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Causes of Civil Wars: The Influence of Natural Resources Extractive Technologies on the Probability of Civil War Outbreak

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1 Introduction

Civil wars currently appear to be as prevalent as they have been in the past decades. While some large-scale violent conflicts have ceased like the ones in Sierra Leone or Angola, new conflicts arise or just repeat like those in Afghanistan, Syria, Iraq, or most recently in Burundi. Although a common phenomenon, civil wars can have as dire consequences as international wars. Economies shrink, ordinary citizens and combatants are killed, and political and social institutions are shattered.

Therefore, one of the aims of political science, and in particular researchers devoted to the study of security and conflict, should be to seek to accumulate knowledge why these violent eruptions occur as it might help to devise remedies to prevent further outbreaks. Along these lines, one of the most prominent factors discerned by researchers in the 1990s seems to be the presence of natural resources. Although they appear to have an independent effect on the probability of civil war outbreak, there is still a large debate on how natural resources are linked to conflict. The debate revolves around various mechanisms ranging from direct explanations which consider natural resources themselves as the incentive to start a rebellion to indirect explanations in which natural resources shape social and political structures which are in turn more susceptible to experience internal violent conflicts.

Amidst this debate, Collier et al. (2009) published their results about the role of natural resources. They focused on what they called the "feasibility" hypothesis which predominately concentrates upon the political, economic, geographic and social structures that enable civil wars. Following this logic, the authors maintained that natural resources are in fact financial sources exploitable by insurgence and thus facilitate the occurrence of rebellions. Referring to case studies, the link between natural resources as a financial source for rebels can not be underestimated. According to Renner and Prugh (2002), it is assessed that UNITA rebels in Angola accrued around $4 billion from 1992 to 2001 and that the RUF rebels in Sierra Leone earned between $25-125 million per year (ibid. 7). For him "[...] about a quarter of the roughly 50 wars and armed conflicts active in 2001 have a strong resource dimension – in the sense that legal or illegal resource exploitation helped to trigger or exacerbate violent conflict or financed its continuation" (ibid. 6).

The results obtained by Collier et al. (2009) seem to corroborate those conclusions on global level. Their "Primary Commodity Exports" (PCE) variable, which attempts to proxy natural resource dependence and hence functions as an indicator for the availability of natural resources, is moderately significant for a the time period between 1960 until 2004. However their findings have been criticised by many authors as it will be explained in the literature review section. Most importantly, critics argued that the PCE variable does not measure what it supposedly should. First, it does not cover the range of identified "conflict" resources by other researchers. The biggest gap seems to be the exclusion of gemstones that are highly prone for exploitation as some researchers argue. Second, export dependence does not discriminate between the influence of different natural resources. Although both oil and gemstones might have an impact on civil conflict, it is commonly assumed that they unfold their "conflict-triggering" effect dissimilarly.

In order to address these shortcomings, this study harnesses theoretical advancements from Ross (2003) and introduces a new variable which captures the feasibility logic better than the PCE indicator. It is commonly assumed that natural resources have to be distinguished according to their "lootability" for rebels. The logic is that the easier it is to loot a natural resource, the easier it is to use it as a financial resource and render rebellions financially feasible. However, this assertion has not been tested so far quantitatively on a larger dataset. Normally, categories are used to distinguish "lootable" resources like gemstones from "non-lootable" resources like oil. Using Ross (2003) concepts of "lootability" and "obstructability", the new variable merges both to the property of *extractability* and thus differentiates between various natural resources based upon this new condition on a newly devised metric scale. Introducing the new variable into the dataset from Collier et al. (2009), it is tested whether in reality the distinction between extractable or not extractable resources provides more explanatory power to the question if it makes sense to differentiate between natural resources on the ground that they vary in their potential to be a financial source for rebels. Instead of the whole global dataset, a subset of Sub-Saharan Africa is chosen as a so-called "most-likely" sample in order to (dis)confirm the validity of the introduced extraction feasibility concept.

The paper is structured in the following way. In the next three subsections the research question including the newly stated hypothesis and the concept of the new variable is introduced. Additionally, the relevance of the study for current academic debate is raised and limitations in its explanatory power are highlighted. In the second section, an extensive literature review is provided based on the work of Collier and Höffler as well as on their critiques (mostly from Fearon) and on

additional research relevant to this study. The latter is mainly comprised of accounts from researchers who attempted to discriminate between different natural resources. In the third section, methodological questions are debated. The conceptualization of the new variable is defended based on previous research, and the calculation, coding and assignment of values to countries is explained in detail. Also, the exact sources of primary data are provided. The fourth section presents the results from descriptive and explanatory statistical processes. After the presentation, an interpretation of the results follows. Lastly, the fifth section concludes with the relevance of the findings and asks which avenues for future research should be of interest.

1.1 Research Question and Statement of the Hypothesis

The goal of this paper is to shed light on a specific approach in the controversy between various explanations of civil war outbreak. The theoretical foundation refers to the work of Collier et al. (2009) which constitutes their most recent work after two previous seminal studies[1]. While former analyses aimed to explain *why* civil wars break out with regard to motivational factors like greed and grievance, the authors deviate from it by claiming that "instead of the circumstances which generate a rebellion being distinctive in terms of motivation, they might be distinctive in the sheer financial and military feasibility of rebellion. [...] that where a rebellion is feasible it will occur."[2] This means that neither greed nor grievance as motivating factors are at the centre of research, but rather the conditions in which rebellions are able to occur. Such conditions can be manifold and therefore the authors explicitly refer to the financial and military pillars of a rebellion (ibid. 3). To put it in a nutshell, military and financial structures have to be favourable for rebels and disfavour the respective government in order to allow the emergence of a rebellion and hence foster civil war outbreak.

Following the logic of the feasibility hypothesis, this paper aims to concentrate on the financial pillar of rebellions with a special focus on natural resources. As it is delineated in the following sections, natural resources play a crucial role for the funding of a broader insurgency. Important work has been conducted so far to address the question *if* natural resources matter (Collier and Hoeffler 1998), *which* kind of natural resources matter[3] (Snyder 2006), *what* kind of

1 Collier and Hoeffler (1998) and Collier and Hoeffler (2004)
2 Collier, Hoeffler, and Rohner (2009, 2)
3 Referring to properties distinct to certain groups of natural resources like lootable vs. non-lootable

natural resources matter (Ross 2006), *when* natural resources matter (Ross 2005), *how* natural resources matter (Humphreys 2005) and *where* natural resources matter (Lujala 2010).

Assuming that natural resources have a distinctive independent and significant impact, this study investigates deeper which kind of resources increase or decrease the risk of civil war outbreak. Former studies focused much on the property of lootablity of resources which supposedly constitute an important source for the financial feasibility of rebellions (see Lujala et al. 2005, Snyder and Bhavnani 2005, Ross 2006 or Ross 2003). Nevertheless, those studies faced important drawbacks. First, they focused extensively on separate natural resources (e.g. primary vs. secondary diamonds or onshore vs. offshore oil deposits) and due to the scarcity of certain resource reservoirs those studies lacked a significant amount of testable cases or experienced that the robustness of their estimation models was dependent on a few cases (cf. Ross 2006, for the case of onshore vs. offshore oil production). Second, treating natural resources separately (e.g. diamonds, coca or oil) renders it more difficult to arrive at general conclusions. This development actually seems odd as the property of lootablity has been assigned to groups of natural resources, but was then often further broken down into specific natural resources in the actual research. Third, natural resources face the ambiguity that it is difficult to assign an explicit causal mechanism to their influence on the probability of civil war. Often, it is not the question if natural resources influence civil war outbreak, but rather how (Humphreys 2005). Furthermore, instances of reversed causality and spurious correlation can produce misdirected theoretical conclusions and policy recommendations (Gleditsch 1998).

This study suggests a new approach theoretically based on already conducted studies which assume that the property of "lootability" plays a significant role to understand the link between natural resources and rebel finance. Instead of focusing on single natural resources *per se*, it is assumed that their lootability property is dependent on a higher level property, concretely the *extractability* of natural resources. It is insufficient to categorize natural resources as either lootable or non-lootable. This dichotomy does not capture the varying degrees of sophistication which are needed to extract a particular natural resource. Furthermore, it creates an interpretative leeway what counts as lootable.

The following example should shed light on this dilemma. Fearon and Laitin (2003) obtain significant results for their oil dummy variable. However, they conceive oil as a non-lootable resource for rebels (or at least not as part of a greed motivated rebellion) and link oil dependence with the weak state hypothesis. Despite this assumption, real world evidence points to the contrary. In fact, the most current and salient rebellion by the Islamic State in Iraq and Levante (ISIL)

ostensibly profits from oil trade which is extracted from captured oil fields in northern Iraq (Sanger and Davis 2014). Revenues were estimated between $1 - $2 million per day or even up to $3 million according to some US agencies (Brannen 2015). Such a financial influx is not negligible thus one should be cautious to categorize oil as a non-lootable resource. Ross (2006) attempted to circumvent this problem and distinguished between onshore and offshore oil production, assuming that the latter is less lootable than the former. However, no reason was provided why rebels should face it harder to exploit offshore than onshore production sites.

What feels like a right decision requires some theoretical support. The author of this study therefore argues that natural resources should be measured by the degree of *extractability* which is a property of the whole extraction process. For instance, certain kinds of diamonds are more easily extractable because they do not require sophisticated devices or foreign experts for the extraction process. Additionally, it is often neglected in studies about lootability that the extraction process occurs within the uncertain environment of civil war. In a civil war, violence is a tool to capture and secure natural resource extraction sites. Hence, the feasibility to extract resources depends on both the natural resource itself and the ability to extract without interference of adversary forces.

Borrowing a conceptual categorization of natural resources from Ross (2003), extractability is composed of *lootability* and *obstructability* of a particular resource. In order to illustrate this point, the following example is provided. Alluvial diamonds which are located in streams or ponds are scattered over a larger territory, and hence are easily lootable for rebels. Furthermore, due to geographical conditions the looting process is very difficult to obstruct as rebels can move from dangerous extraction sites to safer ones. Hence, alluvial diamonds are easier to *extract* during civil war than, for instance, oil which requires trained personnel and which is geographically fixed to a small confined site. The expectation is that the more extractable resources are located in a country, the more favourable conditions exist in which rebellions become feasible due to financial gains from natural resource extraction.

A crucial point is that since the lootability and obstructability properties point to different directions, as explained in the subsequent paragraph, the new variable is conceptualized on a scale in which *low* values indicate the prevalence of natural resources which are *easily* extractable and *difficult* to obstruct. Figure 1 illustrates this reasoning. Hence, the hypothesis is stated as:

H_{1a}: *The lower the extractability property of a particular natural resource, the higher the probability of civil war outbreak*

This statement can also be reversed into:

H_{1b}: *The higher the extractability property of a particular natural resource, the lower the probability of civil war outbreak*

The null-hypothesis which has to be disproved is stated as:

H_0: *The extractability property of a particular natural resource has no effect on the the probability of civil war outbreak*

Following this argumentation, the study will introduce a new variable into the dataset of Collier et al. (2009) which will be called the *extraction feasibility variable*. It is composed of the two measures "lootability" and "obstructability" which are theoretically based on research from Ross (2003) and Snyder and Bhavnani (2005). The exact operationalization is provided in the methodological section. High values indicate that it is difficult to loot a particular resource and that it is easy to obstruct the extraction process. Hence, high values of the variable for respective countries are expected to be negatively correlated with the probability of civil war onset. The reason for this conceptualization lies in the contradictory understanding of lootability and obstructability. In common sense, high values for lootability translate into easily lootable resources and high values for obstructability translate into an easily obstructable extraction process. It would become impossible to add both values in order to create a composite index. Hence, the logic of lootability is reversed. High values for lootability translate into a more difficult looting process. In this case, it is possible to add both sub variables. The hypothesis will be significant in two cases. Either, ceteri paribus, there are more states with conflicts that score low on the new variable than states with high values or states with low values experience more recurring civil wars than states with a higher value.

