Conflict, Economic Growth and Spillover Effects in Africa

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Abstract

While there is a large empirical literature on the determinants of conflict, much less attention has been given to its economic effects and even less to the spillover effects it can have on neighbours. This paper considers the economic effects of conflict for a panel of African countries and develops an approach to calculating the spillovers that moves beyond simply using geographical distance measures and incorporates economic and political differences. The initial empirical results suggest that conflict has a strong negative spillover effect on directly contiguous countries' growth, but no significant impacts were observed on non-contiguous countries. When economic and political factors are considered, this result remains, but the spillover effect is smaller. This implies that it is important to take such factors into account. While the impact of conflict remains devastating, studies that use only geographical distance measures may have been overestimating the impact on neighbours.

Keywords: Conflict; Economic Growth; Spillovers
JEL code: C21; F21; H56; O11

1 Introduction

Conflict has been a common and persistent phenomenon in recent history, afflicting between a third and fifty percent of all nations, depending on which definition is used, and increasing in duration over time. In Africa, the world's poorest continent, more than eighty percent of countries have been embroiled in some form of violent conflict since 1960, with thirty percent having experienced at least ten years of conflict during the period.

While a relatively large literature has grown around the determinants of external and internal conflict, there have been relatively few attempts to try to evaluate the costs of conflict and even fewer have considered the impact of conflict on economic growth (Dunne, 2013). More recently a small literature has developed that analyses the spillover effects of conflict, with de Groot (2010) following the work of Murdoch and Sandler (2002a, 2002b, 2004) and coming to some different conclusions.

This paper contributes to the literature by analysing the spillover effects of conflict in Africa for the period 1960 to 2010 and developing the measure of distance to account for not simply a geographical measure, but also political, economic and cultural characteristics. The potential importance of similarities and differences in these factors in determining the impact of one country on another has been considered in the determinants of conflict literature following Beck et al (2006), but not in the cost of conflict literature. Just like Watts and Strogatz's (1998) argument that two distinct people may be "close" in that they share a common acquaintance, countries' that are far away may be "close" if they share a common economic, political or cultural trait.

The next section considers the literature on the spillover effects of conflict and suggests how the analysis can be extended. Section three then presents the theoretical framework. The dataset and empirical methods are described in section four, while the estimation results can be found in section five. The sixth and final section provides some conclusions.

2 Spillover Effects of Conflict

While there is a substantial literature on the economics of civil conflict, the majority of this has been focussed on the determinants and duration of civil wars (Blattman and Miguel, 2010). A more limited literature has considered the economic effects of conflict, with a number of studies evaluating the costs of conflict (Dunne, 2013). In most cases, these studies have focussed on the effects on the economy in which the conflict is taking place (see Collier, 1999; Gyrimah-Brempong and Corley, 2005), but Murdoch and Sandler (2002a) took the important step of recognising the likely importance of spillover effects on neighbouring countries, considering directly contiguous countries (e.g. those sharing a border). Using a basic Solow growth model and adding domestic and adjacent conflicts, they found that for a sample of 84 countries during the period 1960 to 1990, civil wars had a significant negative influence on the steady-state level of GDP per capita for both the conflict afflicted country and its neighbours. Moreover, while part of the negative civil war effect works on growth through the classical channels of capital and labour, the largest effect was found to come through the unobserved, country specific channel.

In two subsequent papers, Murdoch and Sandler (2002b, 2004) varied the time periods, country samples and the definition of contiguity, using the Gleditsch and Ward (2001) minimum distance between nations dataset. In all three papers, the long-run effects of conflict were insignificant, which they attribute to Organski and Kugler's (1980) phoenix effect, while civil wars were found to have a negative and significant short-run growth effect on both the host and neighbouring countries.[1]

This analysis was developed by de Groot (2010). Firstly, he argued that Murdoch and Sandler's theoretical model restricts spillover effects to be unidirectional and thus lacks the flexibility to estimate a "bounce back" effect

[1]The phoenix effect is named after the metaphor of a phoenix rising from the ashes, symbolising that for a post-conflict society, their GDP per capita may be at such a low base that they are able to rebound quickly and reach their steady-state growth path. Also a representation of conditional convergence.

that exists between contiguous states.[2] Distinguishing between primary, contiguous, neighbours and secondary neighbours, those non-contiguous states within a set distance threshold, allowed both uni and multi-dimensional spillover effects to be captured. Secondly, by replacing the dummy variable for contiguity with the actual minimum distance between countries it gave a more satisfactory continuous measure of spillover. Using data for Africa from the period 1960 to 2000, the distinction between primary and secondary neighbours led to very different conclusions. Rather than a general negative growth effect from conflict on all neighbours, de Groot (2010) suggested that there could be a growth trade-off that benefits secondary neighbours but punishes primary neighbours. In addition, while previous work focused on civil wars, de Groot considered all forms of conflict and found the results to be consistent.

