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Kwiatkowski, Andrzej; Shiva, Mehdi

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Temper and Temperature: The Missing Link of Climate on Armed Conflicts

Mehdi Shiva & Andrzej Kwiatkowski

Department of
Economic Studies
University of Dundee
Dundee
DD1 4HN

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Temper and Temperature: The Missing Link of Climate on Armed Conflicts

Abstract

We investigate the causes of a conflict by adding ambient climate factors to the existing bundle of most significant variables. It turns out that – controlling for possible associations – temperature could actually induce a conflict. We emphasise that temperature could not be a dominant reason in starting a conflict; however, it could escalate the chances when other factors are present. This paper references some of the related psychological studies to support this claim. We also show that grievance factors could actually be rightfully effective in starting an internal conflict alongside greed based reasons. In the end, we believe that it could be informative to study ambient factors more often in economics.

1. INTRODUCTION

Civil wars and internal conflicts have always made interesting discussion subjects for mass media however, academics – from diverse fields – have shown interest to this matter as well. The ambiguous nature of this phenomenon challenged many scholars to figure out the mechanism behind it. Until a while ago, empirical study on armed conflicts was only taken on by political scientists but recently, scholars from other fields showed interest in this subject as well. The body of our work links the traditional field of conflict studies, which is based on political sciences and economics, to psychology. This paper does not try to neglect the importance of any other proven factor, but as a matter of fact, it is just simply proposing a potential missing piece to the conflict puzzle.

Initially, we should have a brief glance at the existing literature in order to demonstrate our contribution adequately. Most of the literature around armed conflicts is somehow associated with natural resources as most of the scholars look for the motivation of the rebels to solve the riddle of insurgency. In most of the works, Economic variables such as "*GDP per capita*" or "*GDP Growth*" get considerable attention. Some studies argue about the possible Sociological and Geographical links of a conflict onset e.g. Gurr (1971) along with many more after him, argues that grievance is one of the main factors of civil war. They claim that grievance is rooted in a behavioural paradigm, and emphasizes relative deprivation, social exclusion and inequality. Collier and Hoeffler (2004) discuss about ethnic dominancy[1] as an influencing factor of civil war but also, they argue that looting

[1] Where one ethnic group makes up to 45-90% of the population.

ability of natural resources has a stronger effect on rebellion. Moreover Fearon and Laitin (2003) introduce rough terrain[2] as an effective factor on conflicts and argue that it prepares a proper place for insurgents to hide.

At this point, one may ask if geographical/environmental features influence conflict in any other way rather than preparation of food or shelter. To be more clear, could weather affect our mood? The above questions have been discussed in a dozen of psychological studies centred on the relationship of temperature and individual's aggression. For instance, Anderson (1989 and 2001), Baron and Bell (1976) argue that hot and uncomfortable temperatures bring more murder, rape, assault and other types of aggressive behaviour. Considering conflict as a collective aggressive act and based on crowd behaviour studies, we can learn that individuals' behaviour could affect the whole group. Therefore, increase of violence and therefore conflict could be added to the negative consequences of global warming. Thus, it would be very beneficial in different aspects to conduct this research.

In this paper, we select the set of control variables that Hegre and Sambanis (2006) verify to be statistically significant after a comprehensive sensitivity analysis of eighty-eight variables that have been frequently used by the literature to explain civil war. Then, we add the annual average temperature data to the model and test for its possible direct affect across regions controlling for the variables it could proxy. We find that consistent heat could be a factor in starting a conflict when controlling for every other potential factor such as soil quality, social infrastructure or diseases like malaria. Moreover, our results support the psychological studies on extreme temperatures and aggression. Accordingly, we could say mild weather decrease the probability of starting a conflict.

Clearly we do not suggest that temperature is the only or even dominant reason for any of the past conflicts, but neither any other factor by itself. Homer-Dixon (1999) suggests "*environmental scarcity is never [emphasis added] a sole or sufficient cause of large migrations, poverty, or violence; it always joins with other economic, political, and social factors to produce its effects*". Therefore, predicting a civil war is almost impossible as for one, conflict is an incident formed of many different causes and for other, solo acts of individuals have been triggered many wars before. Moreover, there is not a main theoretical model for conflict that most scholars agree on it and because of that we see different sets of variables in diverse papers.

In the following, disregarding the appendix and references, there will be seven sections. Considering Introduction as Section 1, we are going to have literature review as the 2nd section right away. This part introduces the research area that our work belongs to and highlights some of the most celebrated results that previous scholars found. Afterwards, we

[2] Defined as the proportion of the country that is mountainous.

will explain briefly the methods Hegre and Sambanis used for their Sensitive analysis along with explanation of our employed method in details in section 3. Also there will be a discussion about the dispute around the number of independent variables one should consider in a model to get the most accurate results. In the 4th section you could expect to learn about the data that we have used and the sources we extracted them from. The main results will be discussed in section 5 alongside the interpretation of the results. We will explain why we believe temperature could have a direct effect on civil war using the estimations. We test the sensitivity of our analysis to change in method and data in chapter 6. There will a brief conclusion to wrap up this paper in few paragraphs in section 7.

2. LITERATURE REVIEW

In this part we are going to go through the related literature that exists in Political Sciences, and Economics, Geography and Climate Studies and in the end, Psychological Sciences respectively. Most studies on conflict and war shape around the paradoxical term "*Resource Curse*". Ross (2001) defines this term as the association of resource dependence/abundance with i) slower economic growth, ii) violent civil conflict, and iii) undemocratic regime types. Most cited theories for conflict are "*Greed*" and "*Grievance*" motives. The rational choice model considers civil war as a special form of non-cooperative behaviour, and the greed motive simply reflects opportunities for rebels (or rebel leaders) to enrich themselves, possibly by seizing resource rents. Grievance, in contrast, has a behavioural pattern, and emphasizes relative deprivation, social exclusion and inequality. In the case of resource rich countries, insufficiently compensated land expropriation, environmental degradation, insufficient job opportunities, and labour migration could be considered as grievance motives.

There is a big dispute around the motive of the rebels, if they are only trying to loot or there are other incentives such as reforming religious, nationalist or economic grievance. Gurr (1971) argues the latter is the main factor of rebellion. However, recent studies are mostly reasoning against – or at least not in favour – grievance and supportive of greed based reasoning as the dominant factor in starting a civil war. Collier and Hoeffler (2004) compare the models based on grievance and greed factors and stated that grievance variables are mostly insignificant in starting a conflict. Although, they notice ethnic dominancy[3] as an influencing factor of civil war but, they argue that looting ability of natural resources has stronger support for rebellion. In another study Fearon and Laitin (2003) argue that occurrence of civil war is not about cultural differences and ethnic grievances, but rather the conditions that favour insurgency. As a result, they consider the proportion of the country that is mountainous[4] as an effective factor on conflict and argue

[3] Where one of the ethnic groups makes up to 45-90% of the population.
[4] Introduced as "rough terrain"

that it prepares a suitable place for insurgents to hide. Moreover, they state that grievance may favour rebellion by leading non-active rebels to help in hiding the active rebels. Similarly, Collier and Hoeffler (2009) conclude if the incidence of civil war is to be reduced; it will need to be made more difficult. This is an implication of the feasibility hypothesis which proposes that where rebellion is possible, it will occur.

Furthermore, it has been argued that resource wealth (specially oil) increases the probability of civil war by giving residents in resource-rich areas an incentive to form a separate state (Le Billon, 2001; Fearon, 2005) or by weakening the state's bureaucratic capacity (Fearon and Laitin, 2003). Ross (2004) conducts a research on thirteen civil wars to explore the mechanisms behind the relationship of resources with conflict. He argues while oil, nonfuel minerals, and illicit drugs appear to influence conflict, other types of primary commodities – notably legal agricultural commodities – seem to be unrelated to civil war in the cases he studies on.

Despite several studies on natural resources, not many considered physical geography and global factors in conflict studies. However, researchers in development studies showed more interest in such factors e.g. Brunnshweiler and Bulte (2008) and Boschini et al. (2012) argue that Latitude proves to be the strongest instrument for institutions quality (they also check fractions of the population speaking English or another Western European language). The use of latitude as an instrument for institutions is initiated by Hall and Jones (1999) who argues the distance to the equator is related to "*western influence*" which in turn leads to good institutions.

Briefly on the studies considering geographical factors; Latitude, as a factor, has been included in the past studies on wellbeing to capture other unobservable cross-country differences that may affect the overall standard of living, such as geography and climate. Countries farther from the equator (whether north or south) tend to have higher overall standards of living, while those near the equator have lower overall standards of living. There is not a very clear definition of these unobservable differences yet. There are some theories around it e.g. Gallup, Sachs and Mellinger (1999) stress the importance of levels of Gross National Product (GNP) per capita in the tropics, arguing that human health and agricultural productivity are adversely impacted by tropical climate. They use 1987 average temperature as an instrument variable to measure the effect of health on GNP per capita. They choose temperature because of its correlation with disease ecology and therefore the burden of disease. Similarly, Masters and McMillan (2001) stress the positive effects of winter frost on agricultural productivity. Acemoglu, Johnson and robinson (2000) argue that certain environments characterized by a heavy burden of infectious disease were exploited by predatory states (European settlers in the early 19th century) rather than nurtured by the rule of law, and thereby failed to achieve sustained economic growth.

There are a few studies on the correlation of climate (or climate change) and armed conflicts. These works are mostly related to the literature that links environmental scarcity to conflict, emphasizing the role of renewable resources such as freshwater and arable land (Gleditsch et al., 2009; de Soysa, 2002; Urdal, 2005). CNA[5] report in April 2007 concludes that climate change not only acts as a threat multiplier for instability in volatile regions but also, it would add tensions to the stable regions of the world (e.g. by decreasing food production and freshwater). While the conventional discourse linking climate change to conflict focuses on long term changes, Hendrix and Glaser (2007) suggest that inter-annual variability in rainfall is a more significant determinant of conflict than the measures of climate, land degradation, and freshwater resources. On the other hand, Ross (2004) suggests that "*There is no statistical evidence – and very little case study evidence – that links agricultural commodities to either the initiation or the duration of civil war*"[6].

The body of this work links the standard Political - Economics approach of studying on conflict to the Psychological Science. Of course there have been some behavioural findings among the past studies on conflict, especially in the grievance motives' works, but none of them specify the psychological studies to support their results. There are various studies in psychology around the relationship of temperature and aggression. It has been argued that heat-induced discomfort makes people cranky and that produces aggressive outbursts in a variety of settings (Berkowitz, 1993). In other words, temperature could increase aggression through two means; by directly increasing feelings of hostility and indirectly increasing aggressive thoughts.

Anderson (1989) argues hot temperatures produce increases in aggressive motives and tendencies (heat hypothesis). Hotter regions of the world yield more aggression; this is especially apparent when analyses are done within countries. Hotter years, quarters of years, seasons, months, and days all yield relatively more aggressive behaviours such as murders, rapes, assaults, riots, and wife beatings, among others.

A mild insult is more likely to provoke a severe insult in response when people are hot than when they are more comfortable. This may lead to further increases in the aggressiveness of responses and counter-responses. Anderson (2001) states "An accidental bump in a hot and crowded bar can lead to the trading of insults, punches, and (eventually) bullets". It has been argued in a few studies (Anderson and Anderson, 1998) that even a cold temperature could cause an increase in aggression (cold hypothesis) though, cold effects are less likely to occur in the natural environment because people can usually compensate fairly easily by

[5] In 2006 "Centre for Naval Analyses" assembled a Military Advisory Board (MAB) of eleven retired admirals and generals to assess the impact of global climate change on key matters of national security.

[6] Ross (2004) also states "Gemstones, opium, coca, and cannabis do not seem to be linked to the initiation of conflict, but they do seem to lengthen pre-existing wars. Timber's role remains untested".

adding clothing. In general, being uncomfortable colours the way people see things. Minor insults may be perceived as major ones, inviting (even demanding) retaliation.

Although alternative explanations occasionally account for the observed increases in aggression when temperatures are high, none are sufficient to account for most such heat effects (Anderson, 2001). Moreover, some researches tried to find the direct effect of heat on aggression using proxies. Kenrick and MacFarlane's (1984) study find that aggressive horn honking increased at hotter temperatures, but only for drivers without air-conditioned cars. Also, Vrij, van der Steen, and Koppelaar (1994) conduct a field experiment in which Dutch police officers performed in a simulated burglary scenario under hot or comfortable conditions. Hot officers reported to be more aggressive and more likely to draw their weapon and shoot the suspect (with laser training weapons), relative to officers in the cool condition.