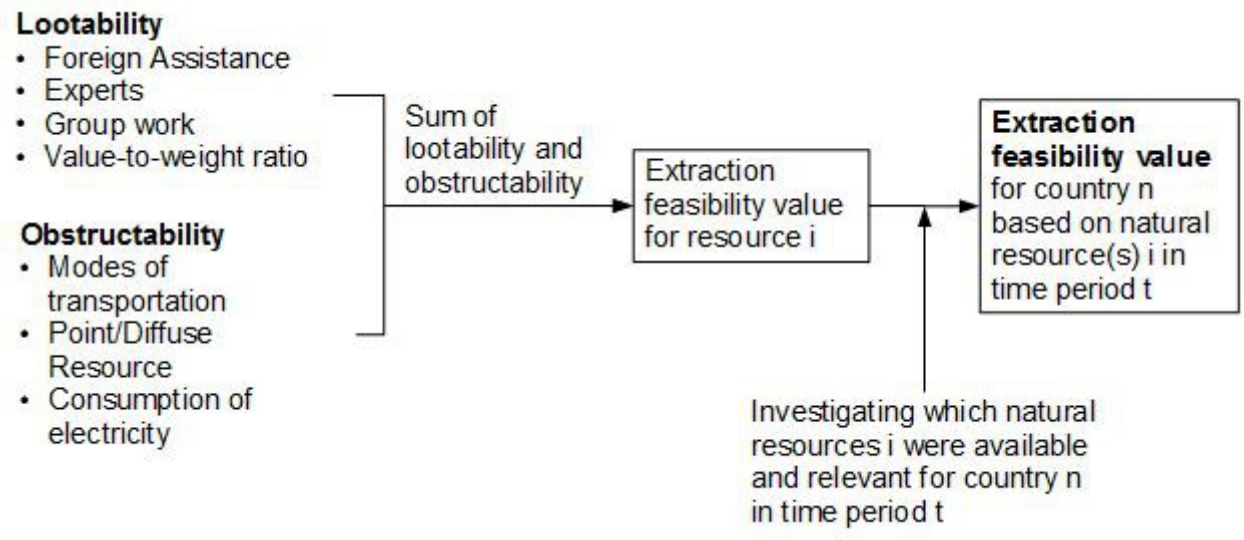

Figure 1: Extraction Feasibility Variable Conceptualization

Typically, the whole universe of cases would be chosen to test this new variable. However, another approach comes from Eckstein (1975). He proposes to test theories according to a *crucial case*, namely one "that must closely fit a theory if one is to have confidence in the theory's validity, or, conversely, must not fit equally well any rule contrary to that proposed" (Eckstein 1975: 118). Gerring (2007) weakens this deterministic approach and interprets it as a most-likely scenario. In such a set up, a case is chosen based on properties which most likely lead to a predictive success of the theory. Hence, the approach is disconfirmatory because the aim is to explore if under the most favourable circumstances the theory holds and thus bears validity. According to this logic, there would be the need to choose one case which would (perfectly) fit the independent variable(s), whereas value of the dependent variable would be the decisive point for (dis)confirmation. Since the hypothesis is formulated in a probabilistic manner, one case could neither be confirmatory nor disconfirmatory. Thus, a sample of cases is required to test the hypothesis. The requirement would be to define a real-world sample of cases which offer the most favourable conditions for the new extraction feasibility variable.

As a result, the sample of Sub-Saharan Africa was chosen due to the following reasons. First, a study of the International Monetary Fund (2012) concludes that "natural resource exports are an important contributor to merchandise exports in close to half of the 45 countries in sub-Saharan Africa" (ibid. 59) and that "natural resource revenues contribute significantly to national budgets in 10 Sub-Saharan African countries, with that number also expected to rise in the coming years" (ibid. 59). Hence, Sub-Saharan Africa presents a sample in which natural resources deem to

play a significant role in revenue structure in many states. This is quite important for the theoretical prediction of the hypothesis because successful rebels should have access to natural resource revenues that are comparable to government revenues, otherwise they will be outspend even if they theoretically could accrue enough money for a rebellion. Second, other researchers sometimes separately analyse (Sub-Sahran) Africa if they use databases covering the globe because much of the knowledge about civil wars derives from this continent and case studies frequently refer to African conflicts. For instance, Humphreys (2005) analyses the effect of oil, agricultural products and diamonds for Africa separately and obtains partly significant results. Corroborating this notion, Smith (2004) obtains significant, although negative, results for the relationship between Sub-Saharan Africa and civil war outbreak in his models using a dummy variable. According to Ross (2006), he also identifies a trend in the research literature which concerns specifically civil wars in Africa "[...] where a rising fraction of the world's civil wars are found" (ibid. 271). Hence, a Sub-Saharan Africa sample should provide in theory a most-likely sample for the expected analysis. If the new variable does not uncover a statistically significant relationship in this part of the world, then it is difficult to imagine that it will hold in other parts of the globe.

Summarizing the intended research of this study, the following aspects are important to bear in mind. The study aims to investigate why civil wars occur. As theoretical foundation the feasibility hypothesis from Collier et al. (2009) is chosen. The feasibility of a rebellion is partly based on financial revenues for the rebels. Natural resources constitute an important source of finance. Rebels can only harness natural resources if those are extractable. The extractability of resources will be calculated by a new variable which is composed on the two indicators (lootability and obstructability) and it will be included into the estimated core model of Collier et al. (2009). Low values in the extractability score translate into easier access to financial revenues by natural resource exploitation and vice versa. Sub-Saharan Africa is chosen as a sample of interest due to former "successful" quantitative research and its overall resource dependence which constitutes a most-likely sample scenario.

1.2 Relevance of the Study

This study aims to mitigate and circumvent problems which arose in many studies of other researchers. First, one of the most prevalent problems in the studies of civil war and the role of natural resources is the reversed causality problem (Ross 2004a: 36–7). The role of natural resources should not be underestimated since manufacturing industries face more difficulties to sustain during civil war than natural resource extraction facilities. Therefore, the share of natural resources to GDP might be exaggerated in comparison with other relevant revenues. Moreover, a lagged natural resource variable cannot overcome this problem because (violent) tensions and incidents often precede full-scale civil wars and anticipation of such an event might lead to a drain of manufacturing industries, thereby artificially producing a higher level of natural resource dependence. The proposed natural extraction variable overcomes this problem since it is not contingent on the overall economy and only focuses on the range of available resources. Since manufactured commodities drop in importance for revenues in the event of a civil war and natural resources increase their share, the extraction variable perhaps approximately captures one of the most important revenue sources for rebels and the government.

Second, another problem pertains to spurious correlation (Ross 2006: 266). A third variable can be responsible for both high natural resource dependency and high probability of civil war outbreak. For instance, bad governance can lead to a dysfunctional economic system in which manufacturing industries cannot develop and bad governance can also lead to grievances among the population, in particular between elites and poor people. In such a constellation, the risk of civil war is heightened, whereas natural resources are not directly causally linked to civil war outbreak.

The extraction variable prevents this kinds of omitted variable bias since it is exogenous to the events unfolding in a state. It is difficult to argue how bad governance or other variables like the motivation of rebels, the ethnic-religious composition within a state, etc. actually determine the degree of sophistication to extract natural resources from the soil. Nevertheless, one caveat has to be raised. Snyder and Bhavnani (2005) argue in his study that government politics in Sierra Leone changed the mode of extraction from artisanal to industrial extraction in the 1970s and 1980s and hence created more stable conditions because artisanal diamonds are more prone to looting. The reverse change in the time after 1985 created an opportunity structure for rebels to exploit. Perhaps it is possible to alter the extraction mode to some degree, but even if this kind of reasoning actually holds, it confirms the expectation of the stated hypothesis that easily extractable resources render

rebellions more feasible. Alluvial diamonds can be extracted by industrial and artisanal means, but the mode of exploitation does not change the geological conditions of diamonds.

Third, referring to various studies, an ambiguous picture emerges about the role and the effect of different natural resources. For instance, some claim that oil can be causally assigned to states with weak institutions (Fearon and Laitin 2003), other claim that high oil dependency actually decreases the risk of civil war by outspending rebels (Collier and Hoeffler 2004) and others relate oil as a lootable resource for insurgents (Ross 2006). The new variable overcomes the problem and focuses on one important property which pertains to all natural resources, i.e. their usefulness to finance a rebellion. This solves also a practical dilemma with regard to available data. In fact, distinguishing effects from particular natural resources led to small samples which natural resources attempt to explain. Hence, explanatory variables are often not robust and lose their significance level once influential cases are dropped. The new variable covers all civil wars (except for those where missing data leads to a list-wise deletion).

Fourth, a more policy oriented reason pertains to the prominence of natural resources in the prevention of civil wars. For instance, Paul Collier was one of the initiator of the "Natural Resource Charter"[4], an initiative that aims to provide governments with information how to manage the wealth deriving from natural resources. Proper administration, extraction and revenue distribution is needed to transform natural resource wealth into prosperity and not into a resource curse. Such an initiative benefits from academic research. Another campaign comes from EITI (Extractive Industries Transparency Initiative)[5] which aims to set standards in revenue and contract openness for states in order to strengthen the position of the civil society towards their respective government. The results of this study can help to understand the financial value of natural resources for rebels and perhaps recommend certain strategies (for instance specific protection of extraction sites) in order to remove conditions which render rebellions feasible.

4 Visit http://naturalresourcecharter.org/ (accessed 8th July 2015)
5 Visit https://eiti.org/eiti (accessed 8th July 2015)

1.3 Delimitations, Limitations, and Assumptions

There are several limitations of this study. First, one consequence of the proposed variable is that it captures *all* relevant natural resources at once. The composite index is calculated by different natural resources which are located within a specific country. However, the variable does not explain which *particular* resource is responsible for a rebellion if there are more than one extractable at the same time. In fact, this is also one of the major criticism of Collier et al. (2009) Primary Commodity Export variable, e.g. by Fearon and Laitin (2003), who shifted their attention to specific natural resources. For instance, a case can arise in which 99% of exports are determined by crude oil which is very difficult to obtain, whereas a rebellion finances itself by selling alluvial diamonds which are very easy to extract. Luckily, this scenario is nevertheless very unlikely. However, this is not contrary to the feasibility hypothesis which states that only the structural conditions have to be favourable.

Nonetheless, the aforementioned problem points at a new one. Since absolute values about available natural resources are not considered except for respective thresholds, the case might arise that although it is very easy to extract natural resources in one country, it does not mean that their absolute value would allow any meaningful resistance against a government which is better endowed due to its own natural resource revenues. This however should be barred by two factors. First, the GDP per capita control variable from the original data set hypothetically captures how much money is indeed available for government to spend on military. Second, a threshold is defined to ban resources that only marginally allow rebel groups to finance themselves.

The second limitation is a further consequence of the new variable; it does not distinguish between the mode of extraction of one resource in various countries. While some countries might face gold extraction on an industrial scale, others might engage in artisanal methods. The new variable will mask this difference. However, the variable will only account for the potentiality of a natural resource. This means that even if gold is extracted on larger scale by industrial means in some countries, the variable will account for the opportunity of rebels to acquire gold also without very sophisticated technical means (if gold would score low on the new variable). Snyder and Bhavnani (2005) illustrated how mode of extraction could be changed for alluvial diamonds.

Lastly, data availability does not allow for precise figures. Sometimes, there is a lack of information for Sub-Saharan countries, especially if it concerns the time period of the 1960s or 1970s. The struggle for independence and weak bureaucratic structures did not allow keeping track of all extraction processes, especially in the case of timber.

