rather short because he focuses on the effect of the form of government on educational spending.

modified index is constructed in the same way as the original weather index, but all wet spells are ignored in the calculation of the averages. As we can see in Appendix 2.3, the results are virtually the same.

By using our instrument, we implicitly assume that weather shocks influence humanitarian aid and food consumption through food production. Although there could be different channels at play, this questions the use of food production and food consumption as control variables. Table 3 presents the regression results of the same regressions as in table 3 but excludes food production and food consumption as control variables. By and large the results are very similar, but two differences stand out. The positive and highly significant effect of humanitarian aid on food consumption vanishes, although the positive and highly significant effect of humanitarian aid on life expectancy remains. These results support the idea that humanitarian aid is (often) given as a response to shocks to food production. In keeping food production constant (as in estimation I), food consumption increases, but in dropping food production from the list of covariates (as in estimation XII), humanitarian aid is used to fill the gap caused by the drop in food production, so the effect of humanitarian aid on food consumption is not significant anymore. The second difference is that table 4 reports a positive and significant effect of humanitarian aid on military spending; increasing humanitarian aid by 1% increases military spending by 0.26%.

Humanitarian aid achieves its goal of improving life expectancy through an increase of food consumption, although we do not find an effect of an increase in public spending on health, which could also affect life expectancy. These positive effects are large and highly significant. Whereas the significant effect of humanitarian aid on food consumption vanishes after one period, the positive effect on life expectancy is still significant after one period. Governments seem to supplement the aid inflow by decreasing public spending on education. There is no contemporaneous effect on health spending, but there is a significant and negative effect after a lag of one period. Some of the aid inflow is used (directly or indirectly) for military purposes.

The results indicate that governments respond to an inflow of humanitarian aid by changing their spending patterns. Public spending on education and (with a lag and at a lower significance level) spending on health are decreased, whereas spending for military purposes is increased.

Table 2: Regression Results

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
dependent variable	food-consumption	life expectancy	log(military spending)	log(military spending)	log(educational spending)	log(health spending)	food-consumption	life expectancy	log(military spending)	log(educational spending)	log(health spending)
log(humanitarian aid)	101.67	6.17	0.25	0.26	-0.50	-0.08					
	(47.94)**	(2.00)***	(0.16)	(0.17)	(0.26)**	(0.29)					
log(humanitarian aid)$_{t-1}$							49.05	6.85	0.01	-0.39	-0.47
							(42.46)	(2.31)***	(0.13)	(0.23)	(0.29)*
age	-5.94	0.47	0.01	0.01	0.03	0.01	-4.69	0.46	0.02	0.02	0.01
	(1.63)***	(0.08)***	(0.005)***	(0.005)***	(0.01)***	(0.01)*	(1.35)***	(0.08)***	(0.003)***	(0.01)***	(0.01)*
conflict	-30.36	-2.71	0.03	0.03	0.003	-0.07	-20.27	-2.56	0.01	-0.003	-0.05
	(16.49)*	(0.65)***	(0.04)	(0.04)	(0.06)	(0.07)	(15.12)	(0.66)***	(0.03)	(0.05)	(0.07)
conflict onset	-13.51	1.60	-0.09	-0.09	-0.04	0.09	-22.42	1.16	-0.02	-0.01	0.10
	(22.17)	(0.77)**	(0.05)*	(0.05)*	(0.07)	(0.09)	(19.47)	(0.87)	(0.04)	(0.07)	(0.10)
economic growth	27.42	2.89	0.51	0.52	0.86	1.04	-41.06	-6.74	0.35	1.31	1.39
	(85.46)	(3.70)	(0.23)**	(0.23)**	(0.38)**	(0.32)***	(86.19)	(4.30)	(0.21)*	(0.42)***	(0.37)***
log(educational spending)	32.51	-0.44					33.77	-0.25			
	(15.90)**	(0.63)					(14.15)**	(0.60)			
food consumption		0.005	0.0001	0.0001	0.0001	0.0005		0.01	0.00002	0.0002	0.0004
		(0.003)**	(0.0002)	(0.0002)	(0.0002)	(0.0003)		(0.002)**	(0.0001)	(0.0002)	(0.0003)
food production	4.40	0.004	-0.001	-0.001	-0.001	-0.003	3.93	-0.02	-0.001	0.0003	-0.003
	(0.64)***	(0.02)	(0.001)	(0.001)	(0.002)	(0.003)	(0.52)***	(0.02)	(0.001)	(0.002)	(0.002)
log(health spending)	3.08	0.86					1.17	1.19			
	(11.21)	(0.47)*					(10.70)	(0.49)**			
HIV	-4.70	-0.26	0.01	0.01	0.03	0.01	-5.62	-0.29	0.01	0.03	0.003
	(1.50)***	(0.08)***	(0.005)**	(0.005)**	(0.01)***	(0.01)	(1.42)***	(0.09)***	(0.005)*	(0.01)***	(0.008)
inflation	0.01	-0.001	-0.0001	-0.0001	0.00005	0.00003	0.01	0.001	-0.00004	0.0001	0.0001
	(0.005)*	(0.0003)*	(0.00002)***	(0.00002)***	(0.00003)	(0.00003)	(0.01)**	(0.0005)	(0.00002)**	(0.00003)	(0.0004)*
log(military spending of enemies)				-0.04							
				(0.02)							
log(military spending of potential enemies)				0.02							
				(0.02)							
log(military spending of security web)			-0.03	-0.02					0.11		
			(0.13)	(0.13)					(0.10)		
m2	-0.87	0.07	0.001	0.002	0.004	-0.003	-0.47	0.07	0.001	0.003	-0.004
	(0.80)	(0.03)**	(0.002)	(0.002)	(0.004)	(0.005)	(0.67)	(0.04)*	(0.002)	(0.003)	(0.005)
polity4	-3.42	0.02	0.001	0.002	0.02	0.01	-2.81	0.04	0.004	0.02	0.006
	(1.21)***	(0.05)	(0.003)	(0.003)	(0.01)***	(0.01)	(1.15)**	(0.05)	(0.003)	(0.01)***	(0.008)
log(population)	-95.73	19.42	0.31	0.28	-0.18	0.36	-100.45	19.08	-0.13	-0.06	0.06
	(98.79)	(5.34)***	(0.50)	(0.51)	(0.47)	(0.50)	(86.50)	(5.58)***	(0.42)	(0.43)	(0.54)
urbanisation	16.25	0.59	0.02	0.02	0.04	0.07	16.18	0.57	0.01	0.04	0.06
	(3.41)***	(0.13)***	(0.01)**	(0.01)**	(0.01)***	(0.01)***	(2.99)***	(0.13)***	(0.01)*	(0.01)***	(0.02)***
number of observations	421	421	454	454	434	434	447	447	481	460	463
Kleibergen-Paap Wald rk F of instrument in 1st stage	14.10	14.78	13.74	11.88	14.57	15.47	11.50	11.64	10.48	10.66	11.88

standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% respectively, all estimates include time dummies, country-specific fixed effects and robust standard errors

Table 3: Regression Results - Excluding Food Production and Food Consumption

	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII
dependent variable	food-consumption	life expectancy	log(military spending)	log(military spending)	log(educational spending)	log(health spending)	food-consumption	life expectancy	log(military spending)	log(educational spending)	log(health spending)
log(humanitarian aid)	49.85	6.34	0.26	0.26	-0.48	-0.03					
	(47.22)	(1.94)***	(0.15)*	(0.16)*	(0.25)*	(0.27)					
log(humanitarian aid)$_{t-1}$							63.84	7.13	0.01	-0.33	-0.46
							(50.12)	(2.39)***	(0.14)	(0.23)	(0.29)
age	-2.01	0.46	0.01	0.01	0.03	0.01	-1.33	0.44	0.02	0.02	0.01
	(1.45)	(0.08)***	(0.004)***	(0.004)***	(0.01)***	(0.01)	(1.36)	(0.08)***	(0.003)***	(0.01)***	(0.01)
conflict	-35.59	-2.88	0.03	0.03	0.001	-0.08	-34.30	-2.67	0.01	-0.01	-0.06
	(17.05)**	(0.66)***	(0.04)	(0.04)	(0.06)	(0.07)	(17.26)**	(0.68)***	(0.03)	(0.05)	(0.07)
conflict onset	-4.55	1.59	-0.09	-0.09	-0.04	0.08	-8.11	1.03	-0.03	-0.02	0.08
	(21.10)	(0.79)**	(0.05)*	(0.05)*	(0.07)	(0.09)	(21.17)	(0.88)	(0.04)	(0.06)	(0.10)
economic growth	24.14	3.00	0.51	0.52	0.88	1.09	-54.01	-6.98	0.34	1.32	1.39
	(84.08)	(3.74)	(0.23)**	(0.23)**	(0.37)**	(0.31)***	(99.26)	(4.43)	(0.20)*	(0.41)***	(0.37)***
log(educational spending)	44.18	-0.23					48.29	-0.05			
	(17.67)**	(0.64)					(16.78)***	(0.61)			
log(health spending)	-6.13	0.82					-7.05	1.20			
	(13.41)	(0.47)*					(13.46)	(0.49)**			
HIV	-7.91	-0.30	0.01	0.01	0.02	0.01	-7.60	-0.32	0.01	0.03	0.002
	(1.60)***	(0.08)***	(0.005)**	(0.005)**	(0.01)***	(0.01)	(1.69)***	(0.09)***	(0.004)*	(0.01)***	(0.008)
inflation	0.001	-0.001	-0.0001	-0.0001	0.00005	0.00004	-0.001	0.001	-0.00004	0.00005	0.0001
	(0.01)	(0.0003)*	(0.00002)***	(0.00002)**	(0.00003)	(0.00003)	(0.01)	(0.0005)	(0.00002)**	(0.00003)	(0.00004)**
log(military spending of enemies)				-0.04							
				(0.02)*							
log(military spending of potential enemies)				0.02							
				(0.02)							
log(military spending of security web)			-0.04	-0.02					0.11		
			(0.13)	(0.13)					(0.09)		
m2	-1.56	0.06	0.001	0.002	0.004	-0.003	-1.21	0.07	0.001	0.002	-0.004
	(0.63)**	(0.03)**	(0.002)	(0.002)	(0.003)	(0.005)	(0.64)*	(0.04)*	(0.001)	(0.003)	(0.005)
polity4	-2.02	0.01	0.001	0.002	0.02	0.01	-1.64	0.02	0.003	0.02	0.005
	(1.35)	(0.05)	(0.003)	(0.003)	(0.01)***	(0.01)	(1.36)	(0.05)	(0.003)	(0.005)***	(0.008)
log(population)	-43.98	19.27	0.31	0.28	-0.20	0.29	-22.78	18.49	-0.15	-0.06	0.01
	(101.52)	(5.44)***	(0.50)	(0.51)	(0.48)	(0.50)	(97.35)	(5.63)***	(0.43)	(0.43)	(0.53)
urbanisation	22.61	0.70	0.02	0.02	0.04	0.08	22.83	0.66	0.01	0.05	0.07
	(4.48)***	(0.14)***	(0.01)**	(0.01)**	(0.01)***	(0.02)***	(4.01)***	(0.13)***	(0.01)	(0.01)***	(0.02)***
number of observations	421	421	454	454	434	434	447	447	481	460	463
Kleibergen-Paap Wald rk F of instrument in 1st stage	13.67	13.67	13.23	11.31	13.59	14.50	11.52	11.52	9.48	10.69	11.74

standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% respectively, all estimates include time dummies, country-specific fixed effects and robust standard errors

2.2.3 Testing the Sensitivity of the Exclusion Restriction (Kraay Test)

The Kraay test examines the sensitivity of the results to a weakening of the exclusion restriction (Kraay (2012)). It proposes a prior distribution about the uncertainty of the correlation between the reduced-form error and the instrument:

$$g(\phi) \propto (1 - \phi^2)^{\eta}, \tag{2.3}$$

where $g(\phi)$ is defined over the interval (-1,1), η represents the prior uncertainty about the exclusion restriction, and ϕ is the coefficient of the instrument in the first stage regression. When $\eta = 0$, the function is uniformly distributed over its support. The larger η, the more $g(\phi)$ gets concentrated around zero and the larger the confidence about the validity of the exclusion restriction. With $\eta \to \infty$, $g(\phi) = 0$ and we are back with the standard exclusion restriction.

Whenever one estimates coefficients or confidence intervals, some structure has to be put on the data.[11] Using an instrumental variables approach, one such assumption is that the correlation of the reduced-form error and the instrument is zero. This is actually too strong an assumption needed to make inference. If we replace it by a well-defined function that is centred around a correlation of zero, we can still make inference with less structure imposed on the data.[12] Intuitively, the Kraay test replaces the exclusion restriction by a weaker assumption and checks how sensitive the overall results are to different degrees of weakening of the exclusion restriction, i.e. to different specific forms of the function used in the Kraay test.

The function the Kraay test imposes has a couple of noteworthy features. It is symmetrically around zero, i.e. we assume the exclusion restriction is on average true. Larger deviations from the mean of the function are less likely than smaller deviations. Furthermore, the parameter of confidence (η) has no natural interpretation.[13] The author applies his methodology to three papers and compares the sensitivity of their results to a change in η. That η cannot directly be interpreted is caused by the fact that the sensitivity of the 2SLS/IV results do not only depend on η but also on the strength of the instrument. A strong instrument is less sensitive to larger degrees of prior uncertainty than weaker instruments. This can easily be seen in the special case with only one endogenous variable and one instrument. In this case the relationship of the estimated parameter of interest ($\hat{\beta}$) and the true parameter of interest (β) is

$$\hat{\beta} \xrightarrow{p} \beta + \phi/\Gamma, \tag{2.4}$$

where ϕ is the coefficient of the instrument in the second-stage regression (which is normally assumed to be zero) and Γ is the matrix of first-stage coefficients. The sensitivity of the results do rest on both ϕ

[11] The exclusion restriction is necessary to identify parameters of interest, otherwise we would be left with too few equations to solve for the parameters.

[12] Even weaker assumptions are possible. For example, not all tests in Conley et al. (2012) assume a well-defined function.

[13] Except of the cases in which the results are not sensitive to a change in η, which would be rather extreme cases of instruments that are extremely valid or extremely invalid.

and Γ. The stronger the instruments (i.e. the larger Γ), the smaller the influence of ϕ on the estimated parameter of interest.

Based on the prior distribution Kraay calculates the posterior distribution and uses this to numerically analyze the effects of different levels of η on the estimated parameter of interest. As expected, the variance of the parameters of interest have to be adjusted upward (only in the extreme case of $\eta \to \infty$ are newly calculated variances equal to the standard estimates). Losing out on precision of the results in the IV estimation, we gain by having assumed a weaker form of the exclusion restriction. One problem of the Kraay test is that it assumes that the probability of the deviation from the textbook case has a specific functional form (up to one parameter). If the researcher has some prior knowledge of the possible deviation (e.g. the mean probability of the deviation is not zero or positive deviations are more likely than negative ones), this cannot be used in the testing. Nevertheless, the Kraay test enables us to test the sensitivity of the results to a weakening of the exclusion restriction that has the functional form as defined in equation 2.4.

After applying the Kraay test to the different equations, we find that (although we think that the exclusion restriction holds) the results would still hold even if we were very uncertain about the validity of this restriction. Concerning the regressions of food consumption and military expenditures, we only have to assume an η of 10; for the regressions of educational and health expenditure we only have to assume an η of 100, and the regression of life expectancy is still significant at an η of only 5. These results can be compared to the empirical applications in Kraay (2012) in which two of the three examples need at least an η of 200 to give significant results. Nevertheless, the test indicates that our results are robust to an even very strong weakening of the exclusion restriction. The results from the Kraay Test should be interpreted with care. The parameter of interest has no direct interpretation and can only compared to the threshold values of other applications. The results could also be different if the test used a different functional form.

2.3 Conclusion

This chapter investigates the effects of humanitarian aid on life expectancy, food consumption, and public expenditure on education, health, and the military. We find that humanitarian aid has a strong and significant effect on both food consumption and life expectancy, with the latter likely to be positively influenced by the former. Increasing humanitarian aid by 1% increases food consumption by over 100 kilocalories and life expectancy by over 6 years. These numbers are likely to be lower bounds of the effect as they are averages over whole countries that include people who did not suffer from a humanitarian crisis and were also not targeted by the aid inflow. Humanitarian aid on average achieves one of its goals of feeding people in immediate need. We also find that humanitarian aid increased public military spending, but has a negative effect on educational spending (a 1% increase in humanitarian

aid reduces public spending on education by 0.5%) and (with a lag of one year) on public spending on health (a 1% increase in humanitarian aid reduces public spending on health by 0.47%). The exact channels through which humanitarian aid influences public spending patterns are not clear and are left for future research. What already emerges from this chapter is that humanitarian aid achieves its goal of helping people in need but that negative effects on public spending patterns need to be monitored when humanitarian aid is disbursed. That humanitarian aid increases military spending whereas public spending on education and health are reduced should not be in the interest of the donors. The problem is that these effects can even arise if the aid inflow is fully managed off-budget by non-governmental organisations. Having someone else pay for public services reduces the incentive for governments to finance them and gives them more freedom in allocating public funds in their own interest.

The main challenge in coming to these conclusions is to overcome the problem of endogeneity in the data. To estimate the causal effect from humanitarian aid to the different variables of interest, we apply an instrumental variable strategy. We use the Palmer Drought Severity Index to construct a weather index to be used as the instrument, which we argue to be a valid and strong one. There is no effect of the variables of interest on weather patterns. The instrument also has a strong effect on the endogenous variable of interest, which is shown using the Kleibergen-Paap Wald rk F Statistic and the fact that irrigation is uncommon in Sub-Saharan Africa. That the exclusion restriction holds is supported by the fact that a large number of control variables have been included in the regressions, but we have also shown that the results are very insensitive to even a strong weakening of the exclusion restriction.

Appendix

Appendix 2.A: List of Countries

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Republic of Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Appendix 2.B: Data Description

Age

The age dependency ratio (young) is the ratio of dependents, people younger than 15, to the working-age population (those ages 15-64). Data are shown as the proportion of dependents per 100 working-age population. Data on the age dependency ratio are provided for virtually all country-years. The mean is 83.84, but there is large variation in the dataset. The higher the age dependency ratio, the more young people have to be fed, educated, and taken care of.

Conflict/ Conflict onset

Conflict and Conflict onset data are from the Armed Conflict Dataset of the University of Uppsala, Department of Peace and Conflict Research (UCDP) and the Peace Research Institute Oslo (PRIO) and are publicly available at: www.pcr.uu.se/research/ucdp/datasets. Incidence of conflict is a binary variable, set to one if a country experienced a conflict in a given year. A conflict is "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths" (Gleditsch, Wallensteen, Eriksson, Sollenberg & Strand (2002)). The binary variable Conflict onset is set to one at the beginning of a conflict and to zero in all subsequent periods that are marked by a conflict incidence. The dataset is complete: it covers all countries and years of our dataset.

Economic Growth

The data on economic growth are from the World Development Indicators. GDP is measured as per capita GDP in constant 2000 USD; the series on economic growth is calculated from this GDP dataset and measures per capita economic growth in constant USD.

Educational Spending

We use an unpublished (but regularly used, e.g. Van de Sijpe (2010)) dataset from the IMF on aggregate public spending on education. The advantage of this dataset, compared to, for example, data from the World Development Indicators, is greater coverage.[14] Educational spending is measured in percentage of GDP. The dataset starts in 1985. From 1991 on, around 25% of the data points are missing. We used the original datasets to calculate the log of total spending in constant USD.

Food Consumption

The data on food consumption are from the African Development Bank database and measures total calorie intake per person per day. Data are available for all countries in our dataset (except Equatorial Guinea and Somalia, for which no data are available, and pre-independence Eritrea) for all years between 1980 and 2007. Mean food consumption is 2163 kilocalories per person per day, which is very close to the minimum level for subsistence. The minimum value in the sample is extremely low (1465), but this value is the average over a country in a certain year. Some of the people might have experienced even lower calorie intakes for some time of the year.

Food Production

The food production index is from the African Development Database and covers all countries for 1980-2009. The average over the years 1999, 2000 and 2001 is set to 100. The only missing data are pre-1993 data for both Ethiopia and Eritrea. Food production in Sub-Saharan Africa is a risky business. Missing irrigation, climate change, small farms, etc. means food production varies a lot. The minimum of 37 is an average across a country in a given year, individual farmers could have experienced even lower levels of production (production levels in different regions of a country are not fully correlated).

