# Commodity Prices and Violence

## The effect of world market prices on violence in the Democratic Republic of the Congo

Marcus Syk
Wessam El Ghoul

# Abstract

In this study it is theorized that the world market price of a certain commodity should affect the intensity of the violence in conflict zones in which this commodity is produced. This is tested on the Second Congo War and the continuing violence since, using statistical methods to analyse the effect of the world market price of gold, diamonds, oil, tin, copper, cobalt and coltan. The methods used are time series graphs for a visual presentation, regression analysis to test the potential correlations and fixed effect analysis to test the strength of the effect by predicting the intensity of the conflict using world market prices. The predicted effect was only found for some of the commodities included in the analysis.

The main findings are that violence in a region follows the world market price of relevant commodities, but with a delay of approximately two years. This is only true for the most violent regions, where there were several actors taking part in the resource plunder. Additional findings included that tin is the most prominent conflict mineral of eastern Congo, rather than gold or coltan as is usually suggested in the literature, and that fixed effects analysis can be used to predict future level of violence.

*Keywords*: conflict minerals, Democratic Republic of the Congo, resource curse, conflict intensity, commodity prices

Words: 8437

# Table of contents

# 1. Introduction

*" It's a tradition. At times of war, when blood is spilled, then there is more gold here. It is as if the blood draws the gold out of the earth" Chonga Ladonga, a Congolese miner, (Eichsteadt 2011 p. 34)*

Civil war remains a reoccurring phenomenon in the world, and its relevance as a field of study is doubted by few. Thus, it has received quite a bit of attention from scholars and so has the role of natural resources in these conflicts. Countries rich in natural resources are more often plagued by civil war and these conflicts tend to last longer {Collier, 1998 #4;Le Billon, 2001 #6}. Several recent studies have also indicated that economic motivations explain conflicts better than social factors {Burch, 2014 #5;Collier, 2004 #3}. Regardless of whether the motivation for the armed actor is personal enrichment or to fund the cause it is the economic gain that matters. When the armed factions in a conflict are after the resources for economic gain they will consider the resources that generate relatively more economic gain to be the more desirable ones. The desirability of controlling a region should therefore be dependent on the desirability of the resources being produced there.

## 1.1 Theory

The *resource curse* is a term that refers to the poor economic performance of states with an abundant wealth of natural resources. The natural resources lock the countries in dependency on the exportation of primary commodities, instead of developing other sectors. According to Ross {Ross, 1999 #42}, where the rule of law is already weak, the curse can become a violent one, locking the country in continuous conflict.

The theory of *new wars* proposed primarily by Kaldor can also be linked into the curse of resources. According to this theory wars tend to devolve into a project for economic gain and not to achieve political goals {Kaldor, 2012 #34`, p. 125}. The primary driver of conflict is economic and close links to the world markets are necessary.

The ambition of this study is to develop the theories about the *resource curse* and *new wars* to gain a new understanding of the role of resources in armed conflicts. Hence, this paper is both theory testing and theory developing. However, the distinction between developing and testing is often vague {Esaiasson, 2012 #31`, p. 113}.

# 1.2     This Study

The economic gain of a specific resource is determined by the difference between the cost of production and the sales price. The main determinant of the desirability of a specific resource is the price at which they can sell it, meaning that the desirability is price-sensitive. Furthermore, these resources are often sold to buyers in other countries through the so-called black market, thus avoiding government regulation and isolation from the world economy. Therefore, the development of the world market price of a resource should have a direct effect on the economic gain generated by said resource, thus affecting the conflict in the area where it is being produced. Thus, we expect that changes in the price of a resource should be a driving force in the development of events in the conflict zones where it is being produced. This paper will demonstrate this relation empirically.

A case most likely to demonstrate this relation is the conflict in the Democratic Republic of Congo (DRC) because this conflict is often associated with so-called "conflict minerals" {Nordstrom, 2004 #32`, p. 91} . The conflict has been ongoing since 1996 meaning that the illegal trade routes from the conflict arena to the rest of the world should be well established by now. The need for funding by the armed actors in the conflict should also be a strong motivator.

Resources as a driving force have been given much attention and their prominence has been repeatedly emphasized in studies of the conflict. Burch and Pizzi (2014) found that, in the case of the Democratic Republic of the Congo, presence of natural resources was a better predictor of the location of violent incidents than ethnic tension. Fearon and Laitin found that the factors that increase the risk of civil war are not ethnicity or religion but rather political instability and poverty, which characterizes a weak state and are favourable for rebel recruitment {Fearon, 2003 #43}. Collier (2004) empirically confirms that countries rich in natural resources also have a higher risk of conflict. This further supports that natural resources should play a significant role in the Congo conflict.

It should be mentioned that Collier (2004) also theorizes that countries with a very high dependency on natural resources do not suffer from this increased risk because they usually tax these commodities enough to be able to support a strong state. This is not the case in the DRC as it appears to have been the conscious strategy of Mobutu to keep the state and the army weak so that it would not pose a threat to him (Stearns 2012, p. 115-116, 126). The soldiers were rarely payed, and instead had to rely on their guns to make a living, often through controlling the mines – a practice that has continued throughout the civil war {Eichstaedt, 2011 #9`, p. 102;Stearns, 2012 #10`, p. 116-118}.

The part of the modern Congo conflict known as the Second Congo War and its aftermath  saw an increase in the resource plunder by the various factions in order to finance their military activities {Stearns, 2012 #10`, p. 229-235}. This

part of the conflict is therefore more relevant to this study as it should further increase the probability of finding support for the theory. We assume that the cost of production is relatively stable since the time period is only 18 years long and the ongoing conflict limits investments to increase production. Consequently, sales price is the main determinant of the economic gain during the examined period. Given the above mentioned arguments on desirability of a resource and concentration of conflict to areas that are rich in resources, then the intensity of violence in a certain area should be affected by the price of the main resources found in that area. This is the main hypothesis of this paper. More specifically, it can be expressed as follows:

*Hypothesis 1*: An increase in the world market price of a specific commodity will generate an increase in the intensity of the conflict in the regions where it is produced as the desirability of controlling that region increases.

This effect might very well take some time, as there are many middle hands between the mineral exchanges in the industrialized countries and the mines in the Democratic Republic of the Congo {Global-Witness, 2009 #33`, p. 7}. We therefore expect a time lag between a price change and the potential effect on violence. Predicting the length of this time lag is a challenging task as it requires extensive knowledge of the legal and illegal trading routes from central Africa to the mineral exchanges around the world, but based on the literature the delay is expected to be around a few months. The problem of predicting the size of the time delay is well known in social science research and the easiest solution is to estimate it by assessing the collected data {De Boef, 2008 #37}.

Hence it is assumed that there will be a time lag in the effect predicted in hypothesis one. This lag is expected to be rather short, between 1 and 3 months. Although, the data will be examined more closely for any indications of time lags and calculations will be amended to account for that. Therefore, the second hypothesis is as follows:

*Hypothesis 2*: There will be a time lag of probably 1-3 months, in the effect predicted in hypothesis one.

# 2 Background

*Map: The provinces of the Congo*



## 2.1 The Congo War

As mentioned above, this paper focuses on the events from the start of the Second Congo War until 2015 because this part of the conflict saw an increase in the resource plunder. The reasons for the Second Congo War are generally explained by the First Congo War, which is in turn explained by the misrule of Mobutu. He reigned the country then known as Zaire for several decades, and over the course of his rule the structure of the state steadily declined due to extensive corruption and mismanagement (Stearns 2012, p. 95). Already at this time, illegal smuggling

networks and a culture of plunder for a living evolved as an established part of the regime, not at least in the Zairian army (Stearns 2012, p. 113-118).

This slow collapse was the context that made the wars possible but the more immediate reason were the events following the Rwandan genocide in 1994 (Stearns 2012, p. 13). The influx of Hutu refugees from Rwanda into Zaire following the advance of the Tutsi militias sparked violence across the eastern parts of the country. The new Rwandan government started making incursions into the country in search of the old regime and the perpetrators of the genocide, leading to further violence. In 1996 outright war started and the rebels backed by Rwanda and Uganda and a few other foreign powers quickly defeated the weak army of Zaire (Stearns 2012, p. 120-126). In May 1997 the capital of Kinshasa fell and the leader of the rebel forces, Laurent Kabila, was installed as president, renaming the country "the Democratic Republic of Congo" (BBC 2015).

During this first war the rebels were largely backed by foreign powers and both rebels and their allies were primarily driven by political goals. Furthermore, the war was short with no fixed frontline as the Zairian army quickly collapsed under the steady advance of the rebels {Stearns, 2012 #10`, p. 125-126}. For these reasons the first war is excluded from the analysis in this paper.

## 2.2 The 2nd Congo War and its Aftermath

The peace following the First Congo War was short-lived as violence escalated once more in mid-1998, this time between the newly installed regime of Kabila and his former allies in the east, Rwanda, Uganda and Burundi. This all soon escalated even further as several other African countries came to the defence of the regime in Kinshasa. (Stearns 2012, p. 183-193). Initially the Rwandans and their allies had the upper hand but frontlines eventually stabilized and the conflict would drag on for years, despite many attempts at peace negotiations and the deployment of a UN peacekeeping mission to the country {BBC, 2015 #35}.

While the initial invasion was mostly politically motivated, the second saw more of the resource plunder. The most prominent reason for the support offered to president Kabila from his allies seems to have been in return for access to part of the riches of the Congo. (Stearns 2012, p. 285-286, 291-297). During the war the enemies of the Kabila-regime also filled their pockets. During the first years of the war the exports of diamonds from Uganda grew tenfold and from Rwanda a hundredfold, despite neither country having any diamond production of its own (2012, p. 241). The resources were smuggled out via the surrounding countries and in turn the militias who were generally involved at some stage in the process could fund their continued activities. Through these illegal trade routes the warring factions could get their hands on most things they might need, even cars {Nordstrom, 2004 #32`, p. 88-91;Stearns, 2012 #10`, p. 39}. This smuggling activity complicates attempts to estimate actual exportations since no data for these transactions was recorded. Official figures for exports of resources from war ridden regions in the DRC are therefore not reliable.