2 Literature Review

This paper builds up on work from various authors, in particular on the results of (Collier et al. (2009). The literature review is thematically structured and opens with an account of Collier and Höfflers work and then leads over to studies which criticise and complement their results and are as well relevant to this paper. New insights offered by all mentioned studies are critically examined and then the concept regarding its benefits to the current state of affairs in this spectrum of research is introduced.

One of the first quantitative studies which assessed the relationship between the occurrence of natural resources in a country and its propensity to experience a civil war was conducted by Collier and Hoeffler (1998). Theoretically, the study confined itself to examine the *motivation* of rebel groups, specifically to capture or to secede from a given state based on potential rewards. Assuming that insurgents are rational actors which act as organized groups and thus have to overcome collective action dilemma[6], it is postulated that rebels are calculating benefits and costs then arrive at an utility which has to be positive in order to initiate civil unrest. Motivational factors were suspected to be only based upon economic gains operationalized by per capita income and natural resource endowment. Rebels might be also inclined to fight for economic gains in order to pay off supporters. In both coup d'etat and secession financial reasons play an important role. Distributional aspects within societies were deliberately excluded from the analysis due to a lack of sufficient intra-state data. However, the authors concede that in secessionist wars distributional factors are probably intrinsic. The effect of different ethnic groups in one state was limited to be a proxy for coordination costs in the analysis. Referring to natural resources, the results showed an inverse U-shaped relationship between primary commodity exports to GDP, while the risk of civil war occurrence peaked at 27% dependence level on natural resource export. The interpretation of the PCE variable was that states with a share close below the peak were a target for rebellions due to the possibility to extract money from natural resource exports, whereas countries that had an even higher dependency on primary commodities were in reality often so rich that they could afford to spend enough on military in order to suppress insubordinate groups.

In a later contribution Paul Collier further specified the importance of natural resources for his favoured “greed” hypothesis as explanation of the outbreak of civil wars. His prevailing

6 See Olson (1971 (1965)) for factors which determine collection action dilemmas like transaction costs, opportunity costs and free-riding

argument emphasized the role of greed as a motivational factor in contrast to grievance (Collier 2000: 91–3). The difference between both concepts lies in the result which rebels want to achieve. Greed based rebellions aim to maximize the wealth of the participants. Such rebellions seek for looting opportunities and power is acquired if it enhances the chances to further expand extralegal revenues. An illustrative example often cited in research is the rebellion in Sierra Leone in 1999. For instance, Ndumbe concludes that "greed, which has been the preponderant characteristic of Sierra Leone's ruling elite, has spawned a particular mind-set among disenfranchised groups in the country. This can be summed up in the following equation: diamonds + guns + terror = power + income" (Ndumbe 2001: 104). In contrast, grievance based rebellions aim to change political and social realities for a group within a state. A prevalent feeling of injustice exceeds a certain threshold so that members of the "oppressed" group revolt to remove perceived inequalities or even strive for dominance of their own group. For instance, it is frequently argued that the civil war in Bosnia was primarily based on ethnic hatred. By using quantitative methods Weidmann (2011) arrives at results which supports two hypotheses of ethnic hatred. On the one hand, ethnic groups used violence to create ethnically homogeneous territories which relates to a macroterritorial explanation. On the other hand, "grassroot" ethnic hate between municipalities also appears to account for the violence conducted by Bosnian Muslims, Serbs and Croats.

The natural resource factor could be used to explain both approaches, however Collier argues that individual wealth-seeking is the main rationale of civil wars as he does not find evidence to corroborate the grievance related justice-seeking approach (Collier and Hoeffler 1999). Therefore, he provides four reasons why especially natural resources play such a crucial role for civil war outbreak (Collier 2000: 93). First, primary commodities can be easier taxed than commodities which require organization, assemblage and transaction. Manufactured goods are sensible to taxation since different procedural steps have to be run thus they are more prone to disruption. Furthermore, manufactured goods are often traded in a competitive environment so that harsh taxation would drive the prize of the commodity too high to be still sold. Natural resources are often more idiosyncratic and the supply side allows for more taxable leeway. Second, natural resources are mostly extracted in rural areas. Hence, rebel groups can achieve control over routes leading from and to extraction sites and force companies or local governments to pay taxes for safe transport. Third, depending on the difficulty to extract natural resources from the soil rebel groups are able to exploit deposits by themselves. Instead of accumulating cash by taxation, rebel groups can engage in their own natural resource trade and set prices according to which they believe to

maximize their benefits. Fourth, in contrast to manufactured commodities the origin of natural resources is more difficult to identify once the goods are already placed on the market.

Additionally, primary commodities allow to alleviate important constraints related to the collective action dilemma. Three difficulties arise in the process of organizing an effective rebel group (Collier 2000: 99–100). First, the free-rider problem renders it difficult to motivate potential recruits if the main goal of the rebellion is to provide public goods (as it is the case with grievance based rebellions). Rebels might feel that their input entails such high costs (e.g. risking one's own life) that it is not worth to invest it as long as other people are fighting for the same objective. If others win, then benefits would be evenly distributed to every person even to those who did not participate in the insurgency. Second, the coordination problem renders it difficult to enlarge a small rebellion at the initial stage. People might be willing to fight, but the prospects of a small rebellion are worse than a large one and therefore they wait until the insurgency develops into a meaningful movement. Third, due to the time-consistency problem potential rebels have to discount their gains heavily. In grievance based rebellions the benefits of the rebellion accrue only after victory. On the one hand side, potential rebels might be concerned that the investments over the course of a long rebellion would accumulate so much that promised benefits could never outweigh them. On the other hand, potential rebels have to trust the rebel leaders that they will deliver public goods after they are victorious and got into power. If they lack sufficient credibility, the rebellion will reach a deadlock and will not be able to enlarge its supporter base.

All three mentioned collective action problems point at difficulties to initiate grievance based rebellions due to their focus on public goods, whereas the existence of primary commodities shifts the focus at the delivery of private goods. A situation with natural resource accessibility has several advantages for rebel leaders (ibid.). First, the free-rider problem is alleviated since only those individuals who participate in an insurgency will receive benefits from the taxation of natural resource benefits. Thus, the motivation to join the rebellion in this greed based activity is much higher than in grievance based rebellion. Second, in order to acquire and distribute gains during and after a rebellion to its participants large rebellions are not anymore required. Groups can be relatively small since their primary aim is to obtain financial benefits so that the control over mines or other natural resources might not necessitate a large-scale rebellion which overthrows the incumbent government. Correspondingly, the smaller the rebellion, the more benefits individuals can receive for themselves. Therefore, the coordination problem is mitigated. Third, the time-consistency problem can be solved by direct and timely payments to participating rebels. Anxiety

about rewards after victory wanes due to permanent availability of cash from natural resource trade. Summarizing the results, greed based rebellions are much more likely for Collier since they only have to monopolize violence or build a government-rebel duopoly in order to extract benefits from natural resource extraction.

Subsequent results from a newer study of Collier and Hoeffler (2004) corroborated the authors expectation of the role of natural resources and spawned huge attention towards this approach by academia and policy-related institutions like the World Bank (for instance, see Collier et al. 2003). However, Collier and Höffler (2004) abandoned the motivation based concept and turned their attention to an opportunity model. This shift is due to the awareness that it is very hard to measure the true motivation of a rebel and that misperception of grievances is very common (Collier and Hoeffler 2004: 564). The new approach emphasizes profitable opportunities for rebellions as a necessary condition for a successful rebellion (or at least that it can be counted as a civil war and not just as a low-intensity struggle which quickly breaks down). Evidence of the logit regression model supports the assumption that primary commodities play a crucial role as a financial source of rebellions. Obtaining an inverse U-shaped pattern, the peak is located at around 33% dependence of primary commodity export to GDP with a risk of 22% of civil war, while keeping all other variables at their mean value (Collier and Hoeffler 2004: 574). The non-montonic relationship points at the possibility that heavily dependent primary commodity exporters are exceptionally rich (e.g. the Gulf states) and are therefore capable to oppress any rebel movement. Disaggregating the primary commodity variable, Collier and Höffler accordingly yield the result that oil distinctively influences the probability of civil war outbreak with an moderate impact (Collier and Hoeffler 2004: 580). In the wake of robustness and specification checks, the authors infer that the opportunity explanation matches their results for oil dependence best.

The most recent study of Collier et al. (2009) regarding natural resources is of core interest for this study. Specifying their former research, the authors call their concept the 'feasibility hypothesis', i.e. “[...] where a rebellion is feasible it will occur” (Collier et al. 2009: 2). Relevant factors for feasibility are the financial and the military components. Rebel groups have to have financial sources to fight against government security forces. Hence, natural resources play a crucial role for the financial pillar of rebellion. As Renner and Prugh (2002) write: “The trafficking of arms is closely linked to illegal trade in raw materials such as minerals, timber, and diamonds. Arms and commodities often travel the same routes, in opposite directions. Revenues from commodity sales finance the purchase of arms, ammunition, military equipment, uniforms, and other items;

sometimes weapons are directly bartered for natural resources, drugs, animal products, and other commodities" (ibid. 20). This of course indicates a partial relationship between both the financial and military factor, but not conclusively a determinative one. For instance, mountainous regions in which natural resources are located can also provide military advantages for rebels which are non-monetary.

Based on the Correlates of War dataset (Singer and Small 1994) and the Armed Conflict dataset (Gleditsch et al. 2002), the authors arrived at a core model with nine variables which fall into four broader categories, i.e. economy, history, social characteristics and geography (Collier et al. 2009: 9). Using significance levels ranging from 10% to 1% (and being generous to two variables), evidence corroborates the effect of GDP per capita, GDP per capita growth, primary commodity export, peace history, being a former French colony, social fractionalization, proportion of young men, population size and mountainous region on the probability of civil war outbreak. The primary commodity variable is at special interest here. Empirically, it is only significant at 10% level so that it actually lost much of its explanatory strength in the more updated dataset compared to the older studies of Collier and Höffler. The inverse U-shaped pattern remained with a peak at 25% primary commodity export to GDP dependency. Regarding the interpretation of this result, the authors cautiously emphasized that there might be different causal processes at work and concluded based on other studies (e.g. Lujala et al. 2005) that in the most likely case rebels use natural resources to finance their activities.

Nevertheless, the work of Collier and Höffler sparked critical reactions in the 2000s. One of the most prominent critiques emanated from Fearon and Laitin (2003) and Fearon (2005). Although they also do not find evidence for grievance as a distinctive source for civil wars, they assume that insurgencies are linked to institutionally weak states. Concretely, the authors "[...] hypothesize that financially, organizationally, and politically weak central governments render insurgency more feasible and attractive due to weak local policing or inept and corrupt counterinsurgency practices". The difference to Collier and Hoeffler (2004) is that while the opportunity hypothesis attempts to identify factors that can be directly exploited for a rebellion (e.g. low GDP per capita translates into low opportunity costs for rebels to abandon their "normal" life), the weak state hypothesis focuses on the institutional structure of the state as a source of contest (e.g. low GDP per capita translates into less financial means to pay for security forces or social programs to strengthen the cohesion within a state, therefore rebels have more leeway to operate for their own benefit).

Although both hypotheses do not have to contradict each other, their causal processes differ so that as a consequence only empirical findings can arbitrate between both. Hence, in their

analysis, Fearon and Laitin (2003) focused on the role of natural resources from the point of view how they shape national institutions. They stated in their hypothesis that especially high oil export dependency renders states weak since political rulers are less dependent on tax revenues from their people thus the motivation to create a "socially intrusive and elaborate bureaucratic system" is low(Fearon and Laitin 2003: 81). Furthermore, from an incentive point of view, oil dependency increases the value to control the state apparatus which extracts the benefits of export. The results of their multivariate analysis corroborated their assumption that oil exports play a significant role in the prediction of civil war outbreak. However, in contrast to Collier and Höffler's assumptions, Fearon and Latin come to different conclusions. First, evidence does not point to a inverse U-shaped, but a linear relationship between oil exports and the probability of civil war. Furthermore, they criticise the primary commodity variable because it covers too many different natural resources of which many are hard to exploit for financing purposes. Second, oil revenues are hard to obtain without control over the state, therefore the authors uphold their assumption that oil has an indirect cause on civil war outbreak through the impact on domestic institutions and national bureaucracy.