Health spending

We received the data on health spending (in percentage of GDP) together with the data on educational spending from the IMF (see above). Their advantage over data from the World Development Indicators is their larger coverage. The dataset starts in 1985, around a third of the data points are missing, but coverage increases in later years. We used this dataset to calculate the log of total public spending on health in constant USD. Spending on health is lower than spending on education and even lower than military spending.

HIV

Prevalence rates of HIV are measured in percentage of the population ages 15-49. Data are from the

[14] I want to thank Gerd Schwartz and Benedict Clemens from the IMF for sharing the data on educational and health spending with us.

World Development Indicators. Some island nations and Ethiopia have not reported any data; data for all other countries is available for all years between 1990 and 2009. On average, around 5.26% of the people (ages 15-49) were infected with HIV, but this number is an average including the early years of the epidemic. In some countries (e.g. Botswana, Swaziland) more than a quarter of population ages 15-49 is currently infected with HIV.

Humanitarian Aid

The humanitarian aid dataset is based on the aid commitment data of the OECD. Although this dataset underreports aid disbursements by about a third, it reports aid commitments by purpose, whereas the aid disbursement data are only available as an aggregate. Furthermore, this underreporting does not seem to be systematic (Mishra & Newhouse (2007)). The purpose codes of the OECD were assigned an aid objective code, i.e. they are classified (by Clemens et al. (2012)) as aid for humanitarian purposes, aid that has a potential short-term impact on economic growth, and aid that has potential long-term impact on economic growth. The following purposes codes are marked as "humanitarian aid": 52010 (Food aid/Food security programmes) and all subgroups of purpose codes 700, 710 and 720 (Emergency Assistance). Purpose code 52010 represents 3.3% of total aid commitments (1997-2001), purpose codes 710, 720 and 730 represent 5.3%. "Humanitarian aid" does not include expenditures for health (although people in distress might need health assistance), education, food production, or any other form of expenditure we concentrate on in this chapter. The OECD dataset starts in 1973 and encompasses all major donor countries. Our data on humanitarian aid are measured in millions of constant USD.

Inflation

The inflation variable is from the World Development Indicators of the World Bank and is measured by the consumer price index.

Life Expectancy

Data for life expectancy at birth are from the World Development Indicators of the World Bank. This dataset provides estimates for all countries and years.

Military Spending

Military spending is measured in million constant (2009) USD. The dataset is from the Stockholm International Peace Research Institute (SIPRI). SIPRI provides this data starting in 1988 and can be downloaded from www.sipri.org/databases/milex. A detailed definition of military expenditures is given on www.sipri.org/databases/milex/definitions. The classification into a country's enemies, potential enemies, and security web is from Dunne & Perlo-Freeman (2003). A country's security web consists at least of all its neighbours as well as regional powers that could influence a country despite not sharing

a common border. Global superpowers are excluded because defending against them is impossible. To qualify as enemies in a given year, two countries must be either involved in an ongoing conflict or must have gone to war in the past with the grievance still unresolved. To qualify as potential enemies, countries must be involved in a dispute with either a history of, or clear potential for, militarised confrontation (Dunne & Perlo-Freeman (2003)).

M2

The data on M2 is from the World Development Indicators of the World Bank and is measured in broad money in percentage of GDP. Money and quasi money comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. It corresponds to lines 34 and 35 in the International Monetary Fund's International Financial Statistics.

Polity IV

The Polity IV database is a project by the Center for Systemic Peace to rate the political system of a country (www.systemicpeace.org). Polity IV is an index, going from -10 (hereditary monarchy) to +10 (consolidated democracy). The Center for Systemic Peace interprets countries as autocracies if they have values from -10 to -6, as anocracies if they score -5 to +5, and democracies if they have a Polity IV index of +6 or more. The Polity scheme consists of six component measures that record key qualities of executive recruitment, constraints on executive authority, and political competition (www.systemicpeace.org/polity/polity4.htm). The Center for Systemic Peace provides data from 1800 onwards.

Population

The data on total population of a country in a given year are from the World Development Indicators. Population estimates are provided for all countries and all years.

Urbanisation

The data on urbanisation are from the World Development Indicators and measure the fraction of urban population in a country. Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects. Data on urbanisation are available for virtually all country-years.

Weather Index

The weather index is based on the Palmer Drought Severity Index (Palmer (1965)). The PDSI is an

index of relative dryness and is only based on readily available data such as precipitation, temperature and soil characteristics (see Palmer (1965) for a detailed description of the model). Its simplicity and wide reach (the series starts in 1870 and is available for the entire landmass of our planet, except Antarctica and Greenland, at a monthly basis for a 2.5 degree grid) have contributed to its prominence in meteorology. Dai et al. (2004) do not only provide recent PDSI data but also show that the calculated index data are highly correlated with actual dryness data. The largest deviations are related to snowfall and snow melt, phenomena that are rarely seen in the countries of our dataset.

Based on the underlying data (precipitation, etc.), Palmer's model calculates an index value of relative dryness/wetness. To make data intertemporally comparable as well as comparable across geographically different points (the Sahel, desert, rain forests, etc.), the index is calculated such that the long-run mean of every (geographical) point is zero. To restate, every point we want to have PDSI values for has a distribution of data on precipitation, temperature, etc., which is first used to calculate a distribution of an index and second is normalised to have mean zero.

We use the PDSI to calculate a weather index. The weather index is calculated by taking the average of all absolute values of the PDSI for a given country in a given year. This way relative dryness and wetness do not cancel each other out, and we do not discriminate between dry and wet spells of weather shocks. Higher values of the weather index correspond to a more distressed situation in a country. We average over the entire country because of possible (explicit or implicit) risk sharing agreements in a country. If one part of a country is experiencing a drought, the government could redistribute food to this region, which would not count as humanitarian aid. Only if larger parts of the country face weather shocks or if the shock in one (smaller) part is very severe (both of which would result in large values of the weather index) do we expect significant amounts of humanitarian aid to flow into the country.

The idea behind using this index as an instrument is that countries that get hit by a weather shock are more likely to experience a shock to food production because irrigation is not common in our sample of countries. A similar reasoning is used by, for example, Miguel et al. (2004), Miguel & Satyanath (2010), and Brückner (forthcoming) who all use rainfall shocks as instruments.

Appendix 2.D: Regression Results - Dry spells only

Table 2: Regression Results

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
dependent variable	food-consumption	life expectancy	log(military spending)	log(military spending)	log(educational spending)	log(health spending)	food-consumption	life expectancy	log(military spending)	log(educational spending)	log(health spending)
log(humanitarian aid)	113.49	6.82	0.24	0.28	-0.62	-0.03					
	(55.17)**	(2.40)***	(0.18)	(0.20)	(0.32)*	(0.33)					
log(humanitarian aid)$_{t-1}$							28.83	8.47	-0.02	-0.40	-0.38
							(49.30)	(3.31)***	(0.17)	(0.29)	(0.33)
age	-6.04	0.46	0.01	0.01	0.03	0.01	-4.60	0.46	0.02	0.02	0.01
	(1.68)***	(0.08)***	(0.005)***	(0.005)**	(0.01)***	(0.01)	(1.30)***	(0.09)***	(0.004)***	(0.01)***	(0.01)*
conflict	-31.49	-2.78	0.03	0.03	0.01	-0.08	-19.51	-2.61	0.01	-0.001	-0.06
	(17.04)*	(0.69)***	(0.04)	(0.04)	(0.06)	(0.07)	(14.82)	(0.74)***	(0.03)	(0.06)	(0.07)
conflict onset	-12.95	1.63	-0.09	-0.09	-0.04	0.10	-21.77	1.12	-0.02	-0.01	0.10
	(22.78)	(0.82)**	(0.05)*	(0.05)*	(0.08)	(0.09)	(19.22)	(1.00)	(0.04)	(0.07)	(0.10)
economic growth	28.79	2.97	0.51	0.53	0.84	1.06	-18.37	-8.57	0.37	1.38	1.33
	(86.65)	(3.91)	(0.24)**	(0.24)**	(0.41)**	(0.32)***	(90.45)	(5.06)*	(0.21)*	(0.45)***	(0.38)***
log(educational spending)	33.03	-0.42					32.43	-0.15			
	(16.36)**	(0.68)					(13.87)**	(0.68)			
food consumption		0.005	0.0001	0.0001	0.0001	0.0005		0.01	0.0001	0.0002	0.0004
		(0.003)*	(0.0002)	(0.0001)	(0.0002)	(0.0003)		(0.003)**	(0.0001)	(0.0002)	(0.0003)
food production	4.45	0.007	-0.001	-0.00005	-0.002	-0.003	3.92	-0.02	-0.001	0.0003	-0.003
	(0.66)***	(0.02)	(0.001)	(0.001)	(0.002)	(0.003)	(0.51)***	(0.02)	(0.001)	(0.002)	(0.002)*
log(health spending)	3.41	0.87					-0.11	1.29			
	(11.46)	(0.49)*					(10.88)	(0.55)**			
HIV	-4.51	-0.25	0.01	0.01	0.03	0.01	-5.84	-0.27	0.01	0.03	0.004
	(1.60)***	(0.09)***	(0.005)**	(0.01)**	(0.01)**	(0.01)	(1.43)***	(0.10)***	(0.005)	(0.01)***	(0.01)
inflation	0.01	-0.001	-0.0001	-0.0001	0.00005	0.00003	0.01	0.001	-0.00004	0.0001	0.0001
	(0.005)	(0.0003)*	(0.00002)**	(0.00002)**	(0.00004)	(0.00003)	(0.01)**	(0.001)	(0.00002)**	(0.00004)	(0.00004)*
log(military spending of enemies)				-0.04							
				(0.03)							
log(military spending of potential enemies)				0.02							
				(0.02)							
log(military spending of security web)			-0.03	-0.03					0.13		
			(0.14)	(0.15)					(0.11)		
m2	-0.89	0.07	0.001	0.002	0.004	-0.003	-0.47	0.07	0.001	0.003	-0.004
	(0.82)	(0.03)**	(0.002)	(0.002)	(0.004)	(0.005)	(0.67)	(0.04)*	(0.002)	(0.003)	(0.005)
polity4	-3.50	0.02	0.001	0.002	0.02	0.01	-2.75	0.03	0.004	0.02	0.01
	(1.25)***	(0.06)	(0.003)	(0.003)	(0.01)***	(0.01)	(1.13)**	(0.06)	(0.003)	(0.01)***	(0.01)
log(population)	-87.30	19.89	0.30	0.31	-0.27	0.40	-118.21	20.57	-0.18	-0.12	0.14
	(103.42)	(5.66)***	(0.53)	(0.55)	(0.52)	(0.51)	(87.22)	(6.51)***	(0.47)	(0.46)	(0.54)
urbanisation	16.43	0.60	0.02	0.02	0.04	0.07	15.70	0.60	0.01	0.04	0.06
	(3.55)***	(0.14)***	(0.01)**	(0.01)**	(0.02)**	(0.01)***	(2.96)***	(0.16)***	(0.01)*	(0.02)***	(0.02)***
number of observations	421	421	454	454	434	434	447	447	481	460	463
Kleibergen-Paap Wald rk of instrument in 1st stage	10.11	10.57	9.50	7.69	10.46	11.15	7.65	7.72	5.94	7.74	8.05

standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% respectively, all estimates include time dummies, country-specific fixed effects and robust standard errors

Appendix 2.C: Within-Country Correlation Matrices

Table C 1: Food Consumption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	1.00													
(2)	-0.33	1.00												
(3)	-0.26	0.27	1.00											
(4)	-0.10	0.00	0.55	1.00										
(5)	0.07	0.04	-0.12	-0.05	1.00									
(6)	0.29	-0.32	-0.16	-0.07	0.11	1.00								
(7)	0.08	0.01	-0.02	-0.03	0.15	0.18	1.00							
(8)	0.26	-0.25	-0.17	-0.06	0.12	0.91	0.12	1.00						
(9)	0.00	-0.14	-0.20	-0.12	0.05	0.59	0.01	0.59	1.00					
(10)	-0.12	0.12	0.12	-0.01	0.04	0.00	-0.04	0.02	-0.01	1.00				
(11)	-0.10	0.07	0.00	0.03	-0.11	0.16	-0.13	0.23	-0.02	-0.04	1.00			
(12)	0.21	0.04	-0.17	-0.02	0.09	0.10	0.06	0.14	0.08	-0.04	-0.03	1.00		
(13)	0.21	0.03	0.07	0.01	0.09	-0.16	-0.05	-0.05	-0.03	0.04	-0.14	0.11	1.00	
(14)	0.32	-0.29	-0.13	-0.02	0.00	0.40	0.05	0.40	0.02	0.06	-0.03	0.16	0.02	1.00

(1) food consumption; (2) log(humanitarian aid); (3) conflict; (4) conflict onset; (5) growth; (6) log(educational spending); (7) food production, (8) log(health spending); (9) HIV; (10) inflation; (11) M2; (12) Polity4; (13) log(population); (14) urbanisation

Table C 2: Life Expectancy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	1.00													
(2)	-0.21	1.00												
(3)	-0.29	0.27	1.00											
(4)	-0.07	0.00	0.55	1.00										
(5)	-0.04	0.02	-0.13	-0.05	1.00									
(6)	0.37	-0.33	-0.17	-0.07	0.13	1.00								
(7)	-0.01	0.02	-0.01	-0.03	0.13	0.18	1.00							
(8)	0.32	-0.26	-0.17	-0.06	0.13	0.91	0.11	1.00						
(9)	-0.08	-0.14	-0.20	-0.12	0.04	0.58	0.01	0.58	1.00					
(10)	-0.11	0.12	0.13	-0.02	0.04	0.00	-0.04	0.02	-0.01	1.00				
(11)	0.29	0.08	0.01	0.03	-0.12	0.15	-0.12	0.22	-0.02	-0.04	1.00			
(12)	0.05	0.05	-0.17	-0.02	0.07	0.09	0.07	0.13	0.08	-0.02	-0.03	1.00		
(13)	-0.15	0.01	0.07	0.01	0.11	-0.14	-0.07	-0.03	-0.04	0.04	-0.16	0.09	1.00	
(14)	0.25	-0.29	-0.13	-0.02	0.01	0.40	0.05	0.40	0.02	0.06	-0.03	0.15	0.02	1.00

(1) life expectancy ; (2) log(humanitarian aid); (3) conflict; (4) conflict onset; (5) growth; (6) log(educational spending); (7) food production, (8) log(health spending); (9) HIV; (10) inflation; (11) M2; (12) Polity4; (13) log(population); (14) urbanisation

Table C 3: log(Military Spending)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	1.00														
(2)	0.20	1.00													
(3)	-0.19	0.21	1.00												
(4)	0.13	0.32	0.28	1.00											
(5)	0.02	0.00	0.11	0.42	1.00										
(6)	0.14	0.07	0.00	-0.09	0.00	1.00									
(7)	0.12	-0.29	-0.45	-0.30	-0.11	0.06	1.00								
(8)	0.16	-0.01	-0.03	0.01	0.01	0.16	0.08	1.00							
(9)	0.15	-0.18	-0.27	-0.23	-0.13	0.03	-0.00	-0.02	1.00						
(10)	0.08	0.11	0.06	0.11	-0.01	0.03	-0.11	-0.04	-0.01	1.00					
(11)	0.28	0.12	-0.10	0.09	-0.04	0.12	0.05	0.12	0.32	0.05	1.00				
(12)	0.22	-0.02	-0.28	-0.08	0.03	-0.09	-0.01	-0.09	0.03	-0.04	0.00	1.00			
(13)	0.05	-0.01	-0.34	-0.26	-0.02	0.09	0.20	0.07	0.14	-0.03	-0.14	-0.11	1.00		
(14)	0.23	0.10	0.02	0.17	-0.02	0.08	0.19	-0.05	-0.08	0.04	-0.03	-0.14	0.03	1.00	
(15)	0.22	-0.27	-0.68	-0.17	-0.02	-0.01	0.39	0.03	-0.02	0.04	0.08	0.02	0.16	-0.03	1.00

(1) log(military spending); (2) log(humanitarian aid); (3) age dependency ratio; (4) conflict; (5) conflict onset;
(6) economic growth; (7) food consumption; (8) food production, (9) HIV; (10) inflation;
(11) log(military spending security web); (12) M2; (13) Polity 4; (14) log(population); (15) urbanisation

Table C 4: log(Educational Spending)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	1.00													
(2)	-0.32	1.00												
(3)	-0.47	0.25	1.00											
(4)	-0.15	0.25	0.26	1.00										
(5)	-0.07	0.00	0.10	0.54	1.00									
(6)	0.10	0.04	0.02	-0.13	-0.05	1.00								
(7)	0.28	-0.32	-0.38	-0.26	-0.10	0.08	1.00							
(8)	0.18	0.01	-0.04	-0.02	-0.03	0.15	0.08	1.00						
(9)	0.58	-0.14	-0.30	-0.20	-0.12	0.05	0.00	0.01	1.00					
(10)	-0.00	0.12	0.06	0.13	-0.02	0.04	-0.12	-0.04	-0.01	1.00				
(11)	0.14	0.07	-0.27	0.00	0.03	-0.11	-0.11	-0.13	-0.02	-0.04	1.00			
(12)	0.09	0.04	-0.28	-0.16	-0.02	0.08	0.20	0.05	0.08	-0.04	-0.02	1.00		
(13)	-0.19	0.03	0.07	0.06	0.02	0.09	0.21	-0.04	-0.02	0.04	-0.12	0.12	1.00	
(14)	0.42	-0.28	-0.61	-0.11	-0.03	-0.01	0.31	0.05	0.01	0.05	-0.05	0.13	-0.05	1.00

(1) log(educational spending); (2) log(humanitarian aid); (3) age dependency ratio; (4) conflict; (5) conflict onset;
(6) economic growth; (7) food consumption; (8) food production, (9) HIV; (10) inflation; (11) M2;
(12) Polity 4; (13) log(population); (14) urbanisation

Table C 5: log(Health Spending)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1)	1.00													
(2)	-0.28	1.00												
(3)	-0.46	0.26	1.00											
(4)	-0.19	0.26	0.26	1.00										
(5)	-0.06	0.00	0.10	0.52	1.00									
(6)	0.10	0.04	0.03	-0.12	-0.02	1.00								
(7)	0.31	-0.34	-0.40	-0.28	-0.10	0.06	1.00							
(8)	0.10	0.01	-0.04	-0.01	-0.03	0.13	0.07	1.00						
(9)	0.56	-0.14	-0.30	-0.21	-0.12	0.05	0.01	0.01	1.00					
(10)	0.02	0.12	0.06	0.12	-0.02	0.04	-0.12	-0.04	-0.01	1.00				
(11)	0.21	0.07	-0.27	-0.02	0.02	-0.10	-0.10	-0.13	-0.02	-0.04	1.00			
(12)	0.11	0.06	-0.28	-0.16	-0.02	0.09	0.20	0.06	0.08	-0.04	-0.02	1.00		
(13)	-0.02	0.02	0.06	0.10	0.01	0.09	0.21	-0.05	-0.04	0.04	-0.16	0.09	1.00	
(14)	0.45	-0.30	-0.62	-0.12	-0.02	-0.01	0.36	0.04	0.01	0.05	-0.05	0.11	-0.05	1.00

(1) log(health spending); (2) log(humanitarian aid); (3) age dependency ratio; (4) conflict; (5) conflict onset;
(6) economic growth; (7) food consumption; (8) food production, (9) HIV; (10) inflation; (11) M2;
(12) Polity 4; (13) log(population); (14) urbanisation

CHAPTER 3

Revolution of Rising Expectations

3.1 Introduction

Commodity prices have been rising substantially in the last years, and even though the financial crisis has lowered them temporarily, the "age of cheap oil is over," as the International Energy Agency's chief economist Fathi Birol said in the beginning of 2011. This price increase has dramatic impacts not only on resource consuming countries but even more so on net producers of oil and other commodities. Whereas most of the existing literature on the resource curse focuses on the effects of different levels of natural resources on different outcomes (such as conflicts or economic growth), this study investigates the effect of relative changes in the value of export commodities (i.e. natural resources that are exported) on political stability in Sub-Saharan African countries. Even countries that export only small amounts of commodities might experience negative effects on political stability from these resources if the value of these export goods increases substantially. A recent example is Vicente (2010) who estimates the impact of the discovery of oil on corruption and political stability in Sao Tome en Principe. In the late 1990s the country discovered offshore oil fields, and in the following years suffered from rising corruption and political instability.