The economic gain driving the conflict is at times obvious as for example, the province of Equator, lacking in natural resources, saw far less violence than the resource rich Ituri and Katanga areas, despite the same parties being involved in both cases (Stearns 2012, p. 211-229).

When the alliance between Uganda and Rwanda broke down in 1999 the resource plunder increased further as the two countries, partially through the use of proxies, competed for control of important mineral deposits throughout the Congo (2012 p. 235).

The assassination of President Laurent Kabila in 2001 allowed for his son, Joseph Kabila, to replace him, who then actively encouraged the start of the peace process {BBC, 2015 #35;Stearns, 2012 #10`, p. 312}. The negotiations and treaties did never deal with the corruption or exploitation of the mines. Instead, the corruption was, in the words of Stearns, "the glue holding the fragile peace together" (2012, p. 318). Furthermore, "peace" is sometimes chosen "from above" to describe a situation in order to reflect certain interests, rather than being an accurate depiction of what is happening on the ground {Nordstrom, 2004 #32`, p. 168}. This appears to be the case in the Congo as, despite the treaties signed during 2002, the fighting continues to this day (BBC 2015). Many violent attacks have been carried out since 2002 and following the elections in 2006, won by President Joseph Kabila, the rebellion in the east was renewed, fuelled by militias and potentially also external powers fearing that they would lose their grip on the resources in the region (Stearns 2012, p. 322-323).

Thus the already war-torn eastern Congo, once again became the epicentre of a new wave of violence as can be seen in the graph depicted in chapter four (*graph 3*). Violent attacks have continued and many militias remain active, especially in the east of the country, and they continue to control the mines, using the revenue to maintain their "rebellion" and thereby also the violence (BBC 2015; Eichsteadt 2011, p. 54-55, 114).

In order to gain control, the government tried to integrate rebel groups into the army, however this only really worked as long as these now former rebels were allowed to continue the exploitation of the mines and deposits they already controlled, but now with the tacit consent of Kinshasa, thus blurring the line between the government and other groups. Even the parties that are officially supposed to be battling each other can cooperate when economic interests are at stake. For example, in the smuggling of the resources and, at least in one case, also in exploiting a mine, serving as a perfect example of the greed that maintains the conflict. (Eichsteadt 2011, p. 101-109). This also goes for the former hostile national armies of some of the involved countries. In 2009 Rwanda and the Congolese government conducted a coordinated clean-up campaign in the Congo, which is likely to have been little more than an attempt to reassert control of the mines in the eastern parts of the country for their own gain {Eichsteadt, 2011 #9`, p. 99-100;Global-Witness, 2009 #33`, p. 17}.

Because of the continued and intensified resource plunder, this study focuses on the years after 2006.  It is also only after 2005 that major investments accelerated the rate of mining as various armed groups developed their ability to gather the minerals {Eichsteadt, 2011 #9`, p. 289}. Previous to that, instability and violence had significantly slowed down investments.

## 2.3     The Role of Natural Resources

There are many accounts of the violence and the resource plunder. The rebels continue to control the mines and use the revenues, partly due to that when the government started incorporating rebel groups into the army, the newly formed army groups were still expected to continue to finance themselves. (Eichsteadt 2011, p. 54-55, 101-109).

There is also an ethnic dimension to the conflict. Examples of mass killings based on ethnicity cannot be explained without considering other factors than the purely economic. Take for example the many massacres of civilians in the Ituri region usually carried out by one of the many ethnically based militias. It is also equally difficult to explain the targeting of mines during military expeditions or the numerous accounts of the greed of the warring factions without considering economic motivations {Burch, 2014 #5}. Much of the heavier fighting in the Kivus for example, was around the Mongbwalu goldmine, one of the largest in the world which in the span of one year changed hands no less than five times. {Eichstaedt, 2011 #9`, p. 39}.

### 2.3.1  Minerals

For DRC to suffer a resource curse it needs to have resources and it has that in abundance. The total untapped mineral deposits in the country are estimated at $24 trillion dollar {Morgan, 2009 #24}. This figure excludes non-mineral resources such as oil and agricultural products such as coffee beans.  Of the minerals, Congo has been blessed/cursed with rich deposits of tin, gold and coltan in the east of the country. (Eichstaedt 2011, p. 102, 135, 138). Orientale province and its capital Kisangani in the middle of the country primarily exports diamonds (Stearns 2012, p. 241). The western Atlantic coast of the DRC manages, despite its narrow size, to offer valuable oil fields {Prunier, 2008 #25`, p. 170}.

Of particular interest are niobium and tantalum which are two element that are naturally found in mineral compounds such as cobalt and coltan {Shaw, 2011 #21}. These two elements are perhaps, in the eyes of the worlds markets, DRCs most important export. They are an essential metal component in all electronics produced today due to their low conducting resistance and high heat tolerance. These characteristics coupled with the relative rarity of the minerals has made the Pentagon classify them as strategically important minerals and the EU to classify them as critical raw materials. {Shaw, 2011 #21;Tegera, 2002 #28}. 80% of the world's total reserves of niobium-tantalum are located in DRC, especially in the conflict ridden eastern parts of the country {Vesperini, 2001 #29}. The explosion of the market for personal electronic devices such as mobile phones in the last 15

years dramatically increased demand and price of coltan and cobalt. Not surprising then that some speculate that this price boom is driving at least some of the violence in eastern DRC where such deposits are located {Stearns, 2012 #10`, p. 229}.


## 2.3.2  Minerals & Conflict

Contradictory, richness in resources has ever since colonial times and perhaps earlier led to poverty and suffering for the Congolese population. The infamous Free State-era when the whole of Congo was deemed a private ownership of the Belgian king Leopold II comes to mind. That era can be described as the whole colonial enterprise distilled to its purest form of subjugation of the whole population as a tool to plunder the land {Hochschild, 1998 #27`, p. 159}. The theme of resource driven violence continued into the modern era after Congo gained independence from Belgium. A brutal internal conflict during the 1960 started after the southern mineral-rich province of Katanga attempted secession aided by western interests {Ndikumana, 2003 #30}. A prolonged period of relative peace followed during Mobutus reign.

Since the population in DRC is mainly impoverished, they cannot act as a reliable funding base for a government or a rebel group. The population primarily contributes manpower to armed factions so funding for an expensive war instead comes from whatever natural resources are available {Burch, 2014 #5}. For this reason, the conflict in the DCR can be said to be a resource war. Resources directly tied to the land such as mines or oilfields also means that one party can never completely secure it by physically moving it and violence is always a risk around that area {Mostafa, 2014 #1}. As long as there are resources to be had and sold, the financing of war continues. Access to foreign markets and foreign capital is essential and the supply chain from a diamond mine to a boutique in Europe is well documented. The link between violence and resources seems to be especially strong in regards to oil {Kaldor, 2007 #2`, p. 11-12}. This is demonstrated by how French oil giant Elf has previously been involved in financing some of the violence in the west of the DRC where the oilfields are located {Prunier, 2008 #25`, p. 169}.

# 3  Methodology

We proposed a quantitative analytical study with both theory testing and theory developing ambitions, to answer the question of whether resource prices has any direct bearing on levels of violence in the provinces of the DRC that export said resource. The investigated time period is from 1997 to 2015. This required three different sets of data; one for levels of violence in DRC during this period, one set of data for resource prices for the same period and data on what resources each province exports.

No other variable except resource price was investigated as a causative factor. This was partly to investigate the resource link in more detail and partly due to time constraints. Other potential factors such as ethnicity, foreign intervention or topography could have been included.

## 3.1  Operationalisation

### 3.1.1  Violence

Violence is here operationalised as number of deaths reported and violent incidents involving the DRC government, rebel group or foreign forces. Despite claims of millions of dead during this violent period since 1997, reporting of casualty figures in DRC is notoriously unreliable {Coghlan, 2006 #12}. The enormous size of the DRC, which is as large as the whole of Western Europe and lacking in infrastructure means that vast areas of the territory are hard to access for aid groups and reporters. This makes it impossible to find exact figures on deaths and incidents of violence. Associated information such as location and date of deaths can be just as lacking. For this reason, operationalisation had to be restricted to only account for number of dead and number of violent incidents that do not necessarily result in deaths.

A wider operationalisation, to also include numbers of wounded, displaced or dead from events not directly caused by conflict related violence would have been useful. However, lack of good data prevented this. We still believe that only counting number of dead and number of incidents does adequately describe the intensity of violence, if reported over time and used in parallel.

### 3.1.2 Resources

Operationalisation of resources was in comparison far more straightforward since we simply needed to record the price of the relevant commodity over the investigated time period. DRC exports a wide range of natural resources so we needed to prioritise and limit the number of resources included in the analysis. We believe that valuable resources that originate from a restricted geographical zone, meaning they are easier for a conflict actor to control, would show the best correlation to violence. Therefore, high volume resources cultivated from large land areas such as coffee or rubber were excluded. This left oil, diamonds and various minerals as suitable candidates. Global Financial Database offers historic data on the value of all exports from DRC and we used it to identify the most valuable export commodities according to income {GFD, 2015 #13}. Using this method cobalt, coltan, copper, diamonds, gold, oil and tin were identified and included in the analysis.

To complete the analysis and allow for comparisons between provinces we also coded the provinces according to which commodities they exported. Levels of violence in provinces that export a certain commodity could thereby be compared to other provinces that did not export it.

## 3.2 Data sources

### 3.2.1 Violence

The Armed Conflict Locations Events Data (ACLED) records violent events between various armed forces, and between armed forces and civilians based on reports from the media, aid groups and international organisations {Raleigh, 2010 #11}. The current ACLED version 6 covers the whole of the DRC 1997-2015 and also provides location, date and any eventual deaths {ACLED, 2016 #14}. No other data set available provides the same amount of information as ACLED leaving it as the only source about violence in this study. Question can be raised about the reliability of the data and its reliance primarily on media reports {Eck, 2012 #15}. Uppsala Conflict Data Program offers similar data but does not record events where no deaths occur and is not as readily presented over time and by region as ACLED is.