A number of developments suggest that this issue is worth revisiting. Firstly, more data has become available, both in terms of quality and quantity.[3] Secondly, the use of five-year averages in all of the above studies can be questioned, as it does not allow conflicts that last one year to be distinguished from ones lasting more than one year and does not allow for more than one episode of conflict during a five year period. Thirdly, the political science literature has raised the issue of whether physical distance measures are adequate in assessing spillover effects. Conley and Ligon (2002) uses different transportation costs (e.g. UPS shipping costs and airfare) to show that cross-country growth spillovers are more noticeable than when geographical distance is used, while Beck et al (2006) suggest that spatial econometrics work in political economy must consider not only geographical distance but also political and economic distances, such as trade and democracy. In the case of Africa, a region with numerous political, economic and historic sim-

[2]This "bounce back" effect describes the ability for the spillover effects to flow back and forth from the host country and its neighbours. This is unlike Murdoch and Sandler's work where they assume the spillover to only flow from the conflict afflicted country to their neighbours.

[3]This new data comprises of an extra 10 years since de Groot (2010). There are also more countries being examined, less gaps in the data set and unlike previous analyses, this paper uses a balanced panel.

ilarities (e.g. type of ruler, colonialism, natural resource abundance and trade) and one that has been plagued with long-lasting conflicts, this seems a particularly important issue.

3 Theoretical Framework

Following previous studies, the basic theoretical model used to estimate the effects of a conflict on economic growth is based the classic Solow (1956) model, augmented to include human capital (Mankiw *et al*, 1992). This model features a Cobb-Douglas production function for diminishing returns (e.g. decreasing marginal product) in labour (L), physical (K) and human capital (H). Constant returns to scale characterises the production function so that proportional increases in inputs leads to proportional increases in output, while along the steady state growth path, savings equals investment in physical and human capital. In order to determine the empirical effects of conflict on economic growth, the model is further augmented to include conflict experience within home and neighbouring countries, via the technology parameter (A). The human capital augmented production function featuring a Harrod-neutral technical progress can be written as:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} [A(t)L(t)]^{1-\alpha-\beta}, 0 < \alpha + \beta < 1 \tag{1}$$

where α and β are the elasticities of output with respect to physical and human capital respectively. $Y(t)$ denotes output at time t, $K(t)$ is physical capital, $H(t)$ is stock of human capital and $A(t)$ is the technology parameter with output elasticity of $(1 - \alpha - \beta)$. Labour is assumed to grow at an exogenous growth rate of n, technical progress will grow at the exogenous rate of g and both physical and human capital will depreciate at the identical rate δ. By dividing both sides of equation (1) by effective labour (AL), gives an expression in terms of income per effective worker ($y = Y/AL$), that equals:

$$y(t) = k(t)^{\alpha} h(t)^{\beta} \tag{2}$$

with $k = K/AL$ and $h = H/AL$ in quantities per effective worker at time t. The model is solved by determining the transition equations of k and h, solving for the steady-state levels of k, h and y and log-linearising (Mankiw *et al*, 1992). This gives a model that can be empirically parameterised as the following:

$$y(t) = \beta_0 + \beta_1 \ln(y_0) + \beta_2 \ln(s_k) + \beta_3 \ln(s_h) + \beta_4 \ln(n + g + \delta) \qquad (3)$$

where $y(t)$ is the growth rate of income per capita at time t, ln denotes the natural logarithm, y_0 is the initial income level of income per capita, s_k is the investment in physical capital, s_h is the level of human capital, n is the growth rate of population, g is the growth rate of technical progress and δ is the rate of depreciation.

Growth in per capita income from the augmented Solow model - shown in equation (3) - depends positively on investment in physical and human capital, but falls with increases in $(n+g+\delta)$ or higher initial levels of income per capita (y_0). An increase in the natural rate of labour growth (n) or labour efficiency (g) raises the denominator of the dependent variable (i.e. income per capita) and thus reducing its level and depreciation limits income growth through reductions in physical and human capital.

If the initial level of income per capita has a negative influence on economic growth, this implies that countries with a lower GDP, ceteris paribus, will growth faster suggesting conditional convergence. Poorer countries with low ratios of physical and human capital have higher marginal products with their respective capital as compared to richer countries and thereby grow at higher rates (Barro, 1991). This is important for post conflict economies as it implies countries can catch up.