Whereas, data consistently shows that violent – crime rates are higher in the South than in other regions of the United States and Europe (Anderson, 1989) but, some argued that other factors may be responsible for this effect. Anderson et al. (2000) use statistical techniques to estimate the effect of temperature on violent-crime rate, while statistically controlling for the southernness, population size, and socioeconomic status of the cities. They find temperature statistically significant – besides having the biggest coefficient amongst the studied factors – and southerness insignificant to violent crime. They conclude that there is a higher violent level in hotter cities compared to the cooler ones even after city-to-city differences in southernness, population size, and socioeconomic status were statistically controlled.

Field studies comparing aggression rates in hotter time periods versus cooler ones also support the heat hypothesis. For example, there are about 2.6% more murders and assaults in the United States during the summer than other seasons of the year; hot summers produce a bigger increase in violence than cooler summers; and violence rates are higher in hotter years than in cooler years even when various statistical controls are used (Anderson et al., 2000). Moreover, there are some works studies on shorter time periods, where they find higher assaults, rapes, and domestic violence at hotter temperatures of the day (e.g. Cohn and Rotton, 1997; Anderson et al., 2005).

Almost all the studies investigating this issue agree on the positive effect of heat on violence, but there is a disagreement about the linearity of this relationship, i.e. some believe aggression increases with heat to some point but then it decreases. For instance, Baron and Bell (1976) suggest that the level of negative affect experienced by subjects and the relative dominance of aggression could have a curvilinear relationship in nature. Furthermore, they argue that "*up to some determinable point, aggression may become* *increasingly dominant as negative affect rises (the fight response) but then, the tendency to engage in such behaviour may decrease as other responses incompatible with aggression (e.g., escaping from the extremely aversive situation, minimization of present discomfort) become increasingly dominant (the flight response)*".

There have been various studies on armed conflict and civil war and different variables have been found to be responsible to start a conflict. But there is no theoretical agreement on what is the right set of variables to include in the model, and there is also mixed empirical support for many variables. One of the most comprehensive papers in this field is "*Sensitivity analysis of empirical results on civil war onset*" by Hegre and Sambanis (2006). These authors perform specification tests to check the robustness of eighty-eight variables (categorized into eighteen concepts) frequently used by the literature to explain civil war. They test the sensitivity of commonly cited and important results to small changes in the set of variables included in a regression. Then, they test how fragile the substantive inferences are to small changes. Their results show the importance of economic factors such as income and growth along with the political variables like institutional instability, incomplete democracy, and undemocratic neighbourhoods and even geographical factors like rough terrain.

3. METHODOLOGY

3.1. Methodology that brought us here

We carefully select our control variables from the solid sensitivity analysis that Hegre and Sambanis (2006) conducted on eighty-eight most celebrated variables in the literature. Initially, we believe it is essential to briefly review the method they practice in their analysis. In their paper, they use the model Sala-i-Martin (1997) introduces in order to find the true set of variables for economic growth – as there were various set of variables introduced by different scholars. He estimates *M* models of the following form:

$$\gamma_j = \alpha_j + \beta_{yj} y + \beta_{zj} z_j + \beta_{xj} x_j + \varepsilon,$$

where γ is the dependent variable and the subscript refers to the model ($j \leq M$ and $j \in \mathbb{N}$), y is a vector of core variables (three variables that appear in all the regressions), which are the natural log of population, the length of peacetime until the outbreak of a war, and the natural log of per capita gross domestic product (GDP) in constant dollars. To continue, z is the variable of interest (i.e., the one whose behaviour is the centre of interest while changing the model specification), and $x_j \in \chi$ is a vector of up to three variables taken from the pool χ of all available variables. To avoid multicollinearity – by including variables that measure a similar concept in the model – they have categorized all the variables into eighteen concepts i.e. they grouped all the variables that could proxy for the similar concept together.

Sala-i-Martin (1997) suggests to look at the entire distribution of the estimators of β_z lying on each side of zero in order to assign some level of confidence to each of the variables. Following Sala-i-Martin's method, Hegre and Sambanis consider separate cases for normality assumption of the distribution in their calculations. In the first case, where they consider the distribution of β_z across model to be normal, they compute the cumulative distribution function [CDF(0)][7] after finding mean and the standard deviation of it from $\hat{\beta}_z = \sum_{j=1}^{M} \omega_{zj}\beta_{zj}$ where the weights, ω_{zj}, are proportional to the (integrated) likelihoods $\omega_{zj} = \frac{L_{zj}}{\sum_{i=1}^{M} L_{zi}}$ and $\hat{\sigma}_z^2 = \sum_{j=1}^{M} \omega_{zj}\sigma_{zj}^2$. The reason for using this weighting scheme is to give more weight to the regressions or models that are more likely to be the true model. In the second case, they assume the distribution of the estimates of β_z across models is not normal. They compute the aggregate CDF(0) of β_z as the weighted average of all the individual CDF(0)'s: $\Phi_z(0) = \sum_{j=1}^{M} \omega_{jz}\Phi_{zj}\,(0/\hat{\beta}_{zj}\,\hat{\sigma}_{zj}^2)$ where $\Phi_{zj}(0/\hat{\beta}_{zj}\,\hat{\sigma}_{zj}^2)$ stands for individual CDF(0) of each of the M regressions. The results provide some information on the best potential model for civil war onset by testing the fit of several theoretically relevant variables.

3.2. Our Model

Our study covers one hundred-twenty countries from 1970 to 2009 where ongoing conflicts considered as missing in our dependent variable data. We consider all the variables that are significant (by one-tailed test) in Hegre and Sambanis (2006) sensitivity analysis for any of the two dependent variables[8] that they used for their estimations. Also, in order to avoid multicollinearity, we just choose one proxy from each concept variable. We end up with the following list of independent variables: Population, GDP per capita, peace years, ethno-linguistic diversity, regulation of participation, regime durability, conflict in neighborhood dummy, GDP growth, oil exporter dummy, rough terrain, 90s (decade) dummy, Middle Eastern and North African countries dummy, partially free dummy, average of neighbors polity. We are not considering the "*Military Personnel*" variable because of too many missing observations. It practically starts from 1989 (except some observations for 1985) and there is a good chance that the reason for missing observations be correlated with the dependent variable [9](see more in 6.3).

[7] Zero divides the area under the density in two. The larger of the two areas will be called CDF(0), regardless of whether this is the area above zero or below zero (Sala-i-Martin, 1997).

[8] They have used two different sources that measure armed conflicts for dependent variable. One from *Sambanis (2004) civil war dataset* and the other from *Uppsala/PRIO internal armed conflicts* (Gleditsch et al. 2002).

[9] Also, one could argue that military size changes with the risk of conflict (before it even happens and reached the benchmark number of deaths) and there could be a high level of endogeneity because of this.

Bearing in mind the various psychological studies on the relationship of temperature and aggression, we find it interesting to examine the potential effect that temperature could have on armed conflicts (since we can consider conflict as a group aggression activity). Although, some argue that grouped acts could not be supported statistically (e.g. in the literature that criticizes grievance motives) however, heat effect function differently compared to grievance motives. We use the average temperature data for each country. This means that this variable is time invariant and acts much like a country-specific effect. We want to look for the direct effect – if any – that temperature could have on the onset of a conflict by controlling for questionable factors that average temperature could proxy (e.g. social infrastructer, malaria, soil quality, precipitation, and tropical climate).

There is not a consensus of opinion on a unified model to explain conflicts, however, we should get statistically correct results as long as the control variables are sensibly explained and justified and not selected merely because they have some impact on the dependent variable. Of course, our model cannot predict the reality completely – but neither does any other model – we believe it is sufficiently reliable. The only shortage of Hegre and Sambanis (2006) methodology could be the limitation on testing joint significance (e.g. non-linear relationship) and that is something that we expect to have for temperature. Therefore, we check for temperature significance through various types of robustness checks after our logistic regressions. Our general model looks as the following:

$$ln\left(\frac{Pr\{Onset_i=1|S,t,W\}}{1-Pr\{Onset_i=1|S,t,W\}}\right) = \beta_0 + \sum_{j=1}^{L}\beta_j s_{j,i} + \sum_{r=1}^{O}\alpha_r(\bar{t}_i^{\,r}) + D_1\sum_{q=1}^{P}\gamma_q w_{q,i}$$

Where s ∈ S (set of controls), L=14 (except ModelA4 where L=13), $\bar{t}$ stands for average temperature, w ∈ W (further controls) and O ≤ 2, P ≤ 5. Moreover, D_1 = 0 if O = 1 and equal to one otherwise except the case for Russia where D1 could be equal to one even if O = 1. We cluster for errors in all the regressions we run. As, observations within a country could be correlated in some unknown way, which could induce correlation in observed errors within a country.

Furthermore, there is a germane dispute around the number of variables one should use in the presence of theoretical ambiguity (as there is no true model for armed conflicts yet). One of the well-known theories that prefers parsimony in empirical exploration is Achen's rule of Three (ART). Achen (2002) proposes to use no more than three independent variables in regression analyses in the absence of a formal model as he believes that could unbalance the results. On the opposite side Oneal and Russett (2005) argue that applying this rule "*severely limits our ability to evaluate theories in nested tests*", and therefore, "lead us to unconnected islands of theory with no indication of their relative importance".

Moreover, it ignores some of the knowledge that could be used to get better predictions. They finish up with an example of a smoker who cannot be studied for hearth failure without considering the smokers' age, sex, weight and so on. "*If applied rigidly*," Oneal and Russett state "*the rule of no more than three independent variables is as bad as rigorously following the poison ivy rule, which would have us avoid all the useful three-leaved plants just to escape those that leave an irritating rash*". We share this view with them alongside of many other scholars as there are numerous prestigious studies that considered many explanatory variables such as studies on economic growth or the literature on development and labour economics.

4. DATA

UCDP[10] defines conflict as: "*a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths*". We use the conflict data that UCDP/PRIO introduced as our dependent variable. By definition, there are four types of conflicts (Gleditsch et al., 2002):

i. Extrasystemic armed conflict occurs between a state and a non-state group outside its own territory.
ii. Interstate armed conflict occurs between two or more states.
iii. Internal armed conflict occurs between the government of a state and one or more internal opposition group(s) without intervention from other states.
iv. Internationalized internal armed conflict occurs between the government of a state and one or more internal opposition group(s) with intervention from other states (secondary parties) on one or both sides.

For the purpose of this study, we primarily focus on "*Internal armed conflicts*"[11]. Moreover, UCDP/PRIO dataset allows us to separate minor conflicts (more than twenty-five deaths in a calendar year) from civil wars (more than one-thousand deaths in a calendar year). In the following, there is a brief introduction of the explanatory variables we use in this research, starting with the core variables that we include in all our regressions:

i) Population (used in logarithm scale), from the World Bank, which counts all residents regardless of legal status or citizenship (except refugees not permanently settled in the country of asylum). ii) GDP Per Capita[12] (used in logarithm scale), from the World Bank, GDP per capita is gross domestic product divided by midyear population. iii) Peace Years[13]

[10] Uppsala Conflict Data Program
[11] We test the results adding "Internationalized internal armed conflicts" to our data in robustness checks but, not much changes really.
[12] GDP/Population
[13] Used as following: $2^{-\text{Years in peace}/8}$

from Hegre et al. (2009), number of consecutive years without conflict up to t - 2. The longer a country is at peace, the lower should be the risk of another war as "conflict-specific capital remains unused and peace-specific capital is accumulated" (Collier and Hoeffler, 2004). This brings out the term "*Conflict Trap*" used by Collier (2007) which describes when certain economic conditions dispose a country to civil war that could form a trap from violence cycle and make it difficult to escape.

Now, we are going to introduce the covariates we use for the purpose of this paper with a brief description. Economic Growth[14] is another suggested influencing factor extracted from the World Bank that we include in our regressions. It stands for annual percentage growth rate of GDP at market prices based on constant local currency. We use Ethno-linguistic Diversity from Collier and Hoeffler (2004). They conduct this measure using the available data for 1960. In the economics literature this measure was first used by Mauro (1995) and it measures the probability that two randomly drawn individuals from a given country do not speak the same language. It stands in between zero to hundred. A value of zero suggests a complete homogenous society where the opposite end, one hundred, indicates a completely heterogeneous country.