In his study of 2005, Fearon scrutinized the primary commodity variable of Collier and Höffler and could not find support for their postulated findings. He raised several points in which he criticised that their findings are too dependent on the format of their dataset and the conceptualization of various variables (Fearon 2005: 485–6). First, by changing the dependent variable from 5-year-period to country-year the primary commodity variable loses its significance. This is due to two factors. On the one hand, independent variables can more consistently account for changes in upcoming years and are not "lagging" behind. On the other hand, additional sixteen wars could be used for the estimation process because missing data led to list-wise deletion of many cases in the calculation process of Collier and Höffler. Since civil wars constitute a rather rare event, it makes a difference to base the estimation on either 52 or on 68 cases (of course this varies according to the model specification). Second, the parabolic (inverse U shaped) relationship between the primary commodity variable and civil wars accounts wrongly for the stepwise decrease in the increasing function. Fearon instead proposes to use a logarithmic function which captures the trend more accurate. This is due to the especially large confidence interval for highly dependent countries regarding their risk to face a civil war (Fearon 2005: 495). Third, a major critique rightly refers to the kind of commodities which are covered by the PCE variable. Although it includes oil, it actually excludes important natural resources like gemstones or drugs that have proven in various case studies to be an important financial source for rebels. For instance, Labrousse (2005) illustrates how ideological very dissimilar groups like the FARC rebels in Columbia and Taliban in

Afghanistan implement similar strategies to benefit from drug trade. Along these lines, Fearon argues that the use of oil for financing a rebellion seems unlikely due to the difficulty to extract and sell this commodity (Fearon 2005: 487). This constitutes an important point which is investigated in the empirical section. Alternatively, Fearon remains at this assumption that high oil exports are an indicator for state weakness.

In summary, according to Ross (2004b) many other studies corroborate the significance of the oil variable, but there is no agreement which causal mechanism actually dominates this correlation (e.g. state weakness vs. incentive based explanations). Referring back to the PCE variable, there is a strong empirical correlation between oil exports and primary commodity exports which hints at the dominant role of oil within Collier and Höffler's PCE variable. Moreover, the primary commodity variable seems only to be relevant for larger countries (12.2 million citizen plus) (Fearon 2005: 494). In sum, these findings point at the weakness of the PCE variable to accurately capture the roles of various natural resources. First, it combines too many different resources. Second, there are too many interpretations possible of this variable and only proper control variables can reveal which mechanisms actually take place.

Analogous to Fearon (2005), other scientists followed suit and their main task generally became twofold. First, examining if different kinds of natural resources have a varying impact on the probability of civil war. Second, investigating which kinds of causal mechanisms lie behind distinctive natural resources. According to this scheme, Ross (2003) analysed several natural resources which were comprised of gems, opium, oil, timber, coca, copper, coltan, diamonds, cobalt, coffee, natural gas, gold, palm oil and more along three dimensions: lootability, obstructability, legality. Distinguishing between lootable and non-lootable resources, he argued that the former resources point at rebellions and riots (non-seperatist conflicts), whereas the latter ones ignite separatist conflicts. More importantly, he hypothesized that lootable resources (like alluvial gemstones) allow participants to finance their rebellion, whereas non-lootable resources (like oil fields) benefit mostly the state since only she can guarantee security for high-skilled workers and required investment capital (ibid. 56-57). Furthermore, Ross (2003) argues that lootable resources can create disciplinary unrest among government security forces who want to benefit from the trade by themselves, while non-lootable resources allow for more consistent taxation of the extraction companies without fearing disorder of one's own security personnel (ibid. 58).

In a subsequent study, Ross (2004a) explored various causal mechanisms based on thirteen case studies. Remaining with the results for the onset of civil war and not considering all other tested hypotheses, he did not find support for the “looting” hypothesis from Collier and Höffler

which states that rebels did not use natural resources to grow before a large-scale civil war breaks out (ibid. 50). However, this does not run counter to the feasibility hypothesis that assumes post-civil war onset lootability. Nonetheless, he finds evidence that oil, nonfuel minerals, gemstones, and illicit drugs are correlated with civil war onset but he could not specify which causal mechanisms are behind these results since neither greed nor grievance could account for the observed conflicts. His most important finding states that actually natural resources work with various causal mechanisms simultaneously (ibid. 62).

A crucial contribution to the understanding of lootability comes from Snyder and Bhavnani (2005). He correctly asserts that studies of civil war often have a selection bias by analysing cases in which civil wars occurred, whereas neglecting at the same time cases in which the same natural resources are present but with no adverse effect. He therefore includes a further explanation based on a revenue-centered perspective (ibid. 564).The argumentation is threefold. First, the resource profile of a state should distinguish between lootable and non-lootable resources. Second, the mode of extraction (arisanal vs. industrial) has an independent effect on civil war onset. Third, the way in which rulers spend their money from natural resource revenues also affects the probability of civil wars. The first step is identical to Ross (2003).

The logic behind refers to an opportunity structure for rebels. Lootable resources can provide revenues for rebels to initiate a civil war, whereas non-lootable resources favour governments since their extraction process is easier to tax and to monitor due to the greater organizational and financial investments. Along these lines, the second step includes a further dimension, i.e. the mode of extraction. The authors argue that "[...] civil war, in countries rich in lootable resources is lowest when nonlootable resources are the dominant source of wealth in the economy. This is because nonlootable resources provide the most favorable revenue opportunities for rulers. By contrast, the risk of state collapse and civil war is highest when lootable resources are the main source of wealth, and the dominant mode of extraction is artisanal. This is because artisanal extraction of lootable resources provides the least favorable revenue opportunities for rulers. Finally, the combination of lootable resources and industrial extraction generates an intermediate risk of state collapse and civil war." (emphasize by the authors) (Snyder and Bhavnani 2005: 569). Hence, artisanal mining increases the risk of civil war since it favours rebels, whereas industrial mining decreases the risk of civil war since it favours the government. Lootable natural resources can be extracted in both artisanal and industrial approaches. Thus, shifting from one to the other increases or decreases the risk factor. Corroborating this claim, the authors provide three case studies about Guinea, Ghana and Sierra Leone. Ghana remained peaceful in the 1980s and 1990s

because its opportunity structure was largely dominated by industrially extracted gold deposits and Guinea remained moderately peaceful since its opportunity structure was mostly shaped by industrially extracted alluvial diamonds (lootable resource) and industrially extracted bauxite (non-lootable commodity). In contrast, industrial mining shifted in Sierra Leone in the 1980s to artisanal mining of alluvial diamonds which created an opportunity structure that allowed rebels to create crucial revenues.

Breaking down the effect of natural resources even further (from "lootable vs. non-lootable" resources to the effect of single resources), one of the most investigated research areas pertains to the influence of diamonds on the probability of civil war outbreak. Lujala et al. (2005) claim that the occurrence of secondary (alluvial) diamonds leads to higher risks of rebellion than the occurrence of primary (kimerblite) diamonds. This is due to the higher degree of lootability of secondary diamonds which creates favourable extraction conditions for rebels. This reasoning is very close to the one of Snyder and Bhavnani (2005), but the authors first deviate because they do not distinguish in the mode of production applied but remain at the structural properties of diamonds and second they proceed further and link the presence of secondary diamonds to a higher degree of grievance in ethnically divided countries because due to the lootability of secondary diamonds those can work as a catalyst for conflict. Additionally, secondary diamonds should appear to be more influential in poor countries with a low GDP per capita.

The statistical results are striking. According to their evidence, neither primary nor secondary diamonds can significantly explain the onset of civil war. Also, the mere presence of diamond deposits cannot explain the variance of the dependent variable. However, primary diamonds seem to be negatively linked to conflict occurrence in highly ethnically fractionalized countries, whereas secondary diamonds have a conflict enhancing effect. Furthermore, secondary diamonds have a positive statistical effect on the incidence[7] of civil war. Other investigations about the role of diamonds come from Humphreys (2005). Investigating greed, grievance, feasibility, weak states and sparse network mechanisms the author obtains significant results for oil and diamond measures in an African as well as global dataset. However, both natural resources are not linked through the greed hypothesis, but evidence rather points at a weak state link. Both past oil and diamond production (per capita) have a conflict enhancing effect on especially weak states, but a probable conflict diminishing effect on already strong states (measured by Polity IV). According to Humphreys (2005), it appears that different causal mechanisms are at work not only depending

7 Different than onset of civil war. Incidence codes every year in which a civil war occurs as one (in contrast to duration measures which receive +1 per year or are coded as missing in some datasets)

on which natural resource is extracted also on the state structure which underwent the extraction process. Another study conducted by Ross (2006) finds no support for the relevance of secondary diamonds, whereas the primary diamond variable is significant in all instances in which the dependent variable is a specified civil war (i.e. separatist, ethnic, ect.). However, he raises caution that diamonds rarely occur in the whole dataset (only 12 out of 90 civil wars contain the presence of diamonds).

Following the line of argumentation on the diamond variable, another well researched field pertains to oil. Based on the findings of Fearon and Laitin (2003), several other studies attempted to falsify, extend and refine certain hypotheses linked to this variable. For instance, Soysa and Neumayer (2007) used a new dataset which does not capture oil exports but oil rents. They wanted to clarify between two competing hypotheses from Collier and Hoeffler (2004) and Fearon and Laitin (2003). The former contends that high levels of natural resource dependence (especially oil) leads to a decrease of the risk of civil wars because governments can outspend would-be rebels. The latter asserts a linear relationship between oil dependency and civil war proneness due to the weak state link. Furthermore, their study distinguishes between a measure of mineral[8] as well as a measure of energy resources[9]. The results contradict Fearon and Laitin (2003) since they do not find a statistical significant relationship between oil exports and civil war onset in their period of interest (1970-1999, instead Fearon's model which extends to 1945-1999).

Energy rents seem to matter in the dataset from Collier et al., but not in Fearon and Laitin's model. Mineral rents are insignificant in all models. Reducing the threshold from 1000 battle deaths to 25, the oil export variable regains significance. In sum, energy rents and oil exports are relevant in low scale conflicts (in the period from 1970-1999). Nevertheless, there is no clear interpretation possible which kind of mechanisms worked behind the violent incidences. Another study comes from Smith (2004) who investigates the role of boom and bust cycles in oil prices. Using an oil export to GDP variable and separate measures to account for rapid increases and decreases in world prizes for crude oil, he does not find a statistical significant relationship between boom or bust periods and civil war.

Another interesting analysis was conducted by Ross (2006) who distinguished between onshore and offshore oil production sites. In all his estimated models onshore production is linked to higher probabilities of civil war onset. In contrast, the offshore variable was only linked to nonethnic and nonseparatist conflicts. However, he acknowledges that his results are highly

8 Comprised of "bauxite, copper, iron ore, lead, nickel, phosphate rock, tin, zinc, gold, and silver" Soysa and Neumayer (2007: 206)

9 Comprised of "oil, gas, and coal" Soysa and Neumayer (2007: 206)

dependent on some few cases like Iran. The onshore vs. offshore distinction actually bears the logic of lootable and non-lootable resources. Whereas the former ones can be captured by rebels or secessionist during the rebellion, the latter requires the control of the national government and thus is practically not lootable during the conflict.

The last development in research about natural resources which has a theoretical impact on this paper pertains to the role of geographic measures of natural resource deposits. Buhaug and Lujala (2005) raise awareness of the problems associated with country level measures. For instance, big countries like Russia or India might have resource deposits which simply by a measure of scale cannot affect certain conflicts in remote areas (for instance, it is difficult to argue how diamond or other deposits in Siberia affect the civil war in Chechnya). They also argue that it does not matter if 20% or 80% of a state a covered by mountains, it only matters if rebels are actually using mountainous regions for their insurgency.