### 3.2.2 Resource Locations

We collated the information on location of active mines and oil fields from various sources starting with the US geological survey {USGS, 2015 #16}. Additional online searches identified articles from both the BBC and Le Monde that provided locations on further sites of mines in use {BBC, 2013 #18;LeMonde, 2006 #17}. We failed in locating any reliable data on size of

production from identified mines, which is as mentioned earlier due to the lawlessness and smuggling.


### 3.2.3 Resource Prices

Historic monthly prices covering the period of conflict were found for copper, diamonds, gold, oil and tin {Indexmundi, 2016 #19;UNCTADSTAT, 2016 #20}. Cobalt and coltan on the other hand, are not traded openly on exchanges like the other commodities are. Transactions are instead negotiated directly between sellers and buyers, and prices are therefore often kept secret {Shaw, 2011 #21}. Only annual estimates were available and only until 2010 for coltan {USGS, 2016 #22;USGS, 2016 #23}. All prices were adjusted to account for inflation.


# 3.3     Analytical Methods


We coded the data according to the province where the violence took place. The data was presented over time according to month and according to year. Each province was also coded according to what commodities are located within and exported. Three different quantitative analysis methods were then applied: times series, linear regression and fixed effect. Having three different approaches offered various perspectives in analysing the data. The large amount of variables and observations also necessitated more than one analytical method. All calculations were made using Stata/SE 13 by StataCorp LP from 2013.


### 3.3.1 Time Series

Simple time series graphs were plotted for each regions level of violence over time on one line and price trend for relevant commodity on a second line in the same graph. This approach neatly presented the visual relation between violence and price and how it changed over time.


### 3.3.2 Regressions

Linear regression was used as the first step of statistical analysis to examine if there is a correlation between increasing price and increasing violence. Probability analysis was also included. The weakness of simple linear regression is that it will not describe the temporal relation. It can demonstrate a correlation but without a time aspect no conclusion about cause and effect can be drawn.

We are aware that using a linear regression presumes independent observations and since our observations are over time it can be argued there is some co-dependence. Price and violence in one month can be affected by price

and violence in the preceding month. Regardless, this model can still at least indicate a correlation if the relation is strong.

### 3.3.3  Fixed Effect Modelling

The third step of analysis was in the form of fixed effect. Fixed effect (FE) models are used to assess the size of change that one independent variable (in this case price) can have on a dependent one (in this case violence) {Wilson, 2007 #36}. The fixed effect analysis was performed on each commodity price compared to each province over time to assess if effect of price change affects provinces with and without the commodity to the same extent. Using this model, a probability estimate can also be done. The coefficient calculated for each commodity also has prognostic use to predict levels of violence in the future. In this case we used FE to calculate how many deaths or how many violent episodes were created by each 1 US dollar change in world market price.

# 4        Findings & Analysis

Table 1 summarises the number of deaths and events observed for each province in the DRC and for the county as a whole. This information is illustrated in graph form as well (*graphs 1-18*). As apparent by the table there is a huge variation in the numbers of recorded deaths and events between provinces. A significant number of events reported did not result in any deaths. The mean values and the large standard deviation for most provinces further confirm this variation. Maniema which in the March of 1997 has a recorded death count of 25000 provides an extreme outlier. This high figure is according to ACLED based on a report from BBC Africa monitoring service about a located mass grave. This observation is only one of many instances of high variation in the death figures (*graphs 2*). Recorded events on the other hand are more consistent in all regions and over time (*graph 1, 3*). As table 1 also demonstrates the standard deviations are also consistently lower compared to recorded deaths.

The results when comparing the number of violent incidents and the aggregated number of deaths in these incidents show a remarkable divergence. Many of the incidents registered in the data file have no registered casualties. However, the accuracy of the data in the file can, as mentioned earlier, be questioned (Eck 2012). The number of deaths is probably more unreliable because of the nature of the procedure necessary to obtain the information and verify the number of casualties. Furthermore, the total number of deaths in the file amount to a mere 73 672. This is quite far from the 3.9 million dead estimated, but in line with other figures estimating that only 2% of all deaths were a direct consequence of the violence {Coghlan, 2006 #12;Stearns, 2012 #10`, p. 250}. We believe the reporting on events are more reliable than on deaths since it is easier to report an occurred event but far more difficult to ascertain the number of deaths from such an event. For these reasons incidents were chosen as a more suitable indicator to be used for the remainder of the analysis. There are of course also doubts about the accuracy of this data but this is primarily in regard to the location of these incidents. Since this study focuses on the different provinces, which are quite large, exact geographic location is of less importance.

Table 1 also exhibits which regions contain which resources. Katanga is known to have the greatest variation in resources as the table demonstrates while the western provinces only have oil. Since Equator and Kinshasa do not have any known active mines or oilfields they were only included in the analysis as control cases.

*Table 1: Deaths and events recorded during the period of January 1997 to December 2015 with means and standard deviation*

| Province | Deaths Recorded (Mean, SD) | Events Recorded (Mean, SD) | Resources |
|---|---|---|---|
| **Bandundu** | 682 (45.5, 153.5) | 99 (2.1, 1.5) | Oil |
| **Bas-Congo** | 726 (34.6, 65.0) | 132 (2.8, 4.6) | Oil |
| **Equateur** | 3162 (81.1, 233.2) | 438 (4.5, 7.9) | - |
| **Kasai-Occidental** | 259 (16.20, 33.3) | 91 (1.8, 1.2) | Diamonds |
| **Kasai-Oriental** | 1379 (31.3, 82.6) | 246 (2.6, 2.2) | Diamonds |
| **Katanga** | 3109 (42.0, 101.1) | 840 (6.0, 5.9) | Copper, cobalt, coltan, tin |
| **Kinshasa** | 1962 (37.0, 91.75) | 417 (3.21, 3.73) | - |
| **Maniema** | 25868 (783.9, 4347) | 242 (2.85, 3.54) | Tin |
| **North Kivu** | 8739 (51.7, 102.7) | 3174 (15.1, 17.9) | Coltan, tin |
| **Orientale** | 18134 (117.0, 271.3) | 2412 (11.9, 12.2) | Diamonds, gold, |
| **South Kivu** | 9652 (65.2, 232) | 1746 (8.6, 8.1) | Coltan, gold, , tin |
| **DRC        total** | 73672 (331.9, 1716.7) | 9837 (43.1, 34.2) | |

# 4.1     Time Series

In graph 1 some important variations in the level of violence is clearly visible. There is an increase in 1998-99, as a result of the start of the second war. The decrease in the year 2000 is due to attempts at peace negotiations. The violence then increases again, only to decrease after 2003 as a result of the peace treaties. In more recent years there is a rapid increase in violence explained by the ascent of the resource war in the Kivus. The data for the various regions confirms this since the majority of violence is recorded in North and South Kivu (*graph 3*)

    Most of the graphs do not display any clear link between the real world market price of the relevant resources and the level of violence in the selected region. However, there are a few interesting patterns in the graphs. Regarding the prices of the commodities there appears to be a general increase in commodity prices in the second half of the studied period, followed by a general decline in those same prices during the last couple of years. There is also a notable fall in commodity prices during the 2008 financial crisis.
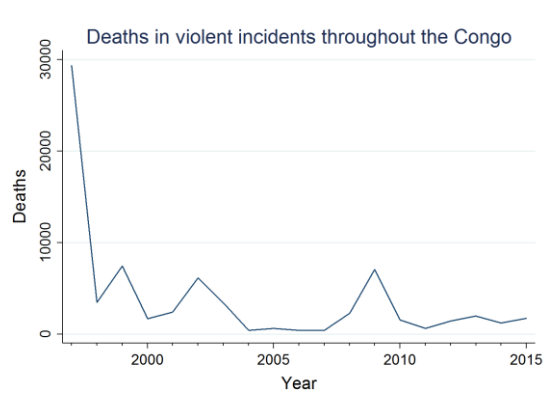
    Regarding violence, there seems to be an overall increase in most regions, starting around 2006-2008, and a temporary dip in violence in 2010. The by far most violent provinces during this latter part of the conflict are Orientale, South Kivu and North Kivu (*graph 3*). These are also the easternmost provinces of the DRC. Orientale and the Kivus all border to Uganda and Rwanda, the two most active foreign powers in the conflict.