This study tests the hypothesis that relative changes in the value of the resource endowments of a country influence its political stability. It first uses a theoretical model to show how a relative change in the value of a country's export commodities can influence political stability and how this effect depends on the political system. Subsequently, the model is tested empirically, and the results from the theoretical model are supported by the data.

In the theoretical model the incumbent dictator faces the possibility of a revolution in every period. But he can bribe the pivotal group before it has to decide whether it wants to accept the proposal of a revolution that would overthrow the dictator and install democracy. As long as the ruler has enough resources at hand to successfully bribe the pivotal group, he can stay in power.

A constant flow of resource revenues guarantees that the dictator always has enough money at hand to pay high enough bribes and stay in power. But if the dynamics of the revenue flow change and future revenues exceed current ones, the return to revolution (based on discounted future resource revenues, i.e. the expectations people have) might exceed the maximum bribe he can pay (based on his current budget constraint), and he can no longer prevent a revolution. We call this the *dynamic resource curse*: political unrest, violence, or even civil war caused by an increase in expected resource revenues (see Section 3.3). The dynamic resource curse of the theoretical model is limited to autocratic countries. Citizens in democratic countries have different means to demand a share of the resource windfall and do not start a revolution. The dynamic resource curse does not only increase the probability of violence and decreases stability but can lead to a *revolution of rising expectations*.

Using political stability as well as UCDP/PRIO conflict onset data, the central prediction of the model is confirmed. An increase in future government resource revenues decreases political stability (and increases the probability of armed conflicts) in autocratic but not democratic, countries. There seems to be a non-linear effect of resource revenue volatility on political stability indicating that there is a diminishing effect of additional resource revenues on political stability. Once a group has the incentive to overthrow the government, extra revenues do not change this. We also find that the political structure of a country (democracy vs. autocracy) plays an important part. Autocratic countries gain much less in terms of stability if experiencing a resource boom.

The chapter is organised as follows: Section 3.2 provides an example illustrating the effects we are investigating in this chapter, Section 3.3 describes the theoretical model, Section 3.4 the empirical results, and Section 3.5 concludes.

3.2 Case Example: The Tuareg Rebellion in Niger

The Tuaregs are a traditionally nomadic people living in the Sahara and adjoining territories. They are spread throughout different countries, but most of them live in the western and northern parts of Niger. For a long time the Tuaregs have fought for more autonomy also by engaging in rebellions and wars. In Niger, a large rebellion started in 2007 when the Niger Movement for Justice (MNJ) attacked army camps and facilities connected to the uranium production.

The rebels stated that the government had not fulfilled its commitments from earlier peace agreements, including sharing a greater share of the mining profits with the local population (the production of Uranium provides the bulk of foreign exchange for Niger). The start of the rebellion occurred after

the price of uranium had increased steeply and ended after the price had decreased sharply again in 2009 (figure 3.1). Figure 3.1 also shows the development of the governance indicator, illustrating a deterioration of the measure during the rebellion period. This paper argues that the timings of the start of the Tuareg rebellion and the peace deal were influenced by the development of the price of uranium. The increase in the (expected) profits from the production of uranium made a rebellion more profitable (in expectations).

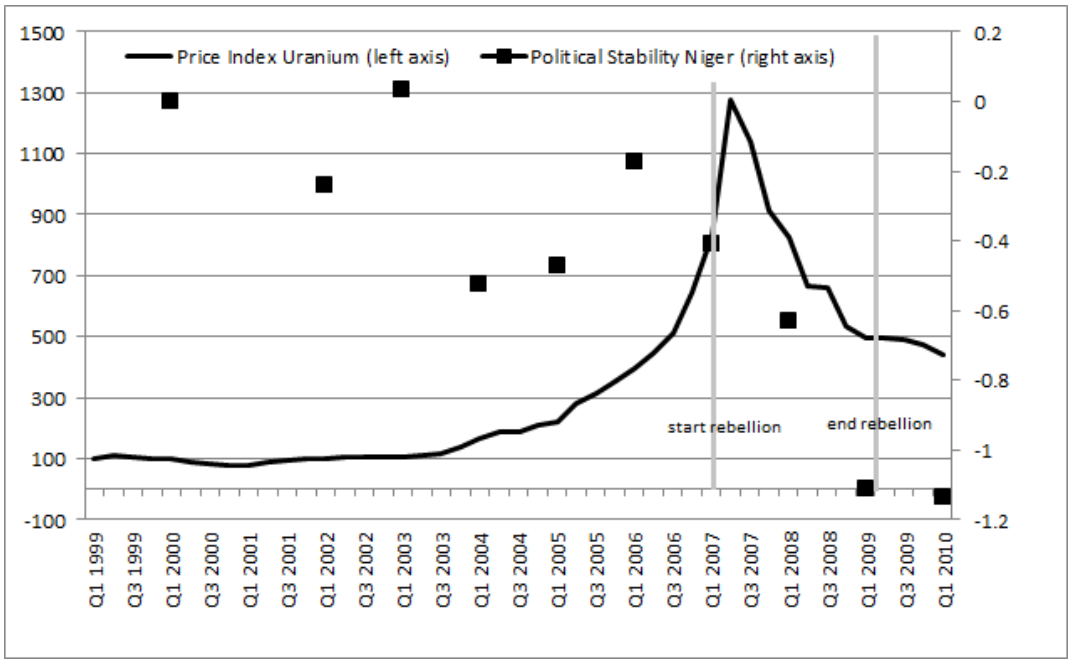

Figure 3.1: Price Index Uranium (1999=100 in USD), Political Stability[1] and the period of the Tuareg Rebellion;
Source: International Monetary Fund, World Governance Indicators, Emerson (2011)

3.3 Theoretical Model

3.3.1 The Environment

Time is discrete and indexed by t in an infinite horizon small open economy. There is only one good the price of which is normalised to one. This good can be produced by all agents in the economy, except the dictator. Additionally it comes as an exogenous cost-free stream from natural resources (X_t). We assume X_t to be exogenous for two reasons. Prices of natural resources are determined on the world market and supply is driven by technology, which is exogenous to many countries in our sample.

[1] See Section 3.4.2 for a description.

The government (which is defined below) cannot borrow against future streams of natural resources because of commitment problems, missing financial markets, or other market imperfections.[2]. There are three groups of agents in the economy. The first group consists of the dictator (or a small elite), who is in power in period $t = 0$ (i.e. he is the initial government). The dictator does not have access to the production technology. The other agents are homogeneous and of mass 1 but divided into two groups i of same size.

The government can pay different transfers to these groups but not to specific members within the groups. Agents cannot change groups by force or voluntarily, they stay in their initial group for all periods, and neither die nor reproduce.[3] We therefore focus on the groups as the actual actors that maximise the utility of a representative member. The government consists of either the dictator or the two groups (who jointly form the government under democratic rule), depending on the outcome of the game as it is described below. Only the government has access to the natural resource stream. The preferences of a representative agent of one of the producing groups i can be represented by the utility function $U^E_{i,t}$

$$U^E_{i,t} = \Sigma^{\infty}_{s=t} \beta^{s-t} u^E_{i,s}(C^E_{i,s}) = \Sigma^{\infty}_{s=t} \beta^{s-t} C^E_{i,s} \tag{3.1}$$

in which $\beta < 1$ is the discount factor, $u^E_{i,s}$ is the instantaneous utility function of group i in period s and $C^E_{i,s}$ is the consumption of group i in period s.The preferences of the dictator can be represented by the utility function U^D_t

$$U^D_t = \Sigma^{\infty}_{s=t} \beta^{s-t} u^D_s(C^D_s) = \Sigma^{\infty}_{s=t} \beta^{s-t} C^D_s \tag{3.2}$$

The utility of the dictator depends on his discounted lifetime consumption in the same way as for all other agents. Without explicitly modeling it, we furthermore assume that the dictator prefers to stay in power (without consumption) over not being in power, which also reduces his consumption to zero.

Consumption of the groups consists of the production of the unique good using the production technology (Y) plus transfers from the government (T, with $T \geq 0$).[4]

$$C^E_{i,t} = Y_{i,t} + T_{i,t} \tag{3.3}$$

The production technology cannot be used by the dictator but by all other agents in the economy and is given by

$$Y_{i,t} = \gamma_{t,n} G^{\alpha}_{t-1} \tag{3.4}$$

Output, which cannot be stored, is a function of "(good) governance" $G \geq 0$. G is a state variable and encompasses investments in public good and the institutional framework of the economy. Investments in schools, the rule of law, an efficient public administration, health care, etc. can all be interpreted

[2]This simplifcation of the model is not crucial for the results and is relaxed in subsection (3.3.4)

[3]We get the same outcome if they reproduce and fully care about their offspring in the sense that they weigh their own utility and the utility of their offspring the same way.

[4]Assuming a non-linear utility function does not qualitatively change the results, see footnote 7.

as being part of G as they all have positive effects on other agents in the society. Everything the government does not invest in governance or pays in transfers, it consumes. This consumption is by definition (and from a societal point of view) waste, as it does not have a positive effect on other agents (apart from the dictator).

G is a state variable, such investments have a time lag before they become productive. They have to be planned and executed before spreading their effects into production. Schools have to be planned and built before they can be used to educate students. Even more time is needed before these students enter the job market and spread their educational externalities. Also, implementing an institutional structure to enhance the rule of law becomes effective only with a time lag, especially since people have to be convinced that the new rules are here to stay and are not just cheap talk.

Governance investments fully depreciate after one period for simplicity's sake. Without full depreciation, the outcome and interpretation of the model would be more complex without yielding any substantial additional insight on top of the mechanisms we want to show using the very simple model introduced above. Also, although a very strong assumption, good governance can be expected to depreciate faster in the countries of our sample than in developed countries. Governments in developing countries have to prove continuously that they respect the rule of law, fight corruption, etc. Some countries have witnessed their Worldwide Governance Indicators deteriorate significantly, such as Eritrea between 1996 and 2006.[5] The World Bank defines governance as the set of traditions and institutions by which authority in a country is exercised[6]: this includes (1) the process by which governments are selected, monitored, and replaced (which very often happened in a non-democratic and violent way in our sample), (2) the capacity of the government to formulate and implement sound policies effectively (which were often impeded by disasters and conflicts), and (3) the respect of citizens and the state for the institutions that govern economic and social interactions among them (which were often low, especially due to problems with (1) and (2)).

$\alpha \in (0, 1)$ and $\gamma > 0$ are productivity parameters. All agents that have access to the production technology are self-employed and inelastically supply one unit of labour in every period. The productivity parameter γ_n represents uncertainty concerning the effects of investments in governance. The exact payoffs of investments in health care or prisons is hard to predict ex ante. For simplicity, γ_n can take two values: with probability p, $\gamma_n = \gamma_h$, with probability $(1 - p)$, $\gamma_n = \gamma_l$, with $\gamma_h > \gamma_l$. The expected value is $\bar{\gamma} = p\gamma_h + (1 - p)\gamma_l$. The values of α, p, γ_h and γ_l are common knowledge, but the realisation of

[5] Its measure for *Voice and Accountability*, for example, decreased from -1.48 in 1996 to -2.02 in 2006. After the war with Ethiopia 1998-2000/2001, Eritrea closed down all privately-owned media and is now the only African country with no privately-owned media. Since 2008 the country has been ranked last in the press freedom index by Reporters Without Borders (http://en.rsf.org/press-freedom-index-2011-2012,1043.html).

[6] Source: http://info.worldbank.org/governance/wgi/faq.htm

γ_n and the investments in G are only known to the government. In case of a dictatorship, the productive groups only observe Y but do not know how much the dictator has invested in G one period earlier.

Consumption of the dictator (C_t^D) in period t is bounded by his budget constraint

$$X_t - T_{1,t} - T_{2,t} - G_t \geq C_t^D \tag{3.5}$$

The political system in the economy is a dictatorship in period $t = 0$ but can transform to a democracy as described in the timing of events below. If it changes into a democracy, it cannot transform back to a dictatorship. In the state of democracy, the two productive groups form the government, set the consumption of the (former) dictator to zero for all subsequent periods, and maximise the utility of a representative agent. The assumption that a democracy cannot change back into a dictatorship is made to simplify the analysis, and as we see in Section 3.3.4, relaxing it does not change the results of the model and can even make it easier for the dictator to stay in power.

The model does not allow the government to tax its citizens. This simplification comes close to reality in most African countries, where only small groups of people pay taxes. But taxes (both distortionary and lump-sum) are mainly left out of the model to show that the results hold even in the absence of taxes that could help the dictator get support from one group. Introducing taxes would not qualitatively change the results.

3.3.2 Timing of Events

In each period t the economy inherits two state variables: the structure of government (either dictatorship or democracy), and the investments in the public good G_{t-1}. The initial government is in the hands of the dictator and the initial investments in the public good are given exogenously (e.g. as investments done by a colonial ruler before independence). If the economy is a dictatorship, the following timing of events applies to every period t:

1. The dictator collects the natural resource stream X_t, sets initial transfers $\Gamma_t = (T_{1,t}, T_{2,t})$ and the investments in " good governance" (G_t). G_t cannot be changed in period t, Γ_t can be changed in step 3.

2. Without loss of generality only group 1 can propose a revolution (if it does and the other group accepts the proposal, democracy is installed in the following period). If group 1 does not propose a revolution, Γ_t and G_t become effective, $\gamma_{t+1,n}$ materialises, production takes place, transfers are paid, all three groups consume and the economy remains a dictatorship in the following period.

3. If group 1 proposes a revolution, the dictator can change Γ_t to Γ_t' before group 2 has to decide whether to agree to the proposal (If group 2 is indifferent about agreeing or not, it does not agree to the

proposal and the revolution is not successful). The new vector of transfers is denoted $\Gamma_t^r = (T_{1,t}^r, T_{2,t}^r)$. Based on the new vector Γ_t^r, the second group decides about the proposal. If the second group agrees on the revolution, the dictator sets transfers to zero. If it does not agree, Γ_t^r becomes effective. If the second group accepts the offer of a revolution, the economy will be a democracy from the next period onwards. If it does not accept the offer, the economy remains under the rule of the dictator.

4. If group 1 proposed a revolution, $\gamma_{t+1,n}$ gets revealed.

5. Based on either Γ_t (if the first group did not propose a revolution) or Γ_t^r (if the second group did not accept a proposal made), production takes place, transfers are paid, and all groups consume.

If the economy changes to democracy from period t to period $t + 1$, the following timing of events applies from period $t + 1$ on:

1. The government collects the natural resource stream (X_{t+1}) and sets transfers $\Gamma_{t+1} = (T_{1,t+1}, T_{2,t+1})$ and G_{t+1}. The democratic government (formed by the two productive groups) sets its policies by maximising the utility of a representative agent.

2. $\gamma_{t+2,n}$ gets revealed.

3. The (democratic) government can change transfers and pays them, production takes place, the two groups consume, and the economy stays democratic in the next period.

This timing of events contains some noteworthy features. First of all, the dictator can only be replaced if both groups agree to do so. This is a reasonable assumption, as dictators can only be driven out of power if a revolution has substantial support among the people. A second important feature is that transfers can be altered, whereas the investments in governance are fixed for each period. Transfers can be simple payments, paid directly out of the dictator's pocket and can easily be paid or changed. Governmental investments, on the other hand, have to be planned and implemented within the administration; simply announcing them would not be credible. Changing them takes time, even in a dictatorial regime. This time lag is assumed to be longer than the time between the proposal of a revolution by group 1 and the decision group 2 has to make. Although this timing is not explicitly modeled, it is implicitly implemented in the setup of the game. Another crucial feature is that the groups cannot collude. Because they cannot make binding commitments the pivotal group has no incentive to stick to its promise in the subsequent period. One could easily change the model such that the groups

make their decisions at the same time, but that would not change the equilibrium outcome as it would still be possible for the dictator to bribe one of the groups later on.

3.3.3 Equilibrium Analysis

This section presents the equilibrium outcome of the model outlined above. Since there are two possible regimes (dictatorship, democracy), we have two equilibria. Due to an assumption we made, the dictatorial equilibrium can change to a democratic equilibrium, but not the other way around.

Democratic Equilibrium

The democratic equilibrium tells us what would happen if the two productive groups jointly form a government. If democracy is installed, the groups collect the natural resource stream, observe the previous period's investments in the public good, and set transfers and investments. Based on these decisions all agents produce and get their transfers. This section investigates the equilibrium outcome of this case.

In every period the government maximises the utility of a representative agent subject to its budget constraint (the groups are symmetric: maximising the utility of a representative agent maximises total utility of both groups together, the subsripct i is hence dropped for readability in the maximisation problem).

The optimisation problem reads

$$\max_{G_{t+1},G_{t+2},...,T_{t+1},T_{t+2},...} C^E_{t+1} + \beta\, C^E_{t+2} + \beta^2\, C^E_{t+3} + ... = \bar{\gamma} G^{\alpha}_t + T_{t+1} + \beta\,(\bar{\gamma} G^{\alpha}_{t+1} + T_{t+2}) + \beta^2\,(\bar{\gamma} G^{\alpha}_{t+2} + T_{t+3}) ... \quad (3.6)$$

s.t.

$$\begin{aligned} G_{t+1} + T_{t+1} &= X_{t+1} \\ G_{t+2} + T_{t+2} &= X_{t+2} \\ &... \end{aligned} \quad (3.7)$$

Which gives the optimal values for G and T_t:

$$\hat{G} = (\alpha\beta\bar{\gamma})^{\frac{1}{1-\alpha}} \quad (3.8)$$

$$\hat{T}_{i,t} = \frac{1}{2}(X_t - (\alpha\beta\gamma_n)^{\frac{1}{1-\alpha}}) \quad (3.9)$$

The instantaneous and discounted lifetime utility of the agents are

$$u^E_{i,t} = c_{i,t} = \gamma_{t,n}(\alpha\beta\gamma_{t-1,n})^{\frac{\alpha}{1-\alpha}} + \frac{1}{2}(X_t - (\alpha\beta\gamma_{t-1,n})^{\frac{1}{1-\alpha}}) \quad (3.10)$$

$$U^E_{i,t} = \Sigma^{\infty}_{s=t}\, \beta^{s-t}\, \gamma_{s,n}(\alpha\beta\gamma_{s-1,n})^{\frac{\alpha}{1-\alpha}} + \frac{1}{2}(X_s - (\alpha\beta\gamma_{s-1,n})^{\frac{1}{1-\alpha}}) \quad (3.11)$$

Investments in G are a function of the expected value of γ_n and are constant over time. A democratic government invests in governance as long as the expected marginal value equals the marginal utility of transfers. The government transfers what it has not invested (i.e., $T_{i,t} = \frac{1}{2}(X_t - G_t)$). The actual transfer is given in equation 3.9, but the expected transfer (before the productivity of the public investments is known) is $\hat{T}^*_{i,t} = \frac{1}{2}(X_t - (\alpha\beta\bar{\gamma})^{\frac{1}{1-\alpha}})$

Dictatorial Equilibrium

We focus on the (pure strategy) Markov Perfect Equilibria (MPE) of the game, which is solved by backward induction. This is reasonable as the process is memoryless, the dictator has no way of making credible threats for future periods in the same way as he cannot punish after being overthrown.