The authors therefore make a plea for the use of Geospatial Information Systems (GIS). Those can, for instance, locate rebel movements and natural resource deposits precisely and test for overlap. One of their empirical findings was that "even in countries that possess easily exploitable resources, nearly half of the conflicts do not overlap with the lootable resources" (ibid. 410). In the same vein, Le Billon (2001) argues to distinguish between point vs. diffuse resources as well as between proximate vs. distant resources. Point resources are geographically strongly confined, whereas diffuse resources are scattered and can be extracted in larger areas. Proximate resources are close to the capital of the respective country, while distant resources are at remote places from the vantage point of a capital. He derives at a fourfold typology with different kind of civil war appearances. Point resources which are closely located to capital should lead to coup d'étas since the control of the government becomes crucial. In contrast, point resources in a larger distance from the capital should motivate for secession. Diffuse resources close to the capital should result in a rebellion which does not require state control and diffuse resources far away from the capital corroborates warlordism.

In sum, there is plenty of research investigating the relationship between natural resources and civil war onset. In this realm, Collier and Höffler dominated the discourse for a long time due to their advanced econometric techniques and the application to ongoing conflicts, like the one in Sierra Leone. However, the debate has greatly diversified and investigates alternative causal mechanisms than the ones proposed by Collier and Höffler. This study harnesses recent theoretical insights and explores deeper if the research which aspires to differentiate between lootable vs. non-

lootable resources can withstand a test on a larger sample only based on this property. However, as explained in the further section, the differentiation is more elaborated than a twofold categorization.

3 Methods

This section provides the conceptualization of the new variable and then proceeds to the calculation part which will present all relevant figures regarding the extraction feasibility variable in relation to different natural resources. In the next step, it will be explained what data will be used to calculate the values of various countries in Sub-Saharan Africa. Lastly, the statistical procedures and models are described.

3.1 Conceptualization

The coding scheme of the new variable is based on Ross (2003) (and also inspired by Snyder and Bhavnani 2005) who conceptualized three dimensions which affect the probability of civil war outbreak with regard to natural resource. Those consists of "lootability", "obstuctability" and "legality". The first two concepts are used to calculate for every particular resource a distinctive value, whereas the latter one is omitted due to the following reasons. First, with the exception of drugs, all other natural resources are commonly legal to buy and sell. Using a legality dimension would only artificially increase the value of the variable for drugs which is not even used for the Sub-Saharan sample. Second, if it had been desired to analyse bans and embargos on certain products, then this would have only made sense if it is controlled which states participate in an international ban of products, how long these bans last and if they were properly enforced at all. Third, due to the aforementioned reason, it would be necessary to investigate the feasibility structure outside a particular country which would require a completely different theory pertaining to transnational linkages and rebellion, in contrast to a one state approach. There is much benefit to investigate transnational influences on rebellion as conducted by Salehyan (2011, c2009) or Gleditsch (2007), but this remains outside the theoretical scope of this paper.

Referring back to the two dimensions of "lootability" and "obstructability", Ross (2003) roughly defined the first one as "[a resource] which […] can be extracted and transported by individuals or small teams of unskilled workers. Drugs, alluvial gemstones, agricultural products, and timber are relatively lootable; deep-shaft minerals and gemstones, oil, and natural gas are

relatively unlootable" (ibid. 54). Moreover, he defined "obstructability" as "a resource is obstructable if its transportation can be easily blocked by a small number of individuals with few weapons; it is relatively unobstructable if it can only be blocked with many soldiers and heavy equipment". Harnessing this notion but partially deviating from Ross (2003), the "lootability" dimension is broken down into four components and the "obstructability" dimension is broken down into three components. The final variable is the sum of all seven components according to each type of natural resource.

The four variables for "lootability" are:

1) Foreign assistance needed for technological expertise	1 = mostly foreign companies 0.5 = foreign and national companies 0 = national companies dominate
2) Experts at the extraction site are required	yes = 1; no = 0
3) In order to extract one unit of the respective natural resource more than five individuals are needed	yes = 1; no = 0
4) The respective natural resource has a low value-to-weight ratio	1 = low value-weight ratio; 0.5 = medium value-to-weight ratio 0 = high value-to-weight ratio

The three binaries for "obstructability" are:

5) Visible and easily destroyable modes of transportation	1 = static transportation 0.5 = limited modes of transportation 0 = flexible choice of transportation
6) Natural resources are point resources in contrast to diffuse resources	yes = 1; no = 0
7) The extraction process requires the consumption of electricity	yes = 1; no = 0

The following reasons are provided to explain why those four factors are determinants of the "lootability" property of a resource and should be included into the conceptualization of the overall extraction feasibility variable.

First, foreign assistance requires the involvement of technology which is not available within the country of interest. Even if extraction sites are already explored, civil war conditions render it difficult to obtain material or devices from foreign companies to continue the exploitation

over a longer period. Rebels as not recognized non-state actors might face difficulties to acquire relevant technology for their captured extraction site. As Renner and Prugh (2002) write: "Governments tend to have the capacity to extract whatever resource is found on their territory (if need be, relying on the technical expertise and capital of private companies). By contrast, rebel or warlord forces often have limited technical and financial resources" (ibid. 12-13). Furthermore, "[...] being capital-intensive, extractive industries provide only a limited number of jobs, and many of those go to skilled technicians from developed countries" (ibid. 16). Hence, dependence on foreign technology should have a rather negative effect on the financial potentiality of natural resources for rebel group purposes. The difficulty of such a process can be seen by work from Ross (2005).

He introduced the concept of "booty futures", whereby rebel groups promise foreign companies access to natural resources *after* a successful civil war occurred and in exchange they expect financial support from those companies during the rebellion. Such techniques are used mostly in the beginning of the civil war, when one party is too weak to exploit natural resources by itself. However, this process is far from being perfect and requires additional efforts of rebels. This variable is coded as 1, if the natural resource is commonly extracted by technologies deriving from the US or Europe. It is coded as 0.5, if industries are mixed with international and national companies and it is coded as 0, whenever national of African companies have been in charge of the extraction process.

Second, specific natural resources are located far under the soil or at places which are not easily penetrable for insurgents. Once a civil war is initiated, rebels face the difficulty to continue the extraction process of captured extraction sites. Since experts leave their workplace or the even the country due to violence and uncertainty about future business this gap has to be filled by other or the same experts who are either affiliated with the rebel group, expect major benefits for themselves or have to be blackmailed or forced to implement their proficiency. Hence, requiring experts for the extraction process should decrease the feasibility of civil war. Following the coding scheme, a 1 will be inserted when experts are needed to operate the extraction site. An expert is a trained, educated person who is able to use devices that necessitate proper skill development.

Third, one of the greatest difficulties faced by rebels is the collective action problem (Collier 2000). Therefore, the less people are required to obtain one unit of a natural resource possible to sell, the easier should it be to render an insurgency feasible. Weinstein (2005) provides an account

how natural resources influence the organizational structure of rebels. The variable will be coded as 1, if more than 5 persons are generally needed to work for the extraction of at least one unit.

Fourth, the higher the value-to-weight ratio, the more financial means can be generated even by selling only small quantities of a particular natural resource. Following the concept of Ross (2003), the categorization should be threefold. High value-to-weight natural resources mainly pertain to gemstones which achieve high prizes for very small quantities. Medium value-to-weight resources are those that have to be sold in certain quantities which achieve moderate rents for their volume. Those are often minerals or ores and also timber can be classified into this category. Lastly, low value-to-weight resources demand huge quantities to be sold to generate revenues that offset the expenses and the investment of the extraction process. Oil and gas are often referred as such commodities since millions of barrels are sold on the world market.

The following explanations provide reasons for the inclusion of three factors in order to adequately capture the "obstructability" property of a particular natural resource.

First, natural resources have to be transported in order to maintain trade. As Ross (2003) delineates, small and solid resources like diamonds can be covertly carried by single airplanes or cars. Other resources like timber are more difficult to hide since they require trucks, ships and specific roads on which they can drive. The greatest difficulty to secure comes with commodities in liquid form. For instance, oil and gas are mostly transported by pipelines which are difficult to defend at their whole length. For instance, one of the key oil pipelines in Columbia, Caño Limón, had been attacked around 900 times between 1986-2001 (Renner and Prugh 2002: 37–8). Hence, the mode of transportation is a determinant of the possibility to trade natural resources. The variable is coded as 1, if the mode of transportation is mostly static (pipeline or railways). It is coded as 0,5 if the mode of transportation can be partially flexible (e.g. using various roads for trucks). Lastly, it is counted as 0, whenever the extracted natural resource can be carried secretly with flexible means of transportation.

Second, Le Billon (2001) differentiates between point and diffuse resources. From the vantage point of rebels, diffuse resources provide less obstructable opportunities for the government. For instance, alluvial diamonds were scattered around a large territory in Sierra Leone, so that it was very difficult for government forces to control and secure all crucial areas (Buhaug and Lujala 2005). Hence, a resource is coded as 1 for this variable, if it is a diffuse resource.

Third, electricity is required to operate with many different devices. Drilling machines or elevators are needed to access natural resources in deep-shafts. It should be easier for a government to obstruct the extraction process by eliminating electricity input to the extraction site. Hence, this binary variable is coded as 1 if electricity is a necessary condition for the extraction procedure of a particular natural resource. In the following section, the respective values for every relevant natural resource is calculated.

3.2 Calculation

The following natural resources were chosen due to their prominence in academic research and alleged links to civil wars (e.g. Le Billon 2001). Drugs are not included into the list because data is sparse on illegal Sub-Saharan African drug trade and even an elaborated dataset from Lujala (2002) only lists cannabis as a potential source of revenues.

The values for different natural resources are presented in Table 1.

Natural Resources	1)	2)	3)	4)	5)	6)	7)	Sum
Alluvial Diamonds	0	0	0	0	0	0	0	0
Kimberlite Diamonds	0	1	1	0	0	0	1	3
Coltan	0	0	0	0.5	0	1	0	1.5
Copper	1	1	1	1	0.5	1	1	6.5
Gas	1	1	1	1	1	1	1	7
Gold	0	0	0	0	0.5	0.5[a]	0	1
Timber	0	0	0	0.5	0.5	0	0	1
Oil	1	1	1	1	1	1	1	7

Table 1: Calculation of the extraction feasibility variable for particular resources
[a] Le Billion (2001) characterizes gold as both point and diffuse resource. Exceptionally an average value was inserted due to the vast dispersion of gold throughout Sub-Sahara African states

Alluvial and Kimberlite Diamonds

Diamonds are distinguished by their three main sources (Smillie 2002: 25). Kimberlite diamonds are found in basic volcanic rock. Alluvial diamonds are either found as weathered kimberlite or have been "washed downstream from kimberlites into oceans" (ibid. 25). Hence, kimberlite diamonds are point resources confined to a small area, whereas alluvial diamonds are much more dispersed. This is in accordance with studies like the one from Buhaug and Lujala (2005). In order to gain access to kimberlite diamonds by so-called kimberlite pipes, huge capital investment is necessary as well as specialized companies. In contrast, alluvial diamonds only require the separation from "earth and gravel" (ibid. 25). As Smillie writes: "this can be done by a single person working with a sieve and shovel, or by large dredging machinery that remove tons of earth and fravel quickly"(ibid. 25). Diamonds are considered as a "low-volume, high value commodity" (Smillie 2002: 7) . Furthermore, their mode of transportation is very flexible and diamonds themselves are highly portable, thus easy to hide (ibid. 7). The world wide biggest diamond production company is De Beers which already exists since 1880 (ibid. 23). Due to its knowledge and operational purview into many different Sub-Saharan African countries, diamond exploration does not require US or EU involvement in the extraction process, except for financial funding.