    In general, when there is a notable correlation between price and violence the previously discussed time lag is around two years. All further analysis therefore accounts for this lag.
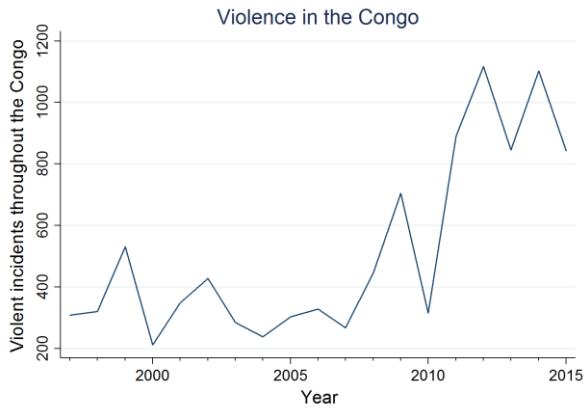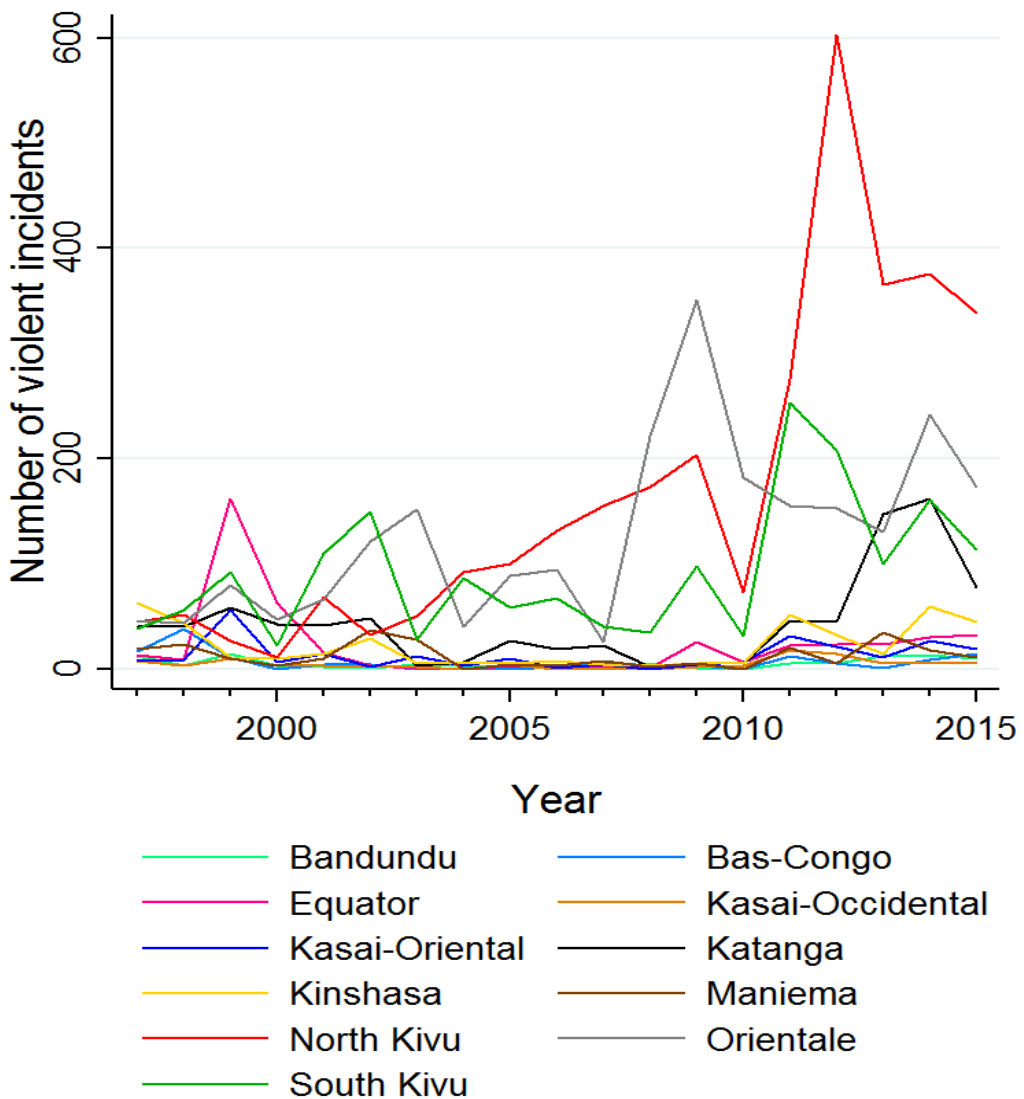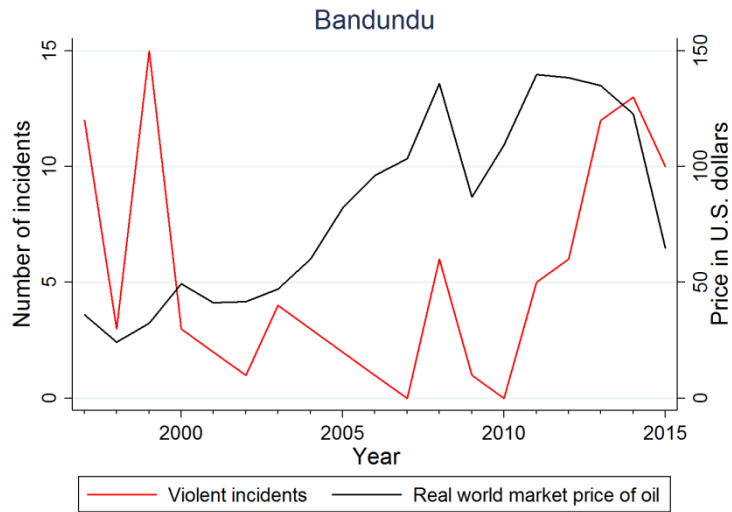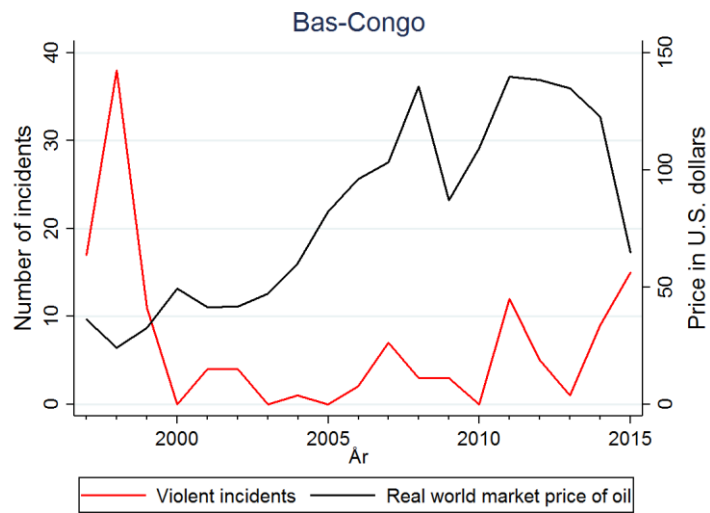
Violence in the Congo

Deaths in violent incidents throughout the Congo

Graph 3:



15

*Graph 4:*



*Graph 5:*



*Graph 6:*



16

*Graph 7:*



Kasai-Oriental

*Graph 8:*



Katanga

*Graph 9:*



Katanga

17

*Graph 10:*

## Katanga



Legend:
- Violent incidents
- Real world market price of copper
- Real world market price of tin

*Graph 11:*

## Maniema



Legend:
- Violent incidents
- Real world market price of tin

*Graph 12:*

## North Kivu



Legend:
- Violent incidents
- Real world market price of tantalum

*Graph 13:*



North Kivu
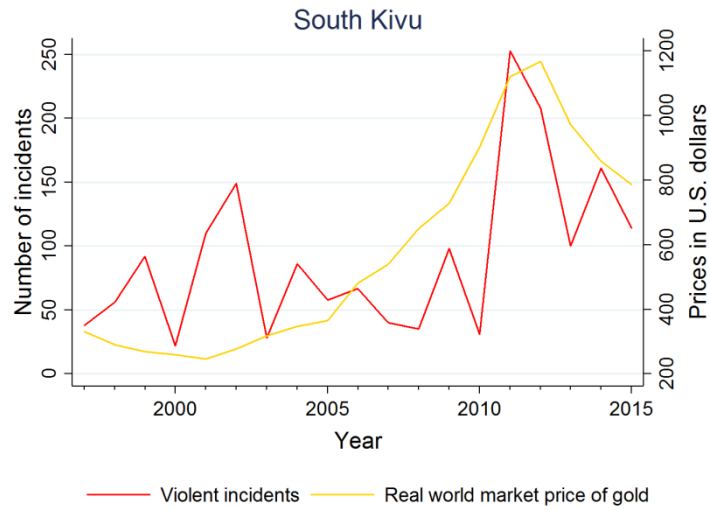
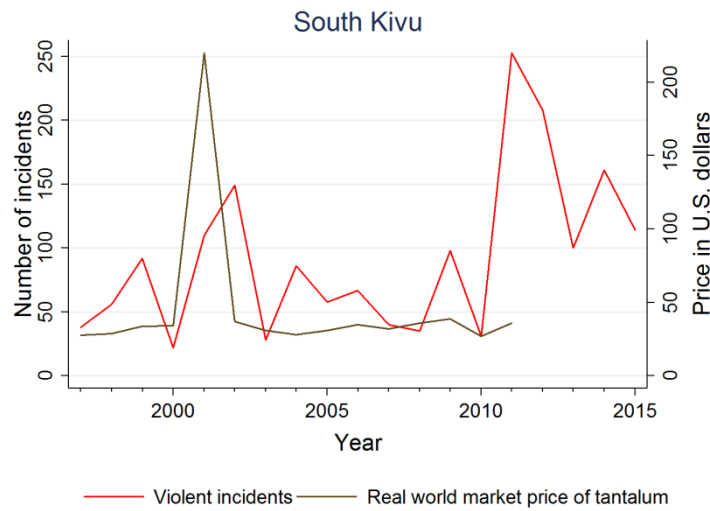*Graph 14:*