The dictator maximises his discounted lifetime stream of consumption (3.12) subject to the participation constraint that guarantees that the discounted lifetime utility of the pivotal group is larger under a dictatorial regime than under a democratic regime.[7] It is straightforward to prove that initial transfers ($\Gamma_t = (T_{1,t}, T_{2,t})$) are set to zero (paying positive transfers without being contested strictly decreases utility).

$$\max_{G_{t+1},G_{t+2},...,T^r_{2,t+1},T^r_{2,t+2},...,T_{2,t+1},T_{2,t+2},...} \quad X_{t+1} - G_{t+1} - T^r_{2,t+1} - T_{2,t+1} + \beta(X_{t+2} - G_{t+2} - T^r_{2,t+2} - T_{2,t+2}) + \beta^2(X_{t+3} - G_{t+3} - T^r_{2,t+3} - T_{2,t+3}) + ... \tag{3.12}$$

s.t.

$$T_{2,t+1} + T^r_{2,t+1} + (\gamma_{t+1,n}G_t)^\alpha + \beta(\gamma_{t+2,l}G_{t+1})^\alpha + \beta^2(\bar{\gamma}G_{t+2})^\alpha + \beta^3(\bar{\gamma}G_{t+3})^\alpha + ... \geq (\gamma_{t+1,n}G_t)^\alpha + \frac{1}{2}\beta X_{t+2} + \beta^3 U^E_{2,t+3}$$

The constraint on the left hand side is the utility of the pivotal group under dictatorial rule. $\gamma_{t+1,n}$ is already known at this point and $\gamma_{t+2,l}$ is not known to the dictator, only to group 1 when it has to decide whether or not to accept the offer. The dictator can only be precautious by assuming that his investments will be of low productivity. All γs from $t+3$ onwards are not known to anyone, all agents use the average value when discounting the future. The right hand side of the constraint is the utility of the pivotal group if it does not accept the offer. In this case (which the dictator anticipates), there are no transfers and $G_{t+1} = 0$. The first term on the right hand side is production in $t+1$, the second term is consumption in $t+2$ ($G_{t+1} = 0$, so there is no production, only the resource revenues are transferred), and the third term is the discounted utility from all periods after that.

[7] Assuming a non-linear utility function does not qualitatively change the results. Non-linearity influences the discounted utility under the democratic equilibrium (right hand side of the inequality in (3.12)). In the democratic equilibrium, investments in G decrease since these investments are risky. In the dictatorial equilibrium (left hand side of the inequality), investments in G are already low (compared to the democratic equilibrium, see equations (3.8) and (3.18)), i.e. the dictator already behaves as being risk-averse, so nonlinear utility does not change his behaviour. Since the democratic equilibrium gets closer to the dictatorial equilibrium under nonlinear utility, the dictator can stay in power under a larger set of possible environments.

The Lagrange Function (L), the first-order conditions (FOC) and the Karush Kuhn Tucker conditions (KKT) are given as

$$
\begin{aligned}
&L(G_{t+1}, G_{t+2}, ..., T^r_{2,t+1}, T^r_{2,t+2}, ..., T_{2,t+1}, T_{2,t+2}, ...\lambda, \nu_1, \nu_2...) = \\
&X_{t+1} - G_{t+1} - T^r_{2,t+1} - T_{2,t+1} + \beta(X_{t+2} - G_{t+2} - T^r_{2,t+2} - T_{2,t+2}) + \\
&\beta^2(X_{t+3} - G_{t+3} - T^r_{2,t+3} - T_{2,t+3}) + ... + \lambda[T_{2,t+1} + T^r_{2,t+1} + (\gamma_{t+1,n}G_t)^\alpha + \beta(\gamma_{t+2,l}G_{t+1})^\alpha + \\
&\beta^2(\bar{\gamma}G_{t+2})^\alpha + \beta^3(\bar{\gamma}G_{t+3})^\alpha + ... - (\gamma_{t+1,n}G_t)^\alpha - \frac{1}{2}\beta X_{t+2} - \beta^3 U^E_{2,t+3}]
\end{aligned}
$$

FOC

$$\frac{\partial L}{\partial T^r_{2,t+1}} = -1 + \lambda = 0 \tag{3.13}$$

$$\frac{\partial L}{\partial G_{t+1}} = -1 + \alpha\beta\lambda\gamma_{t+2,l}G^{\alpha-1}_{t+1} = 0 \tag{3.14}$$

$$\frac{\partial L}{\partial T_{2,t+1}} = -1 + \lambda = 0 \tag{3.15}$$

KKT

$$\lambda \geq 0 \tag{3.16}$$

$$\lambda[T_{2,t+1} + T^r_{2,t+1} + (\gamma_{t+1,n}G_t)^\alpha + \beta(\gamma_{t+2,l}G_{t+1})^\alpha + \beta^2(\bar{\gamma}G_{t+2})^\alpha + \beta^3(\bar{\gamma}G_{t+3})^\alpha + ... \tag{3.17}$$
$$-(\gamma_{t+1,n}G_t)^\alpha - \frac{1}{2}\beta X_{t+2} - \beta^3 U^E_{2,t+3}] = 0$$

This gives the optimal values for G_{t+1}, $T^r_{2,t+1}$ and $T_{2,t+1}$:

$$\hat{G} = (\alpha\beta\gamma_l)^{\frac{1}{1-\alpha}} \tag{3.18}$$

$$\hat{T}^r_{2,t+1} = -\beta\gamma_l(\alpha\beta\gamma_l)^{\frac{\alpha}{1-\alpha}} - \beta^2\frac{\bar{\gamma}(\alpha\beta\gamma_l)^{\frac{\alpha}{1-\alpha}}}{1-\beta} + \frac{1}{2}\beta X_{t+2} + \beta^3 U^E_{2,t+3} \tag{3.19}$$

$$\hat{T}_{2,t+1} = 0 \tag{3.20}$$

The transfers ($T^r_{2,t+1}$) are of less interest because the dictator only has to be able to pay them, but he never actually does so. If he could pay it, he does not need to, because the first group does not propose a revolution (the second group would not accept the offer). If he cannot pay this transfer, he gets ousted anyway and does not pay any transfers. Equation 3.20 confirms the statement made above that the dictator will never announce initial transfers.

The equilibrium level of investments in governance are of more interest. The dictator invests in governance although he gets no direct benefits from that (for example through higher taxes). His investments are an efficient way to bribe the pivotal group, but because these investments might turn out to be less efficient than expected (i.e., γ_l realises), he has to base his optimisation on this lower value, otherwise he might be thrown out of power. In a democratic government, the groups do not care about the actual realisation of γ and just enjoy whatever they produce. The dictator does not maximise the amount of the good but wants to stay in power. Because his objective is different, his optimal value

of G is different as well (it is strictly smaller than under a democratic government). The dictator stays in power as long as he is able to pay the transfer (equation (3.19)). As long as he is able to pay this transfer and invest in G, changes in X do not change investments. But if these changes in X get too large, he might be forced to reduce his investments to secure his power. And if the amount he should be able to pay is larger than his resource revenues in any given period (i.e., he has already decreased G to zero), he will be ousted. This can only be the case if future resource streams are larger than current resource streams (the last term in equation (3.19) depends on the future stream of resources)[8]. If X increases substantially, he cannot bribe enough to stay in power. The future then looks so bright that the people start a revolution caused by *rising expectations*.

There are two possible sources of a resource curse in this outcome. One outcome of this model is that a dictator might reduce his investments in good governance when expecting rising resource revenues. The other is that an increase in resource revenues could increase political instability. If the return to revolution increases, people doubt how long the dictator can pay off pivotal groups and might try to overthrow him. If this outcome can be observed empirically is discussed in the empirical analysis in Section 3.4.

The main hypothesis coming out of the model that we test in the empirical part is the following: *An increase of the value of resource revenues increases (in a nonlinear way) the probability of a revolution to take place in an autocratic country.*

3.3.4 Extensions of the Baseline Model

This section discusses a few possible extensions and their influence on the equilibrium outcome. With stable X, the dictator can stay in power indefinitely, but if X increases, he might get ousted through a revolution. By introducing any of the following extensions, this increase in X has to be larger for a revolution to happen. The extensions relax the constraint of 3.12 above and make it easier for the dictator to stay in power (i.e. he can stay in power under a larger set of possible developments of X).

Access to Financial Markets

If the dictator can relax his budget constraint by borrowing against future streams of X (e.g. by selling licenses for the exploitation of these resources), he can stay in power even if X is increasing over time. But this has its limits as international investors might fear that the government could revoke these licenses in the future. Nevertheless, the reasoning of the baseline model holds even if the dictator can borrow. In terms of the model, the dictator can stay in power in period t if his resources (X_t) are larger than the required transfer ($\hat{T}^r_{2,t}$), i.e. $X_t \geq \hat{T}^r_{2,t}$. Define Ξ_t as the discounted flow of public resource

[8] If resource revenues are constant, the maximum bribe the dictator can pay (all his resource revenues) are always larger than what the pivotal group can expect to get under democratic rule (half the resource revenues)

revenues in period t and beyond that the dictator can borrow against then he can stay in power as long as $X_t + \Xi_t \geq \hat{T}^r_{2,t}$. Access to finance strictly increases his ability to stay in power if $\Xi > 0$.

New Dictator/Coup d'état and Institutional Persistence

The baseline model assumes that the only way the government can change is through a revolution. The implicit assumption made is that a revolution needs substantial backing from the public. Although this is true for a revolution, it is not the case for a coup d'état. But this possibility is easy to introduce in the baseline model and does not substantially change the outcome.

Assuming that a revolution leads to a new dictator (who is randomly drawn from the population) with a certain probability ω (such that transforming to a democratic government happens with the probability $1 - \omega$), the return to revolution decreases by the factor ω. If there is a positive probability that the economy continues to be a dictatorship after a successful revolution, the incumbent dictator has higher chances of staying in power. Such a probability changes the right hand side of the constraint in equation 3.12 to $\omega[(\gamma_{t+1,n}G_t)^\alpha + \frac{1}{2}\beta X_{t+2} + \beta^3 U^E_{2,t+3}]$. Since $0 < \omega < 1$, the possibility of a new dictator reduces the right hand side of constraint 3.12 and makes it easier for the dictator to stay in power.

The same reasoning holds if we relax the assumption that a democracy cannot change back into a dictatorship. Again, assuming an exogenous probability that a democracy changes to a dictatorship would change the optimisation problem of the two producing groups in a very similar way as a coup d'état right after the revolution and would increase the chances of the dictator to stay in power. A similar reasoning holds if the incumbent dictator can invest in de facto political power so that he can offset a possible loss of de jure political power with indirect power through bribes, lobbying, or force. Acemoglu & Robinson (2006) show that this can lead to strong institutional persistence and would clearly decrease the return to revolution in the model outlined above (see also Acemoglu & Robinson (2008)).

Costs of Revolution

If proposing a revolution or accepting it bears costs, it would get easier for the dictator to stay in power. These costs could be actual costs to organize but also punishment by the dictator. If the dictator can imprison opposition members, he could easily change the cost-benefit analysis of the members of the economy and increase his chances of staying in power. With such costs z, the right hand side of the constraint in the maximisation problem 3.12 would change to $z + (\gamma_{t+1,n}G_t)^\alpha + \frac{1}{2}\beta X_{t+2} + \beta^3 U^E_{2,t+3}$. Again, the introduction of this possibility increases the set of possible scenarios (of developments of X over time) under which the dictator could stay in power.

More or Asymmetric Groups

The baseline model assumes that a revolution needs support from all members of the economy to be successful. To stay in power the dictator has to (be able to) bribe half of the people. If there are more groups, he can achieve his goal of breaking full support by bribing a group that is smaller than half of the population. If groups are heterogeneous, the dictator bribes a small group that gains only a little from democracy (so that the bribe can be small) but that is still crucial for a revolutionary movement. This extension also makes it easier for the dictator to stay in power.

Uncertain X

If future values of X are uncertain and only its (constant) distribution is known, the dictator increases his chances of staying in power. The pivotal group would discount the future given this distribution, so the dictator would not have to fear sudden (expected) increases in X. If such increases only get revealed in the period they are flowing to the government, the actual values of X are never part of the decision making process of the two groups. Mathematically speaking, the right hand side of the constraint in 3.12 changes to $(\gamma_{t+1,n}G_t)^\alpha + \frac{1}{2}\beta\hat{X}_{t+2} + \beta^3 U^E_{2,t+3}(\hat{X}_{t+3}, \hat{X}_{t+4}, ...)$

3.4 Empirical Analysis

3.4.1 Identification Strategy

As the theoretical model shows, the resource curse is not only a question of the level of resources but also about their changes over time and whether these changes take place in a dictatorial or a democratic country. Running regressions including variables such as political stability, resource dependence, GDP, etc. all have the problem of endogeneity. To overcome this problem, many scholars use instrumental variables, which creates new problems (Brunnschweiler & Bulte (2008), Roodman (2009)).

This study uses the development of commodity prices in the last decade. As we can see in Figure 3.2, many of Africa's main export commodities experienced a price boom. Other than the oil price shocks in the 1970s, these movements were not based on political influences but (apparently) on supply and demand. Whereas the oil price was expected to fall as soon as OPEC stopped its embargo, this more recent increase in prices seemed different. With booming Asian economies and limited supply, prices were expected to stay at such high levels.

This was not only indicated by the price of oil futures but also expected by established economists (see Frankel (2006) and Hamilton (2011)) and investments banks (in May 2008 Goldman Sachs warned that the price per barrel could reach USD 200 within two years time (Financial Times, May 6, 2008)).

More formally, Bekiros & Diks (2008) show that spot and future prices of crude oil were correlated in the period November 1999 to October 2007 (the correlation between spot prices and future prices 4

months ahead is more than 0.82). And even if these price shocks were seen as fading out over time, the effects we measure in the empirical analysis would be lower bounds of the effects we actually want to measure.

Because these price shocks were unforeseen (otherwise arbitrage would have smoothed them out), they can be used as a natural experiment especially since the countries in our sample (see Appendix) do not influence the world market prices of these goods through either supply or demand (see Brückner (forthcoming)).

Not all countries benefited from the commodity-price boom in the same way because different countries export different commodities (and some countries export no non-renewable commodities at all). The identification strategy is based on this observation. We estimate if a shock in export prices had different effects on political stability in democratic versus autocratic countries.

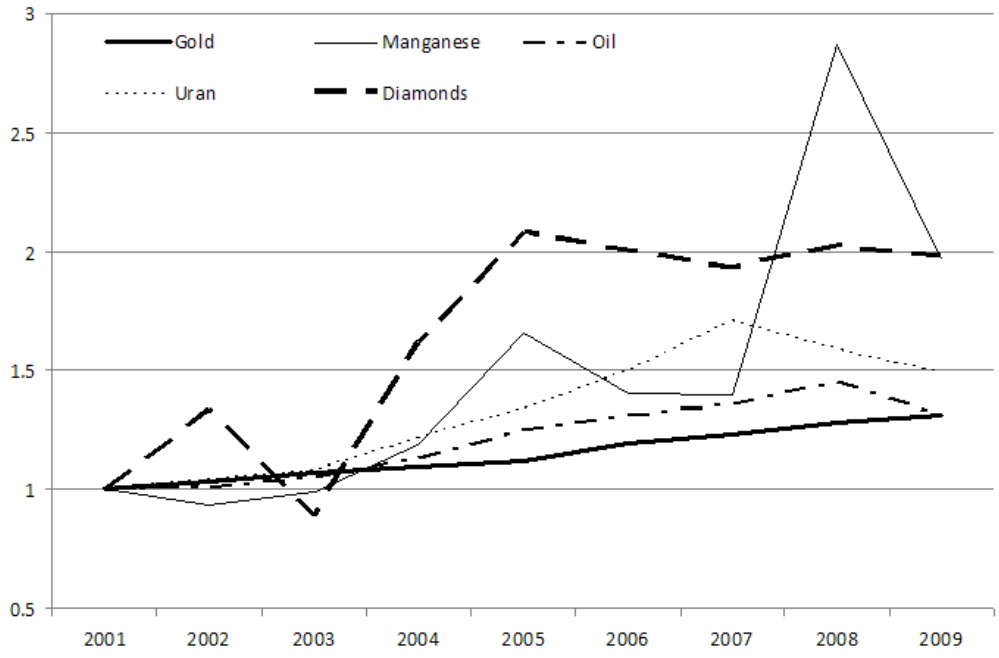

Figure 3.2: Relative Prices (Prices are set to 1 in 2001) of Major African Export Commodities, 2001-2009

The theoretical model predicts that an increase in the value of natural resources increases the return to revolution in autocratic countries. Countries that did not experience a commodity export boom or countries that were relatively democratic to begin with are not expected to have experienced an increase in political instability.

Because these price increases were not seen as temporary changes, they increased the expected future resource revenues and therefore the return to revolution. This section tries to establish that the

theoretical model outlined above does indeed help to understand the impact of resource revenues on political stability and violence and that there is a "dynamic resource curse" which can manifest itself in a revolution of rising expectations.

3.4.2 Descriptive Statistics

We use two different dependent variables in the regressions. First, we use a subindex of the "Worldwide Governance Indicators" (WGI) (Kaufmann, Kraay & Mastruzzi (2010)). As a second dependent variable, we use the (updated) armed conflict dataset from UCDP/PRIO (Gleditsch et al. (2002)) to construct a dataset for the outbreak of a conflict. We recoded all conflicts with more than 1,000 battle-related deaths as conflicts with more than 25 battle deaths. Since only a few country-years fall in the first category, this does not substantially change the results but simplifies the interpretation. The sample mean of this binary variable is 0.03, i.e. 3% of the country-years are marked as conflict onsets.

We use them because they can both be used as proxies for the same issue (political instability) from different perspectives. Whereas the UCDP/PRIO armed conflict data show actual conflicts that broke out, the political stability measure from the World Bank tries to capture the *perception* of possible (future) conflicts that could overthrow the government. The UCDP/PRIO dataset is widely used in the literature to measure conflicts, but this dataset has a few shortcomings. Although based on actual events (compared to the measure for political stability, which is partly based on surveys), it is a 0-1-2 scale with (arbitrary) thresholds at 25 and 1,000 battle-related deaths (and at least one conflict partner is a state). This scale does not only give low variation in the data but is also problematic when comparing countries with very different population sizes (25 battle-related deaths in Cape Verde have a different interpretation than the same number of casualties in Nigeria). The political stability data by the World Bank, on the other hand, can already reflect slight changes in the political stability of a country.

The independent variable of interest is a self-constructed commodity export index in the tradition of Deaton & Miller (1995) and Dehn (2000). Using UN Comtrade data, we calculated per capita revenues of a list of important non-renewable commodities[9] for African countries in the base year 2000. This list encompasses all commodities that Deaton & Miller (1995) used for their export index plus cobalt, platinum, chromium, and precious stones, all of which, except platinum, they had to drop due to missing data. Although the Comtrade dataset distinguishes between exports and re-exports, not all exports are correctly defined; Mauritius, for example, is listed as a major diamond producer. We tried to clean up these data as much as possible by comparing the Comtrade data with the list of commodities that are listed in the CIA World Factbook as being produced in the country and by deleting obvious double-counts. Taking the year 2000 as the base year is based on the fact that the WGI only date back to 1996

[9] Bauxite, cobalt, copper, gold, iron, manganese, nickel, petroleum, platinum, chromium, phosphates, precious stones (diamonds, etc.), uranium.

and that they are not available for the years 1997, 1999 and 2001 (we take 2000 and not 2002 as a base year due to some missing data in the latter). Also, if it would be possible to extend the dataset back into time, we would use constructed trade values that diverge even more from actual trade values. Limiting the dataset to a very few years is not only based on limited data but also on the trade-off between the size of the data set and the accuracy of it.

Following Deaton & Miller (1995) we fix the trade volumes of these goods for the whole sample period to rule out endogeneity issues with changing supplies of different commodities due to, for example, conflicts in a country. We want to measure the effect of changes in the value of natural resources on conflicts and need to rule out the reverse effect of conflicts on export values, which could either come directly (conflicts might stop the production and export of these commodities) or indirectly (through, for example, effects on GDP or economic growth). Fixing the volumes leaves the worldmarket price as the only way trade value can change throughout the sample period, so these reverse effects are ruled out. Setting the initial value of a country's exports equal to 100, we created the index used in the estimations. This index goes from 76.93 (Comoros in 2003) to 1117.17 (Niger in 2007), but the variation is smaller than it appears: the second and third largest values are 731.93 and 541.60 (Niger in 2008 and 2006 respectively). The sample mean of the index is 192.31, which shows that most of the countries in the sample have experienced an increase in the value of their export commodities between 2000 and 2008.

Setting the index to 100 for every country in the beginning of the sample period is a form of heterogeneous rescaling. It assumes that the effects of an increase in commodity exports depend on the relative change of a country's commodity exports. Doubling the world market price for all export commodities of Benin (a small commodity exporter, even relative to its size) has the same effect as doubling the world market price for all export commodities for Nigeria (a large commodity exporter, even relative to its size). This is a different scaling from, for example, Collier & Goderis (2009) but is based on the theory developed in Section 3.3. The theory predicts that a revolution (or political instability in the framework of the empirical analysis) takes place if the dictator cannot pay the pivotal group more than its discounted value of democracy. Whereas the former is based on the current resource revenues, the latter is a function of future flows of resource revenues. Because the theory predicts a revolution will break out if the former is smaller than the latter, the commodity export index used in the empirical analysis should reflect this by being an index built on the *relative* change of commodity exports. Since the model is one of grabbing resource rents (and not one of, for example, taxing GDP), scaling by GDP is not appropriate.