Oil

Sub-Saharan Africa is, in contrast to many other regions, a rather small player. However, there are around nine main countries[10] whose national budget is largely or partially dependent on oil exports (World Bank 2015: 42). Interestingly, almost all of those main oil exporting countries rely on their national oil companies[11]. Nevertheless, those national conglomerates are often intertwined in joint ventures with foreign companies like Exxon Mobile, Chevron or ENI which are indispensable for many extraction endeavours (Friedman 2014). Hence, without international support, oil production would not be at such a scale as today. The drilling and production process itself requires complex technical set ups which are operated by many different experts and require constant energy influx including electricity (Freudenrich and Strickland 2015). The mode of transportation varies throughout Sub-Saharan Africa. Whereas "only Kenya and South Africa have pipelines" (Kojima et al.: 57), railways are also used as a static mode of transport. Trucks are

10 Angola, Cameroon, Chad, Congo (Republic), Equatorial Guinea, Gabon, Nigeria, South Sudan and Sudan
11 For instance, Sasol operates in South Africa, NNPC in Nigeria, SNPC in Congo (Republic), or Star Africa in Ghana

confined to specific roads due to the poor conditions of much infrastructure. Furthermore, oil is generally viewed as a point resource (Le Billon 2001: 573). It is confined to a certain area and extractive technologies are not as flexible as to change location in short time periods. Lastly, according to Ross (2003) oil should be classified as a low value-to-weight commodity.

Coltan

A study from Tegera and Mikolo (2002) who investigated the role of coltan (columbo-tantalite) during the civil war in D.R. Congo sheds light on some aspects of coltan extraction. First, foreign assistance is not needed for artisanal mining. In fact, young students abandoned school to work at the coltan digging holes. Second, sophisticated technical expertise is not required to unearth coltan from the soil. Often only a handful people are involved in one digging hole. Electricity is not needed. As written by Lalji (2007), “because the exploitation of this mineral requires no technology and minimal expertise, it has fast become prey to invading rebel groups“. Regarding the prizes which coltan achieves and the quantities exported, it can be perceived as a medium value-to-weight resource. It is transported by small planes or cars for further export and thus highly flexible to move. Referring to Le Billon (2001), Maystadt et al. (2014) consider minerals like coltan as a point resource.

Copper

According to Garchitorena et al. (2012), copper is mainly located in the South of Africa and experiences a growth in importance for world supply since the beginning of 2000s. The extraction process requires “[...] expensive undergrounding mining operations [...]” (ibid. 6). Taking D.R. Congo and Zambia as examples, the authors' report illustrates the need for foreign companies to invest and provide technical expertise to initiate copper extraction sites. Electricity is needed and raised as a risk factor for potential investors due to the poor supply conditions in both countries. The main mode of transportation are trucks and only partially railways. The extraction occurs either open-pit or underground and requires technical expertise and proper organization (University of Illinois). As extracted ore actually only contains 1% copper, additional facilities are needed to separate the metal. Hence, copper is a low value-to-weight resource in natural state. Lastly, Le Billon (2001) treats copper as a point resource.

Gold

The case of the Central African Republic serves as an illustrative example regarding the access to gold deposits. Although industrial production was prevalent during colonial rule, after independence much of the gold extraction process has shifted to artisanal mining. For Matthysen and Clarkson (2013) "it is an attractive employment opportunity in impoverished, rural areas as it requires very little capital, knowledge and technology" (ibid. 12). Foreign assistance is not needed, if artisanal mining is employed, although it is the case that in other regions of Sub-Saharan Africa industrial mining prevails. However, the possibility for artisanal mining is mostly possible. The digging process itself does not require large organized manpower. Matthysen and Clarkson (2013) describe it in the following way: "The *exploitants artisans* are the miners that are better-off. They command a group of at least three *ouvriers miniers*, working on the mining site that they operate. Groups of miners are often quite small in the CAR, as the alluvial deposits themselves are small and close to the surface". Furthermore, it is expected that around 95% of all gold exports from CAR are conducted secretly without knowledge from the government (ibid. 18). Additionally, "[it is] quite difficult for the [government established] mining brigade to intercept gold or diamonds because of the minerals' small volume-high value characteristics" (ibid. 20). One problem for miners are the limited choices of transportation. Those are normally conducted by car or truck transports on poorly maintained, remote but known roads. Hence, trafficking is susceptible to become victim of bandits (ibid. 21). Lastly, according to Le Billon (2001), gold varies in its environmental characteristics. It can be both, a point as well as a diffuse resource (ibid.). In order to compensate for this characteristic, exceptionally 0.5 was coded.

Gas

Considering the most recent estimates, Sub-Saharan Africa will surpass Russia as the main exporter of gas by 2040 (Crisp 2014). The major exporters will be Angola, Mozambique, Tanzania and Nigeria, whereas other countries will still export significant amounts of gas. As the main importers would be outside Africa, Liquid Natural Gas (LNG) technology is the most favourite mode of delivery. Mozambique is an illustrative case of past development. As there is no technological experience with gas exploration, the government sought help from Sasol, a South African company (Melina and Xiong 2013). First exports via pipelines to South Africa occurred in 2004. Further contracts with European companies like Italian ENI are already forged for new gas

fields in the north of the country as African technology is not sufficient. Due to the need for technological imports as well as the need for foreign experts, foreign and public investment is a precondition for new gas extraction sites. Gas itself is a low value-to-weight commodity since large amounts have to be traded to achieve financial benefits. Especially the export to countries outside Sub-Saharan Africa requires the purchase of large LNG tankers. According to Le Billon (2001), gas fields are point resources.

Timber

Unfortunately, there are not many academic accounts about timber as a conflict resource, apart of the claim that it matters for civil war (Ross 2004b). Therefore, illegal timber trade in Sierra Leone after the civil war is used as a base for argumentation. According to Samura (2011) account, timber logging is carried out by local people, no foreign investment is needed. No more than two or three people are required to cut a unit of timber and to transport it via a truck, however, illegal loggers often work in larger groups. No special expertise is needed to operate with sawing machine. Those are either propelled by electricity or fuel, however no electric supply has to be guaranteed. The value-to-weight ratio is medium since timber trunks weight much more than gems in order to achieve their revenues, but timber is not exported in such large quantities like oil or gas, although environmental degradation is substantial. Lastly, timber is a typical diffuse resource since forests cover vast amount of land (Le Billon 2001).

3.3 Coding

A country which experiences large accessible gold deposits will be coded with the value 1 for the time period in which gold extraction was conducted. However, this calculation only pertains to countries which have only one natural resource. If more than one single natural resource is available, then the arithmetic mean of available resources is taken[12]. In the appendix, five exemplary observations are provided. Under optimal conditions, one would chose to weight various natural resources by their export figures, however in the case of many investigated resources and in particular in the case of Sub-Saharan Africa, there are often no reliable accounts of exports. For instance, Smillie (2002) describes how statistics blur the difference between "country of provenance" and "country of origin". Due to import and export rules, countries like Switzerland,

12 For instance, if gold and timber are extracted at the same time period in one country it will be coded as (1+1) / 2 = 1

Gambia, or Liberia were counted as diamond exporters, although they only re-exported diamonds. Illicit trade furthermore complicates the whole picture (ibid. 35). Gambia has officially never exported diamonds between 1994-1999, but Belgian authorities noticed significant diamond imports from Gambia. Additionally, Gambia has no diamond deposits on its soil. What to do with such cases which are by far not exceptional?

Smillie (2002) assumes that around 20% of the international diamond trade is illicit. This figure is probably higher for Sub-Saharan Africa. Focusing on gold, the same picture appears. Matthysen and Clarkson (2013) estimate that 95% of all gold trade from the Central African Republic is illicit. This picture becomes even more complicated, if one considers that external actors can also intervene into conflicts. For instance, Rwanda exported coltan stemming from the Kivu region, a resource which propelled the rebellion by the RCD (Rassemblement congolais pour la democratie) forces (Tegera and Mikolo 2002). Therefore, instead of relying on export accounts the mere presence of extraction efforts towards a particular resource is assumed to constitute the moment from which on rebels would be able to harness this resource for civil war. This is in accordance with the feasibility hypothesis that the presence of favourable conditions should lead to a civil war. For instance, the DIADATA dataset used by Lujala et al. (2005) indicates in which year a diamond deposit was identified and in which year the extraction process began. Since Collier et al. (2009) coded every country for five-year periods, it is probed if in any year of one five-year period a natural resource exceeds its minimum threshold to count as relevant for the feasibility hypothesis as explained in the next section.

3.4 Data

This section describes the sources of information for the statistical analysis. In order to confine the global dataset from Collier et al. (2009) to the sample of interest, the official definition for Sub-Saharan Africa from the United Nations is used[13]. The full list can be found in the appendix. South Sudan was excluded since it was not an independent country in 2004 which is the last year covered by the global dataset. The countries Réunion and Saint Helena were not included since the global dataset does not include those countries. In sum, the sample consists of 49 different states.

Regarding the dependent variable, Collier et al. (2009) use data from the Correlates of War Project (Singer and Small 1994) which count political violence as civil war based on four criteria.

13 The link is: http://unstats.un.org/unsd/methods/m49/m49regin.htm (accessed 12.07.2015)

First, violence has to emanate from organized military action. Second, at least 1000 battle deaths have to occur in a given year. Third, the weaker party has to inflict at least 5% of all deaths in a given year. Fourth, the national government has to actively participate in the conflict.

Regarding the new independent variable[14], figures about relevant natural resource production was derived from various datasets. First, the information about oil production comes from the "Oil and Gas" dataset from Ross (2013). It is an almost complete dataset for oil production from 1931-2011. The same holds for gas production. Second, data for gold, coltan and copper is available from the British Geological Survey (BGS) Centre for Sustainable Mineral Development[15]. In contrast to the export data from the WTO, this collection includes production figures which fit the feasibility-hypothesis better. For gold, a threshold of at least 50kg produced in a single year is stated, otherwise the amounts for looting becomes too marginal. The same is valid for copper, just here the threshold is set at 100 ton. Furthermore, coltan is only an abbreviation for colombite-tantalite from which tantalum and niobium are extracted (Tegera and Mikolo 2002: 5). Hence, tantalum and niobium are used as a proxy for coltan. Both elements are listed and appear always together. At least 10 tons of coltan have to be extracted in a given year in order to count. Regarding diamonds, the same dataset is used. The production threshold for diamonds in order to to be relevant is set to 1000 carats. Once diamonds in a particular country in a given year surpass this threshold, they are compared to available information from the DIADATA data set (Gilmore et al. 2005). Hence, it is possible to distinguish between alluvial or kimberlite extraction sites. If it is not possible to determine exactly which kind site was used, then it is assessed if one type of extraction (alluvial or kimberlite) dominates the other in terms of available mining sites. If those are in par, then both types are included into the estimation.

Lastly, timber production information faces the problem that timber is often used for domestic purposes and can be easily manufactured, thereby changing its financial value. Therefore, it is the only case in which export data instead of production data is used. The data derives from the "Food and Agricultural Organization of the United Nations Statistics Division"[16]. As a proxy for timber exports, information about the value of roundwood exports is used. The cut-off point is set at $5 million for a given year. The reason is that according to estimations from Renner and Prugh (2002), the lowest revenues achieved by a rebel organization amounted to $25 million per year for the RUF rebels in Sierra Leone (in their very limited set of cases). Since total revenues are

14 Further data sources for other independent variables as well as information about the conceptualization can be derived from the original paper of Collier et al. (2009)

15 The link is: http://www.bgs.ac.uk/mineralsuk/ (accessed 13.07.2015)

16 The link is: http://faostat3.fao.org/home/E (accessed 22.07.2015)

structured by many different sources, conservatively one fifth is estimated to derive from natural resource trade. This is conservatively, because even in such large scale rebellions like the current insurgency by ISIS who control many different oil fields (Sanger and Davis 2014), the estimation is that just 8% of total revenues derive from illegal oil trade (Statista 2015). Of course, all thresholds are open to debate, if they are set too low or too high. However, according to case studies and statistical figures they appear to partially render rebellions "feasible" (in composition with other revenues like bribing, blackmailing, kidnapping, taxation of the local economy, ect.). Unfortunately, for some countries, data about timber does not extended until the 1960s, but no alternative source could be found.