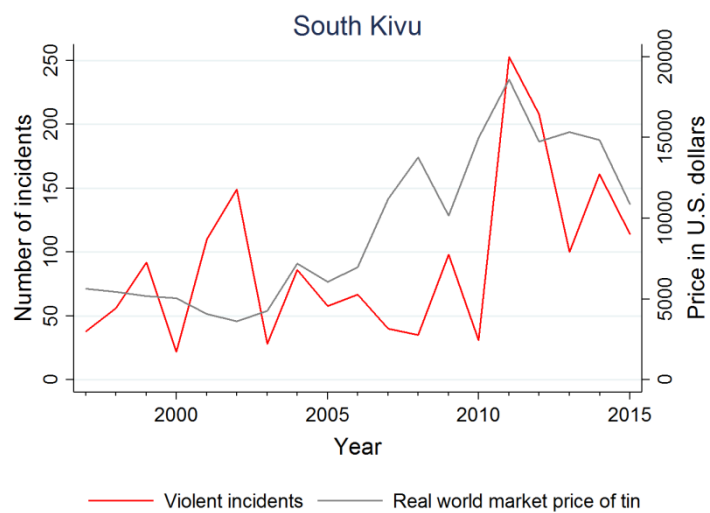Orientale

*Graph 15:*



Orientale

19
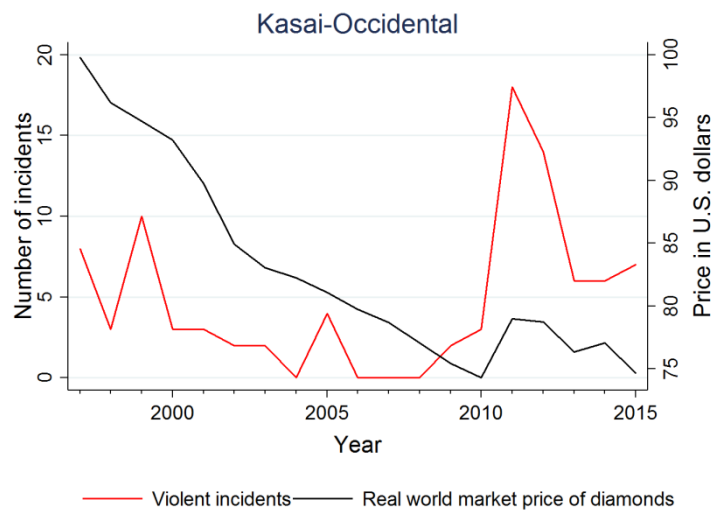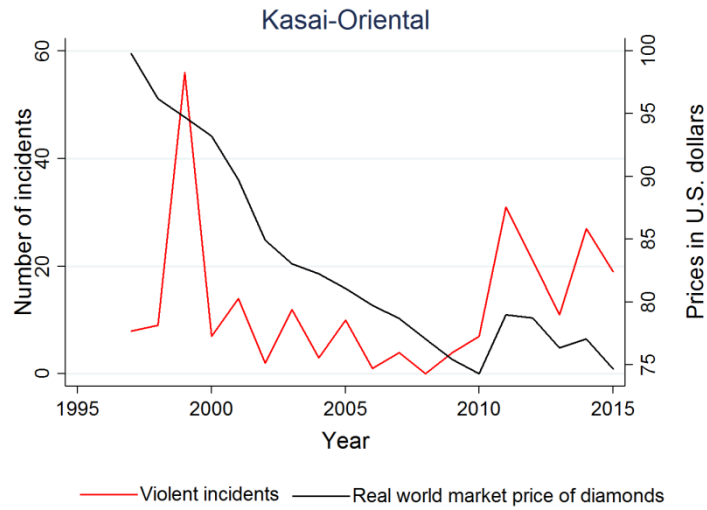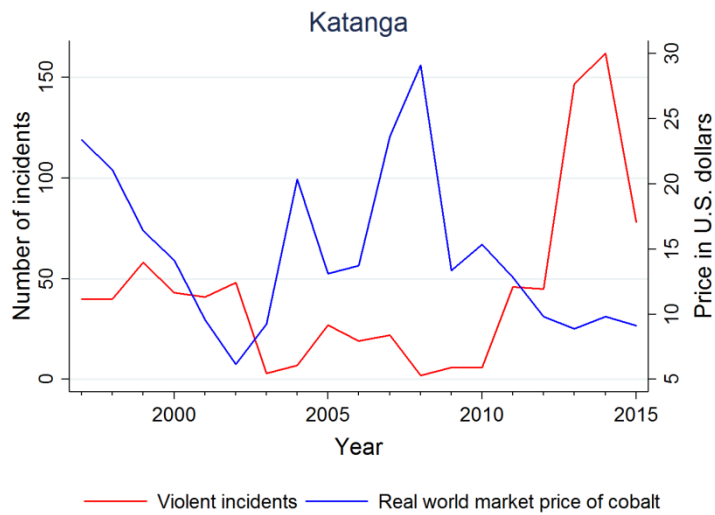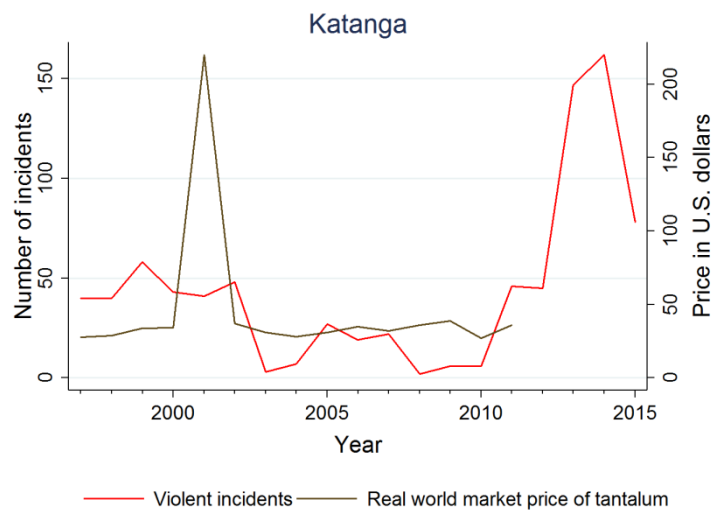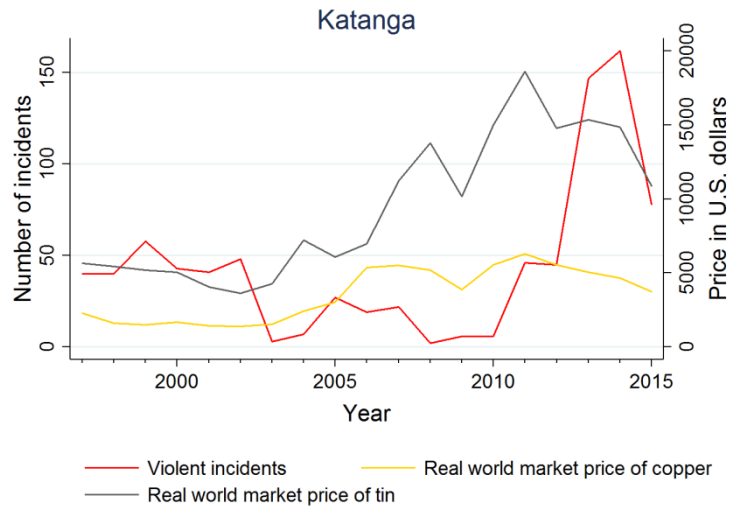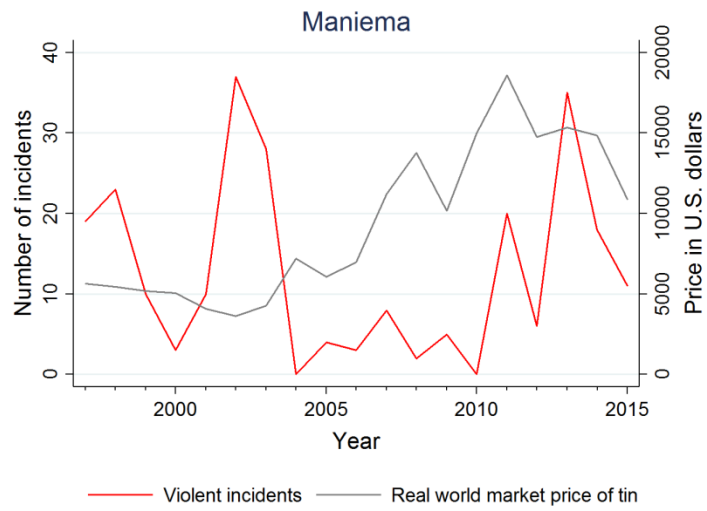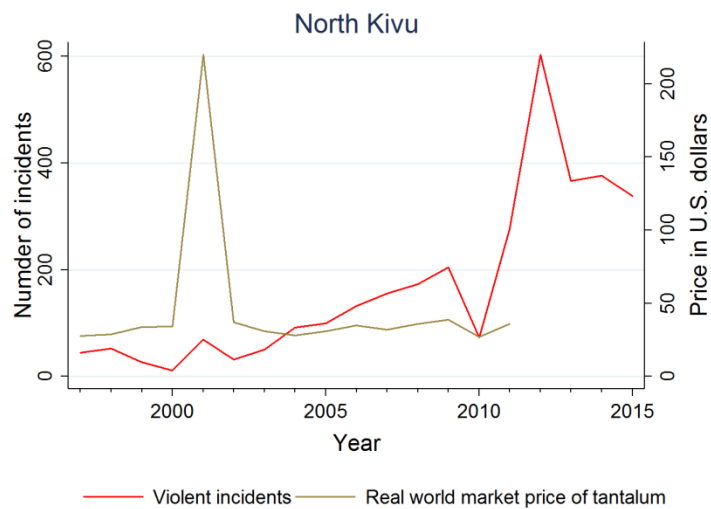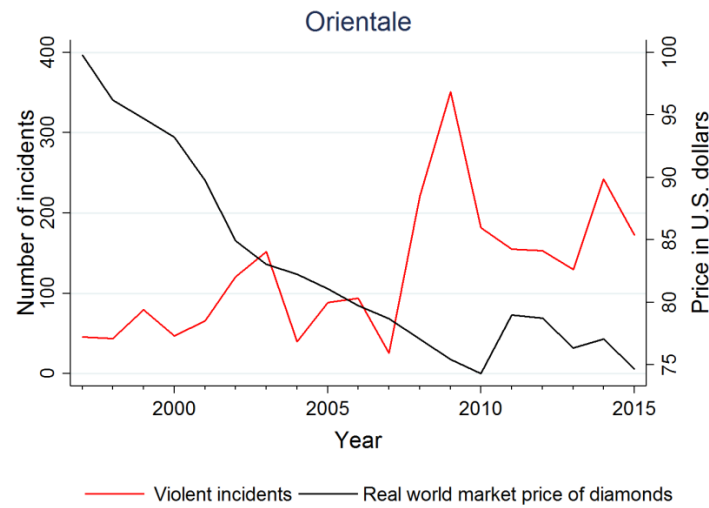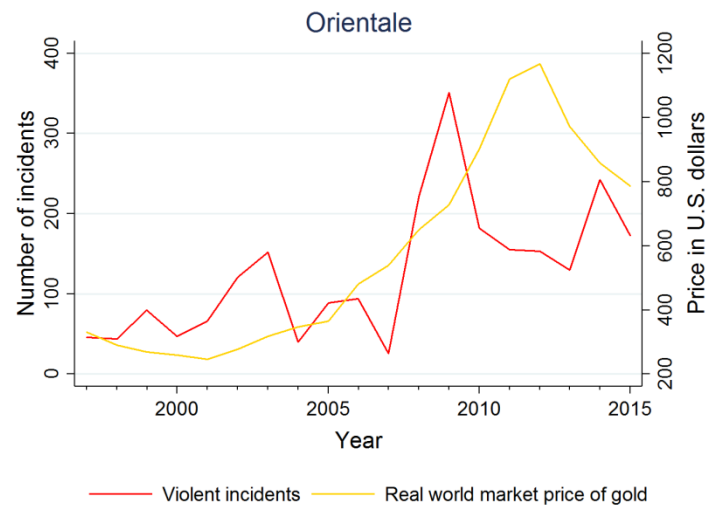
*Graph 16:*



*Graph 17:*



*Graph 18:*

### 4.1.1  Copper

Copper is one of the commodities whose price increases, except for a temporary fall in 2008, for most of the period, only to start falling during the last couple of years. Copper is only found in Katanga, a province that sees a massive relative increase in the number of incidents from 2010 until 2014 however this appears to not be caused by the price of copper as this decreases before the increase in violence in Katanga (*graph 10*).