Moreover, there is Regulation of Participation extracted from Polity IV project. A five-category scale is used to code when, whether, and how political preferences are expressed: i) Unregulated: there are no enduring national political organizations and no systematic regime controls on political activity. ii) Multiple Identity: There are relatively stable and enduring political groups which compete at the national level–parties, regional groups, or ethnic groups. iii) Sectarian: Political demands are characterized by incompatible interests and swing between intense factionalism and government favouritism. iv) Restricted: Some organized political participation is permitted but significant groups are regularly excluded from the political process. v) Regulated: Relatively stable and enduring political groups regularly compete for political influence and positions with little use of coercion (see more in Marshall and Jaggers, 2002). Another variable from Polity IV project that we are including in our main set of our regressions is the Regime Durability[15]. It is defined as the number of years since the most recent regime change (defined by a three point change in the Polity Score[16] over a period of three years or less).

Fearon and Laitin (2003) argue that proportion of the country which is mountainous is a significant factor in starting a civil war as it prepares an insurgent favour environment. They also introduced Oil Exporter dummy which is basically equal to one when, in a country-year, fuel exports exceed one third of export revenues.

[14] $(GDP_t - GDP_{t-1}) / GDP_{t-1}$

[15] Used as the following: $2^{-\text{Durable}/0.5}$

[16] The "Polity Score" captures this regime authority spectrum on a 21point scale ranging from -10 (hereditary monarchy) to +10 (consolidated democracy).

In order to take into account the neighborhood political economy, we use the neighbor's average polity score[17] from Hegre et al. (2009). Civil War in Neighborhood dummy suggested being significant in Hegre and Sambanis analysis as well despite the arguments against spillover effect in some major studies (e.g. Fearon and Laitin 2003).

The next variable we use is a dummy indicating part free countries. A Partly Free country is one in which there is limited respect for political rights and civil liberties. Usually, partially free states "*suffer from an environment of corruption, weak rule of law, ethnic and religious strife, and a political landscape in which a single party enjoys dominance despite a certain degree of pluralism*" (Freedom House). We have also a dummy variable indicating Middle Eastern and North African countries[18] in our main set as it has been suggested to be of important in multiple previous studies. For time periods, we use nineties decade dummy as well.

We take the weather data from the World Bank. Our focus variable demonstrates the average temperature from 1961 to 1999 by country. We change the temperature scales from Celsius to Fahrenheit to get rid of negative values[19]. Furthermore, there are some control variables that we use in some of the regressions to look for temperature's direct effect. We select these variables based on the results from some past development studies. We include latitude coordinates of the country's capital[20] from La Porta (1999)[21] in some of the models as it may capture the life quality in countries.

Moreover, we have the data for the share of 1995 population living in the area with risk of Malaria from Gallup, Sachs, and Mellinger (1999). We extracted soil quality data from the same sources as well. Another climate factor that we use to control for temperatures' direct effect is the level of Precipitation that has been extracted from the World Bank. It measures the mean annual precipitation by country for the period 1961 to 1999. In the end, we use the percentage of 1995 population living in tropics and subtropics[22] from Gallup, Sachs and Mellinger (2000). You could find more details for all the discussed variables in Appendix 2.

Variable	Concept	Brief description	Source
Population	Core variable	Population in Logarithm scale	World Bank
GDP per Capita	Core variable	Gross domestic product divided by	World Bank

[17] Average of the neighbour's polity3 minus the country's own; where a Democracy identifies with the digit 2, an Anocracy with 1, and in the end an Autocracy recognizes with 0.
[18] This dummy has been taken from Hegre and Sambanis (2006) but corrected for Bhutan as they took it as a MENA country by mistake.
[19] Fahrenheit = $((9/5) \times \text{Celsius}) + 32$
[20] $(\text{Absolut value of Capital's Latitude})/90$
[21] We have also used the average latitude of the country – and not the capital's latitude – but no matter which to use, the results would not change.
[22] Defined by Koeppen-Geiger geographical system.

		mid-year population in Logarithm scale	
Peace Years	Core variable	Number of consecutive years without conflict up to t – 2.	Hegre et al. (2009)
Economic Growth	Growth	Annual percentage growth rate of GDP at market prices based on constant local currency	World Bank
Ethno-Linguistic Diversity	Ethnic Fragmentation	Probability that two randomly drawn individuals from a given country do not speak the same language	Collier and Hoeffler (2004)
Regulation of Participation	Level of democracy	When, whether and how political preferences expressed	Polity IV project
Regime Durability	Political durability	Number of peace years since the most recent regime change	Polity IV project
Rough Terrain	Terrain, geography, and population distribution	Proportion of the country that is mountainous	Fearon and Laitin (2003)
Oil Exporter	Resources	Dummy for a country-year with fuel exports more than third of export revenues	Fearon and Laitin (2003)
Neighbor's Average Polity Score	Neighborhood political economy	Average of the neighbour's polity3 minus the country's own	Hegre et al. (2009)
Conflict in Neighborhood	Neighborhood war	Dummy for a conflict in neighborhood	Hegre et al. (2009)
Partially Free	Inconsistency of political institutions	Dummy for a country with limited respect for political rights and civil liberties	Freedom House
MENA	Region	Dummy for Middle Eastern and North African countries	Authors' coding
Nineties	Time	Dummy for 90's decade	Authors' coding
Average Temperature	-	Average temperature from 1961 to 1999 by country	World Bank
Precipitation	-	Precipitation from 1961 to 1999 by country	World Bank

Latitude	-	(Absolut value of Capitals' latitude)/90	La Porta (1999)
Malaria	-	Share of 1995 population living in the area with risk of Malaria	Gallup, Sachs, and Mellinger (1999)
Soil Quality	-		Gallup, Sachs, and Mellinger (1999)
Tropical Area	-	Share of 1995 population living in tropics or subtropics	Gallup, Sachs, and Mellinger (2000)

5. ESTIMATIONS AND RESULTS

5.1. The evidence

In this section we explain our main results from estimating different versions of the logit model we use for explaining the onset of conflict based on the dataset discussed above. In Table 1, we report the estimates corresponding to the models which use our main explanatory variables, with the dependent variable being the onset of intra-state conflicts involving with more than twenty-five fatalities. Column A1 corresponds to the logistic regression (clustered for countries) that includes only those regressors that were used by Hegre and Sambanis (2006). The rest of the columns show the role of additional explanatory variables when they are added to the specification suggested by the authors.

A quick glance at the results reported in Table 1 indicates that some of the explanatory variables which are considered to be crucial in influencing the onset of a conflict turn out to have statistically insignificant impact. While this could be due to the different dataset used in this study, given that our dataset extends the sample period these results could be interpreted as suggesting a further refinement of the role of the variables involved with those that still have significant impact being considered as "*more relevant*" in the context. In particular, out of the fourteen original variables (from different concept groups), the following five have retained their statistically significant impact in our regressions: logarithm of lagged population; logarithm of the number of peace years since the last conflict; ethno-linguistic diversity; regime durability; existence of a conflict in the neighbouring regions; and GDP growth.

There seems to be a general consensus in the literature on the positive impact of population size on the onset of conflict. This, however, could be simply due to the definition of the dependent variable which is usually a discrete dummy constructed on the basis of a predetermined threshold (e.g. onset = 1 if fatalities > n). Thus, the positive causation could be reflecting the fact that the larger is the population of a region the higher is the likelihood that a conflict in that region would result in a larger number of fatalities.

The next explanatory variable which is commonly reported in the literature as a significant determinant of conflict onset is a measure of "*the length of peace period since the last conflict*". The impact of this variable is interpreted within the historical context in that past conflicts in a region are believed to alter its social characteristics. As explained in Collier (2007), "*Conflict Trap*" is a common phenomenon in the regions that have been struggling with "Poverty Trap". He argues that a conflict trap *"shows how certain economic conditions make a country prone to civil war, and how, once conflict has started, the cycle of violence becomes a trap from which is difficult to escape*". We therefore expect the coefficient of this variable to be negative and significant. Moreover, our results are similar to the studies that suggest the existence of a possible link connecting the individual's behaviours (i.e. grievance motives) to triggering an armed conflicts by finding a statistically significant coefficient for ethnic fragmentation (see arguments in favour in Gurr, 1971 and against in Collier and Hoefller, 2004).

A political factor that remained significant throughout our analysis and measures the stability of government is the Regime durability. A change in regime (either democratic or autocratic) unbalances the power structure of the country and results in temporary weakness inside the system. While we study the effect of economic, political and geographical factors of the country on the onset of conflict, we should not forget the role that neighbouring countries could have on this issue. We have found evidence for neighbourhood effect on civil war that is consistent with Sambanis (2001), while some other major studies (Fearon and Laitin, 2003) have argued against the relevance of spill-over effects.

We found a positive coefficient for GDP growth in all our models[23], which is in contrast with some of the past studies (e.g. Collier and Hoefller, 2004) where, growth had been considered as the "*Opportunity Cost*" measurement. There could be two explanations for this (Hendrix and Glaser, 2007);

i. Aggregate measures such as GDP tend to be unreliable in highly stratified, primarily rural developing countries (Heston, 1994).
ii. GDP growth does not accurately capture the opportunity cost to participate in rebellion.

Also, considering that GDP growth derived from dividing the change in GDP over the size of the economy, and keeping in mind that developing countries with smaller economies

[23] GDP growth is not significant in most of the models however, its p value is always in between 0.05 and 0.1

usually experience conflicts more often, one could identify the positive association that growth could have with the onset of conflict.

TABLE A: Main Estimations

	ModelA1: Set of Controls	ModelA2: Adding Temperature	ModelA3: Adding Tempreture^2 (Baseline Model)	ModelA4: Dropping Income	ModelA5: Adding Latitude	ModelA6: Adding Soil Quality	ModelA7: Adding Precipitation	ModelA8: Adding Tropical Area	ModelA9: Adding Malaria Risk	ModelA10: Adding all
Population	0.335***	0.355***	0.385***	0.382***	0.398***	0.381***	0.388***	0.382***	0.413***	0.426***
GDP Per Capita	0.0409	0.104	0.153		0.144	0.154	0.16	0.153	0.224	0.217
Peace Years	-0.755***	-0.744***	-0.732***	-0.716***	-0.740***	-0.730***	-0.730***	-0.731***	-0.730***	-0.733***
Ethno-linguistic Diversity	0.0121*	0.0114**	0.0109*	0.00923*	0.0106*	0.0111*	0.0109*	0.0110**	0.00848	0.00804
Regime Durability	0.640*	0.672*	0.722*	0.669*	0.753*	0.721*	0.717*	0.720*	0.717*	0.759*
Conflict in Neighborhood	0.728**	0.701**	0.651*	0.637*	0.634*	0.645*	0.643*	0.642*	0.616*	0.601*
Rough Terrain	0.0074	0.0113	0.0212**	0.0189**	0.0185*	0.0210**	0.0214**	0.0210**	0.0203*	0.0158*
Neighbors Average Polity	-0.358	-0.35	-0.393*	-0.369	-0.407*	-0.388	-0.381	-0.388	-0.379	-0.394*
Average Temperature		0.0179	-0.161**	-0.151*	-0.175**	-0.160*	-0.158**	-0.159**	-0.155*	-0.180*
Average Temperature^2			0.00161**	0.00149**	0.00160**	0.00160**	0.00160**	0.00159**	0.00150**	0.00153*
Latitude					Yes					Yes
Soil Quality						Yes				Yes
Mean Annual Precipitation							Yes			Yes
%Tropics and Subtropics								Yes		Yes
%Pop. in Malaria Area									Yes	Yes
Constant	-8.883***	-11.08***	-8.005***	-6.769***	-6.731**	-7.973***	-8.032***	-7.987***	-8.931***	-7.103*
Pseudo R^2	0.2873	0.287	0.2938	0.2908	0.2947	0.2905	0.2939	0.2905	0.2942	0.2944
Log Likelihood	-429.98	-428.11	-424.04	-430.94	-423.46	-423.77	-423.97	-423.78	-422.61	-421.49
N	3421	3355	3355	3378	3355	3286	3355	3286	3318	3286