The theoretical model indicates a threshold of discounted resource revenues above which a revolution takes place. Having a threshold implies (for the empirical analysis) that the marginal effect of an increase in commodity exports could diminish (if the conditions for a revolution are given, a further

increase in the value of the exported commodities does not change that), so we include linear terms and squared terms in the regressions.

We focus on non-renewable resources (as opposed to renewable resources such as food commodities) because Dube & Vargas (2007) show that different classes of commodities have qualitatively different effects on violence and stability. By focusing on capital intensive commodities, we can ignore possible indirect effects through wages, focus on the "rapacity channel" (Dube & Vargas (2007)), and stay close to the theoretical model.

To capture the different effects of a change in this commodity export index on autocratic versus democratic countries, we use a country's Freedom House index (i.e. the average of the political rights score and the civil liberties score) in 2000 to construct an interaction term (*Freedom in the World 2010* (2010)) with the export index. The Freedom House index goes from 1 (very free) to 7 (totally unfree). In our sample it goes from 1.5 (e.g., Cape Verde) to 7 (e.g., Sudan).

The time period we concentrate on did not only see an increase in the price of non-renewable commodities but also an increase in the prices of foodstuffs, which might have triggered some of the conflicts in our dataset (Arezki & Brückner (2011*a*)). Food price indices for African countries are often imprecise, because markets are highly fragmented; missing storage and cooling facilities make intra- and inter-country trade costly. Since many rural households in Africa, at least partly, produce their own food and because comparable national food price indices are not available, we use the food production index of the African Development Bank to control for changes in a country's food supply and food price related conflicts. Economic growth could also influence conflicts in a country (Miguel et al. (2004), Fearon & Laitin (2003), Collier & Hoeffler (1998), Collier & Hoeffler (2004*b*)). We therefore also include real GDP growth (per capita) as control variables. Countries that are highly dependent on imports or on foreign trade in general could also be more in danger of experiencing conflicts. If the trade position of a country gets worse, external financing gets more difficult, which might result in economic problems or political instability. To control for this channel, we use the trade balance in percentage of GDP.

Some descriptive statistics on our variables are given in Table 3.1; bivariate correlations are given in Table 3.2. The political stability measure has a negative mean. Sub-Saharan Africa is on average politically unstable (compared to the rest of the world) but political stability is very different across countries. But Africa is not only a continent of perceived political instability but also of actual conflicts. Conflicts break out in 3% of all country-years. On average, the countries in our study are rather unfree, as the high average freedomhouse index indicates. As we can see in Table 3.2, political stability is highly correlated with conflicts and with the freedomhouse index.

Table 3.1: Summary Statistics

	Mean	St. Dev.	Min.	Max.
political stability	-473.37	864.88	-2,457	1145
conflict outbreak	0.03	0.18	0	1
commodity export index	192.31	118.11	76.93	1,117.17
Freedom House index	4.31	1.48	1.50	7
food production index	98.90	14.90	37	165
economic growth	2.49	5.21	-33.05	29.16
trade balance	-6.25	25.03	-65.16	79.86
number of observations: 322 (46 countries over 7 years)				

Table 3.2: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	1.00						
(2)	-0.54	1.00					
(3)	-0.11	0.13	1.00				
(4)	-0.68	0.31	0.05	1.00			
(5)	-0.21	0.10	0.14	0.05	1.00		
(6)	0.14	-0.02	0.04	-0.06	0.16	1.00	
(7)	-0.20	0.08	0.22	0.27	0.16	0.21	1.00

(1) political stability; (2) UCDP/PRIO; (3) commodity export index; (4) freedomhouse index; (5) food production index; (6) economic growth; (7) trade

3.4.3 Regression Results

All estimations are done using a fixed effects estimator. Table 3.3 presents the results from the estimations. The dependent variable in regressions I to VI is the Political Stability measure. The dependent variable in estimation VII-XII is the UCDP/PRIO binary conflict outbreak indicator. For readability, both dependent variables are multiplied by 1,000. All estimations are done using a panel data version of OLS. We also apply OLS to the UCDP data although the dependent variable is a binary one because coefficients of interaction terms cannot be interpreted as marginal values if we use a nonlinear specification (Ai & Norton (2003) (the results of a logistic estimation are given in the appendix). The marginal values could even have different signs than the estimated coefficients. By using OLS we assume constant marginal effects and might generate probabilities that are outside the [0,1] interval. Since the focus of these estimations is to test the model and not to calculate probabilities, this approach seems favourable.

Estimations I and II only include the commodity export index in its basic form. In this very simple setting, increases in commodity revenues decrease political stability although the coefficients are not significant. This effect is independent of the inclusion of the control variables in estimation II.

Table 3.3: Regression Results (Dependent Variable: Political Stability (*1000))

	I	II	III	IV	V	VI
(1) commodity export index	-0.08	-0.03	-0.34	-0.24	1.62	1.80
	(0.42)	(0.42)	(0.90)	(0.91)	(2.33)	(2.34)
(2) (commodity export index)^2					-0.002	-0.002
					(0.002)	(0.002)
(3) commodity export index*			0.06	0.05	-0.30	-0.33
initial fh index			(0.20)	(0.20)	(0.59)	(0.60)
(4) (commodity export index*					0.0001	0.0001
initial fh index)^2					(0.0001)	(0.001)
food production		-1.44		-1.32		-1.01
		(3.21)		(3.25)		(3.25)
economic growth		9.16		9.12		9.33
		(4.89)*		(4.85)*		(4.93)*
trade		-1.47		-1.51		-1.52
		(2.40)		(2.42)		(2.39)
number of observations	322	322	322	322	322	322
F-test (1) & (3)			0.07	0.04		
p-value (F-test)			0.93	0.97		
F-test (1), (2), (3) & (4)					5.18	3.13
p-value (F-test)					0.00	0.02

standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% respectively,
all estimates include time dummies, country-specific fixed effects and robust standard errors

Table 3.4: Regression Results (Dependent Variable: Conflict Outbreak (*100)

	VII	VIII	IX	X	XI	XII
(1) commodity export index	0.05	0.05	0.08	0.08	-0.05	-0.05
	(0.03)*	(0.03)*	(0.04)	(0.04)	(0.09)	(0.09)
(2) (commodity export index)^2					0.0001	0.0001
					(0.0001)*	(0.0001)*
(3) commodity export index*			-0.01	-0.01	-0.002	-0.001
initial fh index			(0.01)	(0.01)	(0.03)	(0.03)
(4) (commodity export index*					-0.0000001	-0.0000004
initial fh index)^2					(0.00001)	(-0.00001)
food production		-0.01		-0.03		-0.05
		(0.12)		(0.12)		(0.12)
economic growth		-0.08		-0.07		-0.07
		(0.11)		(0.12)		(0.11)
trade		-0.005		0.001		0.02
		(0.13)		(0.14)		(0.15)
number of observations	322	322	322	322	322	322
F-test (1) & (3)			2.22	2.10		
p-value (F-test)			0.12	0.13		
F-test (1), (2), (3) & (4)					74.88	53.46
p-value (F-test)					0.00	0.00

standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% respectively,

all estimates include time dummies, country-specific fixed effects and robust standard errors

The theory above shows that an increase in commodity revenues has different effects in autocratic versus democratic countries. To include this heterogeneous effect, an interaction term is included in estimations III and IV. This term interacts the commodity export index with the initial freedomhouse index of the country. Again, the only difference between III and IV is the inclusion of the control variables. In this setting, an increase in commodity revenues decreases political stability although the effect is smaller for unfree countries. Again, the coefficients of the commodity exports are not (individually or jointly) significant. In estimations V and VI, we add squared terms for both the commodity export index and the interaction term. The theory predicts a threshold value of discounted future resource revenues above which a revolution takes place. A threshold value is by its very nature a nonlinear specification. To implement this nonlinearity in the empirical part, we introduce squared terms. Now all coefficients have the expected signs and are jointly significant. The squared terms indicate that the marginal effect of commodity revenues on political stability decreases. As soon as the incentive to start a revolution, or even a civil war to overthrow the government, is established, an extra million dollars in revenues does not change that. A rebel group does not care much if its loot is expected to be USD 50 million or USD 60 million, as long as it pays off to rebel. We have also analysed in which range of the Freedom House index the effect of commodity price changes[10] but did not find significant coefficients (probably due to the low sample sizes at the different levels of the Freedom House index). Although significance is lacking, the coefficients support our reasoning that the free countries gain more (in terms of political stability) from an increase of their commodity exports than unfree countries.

We stress the tests for joint significance because the four variables of interest (i.e. the commodity export index, the interaction term and the squared terms) are by construction highly correlated (by between 0.75 and 0.92). This depresses the *t*-statistics and increases the probability of not rejecting the null of non-significance. Testing for joint significance circumvents this problem, and as we see in estimations V and VI, these coefficients are highly jointly significant although hardly significant at an individual level. The estimations using the dummy for the outbreak of a conflict as a dependent variable confirms the results above. In the simple settings (estimations VII and VIII), an increase in commodity revenues seems to increase the probability of the outbreak of a conflict. This effect seems to be smaller for unfree countries as estimations XI and X show although the coefficients in these estimations are not (jointly or individually) significant. Only when introducing the squared terms do we get the expected signs for the commodity export index and its squared term. The effect of the freedomhouse index is still not as expected, but both coefficients are not (jointly or individually) significant. We find that increasing commodity revenues decrease the likelihood of an outbreak of a conflict in a non-linear way but do not find a significant effect of the level of freedom in the country. Contrary to estimations I-VI, however, there is not much variation in the conflict outbreak dataset which we could exploit in our analysis.

[10] Using the *lincom* command in Stata

3.5 Conclusion

The resource curse is not only a question of the level of natural resources but also of their dynamics over time. Both a theoretical model and the empirical analysis show that although an increase in the value of a country's natural resources has a positive effect on its political stability and internal conflicts, if the country grants its citizens high levels of freedom, this effect turns negative if the level of freedom is low. Because we only investigate non-renewable, capital-intensive commodities, the effect we measure does not work through wages or the opportunity costs of fighting but directly through predatory activities aimed at gaining control over the commodities. These indirect effects are left for future research, together with an investigation of the role of renewable resources.

In a democratic country, windfalls are used in a way that the general public benefits from them. In an autocracy, these windfalls are used to increase consumption of the dictator (or the ruling elite) or to bribe political opponents. If in autocratic countries the higher prices that generated the windfalls are expected to stay, people have a stronger incentive to overthrow the government and share these rents, causing political instability or even a *revolution of rising expectations*.

Appendix

Appendix 3.A: List of Countries

The following countries are included in analysis: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde*, Central African Republic, Chad, Comoros*, Congo (Republic), Cote d'Ivoire, Djibouti*, Equatorial Guinea*, Eritrea*, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania*, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe*, Senegal, Seychelles*, Sierra Leone, Somalia*, South Africa, Sudan*, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

Appendix 3.B: Data Description

Commodity Export Index

The commodity export index is constructed in the tradition of Deaton & Miller (1995) and Dehn (2000). Using UN Comtrade data, we calculated per capita revenues of a list of important non-renewable commodities[11] for African countries in the base year 2000. The index is a geometrically weighted index as

[11] bauxite, cobalt, copper, gold, iron, manganese, nickel, petroleum, platinum, chromium, phosphates, precious stones (diamonds, etc.), uranium

and is structured as follows:

$$commodity - export - index = \Pi_i \, P_i^{W_i} \tag{3.21}$$

W_i is a weighting item, P_i is the international price of the commodity. The weighting item is the value of commodity i in the total of all commodities n for the base year 2000:

$$W_i = \frac{P_{2000,i} Q_{2000,i}}{\Sigma_n \, P_{2000,n} Q_{2000,n}}, \tag{3.22}$$

where Q_i is the quantity sold of commodity i.

Conflict Outbreak

The conflict outbreak data are from the Armed Conflict Dataset of the University of Uppsala, Department of Peace and Conflict Research (UCDP) and the Peace Research Institute Oslo (PRIO) and are publicly available at: www.pcr.uu.se/research/ucdp/datasets. Incidence of conflict is a binary variable, set to one if a country experienced a conflict in a given year. A conflict is "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths" (Gleditsch et al. (2002)). The binary variable Conflict Outbreak is set to one at the beginning of a conflict and to zero in all subsequent periods that are marked by a conflict incidence.

Economic Growth

The data on economic growth are from the World Development Indicators. Economic Growth is measured as the yearly change in per capita GDP in constant USD.

Food Production

The food production index is from the African Development Database. The average over the years 1999, 2000, and 2001 is set to 100.

Freedomhouse Index

The freedomhouse index by freedomhouse.org goes from 1 (very free country) to 7 (very unfree country).

Political Stability

The index of Political Stability is based on the Worldwide Governance Indicators (WGI) from the World Bank (WB). The WGI index is an aggregate of six subindices that are based on surveys of households and firms, assessments of commercial information providers, non-governmental organizations, and public sector bodies. These subindices are aggregated using an *unobserved components model* (for

a detailed description see Kaufmann et al. (2010)). We only use the subindex *Political Stability and Absence of Violence/Terrorism*. This indicator goes (in our sample) from around -3.28 to 1.14, with higher values corresponding to greater political stability in a given year. This indicator tries to capture the "perception of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means" (Kaufmann et al. (2010)). Comparing African data with other countries we see that this continent is, roughly speaking, plagued by greater political instability than the rest of the world. Somalia for example is the most unstable country in the world in most of the years of the sample. The WGI are, strictly speaking, relative indicators as the (global) mean is set to zero and the standard deviation is set to one in every period, so absolute trends in governance cannot be measured. We use this dataset anyhow in our analysis for three reasons: first, we only look at Sub-Saharan Africa (and not the whole world). Second, we are not interested in trends but in short-term changes in the indicator (in a given year in a country). Third and most important, Kaufmann et al. (2010) and Kaufmann, Kraay & Mastruzzi (2007) point out that there is no evidence (from the underlying data of the indices) that there are global trends in governance.

Trade

Trade is measured as the trade balance in percentage of GDP. The dataset is from the African Development Bank.

Appendix 3.C: Regression Results - Logit Estimation

Table 3.C: Regression Results (Dependent Variable: Conflict Outbreak (*100) - Logit Estimation

	I	II	III	IV	V	VI
(1) commodity export index	0.004	0.004	0.008	0.007	-0.007	-0.016
	(0.003)	(0.003)	(0.01)	(0.01)	(0.05)	(0.06)
(2) (commodity export index)^2					0.000001	0.00001
					(0.00001)	(0.0001)
(3) commodity export index*			-0.001	-0.001	-0.001	0.001
initial fh index			(0.03)	(0.004)	(0.01)	(0.03)
(4) (commodity export index*					-0.0000003	-0.0000004
initial fh index)^2					(0.00003)	(0.00003)
food production		0.01		0.004		0.02
		(0.04)		(0.04)		(0.05)
economic growth		-0.06		-0.06		-0.06
		(0.07)		(0.07)		(0.07)
trade		0.02		0.02		0.01
		(0.03)		(0.03)		(0.03)
number of observations	99	99	99	99	99	99
F-test (1) & (3)			1.57	1.69		
p-value (F-test)			0.46	0.43		
F-test (1), (2), (3) & (4)					1.02	1.00
p-value (F-test)					0.91	0.91

standard errors in parentheses; *, **, *** significant at 10%, 5% and 1% respectively,

all estimates include time dummies, country-specific fixed effects and robust standard errors

CHAPTER 4

On the Side Effects of Mineral Wealth - The Case of Trinidad and Tobago

"Le don d'une plante utile me parait plus précieux que la découverte d'une mine d'or, et un monument plus durable qu'une pyramide." Bernardin de Saint-Pierre (Voyage à l'Isle de France, à l'Isle de Bourbon et au Cap de Bonne-Espérance, 1773)

4.1 Introduction

Whether mineral wealth is a curse or a blessing for a country is still debated, especially the conditions under which a country can overcome a curse and turn the wealth into a blessing.[1] Using two different approaches, this chapter shows that Trinidad & Tobago might suffer from its mineral wealth in several ways.

First, we compare Trinidad with Mauritius with respect to their (economic) histories, institutions, structure of the economies, etc.[2] (see Section 4.2). Both countries share many features that determine the development of an economy. Both countries were British colonies for a long time and were used by the colonizers for producing sugar on a large scale. Nowadays both countries are very similar with respect to their institutions and many other factors that influence the state of an economy. The only substantial difference between the two countries is that Trinidad has large natural resource deposits,

[1] See Collier & Venables (2010) and Frankel (2010*b*).

[2] In all sections "Trinidad" and "Mauritius" will mostly refer to both the island and the country and it will be clear if only the respective island is meant.

whereas Mauritius does not. We use this similarity to make inference about the effects of Trinidad's resources on its economy without having to rely on econometric techniques or simulation. We conclude that Trinidad's mineral wealth led to corruption and negatively influenced its rule of law. On the other hand, Trinidad's resources have not undermined its political system, affected its public debt or its income distribution.

Second, we show that oil production has crowded out sugarcane production in Trinidad through its influence on the real exchange rate using time series econometric techniques on data from 1961 until 2010 (Section 4.4.2). Because a temporary appreciation of Trinidad's currency has a lasting negative effect on sugarcane production, this crowding out is wasteful. Trinidad has oil and gas deposits, i.e. a comparative advantage in the production of these goods, and we should expect it to specialise in the production of these goods. But since a temporary shock to Trinidad's real exchange rate has a lasting effect on sugarcane production, this specialisation could be inefficient. If the temporary shock to the real exchange rate would only have a temporary effect on sugarcane production, the current level of sugarcane production would be higher.

To our knowledge, this is the first academic study that investigates whether and how Trinidad & Tobago suffers from its resources. The purpose of this study is not to discuss or even quantify the *total* effect of Trinidad's mineral wealth on its economy and its political system but to focus on a few aspects: its institutions, debt, income inequality, education, and sugarcane production.

The structure of the chapter is as follows. Section 4.2 compares Trinidad & Tobago and Mauritius in terms of geography, (economic) development, culture, and institutions. Section 4.3 presents the structure of the economies of both countries. Section 4.4 investigates possible channels of the resource curse to see if they play a role in Trinidad & Tobago, and Section 4.5 concludes.

4.2 Trinidad & Tobago and Mauritius

This section provides an overview of the geography, development, culture, and institutions of Trinidad and Mauritius.[3]

4.2.1 Geography

The island nation of Trinidad and Tobago is located in the southern Caribbean, close to Venezuela. The main island (Trinidad) is 5,131 km^2 large, mountainous and lies outside the hurricane belt. Hurricanes hit the island only very occasionally, making it especially suitable for agriculture. The main dependency is Tobago, which is located to the north-east of the main island. Tobago is, at 300 km^2, much smaller.

[3]For a detailed introduction to the history of Mauritius and the puzzles that still surround its economic success see Frankel (2010*a*). Sections 4.2.2 and 4.2.3 are mainly based on Frankel (2010*a*) and Mehta & Mehta (2010). An excellent overview and analysis of the problems the Trinidadian economy faces is given by Artana, Auguste, Moya, Sookra & Watson (2007).

All other islands are uninhabited. The climate is tropical with a dry season in the first half of the year and a wet season in the second.

Mauritius, on the other, hand is located in the Indian Ocean, about 900 km east of Madagascar. The main island (Mauritius) is around 2,040 km^2 large and mountainous. Mauritius occasionally gets affected by cyclones (as hurricanes in the Indian Ocean are called), making it (in this sense) less suitable for agriculture than Trinidad. The main dependency is Rodrigues, which is located to the north-east of the main island. Rodrigues is, at 109 km^2, much smaller than Mauritius. All other dependencies have a combined population of several hundred people. The climate is tropical with a warm and dry winter from May to November and a hot and wet summer in the remaining months.

4.2.2 General History

Before the arrival of the Spanish in 1498, Trinidad was inhabited by Arawakan-speaking people, whose descendants still live on the island although their number is extremely small. Mauritius did not have an indigenous population when the Dutch first tried to settle on the island. They first came to the island in 1638 but abandoned Mauritius in 1710. The French took over in 1715, started to develop the island, but lost it to the British in 1810/1814. It remained a British colony until independence in 1968. Trinidad & Tobago, on the other hand, was first colonized by the Spanish, who lost their colony to the British in 1802. It also remained a British colony until independence in 1962.