### 4.1.2  Diamonds

The price of diamonds sticks out as it is the only one to follow a general downward trend. There appears to be little correlation with the intensity of the conflict in Orientale but the graphs of Kasai-Oriental and Kasai-Occidental show greater promise (*graphs 6, 7, 14*). In both cases there is a downward slope during most of the studied period but with two spikes in the last few years, which are in tandem with the price of diamonds.

### 4.1.3  Gold

Gold is found in two provinces (Orientale and South Kivu) which are situated in the east of the country and have the high levels of violence (*graph 3*). In the case of South Kivu, gold seems to offer a potential explanation for the increase in violence since 2007-2008 but cannot do so for the dips (in the case of South Kivu) or spike (in the case of Orientale) during this period, or the shift in the trend to a decline in violence as it in both provinces starts before the gold price falls (*graphs 15-16*). The correlation between the price and intensity of the conflict might in this case therefore very well be spurious. The common cause of these two trends might be that increased demand is driving up prices on several commodities and as a result also violence in the provinces mentioned above. Then there should be another commodity that better correlates with the level of violence.

### 4.1.4  Tin

Tin is found in the "tin-belt" in the south-eastern provinces of Katanga, Maniema and the Kivus. Eichsteadt even claims that the tin mine of Bisie is the biggest prize in North Kivu (2011, p. 102). There is an increase in the price of tin after 2005, and a few years later there is an increase in the violence in Katanga and Maniema but so many years later that there is strong reason to doubt that the tin price would be the cause (*graphs 10, 11*). In both North and South Kivu on the other hand, the trends between the price of tin and the number of violent incidents seem to correlate closely when taking into account the two year lag previously mentioned. (*graphs 13 & 18*).

### 4.1.5  Other resources

The price of tantalum (cobalt and coltan) is, as has been discussed above, a bit different because of the highly secretive nature of the transactions in the trade of this mineral. There is however a very interesting quality in the obtained data, namely the remarkably high average price of this commodity in 2001. If the assumption that price of a commodity affects the conflict, then this spike should definitely generate some sort of change in the level of conflict intensity. In North Kivu there appears to be a small, temporary increase in violence, simultaneous to the 2001 tantalum price chock (*graph 12*). There is also a simultaneous fall in 2010 (and increase thereafter) in violence in North Kivu and world market price of tantalum. In South Kivu there is a similar but bigger change (*graph 17*). There are no such similarities for Katanga (*graph 9*).

Cobalt is only found in the resource rich province of Katanga. The correlation between the world market price and the violence in Katanga appears to be non-existent, or possibly negative (*graph 8*).

Oil is found in the western provinces of the country. There is little or no correlation in Bas-Congo (*graph 5*), but in Bandundu there appears to be some correlation (*graph 4*) after the intensification of the resource plunder in 2005.

### 4.1.6  The Case of Katanga

The province of Katanga differs from the rest of the regions in a few ways. There are a few resources that are only found in this province (cobalt and copper) and the violence follows a different pattern. There was some violence during the Second Congo War, which was followed by a relatively peaceful period up until 2010. This means that the province followed a trend similar to that of the western and central provinces until 2010 but the increase thereafter, seen in most provinces, was much bigger, bringing the amount of violent incidents per year up to a level close to that of the eastern provinces of Orientale and the Kivus (*graph 3*). According to Burch and Pizzi (2014) the level of violence in Katanga is lower than expected based on their findings, and they attribute this to the presence of the Zimbabwean armed forces. In the beginning of the Second Congo War, the regime in Kinshasa struck a deal with Zimbabwe, giving the later access to much of the riches found in Katanga in return for military support in the conflict {Burch, 2014 #5;Stearns, 2012 #10`, p. 291-296}. The increase after 2010 is then probably the result of the uprising in the east against Kabila.

## 4.2      Regression Analysis

A simple linear regression analysis was performed to evaluate correlation between price and violent events. The analysis compared each province with price of resource that said province exported. The data was plotted on a two-way graph with a best fit line. The four easternmost provinces are, as previously mentioned,

the most violent ones and are also the only ones that provided statistically significant results. These results are presented below in the form of graphs (*graphs 19-25*). All correlations shown in the graphs are statistically significant at $p < 0.05$. The data clearly demonstrated a statistically strong correlation between rising price of resource and violence in the province since the year 2005 when the price was lagged by two years. This applies to copper, gold and tin in the four easternmost provinces.

Note also that the analysis was made using the monthly observations and not the annual ones. With monthly observations there were 12 times more observations to work with, allowing the results to reach statistical significance which would not have been possible using annual data. This unfortunately meant that we could not reach a significant result for cobalt and coltan.
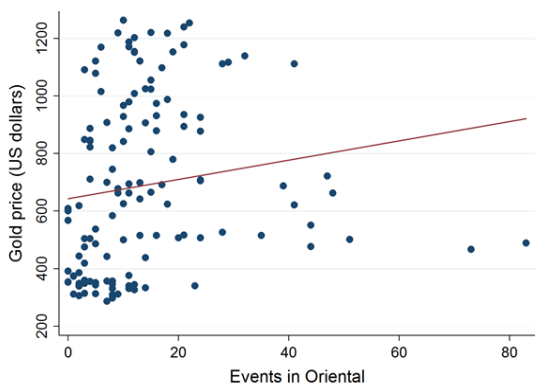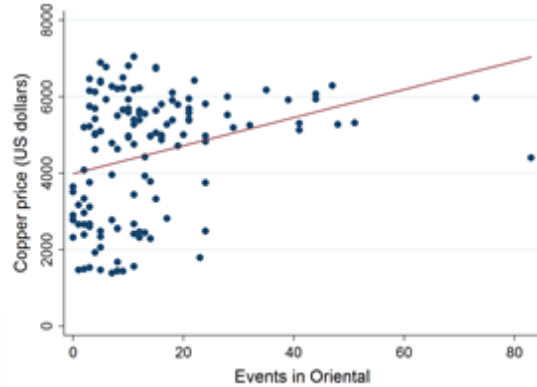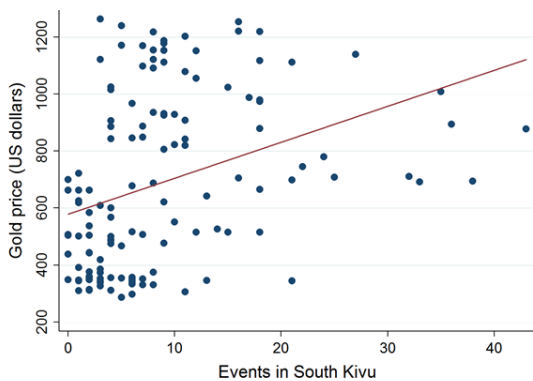
*Graph 19:*
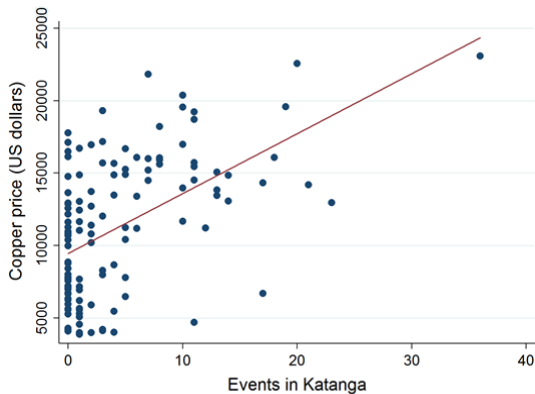


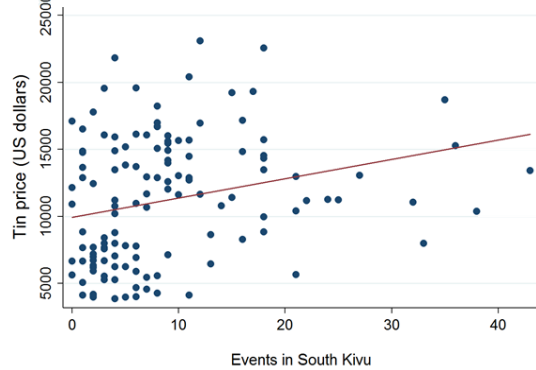*Graph 20:*
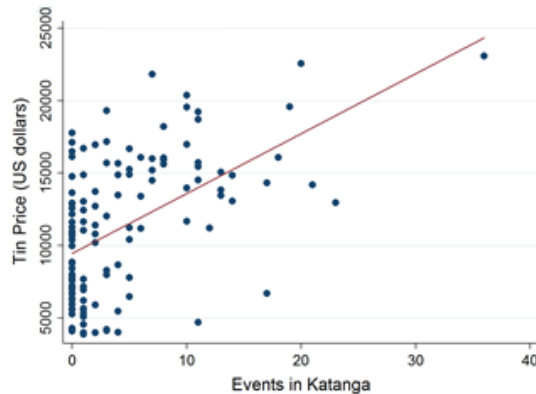