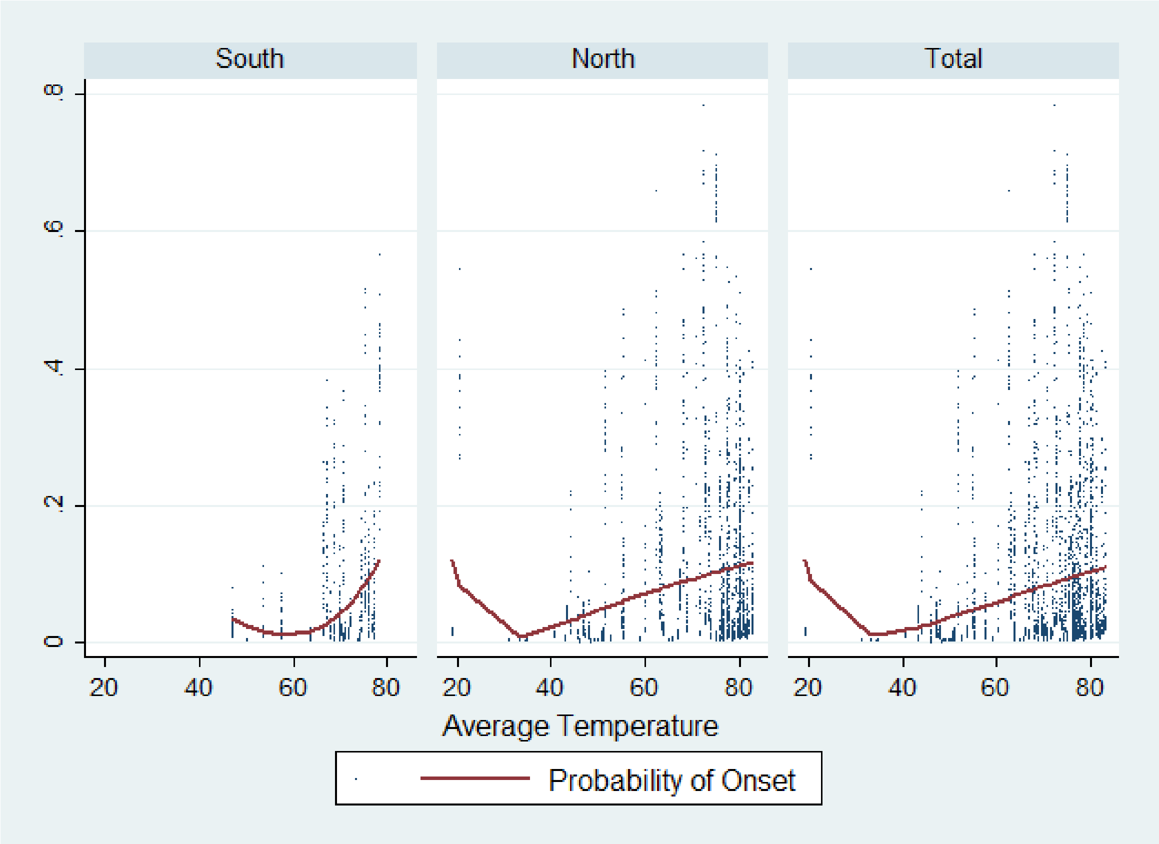
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Controlling for variables that temperature could proxy

Although, adding temperature to the set of variables (Model A2) does not particularly adds more information to the estimates, however, step-wise regression (using t-test) suggests keeping it. Now, if we graph the probability of the conflict onset against the average of temperature, we find a non-linear and convex shaped relationship (Figure 1). Adding the second power of average temperature into Model A2 results in the temperature becoming significant. As a result, we claim that temperature is not significant in the first power however, adding the second power strengthens temperature's ability to predict the dependent variable (Model A3). These results suggest that extreme weathers increase the chance of a conflict. In the psychological papers mentioned in the litereature review section, psychologists argue that a rise in aggressiveness could caused by an increase in the level of discomfort due to an unpleasant temperature (Berkowitz, 1993; Anderson, 2001).

Figure 1: Probability of conflict onset by average temperature



We drop GDP per capita in Model A4 in order to investigate the potential effect that having both GDP per capita and average temperature could have on the results. We do not find any reason to keep any of these two variables out of the estimations.

We want to answer the genuine concern about the possible correlation of temperature with some geographical factors that could lead to a false estimation for temperature's effect on the dependent variable where, it is actually acting as a proxy for another factor. Thus, we control for the most possible factors by adding them to our baseline model separately and also combined (Model A6 - A10). We borrow most of the variables for this part from development literature. For instance, Gallup, Sachs, and Mellinger (1999) argue that the mechanisms linking tropical climates to lower agricultural productivity is the unsuitability of tropical soil, Eurasian agriculture and increased disease burden. Accordingly, we are controlling for the potential effect that either soil quality, precipitation, malaria and the portion of country under tropical area could have on conflict that temperature may proxy them. We also control for latitude as it has a decent correlation with temperature and also it has suggested to have a strong association with institution quality for unclear reasons. Yet again, adding the latitude (for both capital city and country's average) of countries, does not affect the significance that average temperature holds in our model.

Once again, we go around the shape of the relationship that conflict probability have with temperature. The convexity of the curve suggests that not only hot weather could influence aggression positively but also, cold weather as well – by decreasing the level of comfort. Anderson et al. (2000) argues "*if one eliminates this real world asymmetry in ability to compensate for excessive cold vs heat, as one can do in lab settings, then similar hot and cold effects on aggressive behaviour may well occur*".

5.2. Russia's Case

Our results on cold temperature are consistent with what psychological studies suggest, however, it turns out all the conflicts in the cold area of the world correspond to Russia. Moreover, given the large size of Russia[24], the average temperature allocated to it might be imprecise. Therefore, we tested our estimation by dropping Russia in Table B.

Dropping Russia disables the non-linear effect that temperature held over the probability of conflict onset by turning the second power insignificant. By graphing this relationship, we see a linear association this time (Figure 2). Thus, we have dropped the second power in Model B2 – as there was no use in it anymore – which results in a significant coefficient for temperature. This suggests a linear and positive relationship between temperature and the probability of starting a new armed conflict. Just like the first table, we test the estimations by controlling for potential geographical factors. This, again, does not change our results remarkably. We have graphed the relationship of temperature with conflict onset separately for northern and southern countries[25], just out of curiosity, and found out that the conflict probability responds differently to increase in temperature when the heat goes further than 72.6^{o} Fahrenheit (see Figure 2).

In the graph spotting the northern countries, the probability of conflict increases by the temperature till 72.6^{o} Fahrenheit but then it starts to decrease where, this probability increases for southern countries consistently.

[24] The area of Russia (17m km2) is almost double the second biggest country, Canada (10m km2), and even bigger that the whole Europe (10m km2) the continent.
[25] By the sign of latitude, negative (positive) values stand for southern countries (north).

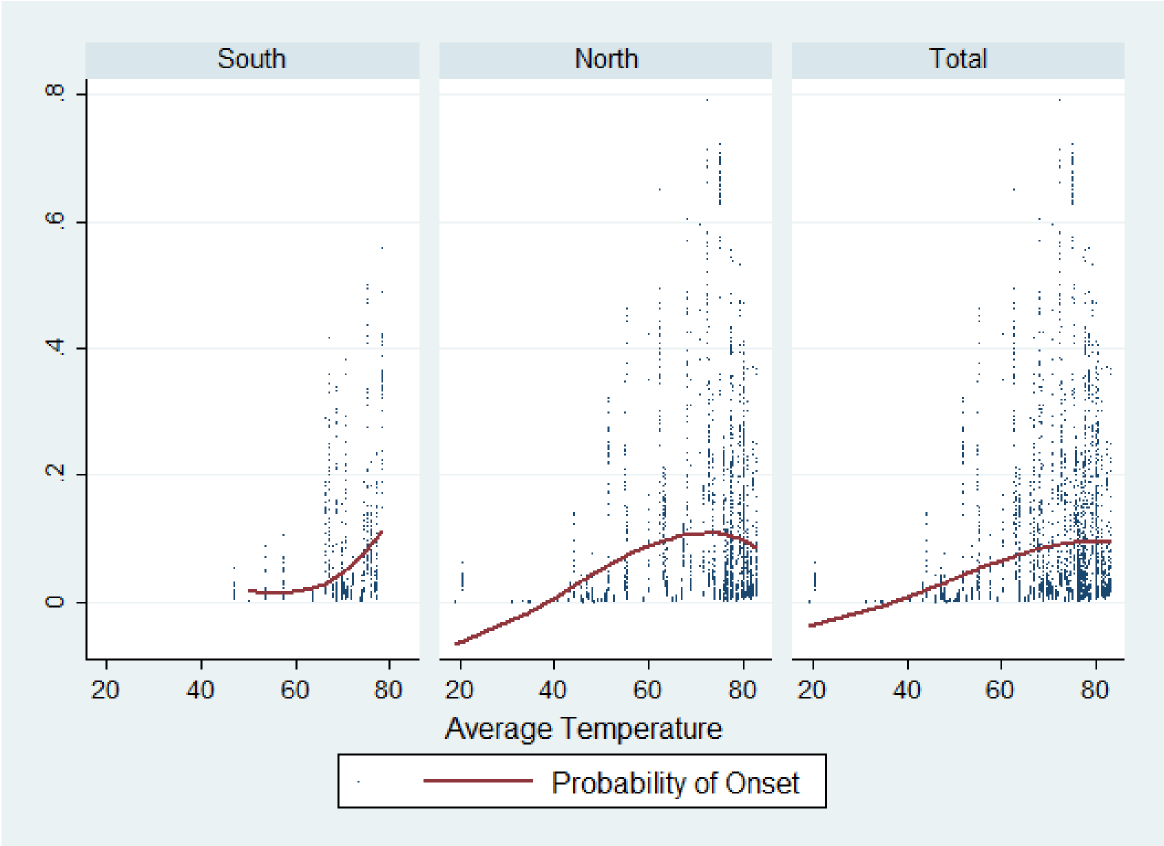
TABLE B: Russia's Case

	ModelB1: Dropping Russia	ModelB2: Dropping Russia and Temperature^2	ModelB3: Adding Latitude	ModelB4: Adding Soil Quality	ModelB5: Adding Precipitation	ModelB6: Adding Tropical Area	ModelB7: Adding Malaria Risk	ModelB8: Adding all
Population	0.388***	0.386***	0.400***	0.384***	0.388***	0.383***	0.418***	0.413***
Peace Years	-0.706***	-0.704***	-0.712***	-0.703***	-0.702***	-0.700***	-0.699***	-0.696***
Ethno-linguistic Diversity	0.0108*	0.0106*	0.0103*	0.0108*	0.0106*	0.0108*	0.00809	0.00807
Regime Durability	0.784*	0.779*	0.809*	0.776*	0.772*	0.772*	0.778*	0.781*
Conflict in Neighborhood	0.646*	0.647*	0.630*	0.629*	0.637*	0.629*	0.600*	0.608*
GDP growth	0.0303	0.0302	0.03	0.0301	0.0306	0.0304	0.0289*	0.0286
Rough Terrain	0.0211**	0.0200**	0.0172*	0.0200**	0.0203**	0.0200**	0.0197**	0.0192**
Neighbors Average Polity	-0.39	-0.388	-0.400*	-0.382	-0.374	-0.379	-0.375	-0.388
Average Temperature	0.000517	0.0578***	0.0419*	0.0575**	0.0596***	0.0588***	0.0511**	0.0503**
Average Temperature^2	0.000446							
Latitude			-1.514					
Soil Quality				-0.0015				0.00411
Mean Annual Precipitation					-0.0000682			0.0000866
%Tropics and Subtropics						-0.0819		-0.105
%Pop. in Malaria Area							0.755	0.822
Constant	-13.51***	-15.16***	-13.87***	-15.07***	-15.18***	-15.12***	-15.98***	-16.11***
Pseudo R^2	0.2911	0.2909	0.2918	0.2879	0.2911	0.2879	0.2921	0.2907
Log Likelihood	-416.62	-416.71	-416.19	-416.38	-416.61	-416.35	-414.87	-414.7
N	3348	3348	3348	3279	3348	3279	3311	3279

Standard errors in parentheses

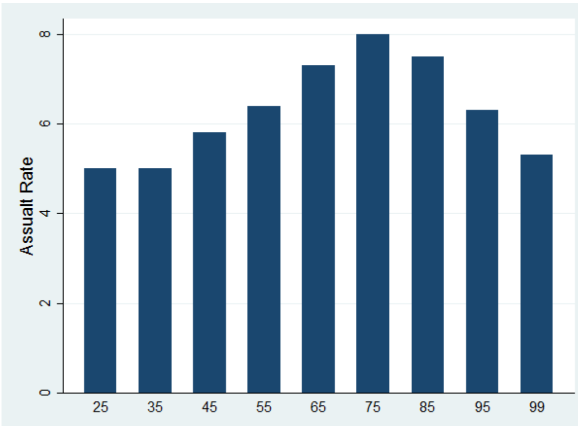
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 2: Probability of conflict onset by average temperature after dropping Russia

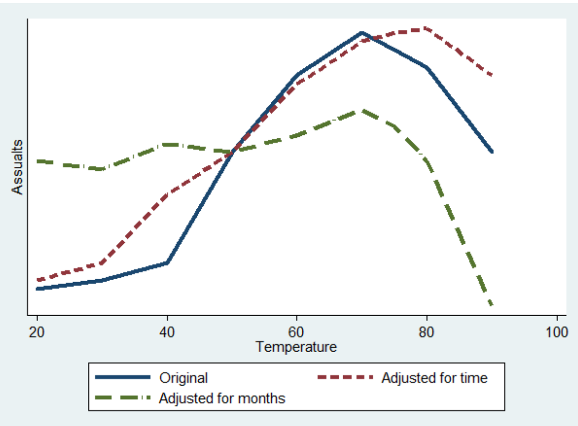


One of the possible explanations for this provided by Baron (1976) and it is called the "*Flight theory*". Briefly, this theory suggests that one's aggression level increases in temperature to some point (argued to be 74.9^{o} Fahrenheit, see Figure 3 and 4) but then, this aggression decreases in temperature if the person is under a big amount of pressure. It would be of interest to check for some of the economic and political characteristics of the countries that sit into this category (temperature more than 72.6^{o} Fahrenheit) to see if we could find a similar situation here.