Both colonies were used by the British to produce and process sugarcane. In the beginning, this labour-intensive work was done by African slaves. After the end of the slave trade and the abolition of slavery, the British brought contract workers from India to work in the fields. The first contract workers arrived in Mauritius in 1834 and in Trinidad in 1845. Although theoretically free men, these people worked and lived under circumstances comparable to what the slaves had to suffer before.

Both islands were not only important producers of sugar but were also of strategic importance. Mauritius was long used as a stopover on the lenght journey to India. During the Napoleonic wars, the French used the island to attack British ships. Mauritius lost its status of strategic importance throughout the centuries (especially with the opening of the Suez channel in 1869) but Trinidad & Tobago remained important as petroleum, natural gas, and asphalt were discovered on Trinidad and offshore.[4] During World War II, Trinidad & Tobago was an important source of crude oil for the United States of America who also had a military base on Trinidad.

Before these natural resources were discovered in Trinidad, the economic structures of Trinidad & Tobago and Mauritius were quite similar. Both countries lacked natural resources, suffered from remoteness to the important world markets, had a small domestic market, virtually produced only a single

[4] Around 1866 oil was discovered on Trinidad, but production was stopped a few years later. In 1893, another well was discovered and production started again, which took off on a large scale in 1907.

crop (sugar) on a large scale and were therefore highly dependent on its exogenous world-market price, had a population that was divided across ethnic and religious lines, and a tropical climate including occasional devastating cyclones (especially in the case of Mauritius). Nobel prize winner Meade (1961) based his negative outlook of the development of Mauritius on these facts.

4.2.3 Economic Development

In the 1960s, the focus of Mauritian economic policy was on import substitution, which resulted in low growth rates and high unemployment (the average per capita growth rate in the 1960s was -1.15% and unemployment was estimated to be around 20%[5]). This changed in the 1970s when the government moved the economic focus outward and started to apply an export-led growth strategy that was supported by a high sugar price. Economic growth accelerated to an average per capita growth rate of 5.9% and unemployment decreased sharply.[6] Around 1979/1980, the economy was hit hard by the oil price shock and the global recession. Inflation increased, growth rates dropped, and the International Monetary Fund had to step in with a structural adjustment programme that included fiscal stabilisation, cautious wage policies, and several sharp devaluations of the Mauritian Rupee.[7] From the early 1980s on, the economy got back on track by diversifying into manufacturing and tourism. Today only around 4% of gross domestic product comes from agriculture (mainly sugarcane), 19% from manufacturing, 10% from financial services, and 7% from tourism:[8]

Over the years, Mauritius enjoyed preferential access to Western markets under the Multi-Fibre Arrangement (for textiles) and the Lomé and Cotonou Conventions (for sugar). With the liberalization of world trade, these agreements started to phase out around 2004. Although this liberalization (which led to an initial output drop in the textile sector of 30%) was followed by a sharp increase in food prices (commodities which Mauritius has to import) as well as the global recession, the government further improved economic conditions to dampen these adverse effects. It did so by simplifying the tax system, reducing red tape, and other pro-business measures (Subramanian (2009) and Frankel (2010*a*)).

Trinidad & Tobago was also actively setting up its own economic policy in the early 1960s. These policies mainly included state interventionalism and monopolies but did not bear the fruits the country had hoped for. With the oil booms the country took the opportunity to change its economic model and transformed into an open and trade-oriented economy. For many years, the main economic activities were based on crude oil, but the country recently started to focus on natural gas as well as encouraging other economic activities.

[5] Source: Penn World Tables and Mehta & Mehta (2010)

[6] Source: Penn World Tables and Mehta & Mehta (2010)

[7] See Mehta & Mehta (2010) for details of the stabilisation programme.

[8] Source: Central Statistics Office of Mauritius - National Accounts

From a similar economic starting point (mono-crop plantation economy based on the exploitation of workers), Trinidad transformed into a natural-resource based economy (the petroleum industry contributes around 40% to GDP) and has no need to support other economic activity (it scores 68 on the 2011 "Doing Business" ranking by the World Bank (Worldbank (2011))[9]). Mauritius, on the other, hand transformed into a diversified economy, based on a wide range of manufacturing industries and tourism. One might argue that Mauritius has a natural advantage over Trinidad & Tobago to attract tourists but the virtually undeveloped northern coast of Trinidad has a great potential as a tourist destination and Tobago also has a lot of potential to further increase its gains from tourism, especially since Trinidad does not suffer from hurricanes and many people sailing in the Caribbean already use its harbours to dock their boats during hurricane season. Mauritius, however, is more exposed to cyclones and has longer trading routes for its manufactured goods and agricultural products than Trinidad. Mauritius has established a pro-business environment and scores as number 23 on the 2011 "Doing Business" Ranking by the World Bank. Its economy is export-oriented, competitive, and diversified, yielding growth rates that are not only robust but also very stable given that it is a small, open, and developing country (see Section 4.3). In particular its liberal trade policies and its high level of financial development (especially concerning foreign direct investments) have contributed to this success story (e.g. Subramanian 2009, Boopen, Kesseven, Jashveer & Binesh 2010). Sugarcane is still grown on large parts of Mauritius, but the high population density (631 people per square kilometer of land area, compared to 261.5 people in Trinidad[10]), development projects, and global competition put pressure on this industry. Whereas Mauritius still has a sugarcane industry which can compete on liberalized world markets without getting subsidised by the government, Trinidad & Tobago recently officially ended cultivation of sugarcane, which had been a subsidised industry for many years.

4.2.4 Culture and Institutions

Both Mauritius' and Trinidad's main ethnicities are people of East-Indian descent. They make up 68% of the population in Mauritius and 40% of the population in Trinidad & Tobago. Descendants of former slaves make up 27% (Mauritius) and 37.5% (Trinidad and Tobago). Notable minorities are people with Chinese and European roots. Both countries have a population of around 1.3 million, with a few ten thousands living on Rodrigues and Tobago.

Both countries are stable democracies with free and fair elections, good human rights records, a free press, etc. (only Trinidad & Tobago had a failed coup attempt in 1990). The parliament and voting system of both countries are based on the British system, and the legal system in Trinidad & Tobago is based on the British system as well; Mauritius' legal system is based on French civil law with elements

[9] *Doing Business* is a yearly report that investigates the regulations that enhance business activity and those that constrain it. It focuses on quantitative indicators such as regulation and property rights so that it is comparable across countries and time.

[10] Data for 2010, source: World Bank

of British common law. Both countries also share a common language for official purposes (English), but in daily life Mauritians prefer to speak a French-based Creole. Many Mauritians are therefore fluent in three languages (Mauritian Creole, French, English).

4.3 Size and Structure of the Economies of Trinidad and Mauritius

Per capita income in Trinidad & Tobago is substantially larger than in Mauritius (Figure 4.1), but Trinidad & Tobago has a more volatile economy (see Figures 4.2 and 4.3). Looking at Figure 4.2, we see where this volatility comes from. The GDP of Trinidad & Tobago partly follows the oil price, the logarithm of GDP and the oil price are correlated by 0.40. The reason of this volatility also explains the recent sharp increase in income. Mauritius suffered from the oil price shock at the end of the 1970s, but since then has managed to grow at a very stable pace. Trinidad seems to be substantially richer in per capita terms than Mauritius, but it is questionable whether the PPP data presented truthfully represent differences in the price level of both countries. The baseline data presented in Figure 4.1 are World Bank data based on different versions of the reports of the International Comparison Program (ICP (2008))[11] Whereas Trinidad was part of the 1993/1996 round, it did not participate in the 2005 report so its GDP levels at PPP (and its price levels in the different years) had to be estimated using the participating countries of the 2005 ICP.

These estimations show that the price level in Trinidad & Tobago increased by roughly 40% between 1993 and 2007 as, for example, reported in Heston, Summers & Aten (2009). The Central Statistical Office of Trinidad and Tobago (CSOTT), on the other hand, measured an increase of the price level between 1993 and 2007 of 99.18%. Assuming that the CSOTT statistics are a better reflection of the changes in the price level in Trinidad and Tobago than the out-of-sample estimation of the 2005 ICP report, the per capita GDP data in Figure 4.1 are biased upwards and the difference between the two countries becomes much smaller. This is indicated by the dotted line, which is an interpolated line between the ICP value in 1993 and an (by the CSOTT inflation rate) adjusted GDP value for 2008. Based on this value Mauritius has been catching up with Trinidad & Tobago in recent years.

[11] The purpose of the ICP is to collect worldwide data on income adjusted by purchasing power parity. Estimating price levels and inflation is an essential part of this exercise. Although most of the countries participate in each round, some are missing for different reason. The values for these countries are estimated using the actual data of the participating countries. Different variables are used to explain price levels in countries and the coefficients derived from this estimation are used to calculate the price levels of non-participating countries.

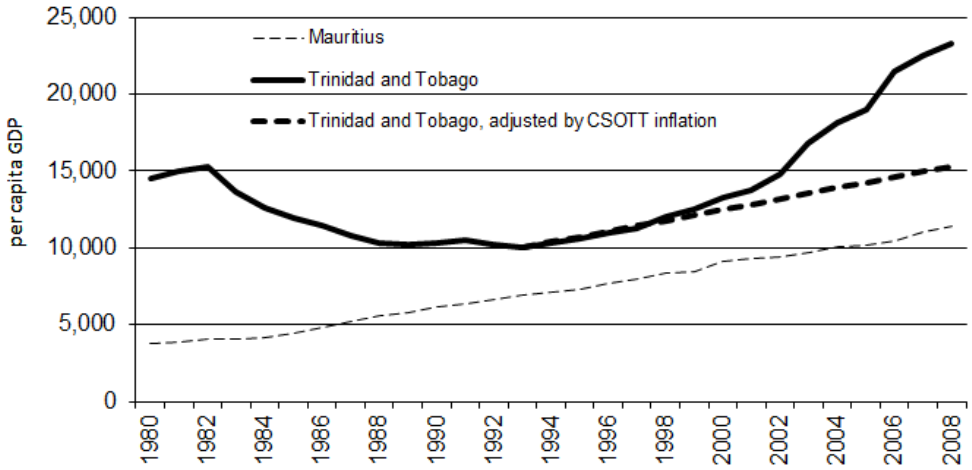

Figure 4.1: Per Capita GDP of Mauritius and Trinidad (1980-2008); in Constant USD (PPP); Source: based on World Bank/ICP (2008) and CSOTT statistics

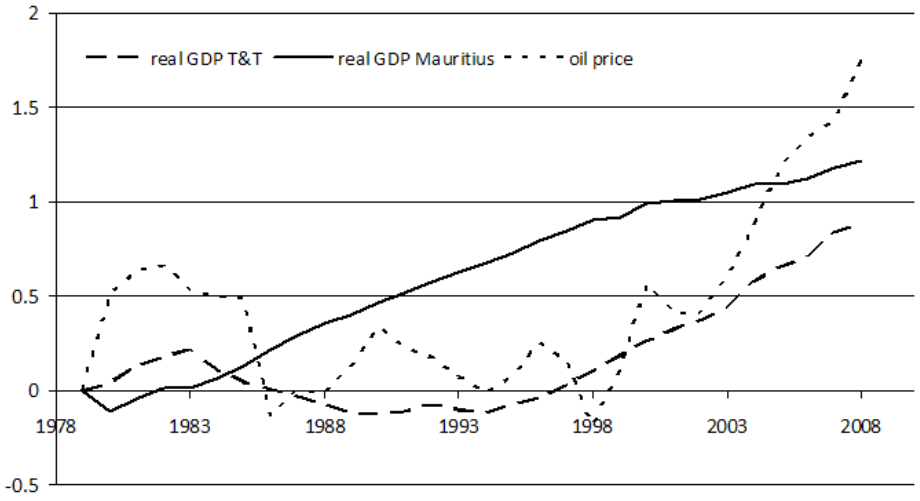

Figure 4.2: Real GDP and Oil Price (Base Year: 1979 = 1; Log Scale; Source: IFS, ICP (2008))

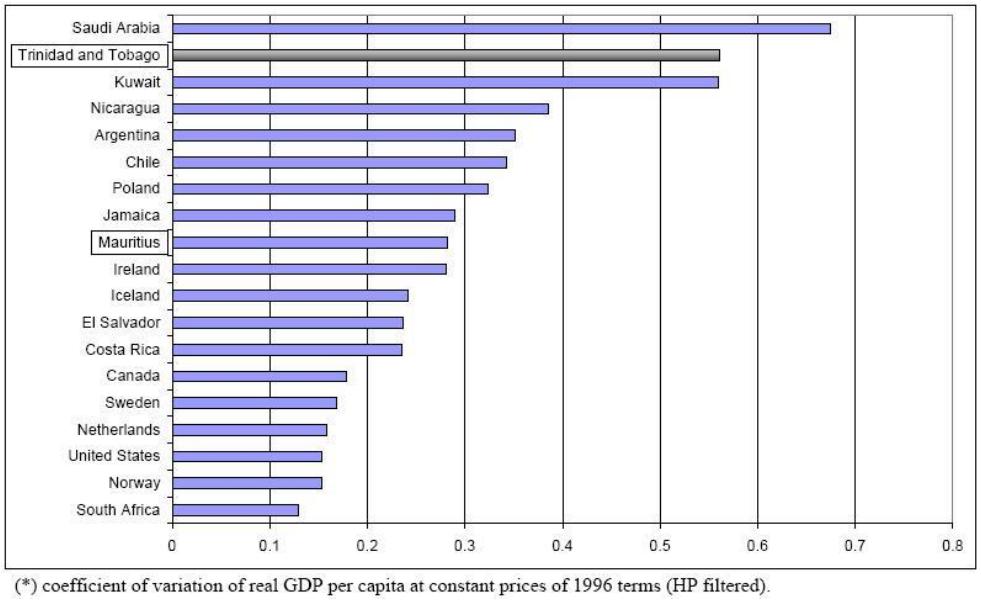

Figure 4.3: Coefficient of Variation of Real GDP Per Capita (1950-2004) at Constant Prices (in 1996 Terms), Source: Artana et al. (2007)

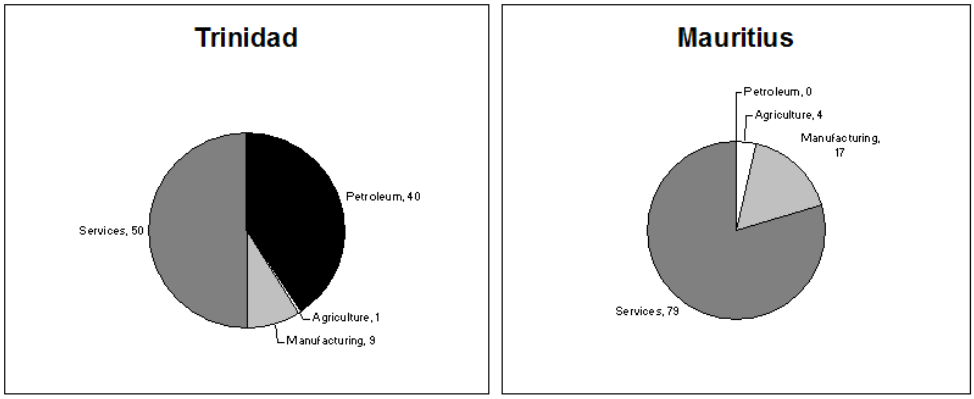

Figure 4.4: Structure of the Economies (2008/2009 average) of Trinidad and Mauritius, Source: National Accounts (Central Statistical Office of Trinidad and Tobago and Central Statistics Office of Mauritius

The structures of the two economies are very different. Whereas production of petroleum accounts for 40% of GDP in Trinidad, manufacturing for 9%, services for 49%, and agriculture for 1%, the respective numbers for Mauritius are 0%, 17%, 79% and 4% (Figure 4.4). The by far largest economic activity in Trinidad is exploration, production, and refining of crude oil and natural gas. The production of food, beverages and tobacco accounts for half of all manufacturing activity. Finance, insurance and real estate are the most important economic activity in the service sector, accounting for 12% of GDP.

The by far largest agricultural activity in Mauritius is sugarcane production and refining. Food and textile production are the most important manufacturing activities and account for 6% and 5% of GDP, respectively. The largest economic activities in the service sectors are finance, insurance, real estate (20% of GDP) and transport, storage and communication (9% of GDP).

4.4 Possible Channels of the Resource Curse

This section discusses different channels of the resource curse that have been proposed in the literature (Van der Ploeg 2011). It is divided into two subsections. The first one deals with channels related to political economy, institutions, debt, income inequality, and education and is (because of limited data in the time dimension) based on the comparison of the two countries. There is some evidence that the natural resource endowment translates into corruption in Trinidad & Tobago although the lack of data does not allow us to quantify the effect or to investigate the exact way the resources influence corruption. The other channels investigated in this subsection do not seem to play a role in Trinidad & Tobago.

The second subsection discusses the role of the real exchange rate and shows how changes in the oil price have crowded out sugarcane production in Trinidad. This subsection focuses on the within-country variation and connects the real exchange rate of the Trinidad & Tobago Dollar to the sugarcane production in the country.

4.4.1 Political Economy, Institutions, Debt, Income Inequality and Education

Mauritius and Trinidad & Tobago have inherited similar institutions from their colonial rulers (see Section 4.2.4) and are so similar that we make inference by comparing them, without relying on a statistical analysis of a large set of countries. Because institutions in both countries were built around the sugar production, they were initially "production friendly" instead of "grabbing friendly" (Mehlum et al. (2006)), i.e. they were built to encourage production and not to enable the elite to extract as many resources as possible (in the case of Trinidad & Tobago, the institutions were set up before the oil deposits were found). But the oil deposits of Trinidad & Tobago might have weakened institutions and led to rent-seeking activities or even conflicts and civil war. The indication for that is mixed: Trinidad did not suffer from civil war although it had a (failed) coup attempt in 1990. The natural resources might have also influenced institutions and governance (Ross (1999)), and indeed, Trinidad scores lower (i.e. worse) than Mauritius on all governance indicators from Kaufmann et al. (2010) (data for 2008) as one can see in Table 4.1.

The governance indicators are based on surveys and other sources. The six dimensions of governance are defined by Kaufmann et al. (2010) as follows: *Voice and Accountability* - "capturing percep-

tions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media". *Political Stability and Absence of Violence/Terrorism* - "capturing perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism". *Government Effectiveness* - "capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies". *Regulatory Quality* - "capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development". *Rule of Law* - "capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence". *Control of Corruption* - "capturing perceptions of the extent to which public sector power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests".

The data are constructed in a way that they can be compared over time and across countries. The scale of all indicators ranges from -2.5 (worst possible governance in this area) to +2.5 (best possible governance in this area), has a mean of zero, and a standard deviation of 1. Based on the number and precision of underlying sources, the authors construct confidence intervals. Simply speaking, the more sources that were available to construct the governance indicator, the smaller the confidence interval. We can interpret the difference between two countries to be significant if both confidence intervals do not overlap. Due to this approach to calculate the confidence intervals, the authors do not provide confidence intervals of different significance levels.[12] Taking averages over all the years available (1996-2009, with some missing years) shows that the difference is smaller than it appears in Table 4.1 (not shown). But the main message from Table 4.1 still holds: *rule of law* and *control of corruption* are in significantly worse shape in Trinidad than they are in Mauritius. The difference in political stability signals the fear of violent change of government in Trinidad (and the access to the natural resources of the country), although there are no objective reasons for this.[13]

The data show that Trinidad scores worse on the rule of law and the control of corruption (the difference between both countries is significant as the confidence bands do not overlap), which is in line with the idea that natural resources undermine institutions and governance because public officials and politicians transform the institutional system to embezzle funds or to use it for patronage. The finding on corruption is supported by the Corruption Perception Index from Transparency International. Their measure shows that Mauritius usually scores better on (the perception of) corruption than Trinidad. That

[12] See Kaufmann et al. (2010) for a detailed description of the methodology.

[13] There are no active terrorist groups in Trinidad. The last election brought the opposition to power and external conflicts are also very unlikely because Trinidad & Tobago is an ally and important natural gas supplier to the USA.