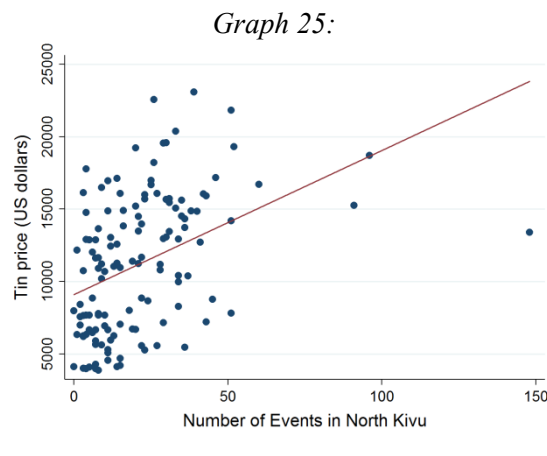*Graph 21:*



*Graph 22:*



*Graph 23:*



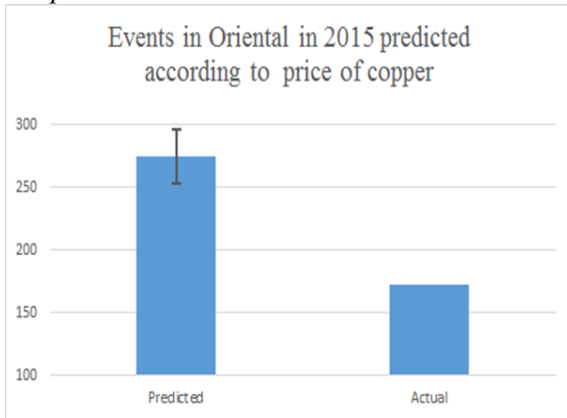*Graph 24:*

*Graph 25:*

# 4.3      Fixed Effect

The FE model was used to calculate how much a change of 1 US dollar in the price of a resource changed the number of events in one province. Calculations were performed twice to include monthly and annual changes during 2005-2015. Prices were again lagged by two years (*table 2*). This demonstrates how much violence changed on average in each province with each change of one US dollar in the price of said resource. The only results to have p value below 0.05 were for Orientale and the Kivus since they are the ones with most recorded observations of violence events. Too few observations were recorded for the remaining provinces for the results to reach statistical significance.

*Table 2: Fixed effect coefficients (change in events in one year with each increase of 1 US dollar in price) for 2005-2015. All statistically significant at $p \leq 0.05$*
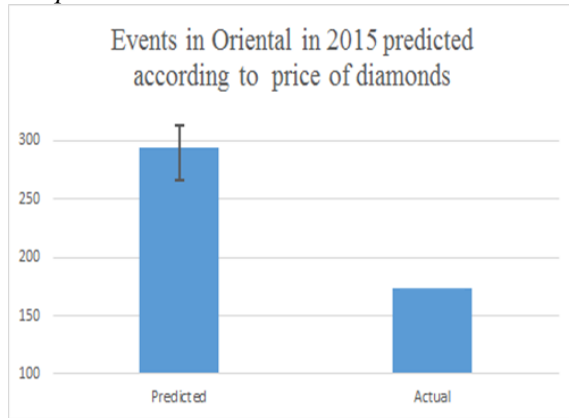
| Province | Copper | Diamonds | Gold | Oil | Tin |
|----------|--------|----------|------|-----|-----|
| **North Kivu** | | | 0.36 | 1.872 | |
| **Orientale** | -0.036 | -20.268 | | -1.236 | -0.012 |
| **South Kivu** | | | 0.192 | | 0.012 |

     To test the strength of using the fixed effect model in predicting violence the calculations where redone but this time excluded events after December 2012. By then calculating the difference in the lagged price change for resources with the fixed effects coefficients, a predicted number of violent events for the following years was reached. To account for drastic changes in violence, the calculations were repeated until 2015 thereby smoothing out the sharp turns between years. Only fixed effect coefficients that reached statistical significance were used for predictions. The following graphs present the results (*graphs 27-34*). The 95% confidence interval for the predicted value is included in the graphs. Once again tin prices and the Kivus show a remarkably accurate prediction (*graphs 33-34*).

*Graph 26:*

Events in Oriental in 2015 predicted according to price of copper

*Graph 27:*

Events in Oriental in 2015 predicted according to price of diamonds

*Graph 28:*

Events in North Kivu in 2015 predicted according to price of gold

*Graph 29:*

Events in South Kivu in 2015 predicted according to price of gold

*Graph 30:*

Events in North Kivu in 2015 predicted according to price of oil

*Graph 31:*

Events in Oriental in 2015 predicted according to price of oil

*Graph 32:*

Events in North Kivu in 2015 predicted according to price of tin

*Graph 33:*

Events in South Kivu in 2015 predicted according to price of tin

25

# 5      Discussion & Conclusion

We managed to complete all the analysis we set out to do and could demonstrate through the time series and linear regression a correlation between increasing price and increasing violence in the easternmost provinces. The following sections will discuss the findings in more detail.

## 5.1      Hypothesis 1

Hypothesis 1 predicted that increasing price of a resource will increase violence in the exporting province. The analysis of the data does not conclusively prove the hypothesis but it offers some support. When l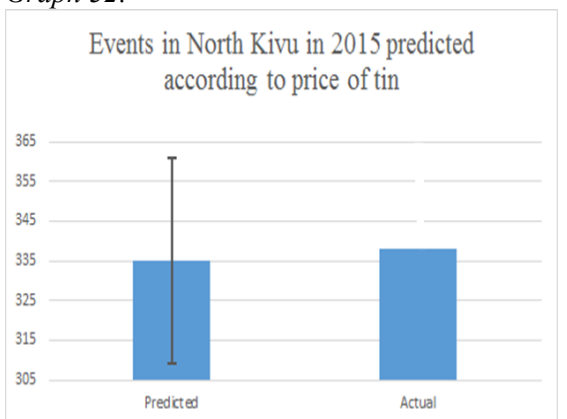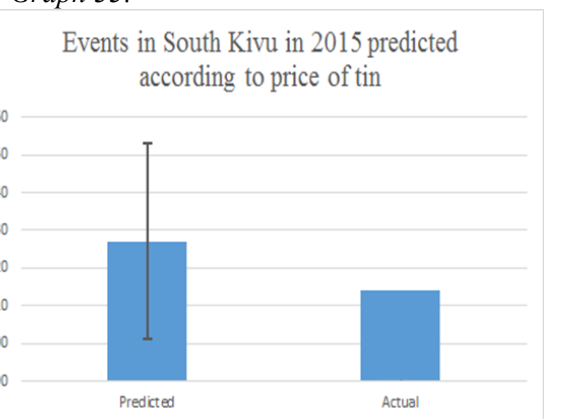ooking at the data presented above it becomes clear that the predicted correlation is mainly found in the more violent, eastern provinces and this relation can be explained by two factors. First of all, these provinces are the most violence ridden accounting for the vast majority of observed violent events. Any relation is therefore easier to demonstrate statistically. Secondly, violence indicates that a province is not under the control of one faction leading to anarchy. This facilitates a battle for resources where price can be a motivator for military action. A province like Bas-Congo is under the control of the DRC government so no rebel group is in a position to challenge the government for the oil fields there.

Furthermore, the correlation is strongest between violent provinces and the prices of the resources that said province exports which is in line with the hypothesis. The best example hereof is the price of tin and North Kivu as demonstrated with the regression and FE analyses. With a larger number of observations more relations would likely have been demonstrated. This is particularly true for cobalt and coltan. Both are only exported by the eastern provinces and have seen a dramatic increase in price in the last 15 years and would therefore be ideal candidates for such a relation. Unfortunately, the price data available to us lacks enough details to allow robust analysis.

An interesting finding that relates to hypothesis 1 is that in the cases where there appears to be a correlation between increases in price and violence, the same correlation appears to hold also for decreases. This was not part of the original hypothesis but is quite easily explained using a similar logic. A decrease in economic gain (caused by the decrease in the world market price) generated by one particular resource should make this resource relatively less desirable and the alternatives relatively more so. An alternative explanation might be that the lower price means lower profits for the various actors, which in turn means less funds to support military enterprises. If the goal of the violence is to make money, then it

simply does not make sense to wage war when the return on the "investment" falls.

### 5.1.1 Tin

Tin is the resource that gives the by far best results throughout the analysis and therefore seems to best determine the course of the conflict. This might at first come across as somewhat surprising because the resources usually mentioned in the literature on the Congo Conflict are minerals like gold and cobalt {Global-Witness, 2009 #33`, p. 20}. Though it might at first come across as logical that the most valuable resources (measured as price per unit of the commodity) are the most desirable ones this is not necessarily the case, as the relevant factor is accessibility. The desirability of a resource should according to the theory presented in this paper be determined by the economic gain, which can in turn be affected by accessibility. A resource that is more accessible might generate more economic gain than a more expensive resource due to greater production for every work hour invested. Tin by being relatively cheap to mine then probably generates more economic gain than for example gold. So it makes sense that tin is more desirable and its price is therefore a stronger driving force in the conflict.

## 5.2     Hypothesis 2

Our results demonstrate a time lag but our hypothesis vastly underestimated it. Instead of the expected three months delays we found it to be two years. A reason for this could be that our data could only demonstrate such a trend over a longer perspective. There could still be a short time lag but the data is not detailed enough to demonstrate this. The long lag effect could also be explained by the fact that to sustain any dramatic increase in violence, the armed groups need time to recruit, regroup and finance efforts to control mines leading to a gradual build-up, only noticeable over a longer period of time.

Another reason is that a price change needs a long time to diffuse from markets, through middle-hands, to the armed groups. The price change might perhaps be noticed by the miners and armed groups in the area only after their stockpiles from previous years have been sold. (Stearns 2012, p. 297-299).

### 5.2.1 The impact of the Financial Crisis

A major confounding event in our data is the financial crisis of 2008. During this period there was a dramatic drop in prices for all commodities except for gold (*graphs 4-18*). This is problematic since no similar financial crisis occurred in the preceding years complicating attempts at comparisons over time. It could also be a blessing in disguise since it acts as a reset button offering a clearer view of how

violence, after first having fallen with the prices then gradually increases as the prices recover to their pre-crisis level.