Figure 3 and Figure 4: Assault rate by temperature



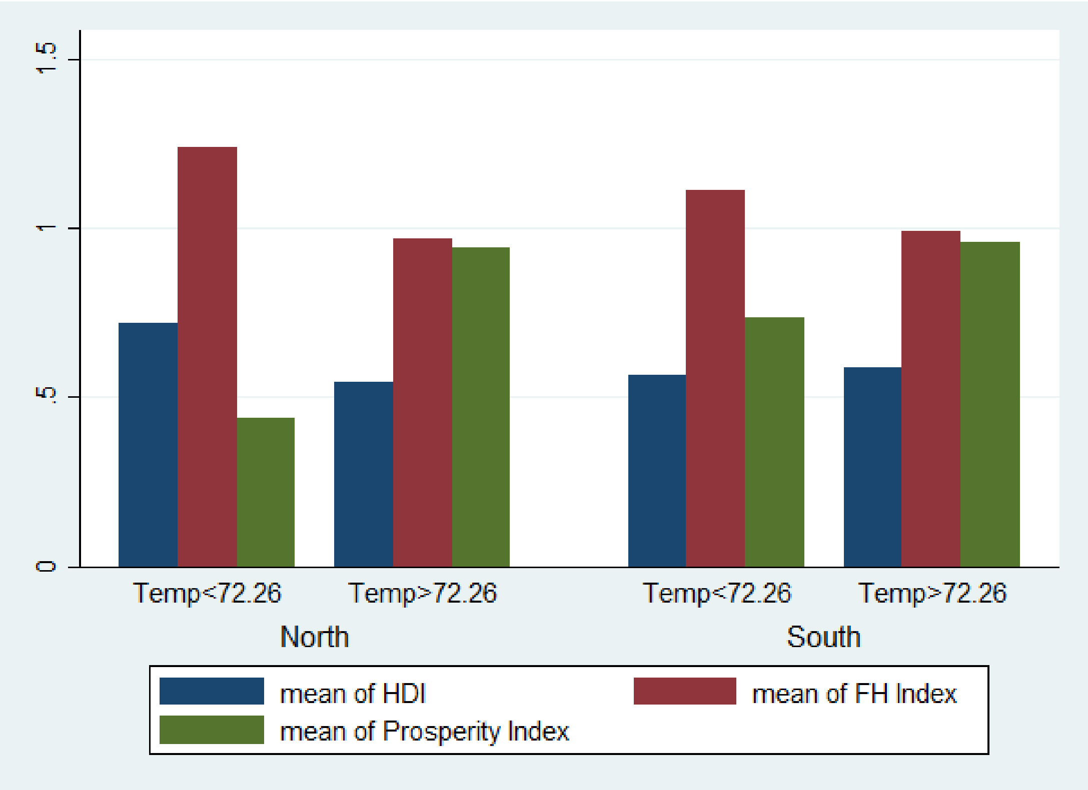
Rohn and Cotton (1997)



Rohn and Cotton (2005)

Considering this, one may argue that northern part of the world with average temperature of more than 72.6^{o} Fahrenheit may be experiencing a worse life condition than the southern part (based on the flight theory). In order to measure the quality of life, we have used an index constructed by UNDP known as "*Human development index*"[26]. It is a composite index measuring average achievement in three basic dimensions of human development – a long and healthy life, knowledge and a decent standard of living. The average HDI for the northern countries – that have a temperature more than 72.6^{o} Fahrenheit – is .54, which gets recognized by a "*low human development*" in the UNDP labelling system. On the other hand, southern countries would be categorized in the "medium human development" group based on UNDP categorization with a HDI level of .59. There are some other measure that we checked here as well; such as the "*Freedom House Index*"[27] that measures the level of freedom in countries where "*Free*"=1.5, "*Part Free*"=1 and "*Not Free*"=0.5. Both the values for HDI and FH Indices are statistically different comparing south to north. However, in terms of "*Propensity Index*"[28] comparison, both northern and southern countries ranked the same in average.

Figure 5: Comparing some of the northern and southern countries' aspects



[26] See Technical note 1 (http://hdr.undp.org/en) for details on how the HDI is calculated.
[27] It assesses each country's degree of political freedoms and civil liberties. See more at (https://freedomhouse.org/)
[28] The Legatum Prosperity Index is an annual ranking, developed by the Legatum Institute, of 142 countries. The ranking is based on a variety of factors including wealth, economic growth and quality of life.

Moreover, the southern and northern part of this sample has statistically different population and GDP per capita where, south holds a better rank in terms of GDP per capita and the volume of peace years. There will be more comparisons for other factors in Appendix 1.

So far, we learned whether we keep Russia in our sample or not, there exists a positive relationship between the average temperature and the probability of a conflict onset. Where, based on the psychological works, this effect is coming from comfort level of individuals. People tend to increase their comfort level by avoiding/terminating the causes of discomfort where possible. This way of describing human behaviours is similar to the definition of grievance motives in some ways (e.g. in both cases people are unhappy) but different in other aspects (unconscious effect for heat). Here, I would like to humbly suggest a new classification for conflict motives:

i. Greed and looting
ii. Convenience (Suitable conditions)
iii. General satisfaction (Level of Comfort)

The significance of this perception in looking at a conflict is simply the fact that it could cover more effective factors compared to the classical classification (i.e. Greed and Grievance). For instance, psychological variables – and other factors influence the behaviour unintentionally – do not have any place in that existing categorization. In this classification, we categorize the reasons of conflicts and not the factors; i.e. each category contains of many different factors that influence the onset of a conflict. Also, normally, different factors should be present in a country – all together – so a conflict happens. In other words, a conflict is a product of many different raw materials, where each of these materials could classify into one of the groups that we just presented above.

The first group is supported in most of the economic papers written on this topic such as Collier and Hoeffler (2004), where they have suggested the greed based motives contain the most statistically significant factors. There is ambiguity about the significance of grievance motives but, we stand with the scholars in favour of this type of motives. Also, to improve this group of motives, we put psychological factors together with grievance motives and label them as "*General Satisfaction*". The last category points out the basic tools required for insurgency. These factors are vital in starting a conflict as the presence of other factors may not lead to a conflict alone if the rebels do not find arming convenient. Fearon and Laitin (2003) argued that suitable conditions (poverty, suitable hiding zones, etc.) have an essential role in starting a conflict.

5.3) Minor Vs Major conflicts

Another interesting result appears when we distinguish between conflicts in respect to their fatality threshold. Basically, we label a conflict as minor when the number of fatalities is in between 25 to 1000 heads and major when there are more than 1000 battle related fatalities. Clearly, there are more minor conflicts rather than the major ones (for onset and also incidence[29], see Figure 6 and 7). In our dataset, there are 135 minor conflict onsets and only 23 major ones (variable list and brief description could be found in Appendix 2).

Figure 6: Number of conflict onsets by year

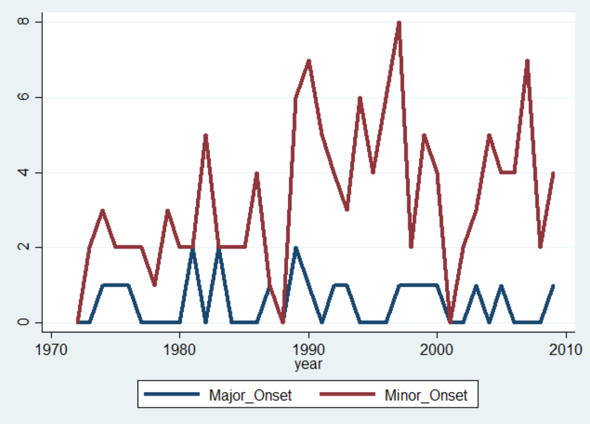
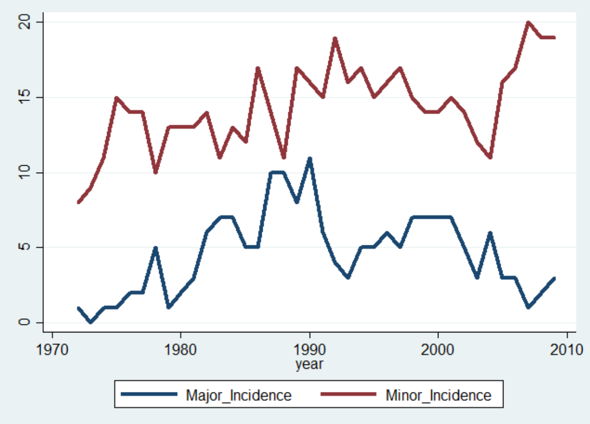


Figure 7: Number of conflict incidences by year



From the results indicated in Table C, we could conclude that temperature's significance – and magnitude – increases when considering just minor conflicts but, temperature's role becomes irrelevant when studying just the major ones. We could interpret this difference by pointing out the ease of occurrence for a minor conflict compared to a major one. Minor conflicts probably need less advanced planning and could happen more sudden and even merely based on emotions. On the other hand, a major conflict needs more planning, stronger army and of course a bigger budget.

We can see the growth has a positive and significant effect on major conflicts, where this relationship is insignificant for the minor ones. This, again, could fit into the argument criteria on the sign of growth variable that we have discussed earlier in this paper.

[29] Incidence: there exists at least one active conflict in the corresponding country-year.

TABLE C: Conflict Types

	ModelC1: Minor Conflicts	ModelC2: Major Conflicts
Population	0.298***	0.645***
Peace Years	-0.652***	-1.287***
Ethno-linguistic Diversity	0.00994*	0.00877
Regime Durability	0.818*	0.112
GDP growth	0.024	0.0324*
Rough Terrain	0.0197**	0.0302
Neighbors Average Polity	-0.343*	-0.697
Average Temperature	-0.150**	-0.173
Average Temperature^2	0.00153**	0.00161
Constant	-6.859***	-11.45**
Pseudo R^2	0.2396	0.3863
Log Likelihood	-408.41	-64.01
N	3355	1364

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6. ROBUSTNESS CHECKS

In this section, we investigate the precision of our results by testing their sensitivity to both data (Table D and E) and method (Table F). With respect to data, we investigate the effect of outlying observations, and of different definitions of the dependent and independent variables. With respect to method, we investigate the outcome of including year dummies, random effects and rare events bias.

6.1. With Respect to Data

6.1.1. Different definition for dependent and independent variables

We start by investigating a simple issue that may bring questions to the way we constructed our temperature variable. As, the temperature's data is averaged by country, one may argue this could privilege this factor when studying its effect on the dependent variable. However, if we use the same method to construct a new variable for GDP per capita (averaging for country throughout the time period), we will still deal with a non-significant GDP per capita. For the next model, we attempt dropping the countries with population less than a million following Fearon and Laitin (2003) method. Except a slightly improved likelihood (obviously), we do not detect any other noticeable change.