4 Statistical Analysis

In the first part, descriptive statistics pertaining to the dataset and the new variable are provided and examined with regard to the extraction feasibility hypothesis. Afterwards, the logit estimation model is applied on the the global dataset. Hence, the first model is a replication of the core model of Collier et al. (2009). The second model is the identical model, but confined to countries from Sub-Saharan Africa. Lastly, the new variable is tested on the Sub-Saharan Africa subset.

4.1 Descriptive Data

The new subset poses favourable conditions to test the feasibility hypothesis. Whereas the original dataset includes 92 occurrences of civil war, the subset comprised of Sub-Sahara African countries contains 41 civil wars. Importantly, the ratio of civil war occurrences to the respective sample is higher in the subset than in the global dataset. Hence, while all civil wars in the global dataset amount to 5,6% of all observations, the ratio is almost double as high in the subset with 10,1%.

However, due to *list-wise deletion* of missing observations in the logistic regression analysis, the core model of Collier et al. (2009) only uses 71 civil wars for its estimation in a set of 1063 total observations which amounts to a ratio of 6,6% (see Table 2). Using the core model for the subset leads to a loss of 5 civil wars so that there are 36 occurrences of civil war for Sub-Saharan Africa

which amounts to 11,8% of all observations in the subset. Unfortunately, the new variable leads to a further loss of over 100 observations due to missing data. Therefore, 28 civil wars remain for the estimation model which consists of 191 observations. This decrease is due to two main reasons.

First, some countries like the islands Cape Verde, Comoros, Mayotte, Mauritius, Seychelles and Sao Tome and Principe are simply too small in order to produce enough natural resources to surpass the stated cut-off points. Already those four islands represent 54 dropped cases. Second, for some countries there is either no reliable data available or neither of the eight proposed natural resources are produced. Such countries are Chad, Djibouti, Gambia, Guinea-Bissau, Malawi, Niger, Togo and Somalia.

Model	Number of observations	Amount of Civil War Onsets	Overall share of civil war onsets
(1)	1063	71	6,6%
(2)	305	36	11,8%
(3)	191	28	14,7%

Table 2: Ratio of civil war onsets to the number of available observations in the three logit estimation models

Regarding the new independent variable, Figure 2 provides graphical information about the distribution of values. As can been seen, more than 25% of all observations include natural resources which can be easily extracted and which should therefore favour rebel groups. The 25th percentile in fact covers the value 1. Such countries typically produce timber, gold or alluvial diamonds. An exemplary case would be the Central African Republic which produces all three kinds of natural resources. The value for the skewness is 0.40 which confirms the graphical impression. The bulk of observations is located at lower values.

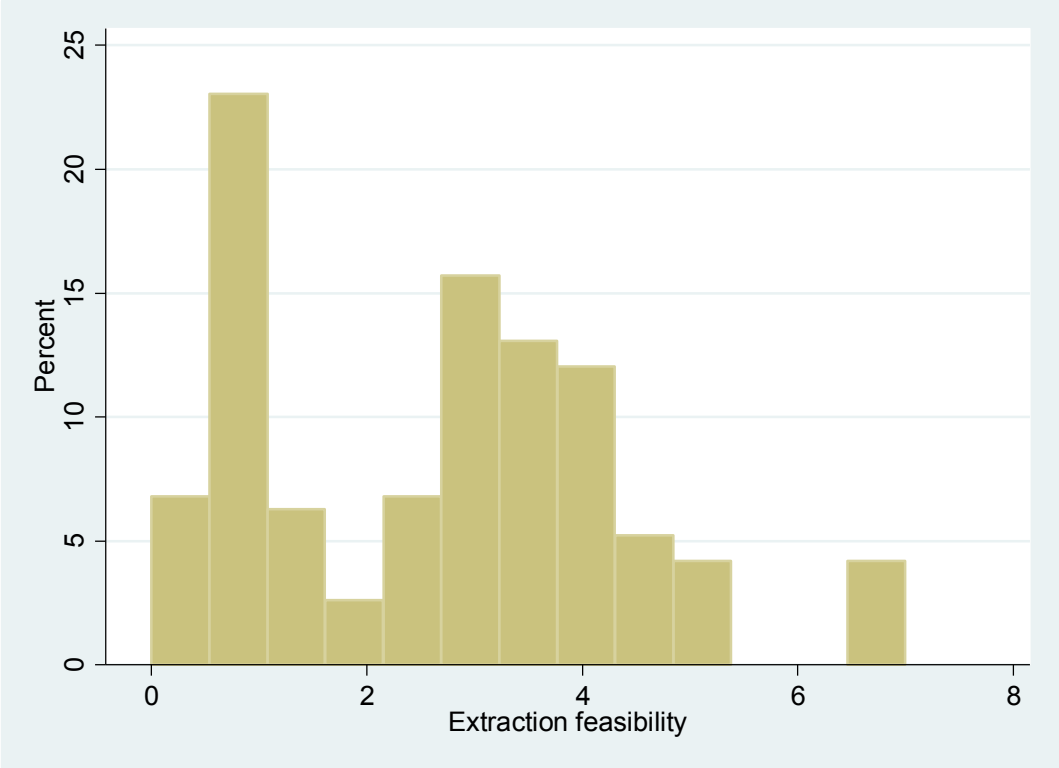

Figure 2: Histogram of the new extraction feasibility variable in percent of all observed values calculated with STATA 12

In order to test if civil wars are located for low or high values of the new variable, Table 3 provides a cross table between rounded values of the extraction feasibility variable and the onset of civil war. The results weakly corroborate the feasibility hypothesis. On the scale between 0 to 8, 16 out of 28 civil wars occur, in the case when the extraction feasibility variable scores below 4 which can be cautiously interpreted in line with the expectation that the easier it is to loot a particular natural resource and the more difficult it is to obstruct the extraction process, the higher the likelihood of civil war. This is however compensated by the fact that the majority of countries which do not experience civil wars are also located below a value of 4. It seems that the extraction feasibility variable does not add explanatory power. There are too many cases which do not have to cope with civil unrest, although they are have a low value assigned for the extraction feasibility variable. Approximately 17% of all cases which score 1 experience civil war, but the same is valid for all countries which score 5. It has to be seen, if other characteristics can unearth a more consistent relationship between the new variable and civil war onset by accounting for the variance in civil wars. Hence, this is tested in the next section in a logit estimation model.

	Civil War Outbreak		
Extraction Feasibility Variable	0	1	Total observations
0	4	1	5
1	49	10	59
2	18	0	18
3	33	5	38
4	37	8	45
5	15	3	18
6	0	0	0
7	7	1	8
Total	163	28	191

Tabelle 3: Cross Table between the Extraction Feasibility Variable and Civil War Onset

4.2 Results of Statistical Testing

Table 4 Feasibility of Civil War at global level and in Sub-Saharan Africa

	Model 1	Model 2	Model 3
ln GDP per capita	-0.216	0.027	0.255
	(1.74)*	(0.10)	(0.74)
Growth (t-1)	-0.144	-0.205	-0.280
	(3.69)***	(3.05)***	(3.33)**
Primary commodity Exports (PCE)	6.988	-1.322	
	(1.77)*	(0.22)	
PCE squared	-14.438	5.046	
	(1.82)*	(0.48)	
Peace	-0.056	-0.045	-0.041
	(5.83)***	(3.21)***	(2.46)***
Former French African Colony	-1.221	-1.795	-2.748
	(2.00)**	(2.43)**	(2.19)**
Social Fractionalization	2.186	1.519	1.592
	(2.71)***	(1.04)	(0.75)
Proportion of young men	12.639	24.733	27.168
	(1.55)	(2.09)**	(1.46)
Ln population	0.266	0.322	0.040
	(2.73)***	(1.42)	(0.11)
Mountainous	0.011	0.018	0.020
	(1.46)	(1.41)	(1.20)
Extraction feasibility			0.023
			(0.12)
Observations	1063	305	191
Pseudo R^2	0.28	0.29	0.33
Log Likelihood	-188.80	-78.16	-53.30

Logistic regressions, dependent variable: war start. Absolute value of z statistics in parentheses. Asterisks (*,**,***) indicate significance at the 10%, 5%, and 1% level, respectively. All regressions include an intercept (not reported).

Table 4 shows the results of all three estimated models. The first model is the core model from the original paper from Collier et al. (2009). It includes several independent variables which shall proxy different feasibility mechanisms. Hence, “GDP per capita” is mainly conceptualized as opportunity cost for prospective rebels, if they decide to join a rebellion. “GDP per Capita Growth” is a proxy for a tight or loose labour market. The worse the economy fares, the more potential recruits are available due to unemployment. The most interesting variable for the purposes of this paper is the “Primary Commodity Exports” (PCE) variable. Whereas earlier studies of Collier and Höffler interpreted the variable as a proxy for motivation of rebels to capture economic benefits through natural resource trade, their most recent study explains high PCE values as available

financial means to start and sustain a rebellion. The “Peace” variable pertains to Collier's work about the effect of past conflict (Collier et al. 2003). Another purpose is to remove fixed effects which could bias the estimated models. One very interesting variable is called “Former French African Colony”. It seems that France acted as a security guarantor for incumbent governments in its former colonies. “Social Fractionalization” is a composite variable of ethnic and religious cleavages. The next variable, “Proportion of young men”, is similar to the economic indicators, but instead investigates demographic accounts. The authors postulate that a broader base of young men provides rebel leaders with more potential recruits. “Population size” controls for effects of large countries. Lastly, the “Mountainous” variable investigates the role of mountainous terrain. According to the authors, mountains provide security for secretly operating rebels.

In the second model, the same estimation procedure was conducted. However, this time Sub-Saharan Africa is chosen as a sample to test all independent variables from the first model. Many weakly significant variables from the global dataset become now insignificant. The loss of significance of the “GDP per capita” variable might be due to less variance in the Sub-Saharan subset. Whereas the standard deviation of this economic measurement amounts to 1.52 for all observations which are relevant for the estimation process, this figure drops to 0.93 in the African sample. This is a clear indicator for less wealth inequality among all states in Sub-Saharan Africa compared to the global dataset. The lagged GDP growth variable remains highly significant, pointing at the importance of economic downturns and upturns for civil war onsets. Interestingly, the primary commodity exports variable is completely insignificant for Sub-Saharan Africa. This is clearly a surprise as this part of the world continues to be the main focus of researchers regarding the link between natural resources and civil war occurrence. The critique raised by Fearon (2005) seems to be valid, namely that the PCE variable covers not all important “conflict” resources. One of the main gaps pertains to the lack of gemstones which in many studies seem to be correlated with civil conflicts in Africa.