# 5.3     Flaws in this Study

The main flaw in our study is that we have not included any other independent variables beside resource price. Our study cannot prove causation, only correlation. We did include temporal relation in the analysis to try to minimise this major flaw. If a price change can be demonstrated to precede a change in violence, then it does support our hypothesis. Other potential causative variables include ethnic make-up of an area, access to airports, borders and rivers, proximity to international borders and to Kinshasa. Number of active armed groups in an area and accounting for periods when foreign armies intervened would also warrant inclusion. All of these potential explanatory variables are instead represented by deaths and violent events only in this study.

Another major flaw is the lack of quantitative data on the size of exports from different regions. No reliable data exists as mentioned in section 3.2.2. The whole analysis therefore becomes very limited since we cannot account for how productive each province is. For example, a price spike in gold might not lead to a violence spike in South Kivu since it only exports a small amount of gold or it only exports from one mine that is in an area far away from any frontline.

Reporting on violence and deaths can also be questioned. According to ACLED, violence increased in the last 10 years {ACLED, 2016 #14}. We are unsure if this increase is real or if it is a result of better reporting from the area. Could it be due to a higher number of journalists and investigators? Could it be due to an improvement in communications infrastructure such as the build-up of mobile phone coverage in remote areas in eastern DRC? A potential solution to this uncertainty would be to attempt including data from UCD or another source in the analysis.

# 5.4     Areas for Future Research

This study provides a basis for further studies. The next logical step would be to see if the correlation discovered in this study also holds for other conflicts. One could for example look at the effects of changes in the price of cocaine on the conflict in Colombia or maybe oil in Libya. Another way could be to compare between conflicts to see what resources are relevant, or if the financial crisis of 2008 decreased the violence in other conflicts as well. Another way to build on the discoveries would of course be to redo the study and include other variables to account for at least some of the flaws discussed in 5.3.

Furthermore, this study is based on the implicit assumption that the price on the black market of central Africa follows the world market price, and even if this is a correct assumption, the correlation should then be significantly better when

comparing violence to the black market price in central Africa. Examining the African black market is a challenging task in itself and well beyond the scope of this paper, but it might be suitable for future research. This aspect should be of particular interest if trying to develop a better model to predict the future intensity or development of a conflict.

Sadly, and somewhat ironically, time prevented any further examination of the time factor in this study, but it is an area that should be studied further in future research. This could be done both by looking at which time lag gives the best correlation, in order to determine how long the time lag seems to be, and by looking at how long it should be when estimating the time it takes to transport the goods and so on. A first attempt at this was made in this paper but a paper focusing more on this part holds much promise for the future study of the effect studied in hypothesis 1.

# 5.5 Conclusions

The main result found in this paper is support for hypothesis 1; changes in the world market price of commodities that are produced in a conflict zone changes the intensity of the conflict. This only holds for conflict zones that are quite violent, with extensive resource plunder as a prominent element in the conflict and with several different actors taking part in it.

Regarding hypothesis 2 it can be concluded that there was indeed a time lag but this effect was much longer than expected. Plausible explanations for this have been discussed in 5.2.

These findings also provide an alternative explanation to the recent escalation of violence in the eastern provinces of the Democratic Republic of the Congo. Whereas earlier work has considered this a result of the rebellion in order to maintain the status quo, this study suggests that the escalation is in fact because of the increase in world market price of several metals that are found in these provinces. The results of the statistical analysis further suggest that it is tin, rather than any other natural resource, that is the main conflict mineral.

Last but not least the model used to predict the violence in the Kivus using the price of tin can of course also be used to predict the future level of violence in these provinces or in another conflict zone that is also plagued by resource plunder, as long as the most desirable resource(s) have been identified.

# 6 References

ACLED. 2016. *ACLED Version 6 (1997 – 2015)* [Online]. Available: http://www.acleddata.com/data/version-6-data-1997-2015/ [Accessed 2016-05-07].

BBC. 2013. DR Congo: Cursed by its natural wealth. Available: http://www.bbc.com/news/magazine-24396390 [Accessed 2016-05- 02].

BBC. 2015. Democratic Republic of Congo – timeline. Available: http://www.bbc.com/news/world-africa-13286306 [Accessed 2016-05-07].

BURCH, M. & PIZZI, E. 2014. Local Fights in National Conflicts: Understanding the Location of Conflict Events during Intrastate Conflict. *Civil Wars,* 16**,** 24-45.

COGHLAN, B., BRENNAN, R. J., NGOY, P., DOFARA, D., OTTO, B., CLEMENTS, M. & STEWART, T. 2006. Mortality in the Democratic Republic of Congo: a nationwide survey. *Lancet,* 367 North American Edition**,** 44-51 8p.

COLLIER, P. & HOEFFLER, A. 1998. On economic causes of civil war. *Oxford economic papers,* 50**,** 563-573.

COLLIER, P. & HOEFFLER, A. 2004. Greed and grievance in civil war. *Oxford economic papers,* 56**,** 563-595.

DE BOEF, S. & KEELE, L. 2008. Taking Time Seriously. *American Journal of Political Science,* 52**,** 184-200.

ECK, K. 2012. In data we trust? A comparison of UCDP GED and ACLED conflict events datasets. *Cooperation & Conflict,* 47**,** 124-141.

EICHSTAEDT, P. H. 2011. *Consuming the Congo: War and conflict minerals in the world's deadliest place,* Chicago, Ill., Chicago Review Press.

ESAIASSON, P., GILLJAM, M., OSCARSSON, H. & WÄNGNERUD, L. 2012. *Metodpraktikan : konsten att studera samhälle, individ och marknad*, Stockholm : Norstedts juridik, 2012 (Vällingby : Elanders) 4., [rev.] uppl.

FEARON, J. D. & LAITIN, D. D. 2003. Ethnicity, insurgency, and civil war. *American political science review,* 97**,** 75-90.

GFD. 2015. *Commodity Data* [Online]. Available: https://www.globalfinancialdata.com/Databases/CommodityDatabase.html [Accessed 2016-05-07].

GLOBAL-WITNESS. 2009. Global Witness Report: 'Faced with a gun, what can you do?'. Available: https://www.globalwitness.org/documents/17817/report_en_final_0.pdf [Accessed 2016-04-30].

HOCHSCHILD, A. 1998. *King Leopold's ghost : a story of greed, terror, and heroism in Colonial Africa*, Boston : Houghton Mifflin, cop. 1998.

INDEXMUNDI. 2016. *Commodity Prices* [Online]. Available: http://www.indexmundi.com/commodities/ [Accessed 2016-05-07].

KALDOR, M. 2012. *New and old wars : organized violence in a global era,* Cambridge, Polity.

KALDOR, M., KARL, T. L. & SAID, Y. 2007. Introduction. *In:* KALDOR, M., KARL, T. L. & SAID, Y. (eds.) *Oil Wars.* London: Pluto Press, 2007.

LE BILLON, P. 2001. The political ecology of war: natural resources and armed conflicts. *Political Geography,* 20**,** 561-584.

LEMONDE. 2006. *Democratic Republic of Congo's mineral resources* [Online]. Available: https://mondediplo.com/maps/congo2006 [Accessed 2016-05-07].

MORGAN, M. J. 2009. DR CONGO'S $24 trillion fortune. *African Business*, 52-56.

MOSTAFA, M. M. & AL-HAMDI, M. T. 2014. Visualizing the Influence of Geography, Oil and Geopolitics on Civil Wars in the Arab World: A Novel Application of Self-Organizing Maps and Duration Models. *Civil Wars,* 16, 239-254.

NDIKUMANA, L. & EMIZET, K. 2003. The economics of civil war: The case of the Democratic Republic of Congo. *Political Economy Research Institute* [Online]. Available: http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1051&context=peri_worki ngpapers [Accessed 2016-05-10].

NORDSTROM, C. 2004. *Shadows of war : violence, power, and international profiteering in the twenty-first century,* Berkeley, Calif. ; London, University of California Press, 2004.

PRUNIER, G. 2008. *Africa's World War: Congo, the Rwandan Genocide, and the Making of a Continental Catastrophe,* Oxford ; New York, Oxford University Press, 2009.

RALEIGH, C., LINKE, A., HEGRE, H. & KARLSEN, J. 2010. Introducing acled: An armed conflict location and event dataset special data feature. *Journal of peace research,* 47, 651-660.

ROSS, M. L. 1999. The political economy of the resource curse. *World politics,* 51, 297-322.

SHAW, R. & GOODENOUGH, K. 2011. Niobium–tantalum. *British Geological Survey* [Online]. Available: https://www.bgs.ac.uk/downloads/start.cfm?id=2033 [Accessed 2016-05-02].

STEARNS, J. 2012. Dancing in the glory of monsters: The collapse of the Congo and the great war of Africa. Ipswich, MA: PublicAffairs.

TEGERA, A. 2002. The Coltan Phenomenon: How a rare mineral has changed the life of the population of war-torn North Kivu province in the East of the Democratic Republic of Congo. Available: http://www.kongo-kinshasa.de/dokumente/ngo/polinst_coltan.pdf [Accessed 2016-05-08].

UNCTADSTAT. 2016. *Commodity Prices* [Online]. Available: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx?IF_ActivePath=P,8 &sCS_ChosenLang=en [Accessed 2016-05-07].

USGS. 2015. *Mineral operations outside the United States - Congo (Democratic Republic of the)* [Online]. Available: http://mrdata.usgs.gov/mineral-operations/select.php?place=fCG&div=fips [Accessed 2016-05-07].

USGS. 2016a. *Cobalt Statistics and Information* [Online]. Available: http://minerals.usgs.gov/minerals/pubs/commodity/cobalt/ [Accessed 2016-05-07].

USGS. 2016b. *Niobium (Columbium) and Tantalum Statistics and Information)* [Online]. Available: http://minerals.usgs.gov/minerals/pubs/commodity/niobium/ [Accessed 2016-05-07].

VESPERINI, H. 2001. Congo‟s coltan rush. Available: http://news.bbc.co.uk/2/hi/africa/1468772.stm [Accessed 2016-05-08].

WILSON, S. E. & BUTLER, D. M. 2007. A Lot More to Do: The Sensitivity of Time-Series Cross-Section Analyses to Simple Alternative Specifications. *Political Analysis,* 15, 101-123.