We have substituted the average temperature with variables capable of capturing the effect we are looking for in Model D3 and D4. In these models we use average maximum temperature and a category variable – to group all temperature values into either cold, mild or hot[30] – respectively to see if the heat effect still exists when we replace the focus variable with something of similar concept. We see that maximum temperature responds to conflict onset in the same manner as our focus variable. Also, hot countries have 72% more chance of conflict (onset) comparing to the mild ones.

To continue, some of the studies in development literature argue that latitude could linearly proxy welfare and/or institutions quality. Testing this assumption in our model, we found latitude to be insignificant in the first power; however, it could have a cubic relationship with the probability of conflict. Considering figure 8 and Model D5, one could argue that latitude could proxy temperature in its cubic form. By allowing the ongoing conflicts to take the value of zero – in ModelD6 – instead of marking them as missing data, nineties decade gets significant apart from the decrease in our model's precision (lower R^2 and bigger absolute value of likelihood) and increase in the number of observations. Moreover, we have considered including internationalized conflicts in the dependent variable (twenty-two extra onsets) for Model D7. This supplement, again, does not change our results except worsening the log likelihood, which was expected as internationalized conflicts could sometimes be contradictory to the normal conflicts; i.e., an international conflict could contain a country in one side that is situated far away from the place that war is actually taking place (incidence location).

And finally, Model D8 conducts a logistic regression on the set of explanatory variables that found to be significant when Hegre and Sambanis (2006) used UCDP conflict data as the dependent variable's source.

[30] A country classifies into Cold if its average temperature < Mean (average temperature) – std dev., Hot if average temperature> [Mean (average temperature) + std dev] and Mild if [Mean (average temperature) – std dev.] <average temperature< [Mean (average temperature) + std dev.]

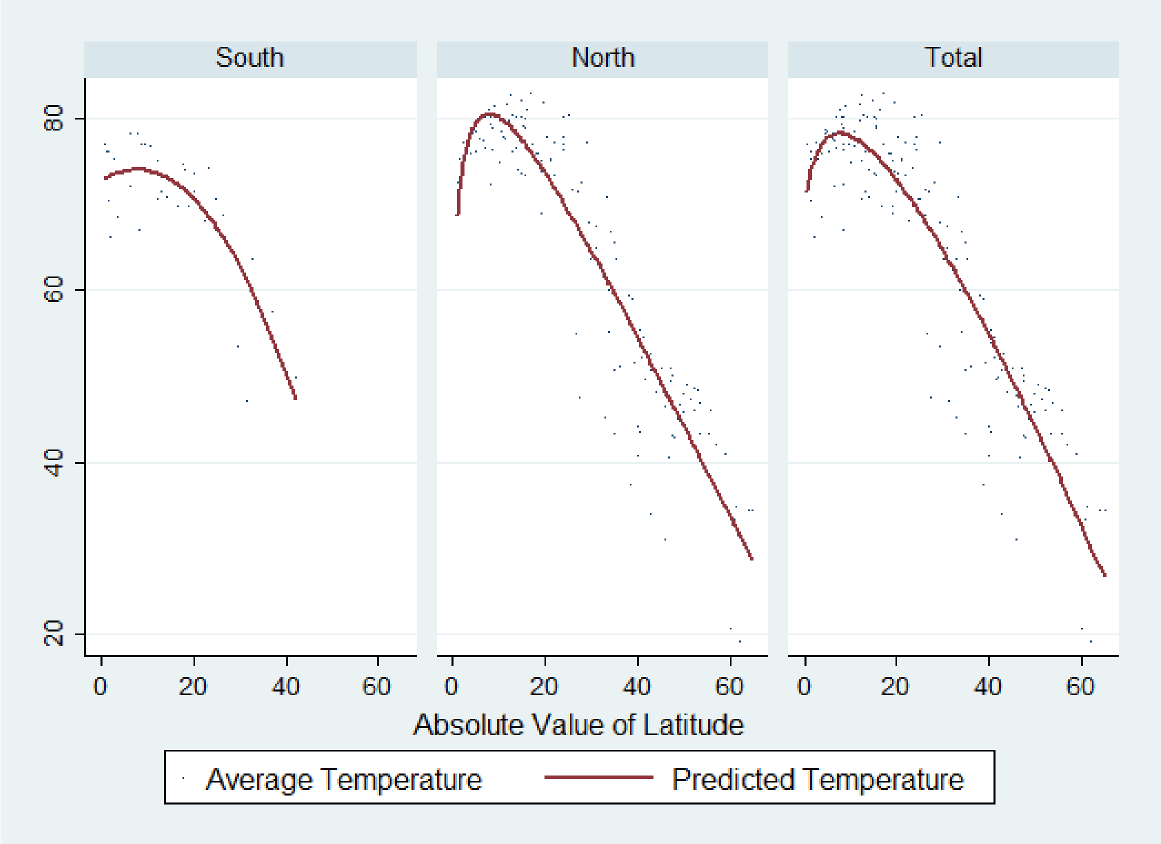
TABLE D: Robustness Checks with Respect to Data

	ModelD1: Average Income	ModelD2: Dropping Counries with Population<500000	ModelD3: Maximum Temperature	ModelD4: Hot, Mild and Cold	ModelD5: Cubic Latitude	ModelD6: Considering Ongoing Conflicts as "0"s	ModelD7: Including Internationalized Conflicts	ModelD8: Just UCDP Factors
Population	0.383***	0.382***	0.396***	0.391***	0.423***	0.423***	0.359***	0.374***
Average GDP per Capita	0.0659							
Peace Years	-0.718***	-0.733***	-0.734***	-0.732***	-0.745***	-0.745***	-0.689***	-0.720***
Ethno-linguistic Diversity	0.0100*	0.0107*	0.0105*	0.00982*	0.0107**	0.0107**	0.0104*	0.0115**
Regime Durability	0.678*	0.720*	0.673*	0.686*	0.759*	0.759*	0.634*	0.642*
Conflict in Neighborhood	0.644*	0.654*	0.641*	0.687*	0.658*	0.658*	0.601*	0.746**
Rough Terrain	0.0199**	0.0211**	0.0187*	0.00928	0.0123*	0.0123*	0.0206**	0.0190*
Nineties	0.241	0.213	0.206	0.244	0.219	0.523*	0.247	0.167
Neighbors Average Polity	-0.37	-0.397*	-0.34	-0.36	-0.401*	-0.527***	-0.438*	
Average Temperature	-0.153**	-0.161**				-0.110*	-0.158**	-0.111*
Average Temperature^2	0.00153**	0.00161**				0.00111*	0.00157**	0.00116*
Average Maximum Temperature			-0.0747*					
Average Maximum Temperature^2			0.00428**					
Cold				-0.814				
Hot				0.721*				
Latitude					7.776			
Latitude^2					-49.34*			
Latitude^3					57.43**			
Constant	-7.376***	-7.902***	-8.108***	-10.98***	-11.03***	-6.658***	-7.333***	-8.356***
Pseudo R^2	0.291	0.2934	0.2943	0.2904	0.2973	0.1624	0.2739	0.2768
Log Likelihood	-430.8	-423.75	-425.74	-426.04	-423.94	-544.29	-454.05	-448.405
N	3378	3338	3421	3355	3421	3930	3363	3519

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 8: Average temperature by latitude (in absolute value)



6.1.2. A different main set

We are going to answer to the following question in this section: What happens if we choose a different set of main variables that proposed to be significant in Hegre and Sambanis (2006) analysis? Obviously, we follow the same rules in selecting the variables by not including two variables defining the same concept to avoid any possible multicollinearity. Just like before, we include the three core variables in all the models. But, apart from that, we have substituted the variables in our previous main set with other significant variables defining the same concept group (if available)[31], to detect any possible change in our focus variable's significance level. We have used the same variable as before when there was no substitutes available. Also, we add variables that hold a significant p-value in Hegre and Sambanis (2006) analysis when they use a normal distribution assumption but not significant when tested assuming a non-normal distribution (e.g. Number of languages in Ethnologue, Ethnic dominance, Polity score, Presidential government, Western Europe and the US dummy, Primary commodity export/GDP).

The new variables we used in the models shown in Table E are: Ethnic Fractionalization Index, Share of Largest Group & Anocracy dummy (Fearon and Laitin, 2003); Linguistic Component of ehet & Religious Component of ehet (Vanhanen, 1999); Polity Score

[31] Some concepts do not have more than one variable that be significant.

(Marshal and Jaggers, 2002); Ethnic Dominance Measure (Collier and Hoeffler, 2004); Oil Production & Oil Export/GDP (World Bank); Presidential Democracy (cheibub et al., 2010); Political Instability & Western Europe and the US dummy (Authors' coding); Total Number of Neighbours at war (Sambanis, 2004). Due to termination of preparing "*Primary Commodity Exports/GDP*" data by the World Bank, we have used "*Oil Production*" and "*Oil Export/GDP*" data instead as suggested by Fearon and Laitin (2005).

TABLE E: Selecting a Different Main Set

	ModelE1: Different Set of Control Variables	ModelE2: Adding Temperature (Baseline)	ModelE3: Different Variable measuring Ethnic Fragmentation	ModelE4: Different Variables measuring Ethnic Fragmentation	ModelE5: Oil Export/GDP Inseat of Oil Production	ModelE6: Adding Controls for Temperature	ModelE7: Adding Military Personnel	ModeE8: Adding Autonomy	ModelE9: Total Neighbours at War
Population	0.374***	0.428***	0.389***	0.346***	0.445***	0.450***	0.379***	0.390***	0.397***
Peace Years	-0.735***	-0.708***	-0.694***	-0.712***	-0.826***	-0.699***	-0.848***	-0.616***	-0.619***
Ethnic Fractionalization Index	1.174*	0.857			0.85	0.389	0.686	0.774	0.708
Conflict in Neighborhood	0.612*	0.569*	0.564*	0.555*	0.577	0.569	0.672	0.469	
Rough Terrain	0.00566	0.0187**	0.0185**	0.0215**	0.0244**	0.0132	0.0268**		
MENA	0.502	0.790*	0.756	0.822*	0.858	1.275**	0.682	1.134***	1.159***
Average Temperature		-0.151*	-0.142*	-0.157*	-0.187**	-0.174*	-0.175*	-0.154*	-0.158*
Average Temperature^2		0.00153*	0.00145*	0.00163**	0.00181**	0.00148*	0.00179*	0.00160**	0.00164**
Ethnic Heterogeneity Index			0.00799**						
%Largest Ethnic Group				0.063					
Religions				0.00000981					
Languages				0.0309*					
Oil export/GDP					4004324.6				
Military Personnel							0.000329		
Autonomy								0.718*	
Total Neighbours at War									0.0595
Latitude						Yes			
%Pop. in Malaria Area						Yes			
Mean Annual						Yes			
Soil Quality						Yes			
%Tropics and Subtropics						Yes			
Constant	-8.116***	-7.098***	-6.605***	-6.032***	-5.760**	-5.770*	-6.431**	-5.992**	-5.716*
Pseudo R^2	0.2749	0.28	0.2827	0.2819	0.3533	0.2822	0.3569	0.2509	0.2389
Log Likelihood	-451.41	-446.12	-444.48	-444.93	-288.6	-442.5	-260.45	-356.24	-354.68
N	3577	3509	3509	3509	2331	3437	1985	2632	2626

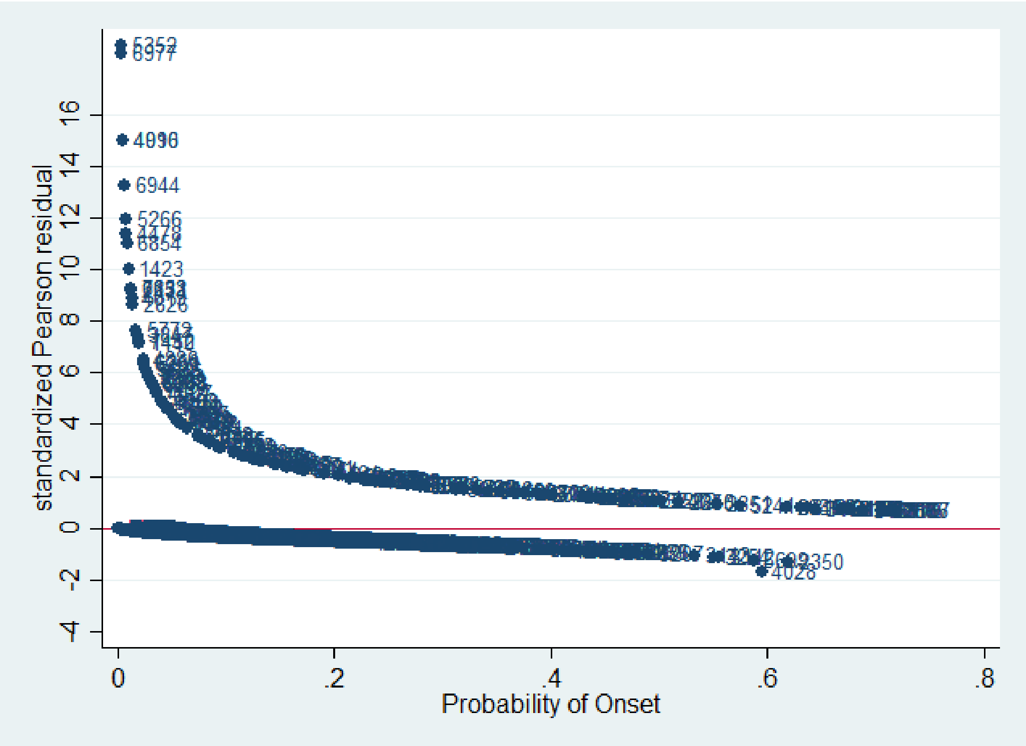
Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.1.3. Influential Cases

We next check the sensitivity of our results to exclusion of influential cases. We find Pearson residuals after predicting the probability of a conflict where, they are defined to be the standardized difference between the observed frequency and the predicted frequency. In other words, Pearson residuals measure the relative deviations between the observed and fitted values where, large value suggests a poor fit for the corresponding observation (Figure 9).