Table 4.1: Governance Indicators, 2008

dimension of governance (standard error)	Trinidad & Tobago	Mauritius	difference
Voice and Accountability	0.53 (0.16)	0.88 (0.14)	0.35
Political Stability	0.08 (0.24)	0.84 (0.22)	0.76*
Government Effectiveness	0.30 (0.21)	0.60 (0.17)	0.30
Regulatory Quality	0.62 (0.22)	0.95 (0.16)	0.33
Rule of Law	-0.25 (0.16)	0.88 (0.14)	1.13*
Control of Corruption	-0.17 (0.19)	0.53 (0.15)	0.70*

Higher values indicate better governance; see Kaufmann et al. (2010) for details on the construction of the standard errors; * indicates a significant difference

this (significant) difference is the result of the oil deposits depends on the validity of our assumption that Trinidad & Tobago and Mauritius are similar enough that large differences can be attributed to the most important feature distinguishing the two countries, i.e. the oil deposits of Trinidad. Although we argue above for this assumption to be valid, the results of our method cannot be scrutinised in the same way as an econometric analysis and should be interpreted with appropriate care.

There is no indication that the natural resources have influenced the democratic system in Trinidad & Tobago. The country has been an active and stable democracy ever since independence and elections are free and fair. While there is some indication of a negative effect from natural resources on institutions, the effect is not directly on the political system (e.g., through rebels trying to get into power) but is more subtle through corruption and the legal system.

There is no indication that the natural resources of Trinidad have hampered growth through conflicts, as no civil conflicts, wars, etc. have occurred in Trinidad in the last decades.

In times of high commodity prices, resource-rich countries have the incentive to borrow excessively (Manzano & Rigobon (2001)), increasing public employment and public transfers, and invest in "white elephants". Public debt stands at 36.1% of GDP in Mauritius (2008) and is expected to reach 49.4% of GDP in Trinidad & Tobago in 2010[14]. The latter does not include the assets in the "Heritage and Stabilisation Fund", Trinidad's sovereign wealth fund, which (at the end of 2009) was equal to around 10% of Trinidad & Tobago's GDP. Because net public debt is similar in both countries, there is no evidence that the previous governments of Trinidad & Tobago have borrowed excessively, but the fact that this resource-rich country has a public debt comparable to Mauritius supports the argument that resource revenues weaken the incentive for state building (Besley & Persson (2010)). Having benefited

[14] Budget Statement 2011 of the Minister of Finance of Trinidad & Tobago on September 8, 2010.

Table 4.2: Difference in Education (in Percent)

	Trinidad & Tobago	Mauritius
adult literacy rate	99	88
youth literacy rate	100	96
gross intake grade 1	97	100
progression to secondary school	90	68
labour force with tertiary education (% of total)	8	9
public spending on education (% of GDP)	4	4

Source: World Development Indicators (latest data available)

from huge windfalls from oil and gas production, we could expect Trinidad to have less debt or even net public wealth. But with a constant flow of windfall profits from oil and gas production, the incentive to install a well-functioning public administration with checks on expenditures and an optimal taxation system is low.

Resource revenues can also change growth perspectives through their influence on the income distribution. There is no evidence for this in our case. In 2005, both countries had a Gini coefficient of 0.39. This values has not changed much as Mauritius scored 0.37 in 1987 and Trinidad 0.39 in 1998.[15]

Natural resources can slow down the accumulation of education (Gylfason 2001), a hypothesis that does not get support from the comparison of Trinidad & Tobago and Mauritius. Trinidad & Tobago even scores better on a number of indicators than Mauritius. Table 4.2 compares differences in education of the two countries, and Trinidad scores higher than Mauritius in most categories.[16] The most striking differences are visible for the adult literacy rate and the progression to secondary school. But the relatively low adult literacy rate in Mauritius is expected to increase over the next years as the youth literacy rate is very close to 100%. Only the low number of students progressing to secondary school in Mauritius is worrisome, but discussing the reasons for this is beyond the scope of this study. The purpose of this exercise is to show that the resource endowment of Trinidad does not have a negative effect on educational outcomes as suggested by Gylfason (2001).

[15] Source: Mauritius: CIA World Factbook (09-13-2011), Trinidad & Tobago: *Analysis of the Trinidad and Tobago Survey of Living Conditions* (2005).

[16] The gross intake in grade 1 in Trinidad is probably a statistical artifact because the value one year earlier was above 100, so some people apparently got counted in the wrong year. The difference in the labour force with tertiary education is probably also not significant: the value for Mauritius is from one year later than the value for Trinidad and both countries are expanding tertiary education.

4.4.2 Real Exchange Rate Volatility

The production of natural resources might have crowded out production in other sectors of the economy of Trinidad & Tobago. Although the focus of large parts of the literature is on the crowding out of manufacturing (and the resulting negative effects on the economy as a whole), there could also be an inefficient crowding out of agricultural production. Benjamin, Devarajan & Weiner (1989) develop a general equilibrium model of Cameroon to investigate the effects of an oil boom on other sectors of the economy. They find a positive effect on other exporting (manufacturing) sectors because of an increase in real wages and the assumption that imported goods are imperfect substitutes for locally produced goods. The effect on the agricultural sector, on the other hand, is negative because domestic costs rise and imported goods are assumed to be perfect substitutes.

To see if Trinidad has experienced an inefficient crowding out of non-oil sectors, we focus on the sugarcane industry. This sector has traditionally exported almost all of its output and was an important source of foreign exchange revenues, but production (measured in tonnes of output) has been declining in the last decades (Figure 4.5).

This section first gives an overview of the exchange rate regime of the Trinidad and Tobago Dollar and subsequently tests if its exchange rate has crowded out the sugarcane industry and if this crowding out was inefficient.

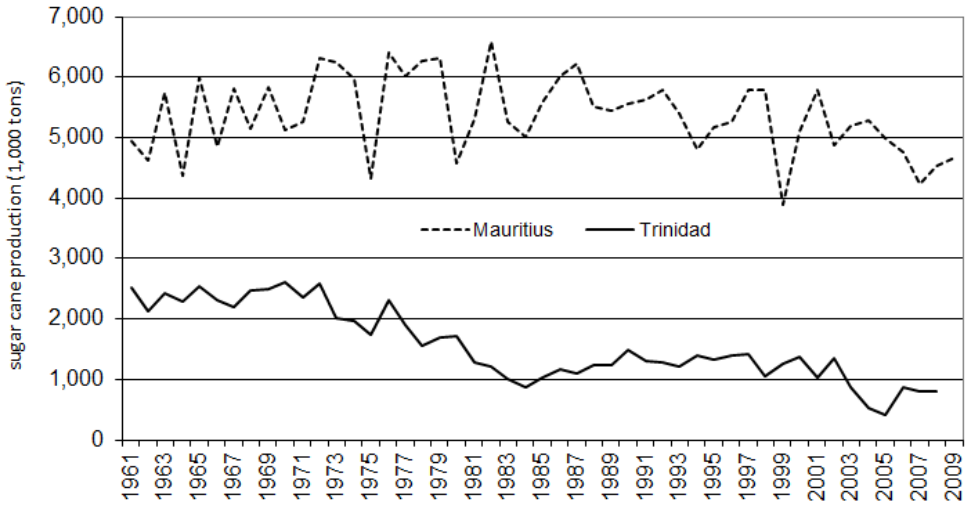

Figure 4.5: Sugarcane Production (1000 Tons), 1961-2009, Source: FAO (2010)

The nominal exchange rate has been managed by the Central Bank of Trinidad & Tobago (CBTT) and is virtually fixed against the US Dollar.[17] Figure 4.6 shows that periods of stable nominal exchange rates are interrupted by sharp devaluations. Through the manipulation of the nominal exchange rate, the CBTT can also influence the real exchange rate. The World Bank provides real effective exchange rates (i.e., real exchange rates that are weighted by the relative importance of trading partners), but its dataset only goes back to 1975. Instead we use real (bilateral) exchange rates that are based on the nominal exchange rate data (TTD/USD) and relative changes in the CPI of both countries.[18] Calculating the real exchange rate this way, one can see that the Trinidad & Tobago Dollar has appreciated (in real terms) against the USD over the last decades (Figure 4.7).[19] Using the bilateral real exchange rates instead of the (multilateral) real effective exchange rates should not qualitatively change the results as both series are correlated by over 0.9.

The data used in the figures and the econometric analysis are summarized in Table 4.3. Both the nominal and the real exchange rates are measured in domestic currency relative to the United States Dollar, so an increase is thus a depreciation of the exchange rate. Because we are using time-series data, we first have to test for the presence of unit roots. Using an augmented Dickey-Fuller test with an intercept and no trend yields a t-statistic of -1.62 (p-value: 0.47) for sugar and -1.48 (p-value: 0.53) for the real exchange rate. The null hypothesis of a unit root cannot be rejected for both series. The differenced series clearly have no unit root (t-values of -9.72 for sugar and -6.10 for the real exchange rate), so both series are integrated of order one. Because both series are integrated of the same order, they could be cointegrated.

Estimation I in Table 4.4 presents the results of an Ordinary Least Squares (OLS) regression of sugar production (in 1,000 tons) in Trinidad & Tobago on the real exchange rate, controlling for the sugar price (to capture the effect of a change in the price of sugar on production), the level of GDP in the US (to capture a wealth effect on demand for sugar), the unemployment rate and the interest rate (as proxies for the costs of labour and capital in Trinidad). There seems to be a strong relationship between the production of sugar and the real exchange rate: a deprecation of the real exchange rate increases sugarcane production. But this result could be spurious as it is not possible to reject the null of a unit root in the residuals using the Engle & Granger (1987) test for cointegration (which is basically a Dickey-Fuller test with different critical values).

[17] According to the Central Bank of Mauritius, the exchange rate of the Mauritian rupee is determined by market forces. Imam & Minoiu (2011) find that the exchange rate of the Mauritian Rupee (in 2006-2007) was in line with fundamentals, supporting the claim by the Central Bank of Mauritius.

[18] Period-average nominal exchange rates and consumer price indices for both countries are from the *International Monetary Fund's International Financial Statistics* (IFS).

[19] This calculation implicitly assumes that the real exchange rate was unity in 1961, but this is only a matter of scaling and does not influence the main conclusions drawn below.

Table 4.3: Summary of Variables

Trinidad & Tobago						
variable	abbreviation	measurement	minimum	maximum	average	source
sugarcane production	SUGAR	1000 tons	420	2610	1565	FAO
nominal exchange rate		TTD / USD	1.71	6.36	3.79	IFS
real exchange rate	RER	$\frac{TTD*CPI_{TT}}{(USD*CPI_{USD})}$	0.63	1.14	0.91	IFS
appreciating real	ARE	*see text*	0.004	1	0.50	
GDP (US)	GDP (US)	in billions of chained 2005 dollars	2894.4	13313.4	7643	US National Accounts
sugar price US	sugar price	cents/kg, constant 2000$	40.03	147.78	58.48	World Bank
oil price	oil price	price per barrel in 2000 USD	7.88	77.79	29.90	Ross (2011-04)
unemployment rate		total unemployment in % of total labour force	4.6	28.1	14.18	World Bank
real interest rate		percentage	-10.38	52.57	6.99	World Bank
Mauritius						
sugarcane production		1000 tons	3883	6582	5377	FAO
real exchange rate		$\frac{MUR*CPI_{MU}}{(USD*CPI_{USD})}$	0.93	1.72	1.28	IFS
change in real exchange rate	dRER	y-o-y change of real exchange rate	-0.21	0.18	0.01	*based on real exchange rate*
economic growth US	growth	y-o-y change of GDP (US)	-1.98	7.19	3.21	based on *GDP (US)*
real interest rate		percentage	1.07	18.30	9.31	World Bank

FAO - Food and Agriculture Organisation; IFS - International Financial Statistics (from the International Monetary Fund);

TTD - Trinidad & Tobago Dollar; CPI - consumer price index of Trinidad & Tobago (TT) or Mauritius (MU)

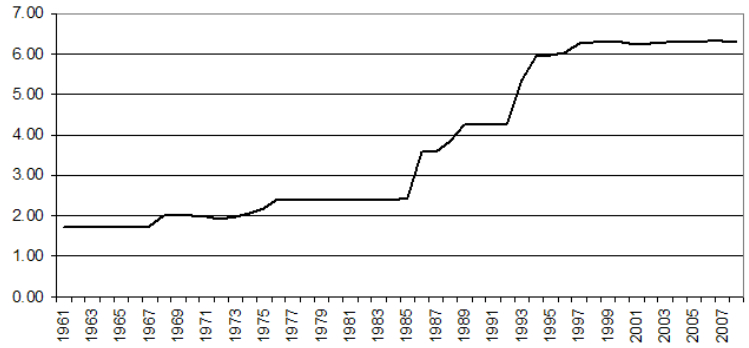

Figure 4.6: Nominal Exchange Rate TTD/USD, 1961-2010

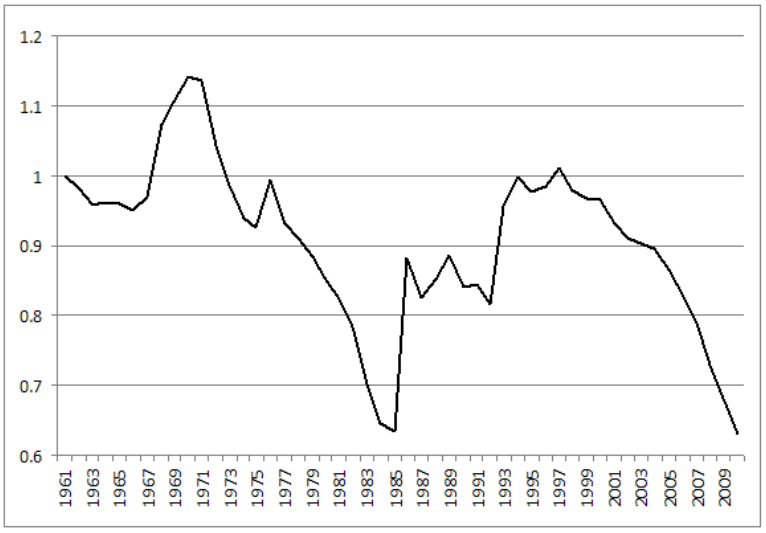

Figure 4.7: Real Exchange Rate TTD/USD, 1961-2010

This regression represents the assumption of a simple Dutch Disease-like relationship between the real exchange rate and sugar production. The coefficient actually has the right sign: a depreciation of the real exchange rate increases production in the (export-oriented) sugar industry. As this does not seem to fully capture the relationship, we introduce the variable *real exchange rate appreciation* (ARE).

The variable ARE is a transformed series of the real exchange rate series and captures the asymmetric effect of a depreciation versus an appreciation of the real exchange rate. The two series are based on the same data; the only difference between them is that in the variable ARE the real exchange rate does not depreciate. Every time the real exchange rate depreciates (in the original series), the value in the transformed series is put at last period's value. Simply speaking, every time the real exchange rate appreciates, the variable ARE "appreciates" as well, but every time the real exchange rate depreciates, the transformed variable stays constant, i.e. it is then set at last period's value.

By including this asymmetric effect of a change in the real exchange rate, we can show that such an asymmetric effect exists. A *symmetric* effect could be the result of a country specialising in certain

Table 4.4: Estimation and Cointegration Test

Dependent Variable: Sugarcane Production in Trinidad (in 1000 tons)							
estimation	I	II	III	IV	V	VI	VII
RER	1110.82**		1540.75***	1372.72	1432.69*	1550.81***	1520.88***
	(516.91)		(287.20)	(873.49)	(760.73)	(338.00)	(296.05)
ARE		2725.63	1391.04***	-1180.78	-1511.52	1346.72***	1407.19***
		(1980.50)	(97.30)	(3128.74)	(2225.88)	(336.16)	(109.51)
sugar price	0.90	-4.42		4.61	6.58	-0.65	-0.62
	(14.99)	(18.06)		(18.26)	(12.81)	(1.89)	(1.86)
GDP (US)	-0.25**	-0.15		-0.30*	-0.31**	-0.01	
	(0.11)	(0.15)		(0.17)	(0.12)	(0.03)	
unemployment rate	-51.49	-56.94		-49.96	-51.26		
	(35.92)	(38.37)		(37.08)	(35.08)		
interest rate	2.46	5.07		0.93			
	(4.26)	(5.58)		(5.96)			
constant	3347.06**	3141.05	-522.59**	3617.72*	3735.76**	-426.41	-476.25*
	(1583.15)	(1823.89)	(241.46)	(1775.91)	(1558.40)	(385.84)	(280.53)
R^2	0.66	0.61	0.91	0.66	0.66	0.91	0.91
adjusted R^2	0.56	0.49	0.90	0.53	0.59	0.90	0.90
Engle-Granger	-3.48	-3.48	-4.03**	-3.35	-3.29	-4.00	-4.00 **
Test for Cointegration							
Johansen Cointegration Test							
trace statistic							
no CV	124.03***		17.39			64.12**	41.99*
at most 1 CV	74.35**		7.15			35.33	15.68
at most 2 CV	46.67					14.71	7.11
max-eigen statistic							
no CV	49.68***		10.24			28.79	26.30**
at most 1 CV	27.68		7.15			20.63	8.57
at most 2 CV	24.64					10.10	7.11
Breusch-Godfrey test for serial correlation (1 and 2 lags, p-value in parentheses)							
1 lag	0.20 (0.66)	0.79 (0.37)	0.86 (0.35)	0.16 (0.69)	0.19 (0.66)	0.71 (0.40)	0.74 (0.39)
2 lags	1.12 (0.57)	1.88 (0.39)	0.87 (0.65)	0.75 (0.69)	1.12 (0.57)	0.75 (0.69)	0.78 (0.68)
sample size	23	23	49	23	23	49	49
***, **, *, significant at 1%, 5% and 10% level							

economic activities (which would be an efficient choice). The asymmetric effect shows that sugarcane production does not return to its previous level after a shock, a temporary appreciation of the real exchange rate causes lasting damage to the sugarcane sector. Because the level of production after the shock has faded is smaller than the pre-shock level of production, the latter is suboptimal.

Estimation II in Table 4.4 shows the results of a regression of sugar production on this transformed variable. In contrast to estimation I, the coefficient of ARE is not significant. Estimations III and IV combine both variables (RER and ARE). Both variables are significant in estimation III, and the Engle-Granger test indicates cointegration, but both findings are not robust to the inclusion of the set of control variables in estimation IV. To increase the sample size, we drop insignificant variables in estimations V-VII. In estimation VII, we are only left with the sugar price as a control variable. We use this as our preferred specification (in contrast to estimation III, where the sugar price is not included) because the variables seem to be cointegrated not only on basis of the Engle-Granger test but also because the Johansen test statistics indicate a cointegration relationship. Furthermore, the coefficients for RER and ARE of estimations III and VII are very similar (and not significantly different).

Estimation VII shows us that the real exchange rate influences the sugar production in the expected direction but not symmetrically in both ways (otherwise the coefficient of ARE would not be significant). An increase in the "real exchange rate", i.e. a depreciation of the real exchange rate, increases sugar production. An appreciation, on the other hand, has a much larger negative effect on sugar production through the coefficient of "appreciating real exchange rate". Estimation IV tells us that a 10 percentage point (compared to the initial level of the exchange rate) depreciation of the real exchange rate increases sugarcane production by 152,088 tons, but an appreciation decreases it by 292,807 tons (152,088+140,719). The permanent loss due to a temporary appreciation of the real exchange rate of 10 percentage points equals 140,719 tons, which is 9% of the average yearly sugar production of Trinidad over the sample period. Whereas the real exchange rate has an (asymmetric) effect on sugarcane production in Trinidad, the price of sugar does not. The coefficient of the sugar price is insignificant in all estimations. Including a variable that depicts only price decreases of sugar (equivalent to ARE that only depicts real exchange rate appreciations), shows that there is also no asymmetric effect of the sugar price on sugar production (see Appendix 4.5).

Temporary shocks to the real exchange rate are crowding out the sugar industry in Trinidad & Tobago (an appreciating real exchange rate makes this sector internationally less competitive). The problem is that even after the shock faded, production does not fully recover again.