Another possibility might be that the ratio of exports to GDP is a weak predictor for conflict resources. Firstly, it does not capture the availability of natural resources for rebels per se. Even low primary commodity exports do not prevent rebels of harnessing diamond or gold deposits for their purposes. Second, exports are highly dependent on reliable export statistics and as mentioned before, due to difficult measurements even countries like Gambia which do not posses any diamond deposits were listed as diamond exporters. Another case is Central African Republic for which it is estimated that 95% of all gold trade is illicit. The new extraction feasibility variable aims to remedy those shortcomings in the third model. The “Peace” (or “previous conflict”) variable is highly

significant in all models which highlights the importance to control for "endemic" or "self-sustaining" conflicts. The longer peace periods persist, the higher are the chances not to experience setbacks. Being a former French colony was suited to African states, therefore it is no surprise that this variable remains its significance in the Sub-Saharan sample. Also very interesting, the indicator for social fractionalization loses its significance. This is quite remarkable as especially conflicts in African countries which are sometimes viewed as products of the colonial period are thought to be often grievance based. However, for this result there is no clear answer which can be provided. The demographic variable which measures the share of young people in a country becomes highly significant in the subset. This fits current statistical data according to which in Sub-Saharan African states people who age between 10 and 24 compose over 30% of a given society (Gupta et al. 2014). Additionally, youth unemployment figures are very high compared to employment figures for adults with varying ratios from 2.5:1 up to 3.8:1 in this part of the world (African Economic Outlook 2015). The population size itself seems not to play a significant role in the explanation of civil war occurrence in contrast to the global dataset. This might be also due to the much smaller variance in the variable. Mountainous terrain has almost exactly the same significance level for Sub-Saharan Africa as in the global dataset (approximately $p = 0.15$). The Pseudo-R^2 values are not directly comparable for two different samples.

The third model excludes the PCE variable from the estimation process since conceptually it should measure the same as the new constructed extraction feasibility variable. All significant variables from the second model remain significant, except for the "proportion of young men" variable. However, this can be due to the loss of over 100 observations The new extraction feasibility variable is highly insignificant in this model. Even including the PCE variable (not reported in this paper) does not change anything in the estimation process. Also controlling with another dataset for the dependent variable, namely the Armed Conflict Dataset (ACD) constructed by Gleditsch et al. (2002) does not change the insignificance of the extraction feasibility indicator. The consequences and interpretation of this result are provided in the following section.

In order to validate whether one particular resource has an effect on civil war outbreak in Sub-Saharan Africa, a dummy variable was included for each resource. The model is not reported here, but all dummy variables were insignificant, except for copper ($p < 0.1$) which had a negative sign for the sample that was used to test the new extraction feasibility variable. Apparently, the presence of copper which is very difficult to extract seems to have a negative influence on civil war occurrence. The precise causal link has to be investigated in further case studies.

4.3 Interpretations of Statistical Results

The new extraction feasibility variable aimed to provide information if there is a consistent link between the characteristics of the extraction process and civil war onset. However, no significant link could be discovered. It appears that the mere presence of exploitable resources does not inevitably lead to a higher risk of civil war onset. At least, this interpretation seems valid for Sub-Saharan Africa. The Primary Commodity Exports variable already had weak explanatory power in the core model of Collier et al. (2009) which ceased to exist in the sample for Sub-Saharan Africa. This is remarkable, if one thinks of Africa as a breeding area for civil wars in which natural resources are perceived to be a catalyst. As explained before, this insignificant result of the PCE variable for Sub-Saharan Africa might be due to its definition. For instance, it does not cover gemstones which are thought of being one of the most important sources of civil conflict in Africa due to the easy access to various diamond fields. The new variable attempted to overcome some of the shortcomings of the PCE variable by focusing on the availability of extractive resources, instead of relying on bundled export figures which hardly provide an accurate picture of civil war realities. Nevertheless, it seems that the mere presence of extractable natural resources is not a sufficient condition for higher risk of civil war. Its insignificance can be due to various reasons.

First, conceptually other intervening variables might affect its influence on civil wars. Fearon and Laitin (2003) illustrated how high dependence on oil revenues can lead to bureaucratically weak states which are less susceptible for the demands their people. Regarding Sub-Saharan Africa, an interesting account comes from Reno (1998) who investigates how specific states are governed in Africa. Some states, like Liberia, were run by patronage systems in which a network of powerful leaders controlled each one part of the domestic economy and territory. It is a system of dependence and dominance where cronies of powerful leaders stabilize the system by force. As he writes, "[...] resources, per se, do not cause predatory uses of violence. Instead, regime fears of bureaucratic challenges – the most threatening in the form of military coups – and their uses of non-bureaucratic forms of patronage and of armed youth groups as enforcers produced terrible business environments for those without political connections. […] The economies of these states became dependent upon natural resources, but more as a result of regime strategies that destroy politically unreliable segments of the economy rather than the attractions of these resources in the first instance" (Reno 2007: 328). This might also explain why there is a bulk of countries which have not experienced civil wars but are endowed with easily exploitable natural resources.

Depending on the institutional structure within a state, natural resources might play different roles for the probability of civil war outbreak

Second, another explanation for the insignificance of the extraction feasibility variable might be that it apparently does not matter how difficult it is to extract natural resources. Every kind of natural resource might determine a different type of civil war, but not prevent any violent conflict only because it is more difficult to loot and easily to obstruct. Such an environmental deterministic approach is pursued by proponents of the "political ecology" debate (Le Billon 2001). Some resources might be more prone to secessionist movements (e.g. oil extraction sites at the periphery of a country), others might only require unrest in a region to secretly extract the resources (e.g. alluvial diamonds). Although such explanations normally overlap with other approaches (e.g. secessionist movements with grievance based rebellions), it might be worthwhile to investigate further how much environmental conditions in which natural resources are situated actually determine civil war onset.

Third, another point of departure can be to assess how important natural resources are truly as financial sources. This point is raised because although rebel groups might financially benefit from natural resource trade, it does not mean that their overall revenue structure is completely dependent upon it. The clearest example is the rebel group ISIS which supposedly only derives 8% of its total revenues from secret oil trade (Statista 2015). Apart of some cases in which natural resources played a dominant role like in Sierra Leone or Angola, the picture might be different for the whole universe of civil wars. Hence, natural resources might not be conflict triggering, but perhaps conflict shortening or prolonging as Humphreys (2005) attempted to investigate.

Fourth, clearly one problem of this study was the lack of precise and reliable data. Many accounts which are dated prior 1990 were estimates. This pertains especially to timber exports or gemstone production. It might be well the case that production occurred in many instances, but has not been properly recorded so that many missing cases are the result. Furthermore, especially the time period after 1960 was fraught with turmoil in many African countries due to their struggles for independence so that keeping track of extraction and export processes was not accurately possible. It might have been the case that more available observations could have provided a clearer picture. However, there are no clear indications for a selection bias against the new variable. In fact, the bulk of civil wars occurred after 1990s and for this time-period the data is more consistent. Also do many authors argue that the role of natural resources actually

became relevant after the end of the Cold War as financial assistance from the USSR and the USA ceased (Renner and Prugh 2002: 10). This speaks against the concept of the extraction feasibility variable.

Fifth, the conception of the dependent variable can lead to a wrong conclusion. Perhaps changing the dependent variable from five-year intervals to a country-year format as proposed by Fearon (2005) could change the results. The reason why the dataset from Collier et al. (2009) was chosen is their particular focus on the feasibility hypothesis. Their independent variables suited the research question as control variables and their own research provided significant results for the PCE variable. Fearon (2005) criticised the five-year format since it provides a more timely consistent link between the independent variables and the dependent variable and since due to the "list-wise deletion" technique of the logit estimation process in STATA many observation which in reality are comprised of 5 years become deleted. This estimation process definitely had an impact on the amount of available cases for this study, however it remains to be proven if the country-year format does not just artificially inflate the amount of observations without providing additional explanatory power. Theoretically, in an infinitely large dataset the variance of an independent variable asymptotically approaches zero which renders every variable significant.

5 Conclusion

The debate over the role of natural resources in civil wars is still ongoing and has not been resolved yet. Many studies attempted to find a clear relationship between a group of resources or particular resources and the probability of civil war onset. A large part of the debate revolves around the question which precise causal mechanisms are at work since previous attempts left much leeway for interpretation. Until today, there is a debate if for instance high primary commodity export dependence is related to more exploitable natural resources for rebels or if high primary commodity export dependence leads to bureaucratically weaker states which alienate their own people. However, critiques point at shortcomings and raise the question about omitted variable bias or reversed causality.

The aim of this paper was to address these shortcomings and shed light on a property of natural resources which has been at the focus of many researchers, namely their "lootability". It proposed the "extractability" property which is based on both "lootability" and "obstructability". Using Sub-

Saharan Africa as a most-likely sample should shed light if the degree of extractability truly matters once tested on a larger dataset.

The findings are clear. Neither Collier et al. (2009) PCE variable holds its promise for Sub-Saharan Africa, nor is there is any significant relationship between the new extraction feasibility variable and the probability of civil war outbreak. It seems that natural resources do not unfold their influence distinctively through the process of looting by insurgents. The new variable was based upon eight different natural resources which seemed to be so called "conflict" resources. Hence, it even exceeded the definitional coverage of the PCE variable. Conceptually, it was closer to the feasibility mechanism than the PCE variable since it measured the pure opportunity for a rebel group to finance itself through natural resource looting. As a result, the focus should not rely on the direct link between natural resources and conflict occurrence and shift to alternative approaches. Future research should pursue different paths than the feasibility mechanism. Apart of anecdotal evidence like Sierra Leone or Angola, it is difficult to explain only on the grounds of feasibility why a large amount of countries with extractable resources does not suffer from civil wars. Therefore, for instance a deeper understanding of institutional systems and their relationship towards natural resources might prove to provide more fruitful results. It is hoped that this study provided a solid contribution to the controversy about the role of natural resources and its influence on real world politics.

6 Abstract

This study aimed to provide more general knowledge about the mechanisms which link natural resources with civil war outbreaks. The theoretical point of departure was the feasibility hypothesis hypothesis of Collier et al. (2009) in which the authors state that the paramount interest of researchers of civil wars should be directed at the structural conditions within a country. One of their assertions pertained to the role of natural resources. Those provide a potential revenue source for insurgents to finance their rebellion. Hence, the higher the dependence of a state on natural resource exports, the higher should be the probability of civil war outbreak. However, this account was heavily criticized by other researchers. Some claimed that the conceptualization of the Primary Commodity Exports (PCE) variable does not cover relevant natural resources (Fearon 2005), others pointed at the problem of reversed causality and endogeneity (Gleditsch 1998) and also others stressed to differentiate between different natural resources according to their proneness to be looted by rebels (Ross 2003). In order to address these problems, a new variable was conceptualized. The "extraction feasibility" variable measures the degree of extractability of a particular resource. It is composed of two notions, namely "lootability" and "obstructability". The easier it is to loot a particular natural resource and the more difficult it is to obstruct the extraction process, the higher risks for civil war were expected. Based upon eight different so-called "conflict" resources, their values were calculated and assigned to their respective countries. Sub-Saharan Africa was chosen as a "most-likely" sample in order to (dis)confirm the validity of the newly introduced variable. Using the dataset of Collier et al. (2009) and including the "extraction feasibility" variable led to highly insignificant results. It appears that the mere presence of extractable resources does not per se increase the likelihood of civil war. Two factors were decisive for the insignificant result. First, there are a bulk of countries which possess easily extractable resources, but have not experienced civil wars. Second, it appears that even resources difficult to extract do not lower the amount of civil war incidents. This can be due to following reasons. First, natural resources have an influence on civil war which is different than postulated by proponents of the feasibility hypothesis. Second, the presence of natural resources does not per se determine higher chances of conflict. Intervening variables such as weak institutions might be a better predictor of civil war outbreak. Third, it is also possible that natural resources simply provide to less revenues for rebels to sustain or initiate a large scale civil war. The prominence of Sierra Leone and Angola might have created a selection bias.

7 References

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8 Appendix

Sample

Following countries are designated to belong to the Sub-Saharan region according to the official UN definition:

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

Five exemplary observations are provided:

Country	Year	Timber	Alluv. Diamonds	Kim. Diamonds	Coltan	Copper	Gold	Oil	Gas	Sum	Ext. Feas. Var.
Angola	1960-64		0			6.5		7		13.5	4.50
Angola	1965-69	1	0					7	7	15	3.75
Angola	1970-74	1	0				1	7	7	16	3.20
Angola	1975-79		0					7	7	14	4.67
Angola	1980-84		0					7	7	14	4.67