Figure 9: Pearson residual versus the probability of onset



Also, another statistic that we use to identify outlier observations is the Deviance residuals. They measure the divergence between the maxima of the observed and the fitted log likelihood functions. As logistic regression follows the maximal likelihood principle, logistic regression aims to minimize the sum of the deviance residuals (Figure 10).

After we find outliers, we check for the observations that have impressive influence on the results to see if omitting them from our sample data could change the results. We use Hat diagonal (a.k.a. Pregibon Leverage) to measure the leverage of an observation (Figure 11).

Figure 10: Deviance residual versus the probability of onset

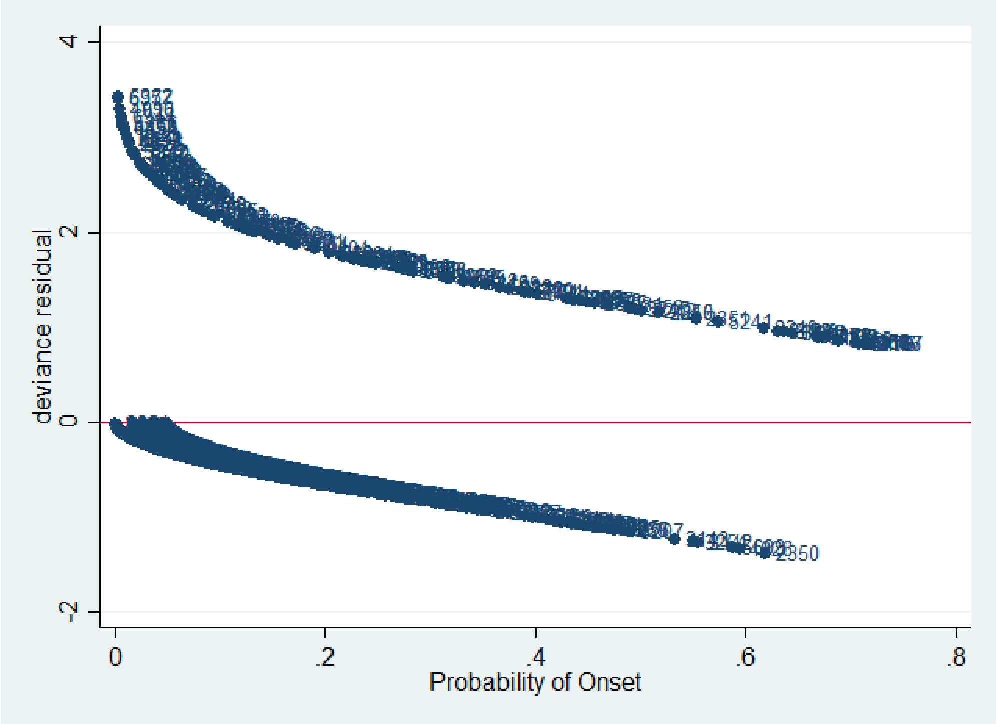
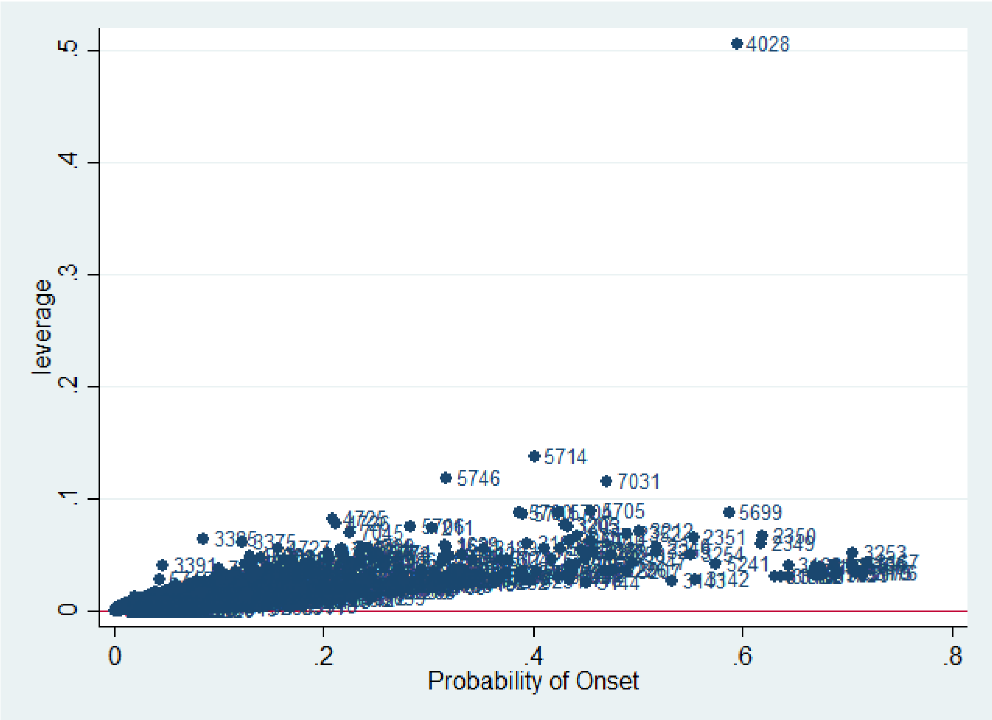


Figure 11: Leverage versus the probability of onset



We next analyse whether omitting the observations with a large error and/or leverage from our baseline model could actually affect our results (Table F). Dropping the observation that corresponds to Liberia on 1998, solely results in a big change in the growth significance level. This could be due to the high and unusual growth rate (106%) that this country experienced the year before (1997), but it actually accounted for the year 1998 in our model – as we gapped our growth data by one year.

TABLE F: Outliers and Influential Cases

	ModelE1: Baseline Model	ModelE2: Omitting odd cases	ModelE3: Omitting influential cases
Population	0.385^{***}	0.415^{***}	0.379^{***}
Peace Years	-0.732^{***}	-0.784^{***}	-0.734^{***}
Ethno-linguistic Diversity	0.0109^{*}	0.0120^{**}	0.0109^{**}
Regime Durability	0.722^{*}	0.704^{*}	0.747^{*}
Conflict in Neighborhood	0.651^{*}	0.897^{**}	0.656^{*}
GDP growth	0.0272	0.0284	0.0434^{**}
Rough Terrain	0.0212^{**}	0.0246^{**}	0.0206^{**}
Neighbors Average Polity	-0.393^{*}	-0.453^{*}	-0.399^{*}
Average Temperature	-0.161^{**}	-0.187^{**}	-0.163^{**}
Average Temperature^2	0.00161^{**}	0.00185^{**}	0.00162^{**}
Constant	-8.005^{***}	-8.436^{***}	-7.715^{***}
Pseudo R^2	0.2938	0.3242	0.2961
Log Likelihood	-424.04	-395.1	-422.62
N	3355	3350	3354

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2. With Respect To Method

In this sub section we test the sensitivity of our results with respect to the method by investigating the significance of results when including time dummies, using random effects, and rare-event logistic model. Using fixed effects is not practical in our case as many of the variables – including the focus factor – are fixed through time (categorized by country) and also, the majority of countries would get ignored form the analysis as the dependent variables did not change through the time periods for most of the countries (peaceful). We want to analyse whether time effects matter by including time dummies in Model G1. Adding year dummies takes into account the fixed intra-year effects besides the intra-country fixed characteristics that we are already considering (by clustering). Doing so does not change our regressor's significance, however, it decreases the log likelihood (we should note that part of this could be because of the omitted observations from excluding years 1988 and 2001 due to presence of no event then).

The results presented in King and Zeng (2001) suggest that standard logit estimation may underestimate the probability of an event occurring when the events are rare. As a result, Gary King et al. (2003) introduce a new method to use logistic regression when we are dealing with very few events (onset of a conflict) compared to non-events. They have specifically conducted this method in order to study wars, political activism or epidemiological infections. Our data in this research is characterized by a relatively small number of events (conflicts), only about five percent of the observations being characterized by a conflict outbreak. Moreover, rare-events logit estimates the same model as the logistic regression, but with an estimator that gives lower mean square error in the presence of rare events data for coefficients, probabilities, and other quantities of interest. After using this methodology in Model G2, we do not observe a great change except the first power of temperature which becomes significant.

TABLE G: Robustness Checks with Respect to Method

	ModelF1: Pooled Logit Plus Time Dummies	ModelF2: Rare Events Logit	ModelF3: Random Effects
Population	0.388***	0.378***	0.403***
Peace Years	-0.746***	-0.718***	-0.695***
Ethno-linguistic Diversity	0.0102*	0.0105*	0.0115*
Regime Durability	0.770*	0.726*	0.785*
Conflict in Neighborhood	0.745**	0.623*	0.651*
GDP growth	0.0264*	0.0262	0.0267*
Rough Terrain	0.0203**	0.0209**	0.0221**
Neighbors Average Polity	-0.408	-0.384*	-0.403*
Average Temperature	-0.166**	-0.161**	-0.161*
Average Temperature^2	0.00164**	0.00160**	0.00164**
Constant	-6.825**	-7.532***	-8.710***
Pseudo R^2	0.3164		
Log Likelihood	-402.38		-423.66
N	3101	3355	3355

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.3. Armed Forces Personnel variable[32] omission

We choose to omit military personnel data from all the analysis due to three main reasons:

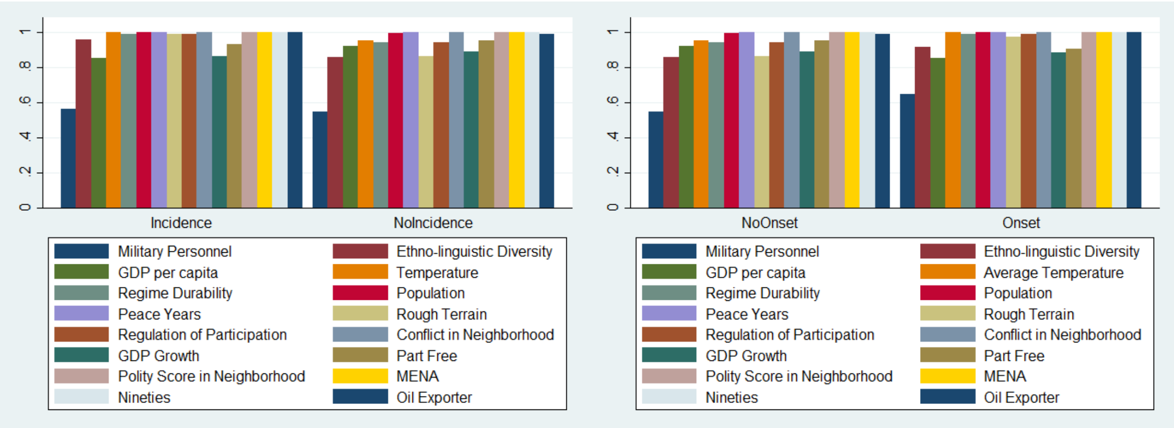
i. Too many missing variables (Specially in the case of conflict onsets, which is the focus of this study)

In figures 12 and 13, the vertical axis indicates the percent of available observations in the dataset we used. Basically, when the value gets bigger, it means the variables cover more of the observations. For military personnel data, we could see that almost half of the observations are missing when there was no onset and around 40% when there was one. Comparing these results with other variables that we used, explains why we decided to drop this variable from our analysis.

ii. There is a good chance that the reason for missing observations be correlated with the dependent variable as countries with a rich history of conflict and an instable government could either ignore recording their military data or simply would not permit access.

iii. One could argue that military size depends on the risk of conflict (before it even happens and reached the benchmark number of deaths) and there could be a high level of endogeneity as a result.