Stock (1987) has shown that the parameters in estimation VII are *superconsistent*, i.e. they converge to their true value faster than the conventional rate of convergence of the square root of the sample size. Because the residuals in estimation VII do not suffer from autocorrelation, the coefficients of this estimation have an asymptotic t-distribution and the usual critical values apply (e.g. Enders 2004). The only problem is that the results might be biased, but the R^2 of this estimation is only slightly smaller

Table 4.5: Pairwise Granger Causality Tests

Lags: 2, observations: 47		
Null Hypothesis	F-Statistic	p-value
ARE does not Granger cause *SUGAR*	6.48	0.00
SUGAR does not Granger cause *ARE*	0.47	0.63
RER does not Granger cause *SUGAR*	0.96	0.39
SUGAR does not Granger cause *RER*	1.13	0.33
Lags: 3, observations: 46		
Null Hypothesis	F-Statistic	p-value
ARE does not Granger cause *SUGAR*	3.70	0.02
SUGAR does not Granger cause *ARE*	0.42	0.74
RER does not Granger cause *SUGAR*	1.02	0.40
SUGAR does not Granger cause *RER*	1.01	0.40
Lags: 4, observations: 45		
Null Hypothesis	F-Statistic	p-value
ARE does not Granger cause *SUGAR*	2.81	0.04
SUGAR does not Granger cause *ARE*	0.24	0.92
RER does not Granger cause *SUGAR*	1.13	0.36
SUGAR does not Granger cause *RER*	0.78	0.54

ARE: Appreciating Real Exchange Rate; RER: Real Exchange Rate

SUGAR: Sugarcane Production in Trinidad in 1,000 tons

than the "critical value" of 0.95 proposed by Banerjee, Dolado, Hendry & Smith (1986) and Hendry (1986) (cited in Layton & Stark (1990)). Testing the residuals of estimation VII for heteroscedasticity (White test with cross terms) gives a Lagrange multiplier statistic of 7.83 (p-value of 0.5), indicating homoscedasticity. Our interpretation of the regressions presented in Table 4.4 assumes that the real exchange rate influences sugarcane production and that there is no reverse effect from sugarcane production to the real exchange rate. This is not only a reasonable assumption given the small size of the sector in the Trinidadian economy (see Section 4.3), but also a Granger causality test indicates that real exchange rate appreciation drives sugar production (Table 4.5). The null hypothesis that an appreciating real exchange rate does not Granger-cause sugar production can be rejected at 1% (5%) level if 2 (3 or 4) lags are included in the Granger causality test. Although the results of Granger causality should not be interpreted as a proof of causality (they only tell us that (lagged) values of the *appreciating real exchange rate* help in forecasting (future) values of *sugarcane production* but not the other way round), they support our assumption of causality running from the real exchange rate to sugarcane production and not the other way round.

Table 4.6: Estimation (Mauritius)

Dependent Variable: Sugarcane Production in Mauritius (in 1000 tons)		
estimation	VI	VII
dRER	-99.96	-89.46
	(1043.86)	(1035.00)
growth (US)	94.24*	86.11*
	(49.41)	(46.77)
sugar price	3.14	
	(5.70)	
constant	4935.56***	5143.76***
	(416.90)	(175.01)
R^2	0.08	0.08
adjusted R^2	0.01	0.03
***, **, *, significant at 1%, 5% and 10% level; 45 observations (1964-2008)		

Replicating these results for Mauritius gives a very different outcome. The null hypothesis of a unit root in sugarcane production can be rejected at a 1% level, but the bilateral real exchange rate (again based on nominal exchange rate and CPI data from the International Monetary Fund) apparently has a unit root (ADF statistic of -2.16, with a 10% critical value of -2.60; see also Figure 4.8). Since both series are integrated of different order, they cannot be cointegrated. Table 4.6 shows the results of estimations testing for a relationship between sugarcane production, changes in the real exchange rate (which is a stationary series), economic growth in the US (no unit root), and the sugar price (no unit root). These estimations do not give significant results for the real exchange rate variable; only economic growth in the US (used as a proxy for the global business cycle) has a positive influence on sugarcane production in Mauritius.

Having established cointegration in the Trinidadian data (estimation VII), it is possible to write the estimated equation as an error correction model (ECM). Rewritten as an ECM, we can estimate the speed of adjustment and the short-run parameters. The number of lags included in the ECM is based on comparing the information criteria for the model with different lags. As we can see in Table 4.7, both information criteria prefer the model with one lag.

Table 4.7: Testing for Lag Length

	Number of Lags			
	1	2	3	4
Akaike Information Criterion	13.72	13.78	13.94	14.00
Schwarz Information Criterion	13.96	14.18	14.50	14.73

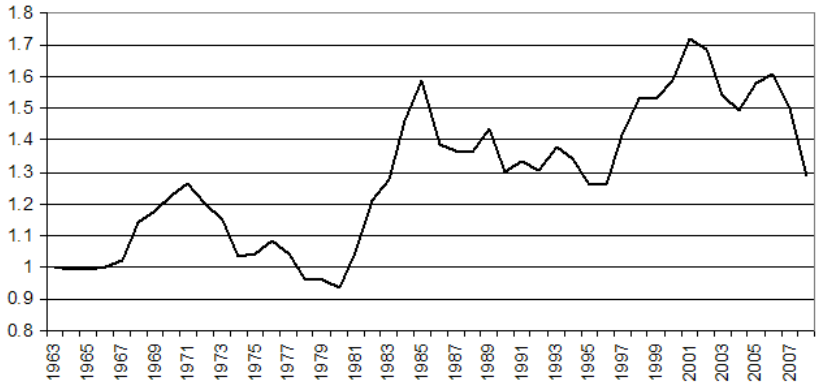

Figure 4.8: Bilateral Real Exchange Rate Mauritius (MUR/USD), 1963-2008

Table 4.8 presents the short-run parameters and the speed of adjustment from the ECM. The coefficient measuring the speed of adjustment is significant at a 1% level and shows that 26.5% of a deviation from the long-run equilibrium gets adjusted in the following year. Except for the coefficient of the change in the real exchange rate (RER), all coefficients are significant at a 10% level. The short-run effect from a change in the real exchange rate is different from the long-run effect. Whereas in estimation VII in Table 4.4 both variables RER and ARE are significant, in the short-run (Table 4.8) only the coefficient of ARE is significant. In the short-run, a depreciating real exchange rate does not influence sugarcane production, only an appreciating real exchange rate does. Whereas the sugar price does not have an effect on production in the long-run, in the short-run there is a negative relationship.

There are several possible explanations for the asymmetric effect we observe in the data. Given that sugar cane production is a process with steep economies of scale due to the importance of processing and refining costs and the fact that sugarcane must be processed within hours after the harvest, it gave rise to the term "Plantation Economy" (Sudama (1979) and Mandle (1972)). Trinidad, for example, had only one sugar refinery (operated by Caroni (1975) Ltd), which led to increasing average costs every time sugar production dropped, making is less attractive for small producers to resume production after the real exchange rate has returned to its pre-shock level. As most farms were very small (there were 6,000 sugarcane farmers in Trinidad in 2002), coordinating decisions was difficult.

Table 4.8: Error Correction Model

Dependent Variable: Sugarcane Production in Trinidad (in 1000 tons)	
	coefficient
Constant	31.5395
	(49.1429)
Speed of Adjustment	-0.2654
	(0.1088)***
Short Run Parameters	
Δ RER$_{t-1}$	-270.9178
	(769.213)
Δ ARE $_{t-1}$	3404.958
	(1872.85)*
Δ SUGAR$_{t-1}$	-0.2616
	(0.1427)*
Δ sugar price $_{t-1}$	-4.0874
	(2.0844)*
R^2	0.31
number of observations	47

***, **, *, significant at 1%, 5% and 10% level

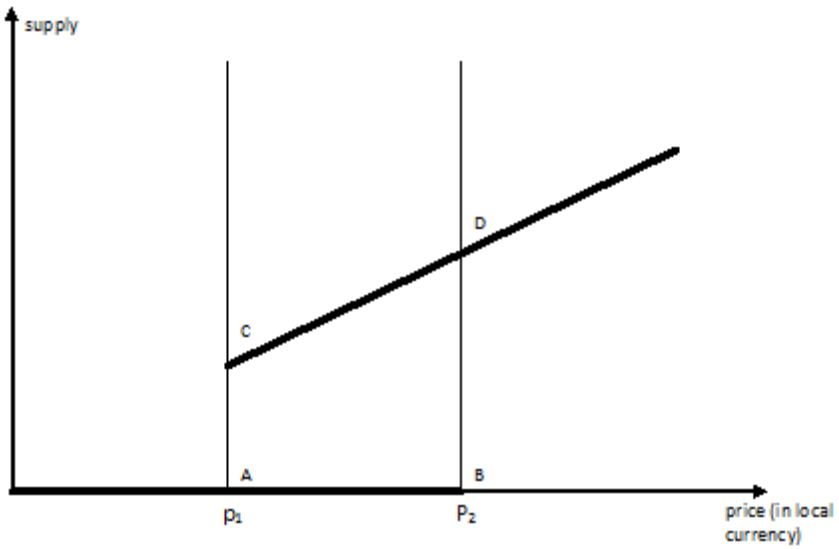

Figure 4.9: Path Dependence (One Firm)

That Mauritius still has a sugarcane industry that can compete with countries such as Brazil shows that small country size, remoteness, and high population density do not prohibit the existence of a competitive sugarcane industry in Trinidad.

Figure 4.9 visualizes how temporary shocks to costs of production can have lasting effects on the supply of a good in the presence of path dependence. As long as the price (in local currency) is below P_2, taking up production is not lucrative. Once the price has been above P_2, the firm makes some initial investments and its incentives change. Now it even continuously produces the good if the price of the good falls below P_2. The firm only ends production if the price falls below P_1. After the price falls below P_1, it has to increase to at least P_2 to have the firm resume production.

Sugarcane production requires very specific physical and human capital (compared to, for example, bananas, another Caribbean export crop). Seukaran Tambie (General Secretary of the Cane Producers Association) told a Trinidadian Newspaper that most farmers with sugarcane producing skills are older than 55 years and that most of them have dismantled their sugarcane specific capital such as trailers and tractors.[20]. Beckford (2005) also points to the importance of capital specificity, human capital, and the negative impacts of risk and uncertainty on the decision of farmers to produce sugarcane in Trinidad.

There are several possible and related explanations why temporary shocks can have permanent effects on sugarcane production, and they probably all have their relevance. Disentangling to what degree the different explanations account for the effects we see in the data is beyond the scope of this paper.

The question remains what drives the real exchange rate of Trinidad & Tobago. Because of the importance of the energy sector for the economy and especially the export sector of Trinidad, the oil price is likely to influence the real exchange rate. Table 4.9 shows that the oil price indeed drives the real exchange rate of the Trinidad & Tobago Dollar. A simple regression (estimation VIII) of the oil price (and a constant) on the real exchange rate gives a significant coefficient and can explain almost 50% of the variation of the real exchange rate. The coefficient is negative, indicating that an increase in the oil price of one USD results in an appreciation of the real exchange rate of 0.004 (compared to an average real exchange rate of 0.91 over the sample period). Estimation IX includes the unemployment rate and the interest rate as control variables. They are proxies for the costs of the factors of production and are both significant. Compared to estimation VIII, the coefficient of the oil price decreases slightly in estimation IX, but the main finding is confirmed: an increase in the oil price leads to an appreciation of the real exchange rate of the Trinidad & Tobago Dollar. Increases in the unemployment rate and the interest rate are significantly correlated with an appreciation of the real exchange rate. The Johansen cointegration test statistics show that the variables in estimations VIII and

[20]Trinidad & Tobago's Newsday, September 12, 2009

Table 4.9: Drivers of the Real Exchange Rate

Dependent Variable: Real Exchange Rate Trinidad (VIII & IX), Mauritius (X & XI)				
estimation	VIII	IX	X	XI
oil price	-0.004***	-0.006***	-0.00015	-0.0002
	(0.0006)	(0.001)	(0.002)	(0.002)
unemployment rate		-0.007***		
		(0.002)		
interest rate		-0.003***		0.018*
		(0.001)		(0.006)
constant	1.03***	1.22***	1.29***	1.26***
	(0.02)	(0.05)	(0.06)	(0.10)
R^2	0.48	0.79	0.00	0.31
Johansen Cointegration Test				
trace statistic				
no CV	19.63**	49.21**	5.69	29.64*
at most 1 CV	4.55**	29.68	0.47	10.58
max-eigen statistic				
no CV	15.08**	27.41**	5.22	19.07*
at most 1 CV	4.55**	13.07	0.47	9.20
observations	49	23	46	26
***, **, *, significant at 1%, 5% and 10% level				

IX are cointegrated, indicating a long-run equilibrium relationship between the real exchange rate and the explanatory variables.

Estimations X and XI replicate estimations VIII and IX for Mauritius. The unemployment rate could not be included in estimation XI due to missing data. The results for Mauritius are, as expected, different than the results for Trinidad. The oil price is not significantly correlated with the real exchange rate. Adding the interest rate as in estimation XI gives a significant coefficient, but the oil price is still insignificant. The parsimonious model (estimation X) also indicates that there is no long-run (cointegration) relationship between the oil price and the real exchange rate.

It seems that the oil price has a strong influence on the real exchange rate of Trinidad & Tobago but not on the real exchange rate of Mauritius. Since the real exchange rate is driven by the oil price, we conclude that the oil and gas sector is crowding out the sugar industry through its effects on the real exchange rate.

A temporary appreciation has a permanent negative effect on the sugar industry. This effect is larger than the positive effect coming from a depreciation of the real exchange rate.[21]

Based on its geography and its soil, Trinidad & Tobago is well-suited for the production of sugarcane. Looking at Mauritius, it is clearly possible to produce sugarcane at a competitive price, even for countries of such a small size. Exploiting this would also create positive external effects for the rest of the economy. Not only does sugarcane production increase the demand for unskilled labour, but the processing and refining needs further inputs (as any other industry) and could stimulate downstream products such as rum, bagasse (which can be used as a biofuel, paper, or food containers), or ethanol. Ethanol especially has a large potential for positive external effects, on top of the positive effects from sugarcane production. It decreases the dependence on oil imports and/or increases exports, increases value-added and employment, and can be used either domestically or exported.[22]

Although Brazil is probably the best-known example of a sugar producer that also produces ethanol, even Mauritius is intensifying its research in this area. The *Mauritius Sugar Industry Research Institute* (MSIRI) focuses not only on pest-prevention, irrigation technologies, plant breeding, etc., but also on the process of turning sugarcane into fuel. In the long-run, Mauritius will have a relative advantage over Trinidad in the production of ethanol because much of the research (e.g. concerning pest control and irrigation) cannot be transferred from other countries to Trinidad due to differences in soil, climate, etc. Because of these learning-by-doing features of research on and production of sugar-based ethanol, Mauritius is building up an advantage in this field compared to Trinidad.

4.5 Conclusion

This chapter shows that the effects of its mineral wealth are not only positive for Trinidad and Tobago. Although the country is richer (in per capita terms) than Mauritius, it suffers from corruption and a weak rule of law. Also, oil production has crowded out sugarcane production, an effect similar to Dutch disease. We use two very different approaches to come to this conclusion. The first approach is to compare Trinidad with Mauritius, two (in many aspects) very similar countries. Because the countries are so alike, we can make inference without having to rely on a statistical analysis of a large

[21] The agricultural sector is not the only one that seems to be influenced by the petroleum and gas industries. Overall, the number of registered business in 2009 was much higher in Mauritius (120,071) than in Trinidad & Tobago (29,483) (source: Central Statistical Office of Trinidad and Tobago and Central Statistics Office of Mauritius). But whether this is a direct (e.g. Dutch Disease) effect or an indirect effect through governmental policies is not clear as it is easier to start and run a business in Mauritius than in Trinidad. Mauritius scores higher on the Global Competitiveness Index (World Economic Forum) than Trinidad. It comes 55th with a score of 4.32, whereas Trinidad & Tobago comes 84th with a score of 3.97.

[22] Sokoloff & Engerman (2000) are rather negative about the role of sugarcane in the development of the Americas, but they look at sugarcane from a historical perspective and how it shaped institutions. This does not necessarily mean that the cultivation of sugarcane in the current economic and societal environment would be bad for Trinidad.

set of countries. Comparing the two countries, we see that Trinidad and Tobago scores significantly worse on measures for corruption and rule of law, suggesting that the production of oil undermines institutions and governance. There is no indication that the resources have undermined the political system as democracy is thriving in both countries.

The second approach is a time series analysis of the effects of oil production on sugarcane production. We show that oil production drives the real exchange rate of the Trinidad and Tobago Dollar, which has an impact on sugarcane production. Because there is an asymmetric effect of the real exchange rate on sugarcane production (an appreciation of the Trinidad and Tobago Dollar reduces sugarcane production by more than a depreciation increases it), we conclude that the crowding out is likely to be inefficient. An *efficient* response would be that the effects of an appreciation and a depreciation are symmetric. We show that a temporary appreciation of the real exchange rate of 10% permanently lowers sugarcane production by around 9% of total average production. We argue that there are several possible (and related) explanations for the asymmetric effect, like steep economies of scale, path dependence in production, and the specific forms of physical and human capital that are required for sugarcane production.

Most of the decline in sugarcane production after a shock to the real exchange rate happens in the short-run. Economies of scale and lack of coordination of sugarcane producers results in a permanently lower level of production. If the country would overcome this coordination problem and would manage its (volatility of the) real exchange rate, it could have a thriving and internationally competitive sugarcane sector, like Mauritius. This scenario is also attractive because Trinidad will enjoy preferential access to European markets under the CARIFORUM-EU Economic Partnership Agreement, which will bring duty and quota free access (to European Union markets) of Caribbean sugar as of October 2015. The main responsibility in this regard lies with the Central Bank of Trinidad and Tobago. It should manage the nominal exchange rate in a way that does not have such negative effects on the economy. A less volatile real exchange rate could increase the number of products that are competitive on the world market and decrease the dependence on oil and gas exports. With stable inflation rates, this means that the nominal exchange rate should be allowed to move more freely.

The data indicate that there are more channels through which natural resources hinder economic development of Trinidad and Tobago. For example, the high volatility of its gross domestic product could have negative impacts on economic growth, but investigating this effect is beyond the scope of this study. Estimating the effect of oil production on (non-oil) manufacturing would also help us get closer to calculating the *total* effect the oil and gas deposits have on the economy of Trinidad and Tobago. Also, the fact that Trinidad scores significantly worse than Mauritius on measures for corruption and rule of law needs be further investigated. This chapter is only a first step in the investigation of the total effects of its mineral wealth on the economy of Trinidad and Tobago and, as indicated, further research

is required to be able to fully quantify these effects and to give guidance on how to increase the benefits Trinidad and Tobago gets from its natural resources.

Appendix

Appendix 4.1: Estimation Results including Asymmetric Sugar Price Effects

Estimation and Cointegration Test

Dependent Variable: Sugarcane Production in Trinidad (in 1000 tons)							
estimation	I	II	III	IV	V	VI	VII
RER	1078.86**		1520.88***	1323.92	1394.46	1555.63***	1523.79***
	(547.18)		(296.05)	(996.78)	(867.63)	(345.13)	(302.49)
ARE		2768.74	1407.19***	-1034.64	-1406.82	1330.26***	1394.79***
		(2008.66)	(109.51)	(3471.43)	(2509.62)	(344.25)	(115.50)
sugar price	0.02	-7.93		3.70	5.91	-0.48	-0.49
	(15.82)	(18.92)		(20.46)	(14.68)	(1.96)	(1.93)
sugar price-	6.84	20.79	-0.62	3.51	3.03	0.46	0.43
decrease	(27.59)	(28.27)	(1.86)	(30.53)	(29.44)	(3.04)	(3.00)
GDP (US)	-0.25**	-0.14		-0.29	-0.31**	-0.01	
	(0.11)	(0.15)		(0.18)	(0.13)	(0.03)	
unemployment rate	-50.49	-53.56		-49.64	-51.06		
	(37.17)	(39.17)		(38.38)	(36.19)		
interest rate	2.22	4.61		1.00			
	(4.48)	(5.69)		(6.19)			
constant	3388.61**	3169.17	-476.25*	3605.52*	3732.88**	-430.17	-483.42*
	(1637.34)	(1849.44)	(280.53)	(1836.42)	(1606.08)	(394.17)	(286.52)
R^2	0.66	0.62	0.91	0.66	0.66	0.90	0.90
adjusted R^2	0.53	0.48	0.90	0.50	0.53	0.89	0.89
sample size	23	23	49	23	23	49	49

***, **, *, significant at 1%, 5% and 10% level

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