Figures 12 and 13: Percentage of available data (non-missing) by incidence/onset of conflict



However, even after all these we could still test our results including military personnel data in the regression models (Table H). You could see the number of observations drops dramatically after adding this variable (from around 3500 to 2050)

[32] Active duty military personnel in thousands

TABLE H: Including Military Personnel Data in the Models

	ModelG1: Adding to the Initial Set	ModelG2: Adding Temperature	ModelG3: Adding temperature^2	ModelG4: Adding Potential Factors	ModelG5: Adding Hot, Mild and Cold	ModelG6: Adding Cubic Latitude	ModelG7: Just Minor Conflicts	ModelG8: Dropping Russia
Population	0.272*	0.237*	0.296**	0.381***	0.274**	0.334***	0.265**	0.265**
Peace Years	-0.854***	-0.851***	-0.840***	-0.854***	-0.825***	-0.851***	-0.791***	-0.812***
Ethno-linguistic Diversity	0.0127*	0.0134*	0.0125*	0.00972	0.0111	0.0132*	0.0123*	0.0126*
Conflict in Neighborhood	0.858*	0.836*	0.796*	0.705	0.796*	0.843*	0.697*	0.836*
Rough Terrain	0.0102	0.0149	0.0264**	0.0250**	0.0121	0.0160*	0.0280**	0.0259**
Neighbors Average Polity	-0.543*	-0.489*	-0.553*	-0.468	-0.495*	-0.598*	-0.482*	-0.524*
Millitary Personnel	0.00029	0.00052	0.000425	0.000352	0.000557	0.000486	0.000023	0.000604
Average Temperature		0.0212	-0.165*	-0.209**			-0.169*	0.0725**
Average Temperature^2			0.00172*	0.00187**			0.00172**	
Latitude				Yes				
%Pop. in Malaria Area				Yes				
Mean Annual Precipitation				Yes				
Soil Quality				Yes				
%Tropics and Subtropics				Yes				
Mild					1.037			
Hot					1.715*			
Latitude						0.117		
Latitude^2						-0.00784**		
Latitude^3						0.0000987**		
Constant	-6.968***	-8.836***	-6.338**	-5.636	-8.579***	-9.227***	-5.907**	-14.00***
Pseudo R^2	0.3491	0.3485	0.3557	0.3605	0.352	0.3622	0.3017	0.3543
Log Likelihood	-265.43	-264.19	-261.26	-257.92	-262.75	-260.11	-258.23	-254.011
N	2038	1994	1994	1953	1994	2038	1994	1987

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7. CONCLUSION

All in all, we find evidence that ambient environment factors – such as temperature – could have a role in economical/political phenomena. In this study, we realize that some of the factors argued to be the most significant in triggering a conflict (from Hegre and Sambanis, 2006), could actually lose their statistical significance when studying on a different dataset (or time period). However, some of the most cited factors stay significant throughout all the analysis and robust checks in our work. Focus of this paper is on the possible role of ambient factors, not only on individuals, but also on groups – considering conflict as a collective group movement. We believe these factors have been omitted from economic studies for no good reason. In this work, we propose that temperature could have a significant – and positive – effect on starting a conflict not only through change in the agricultural production, but also directly by altering the behaviour and mood of individuals. This could be of more interest when we argue that increase in violence could be added to the negative consequences of global warming.

To continue, we control for various potentially relevant factors to investigate the existence of this direct link from temperature to the onset of conflict by adding them to the model including temperature and yet, this variable remains significant throughout the analysis. Also, we conduct solid robustness analysis to test the sensitivity of our results to changes with respect to both data and method. Moreover, dividing conflicts by their predetermined fatality threshold provides us with some new insights. Based on the evidence, we conclude that the behavioural effect of temperature on a collective aggressive movement is stronger – and more reliable – if we focus just on minor conflicts. One could reason that minor conflicts require less preparation and they could happen more suddenly; as a result, behavioural factors could influence them more easily.

Dropping Russia (for the mentioned reasons) from our sample study does not change the positive effect of temperature on the conflict onset. However, by studying the shape of the relationship between onset and temperature, we learn that northern and southern countries, respond oppositely to increase in temperature when the heat exceeds 72.6^{o} Fahrenheit. This reminds us the earlier psychological study suggesting individuals could respond reversely to increase in temperature when under pressure and the heat passes some measurable point. However, this is not the focus of our work and we did not find strong evidence for it.

In the end, this study tentatively proposes a novel classification system to the existing literature in order to group the reasons that could trigger a conflict. This new approach keeps the "*Greed*" motives as one of the main reasons but combines unintentional behavioural intentions with "*Grievance*" motives and labels it as "*General Satisfaction*". Also, as suggested by Fearon and Laitin (2003), the suitable environment and proper conditions plays an important role in insurgency activities and as a result, the third group is called "*Convenience*".

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9. APPENDIX

Appendix 1

Here, we have the comparison for some of the factors covered in this study when dividing by Northern and Southern part of the world.

Figure 14: Comparing some of the Northern and Southern countries' aspects

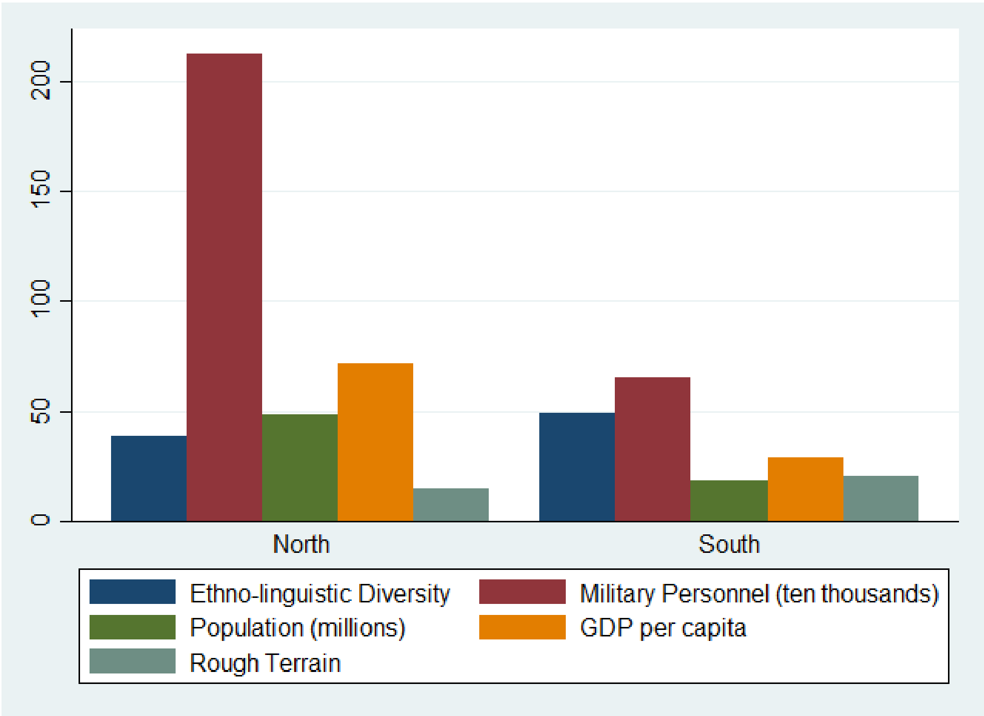
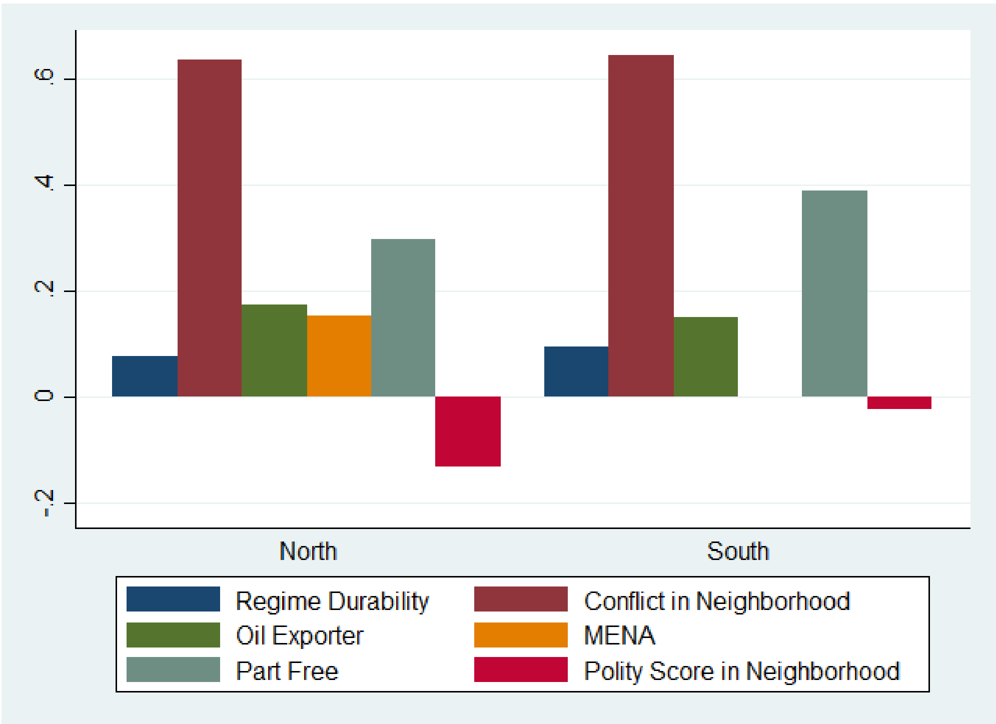


Figure 15: Comparing some of the Northern and Southern countries' aspects



Appendix 2

In the following, there is a summary of the variables used in this work. First table illustrates all the independent variables and the second one, demonstrates our dependent variable in more details.

Table I: Summary of the Explanatory Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Population	3355	15.97803	1.546576	12.95768	21.00442
GDP per Capita	3355	7.428245	1.600926	4.054136	11.46363
Peace Years	3355	2.73359	1.161788	0	4.143135
GDP Growth	3355	3.959289	5.432463	-50.2481	106.2798
Ethno-linguistic	3355	41.37019	28.33696	0	93
Participation	3355	3.588674	1.17192	1	5
Regime Durability	3355	0.059719	0.213623	0	1
Polity Neighborhood	3355	-0.09375	0.685237	-2	2
Rough Terrain	3355	15.91123	20.9989	0	94.3
Oil Exporter	3355	0.165425	0.371619	0	1
Conflict Neighborhood	3355	0.633383	0.481953	0	1
Part Free	3355	0.317735	0.465665	0	1
MENA	3355	0.102236	0.303003	0	1
Nineties	3355	0.269449	0.44374	0	1
Temperature	3355	65.89031	14.57696	19.148	82.94
Latitude	3355	0.275305	1852351	0.011111	0.711111
Malaria	3318	0.394585	0.437385	0	1
Precipitation	3355	1132.976	762.3558	31.01	3268.27
Soil Quality	3286	12.43708	9.018787	0	48.1481
Tropics	3286	0.400073	0.424269	0	1

Table J: The Dependent Variable in More Details

Conflict Onset	Freq.	Percent	Cum.
No Conflict	3,209	95.65	95.65
Minor Conflict	126	3.76	99.4
Major Conflict	20	0.6	100
Total	3,355	100	

Appendix 3

Marginal effects are changes of the dependent variable in response to change in a covariate when all the covariates are fixed.

Figure 16 and 17: Marginal effects for average temperature with and without Russia