Conflict can influence home and neighbouring country growth through five theoretical channels summarised in Table 1. The first is through the destruction of physical capital stocks. This destruction effect mainly applies to host nations and through collateral damage on primary neighbours, with

secondary neighbours likely to suffer little to no collateral damage. This implies that the further a country is from the conflict origin the lower the negative influence it has, with a potential to have no effect. Conflict may also affect foreign direct investment (FDI) flowing to the region due to higher perceived risk, which will have a negative burden on host nations and primary neighbours. It is unclear what the impact is on secondary neighbours, as conflict may decrease investment in the region, but secondary neighbours may benefit from diverted investment from the host country and its immediate neighbours.

The second channel is labour and human capital, with its largest effect likely to be destruction and displacement of productive labour and the reassignment of labour to less productive activities (e.g. border patrols, management of refugees or soldiering). Similar to the capital channel, primary neighbours are thought to experience the same negative effects as host nations. A further concern is the influence of refugees from the conflict region, with primary neighbours bearing the bulk of refugee inflows. This is likely to be costly, reducing their income per capita in the short run. In the long run, the effect is unclear, as a portion of the negative effect can be cancelled out by the positive inflow of human and physical capital that some refugees bring, but also a worsening through conflict diffusion (Salehyan and Gleditsch, 2006).[4] Secondary neighbours are less likely to be affected and when they are it is possible that those refugees who are able to cross multiple borders carry higher human capital than usual.

Channel three is trade. In a host country afflicted with conflict, both domestic and international trade are likely to be negatively affected, which can directly harm economic growth. Although primary neighbours have more opportunity to divert trade flows, there is likely to be some effect. Conflict may have a large regional effect on trade, which also harms secondary neighbours, but the redirection of primary neighbour trade could provide new trade opportunities for secondary neighbours (de Groot, 2010).

[4]Refugees may facilitate in the transnational movement of arms, combatants and ideologies that are conducive to civil conflict.

A fourth channel is the reallocation of resources to less productive activities. This can include efforts to quell local conflicts or bolster defence spending in order to defend territorial borders. In the case of increased defence spending, resources must be diverted from productive activities and will have a negative impact on economic growth (Dunne and Tian, 2015). For the host nation and primary neighbours, activities such as border patrols, deployment of personnel and resources to manage the inflow of refugees have a clear cost, but these are less likely to be necessary for secondary neighbours.[5]

The final channel through which conflict can influence economic growth is the potential spillover effect of conflict itself. This can be significant for primary neighbours, particularly if they end up getting dragged into host country conflicts, but the effect on secondary neighbours is likely to be minimal (Bosker and Ree, 2014).

Table 1: Theoretical Channels of Spillover on Types of Countries

Spillover Channels	Host Nation	Pri. Neighbour	Sec. Neighbour
Capital	-ve effect	-ve effect	-ve, no effect, +ve
Labour	-ve effect	-ve, no effect	-ve, no effect, +ve
Trade	-ve effect	-ve, no effect	-ve, no effect, +ve
Resource Allocation	-ve effect	-ve effect	no effect
Conflict	-ve effect	-ve, no effect	-ve, no effect

While the country hosting the conflict is likely to experience negative growth shocks, the impact on primary and secondary is less clear and given that the spillover effects vary depending on the channel and type of country, the overall effect can only be determined empirically. To augment the growth model for this purpose, variables are introduced for host country conflict and primary and secondary neighbours conflicts are weighted by some measure of distance:

[5]An exception to this case would be if the host country, primary and secondary neighbours are part of a security web or some form of regional security agreement.

$$\Delta \ln y = \alpha_0 + \beta_1 \ln(y_{0,i}) + \beta_2 \ln(s_{k,i,t}) + \beta_3 \ln(s_{h,i,t}) + \beta_4 \ln(n + g + \delta) + \beta_5(conf_{i,t}) + \beta_6 W_{pri}(conf_{pri,i,t}) + \beta_7 W_{\text{sec}}(conf_{\text{sec},i,t}) + \varepsilon_{i,t} \quad (4)$$

where $conf$ is a measure of conflict experience, and W_{pri} and W_{sec} are weighted contiguity matrices of primary and secondary neighbours respectively.

Although most work within the conflict literature has made a clear distinction between civil and interstate conflicts, Gleditsch (2007) makes a compelling argument that such events are at times not distinctively different, particularly when looking at spillover costs, so both civil and interstate conflicts are considered. Keeping with the literature, host country conflict is a dummy variable and primary neighbour contiguity matrices are constructed using two approaches. Firstly, using a dummy variable approach, a value of 1 is given to countries sharing a border with the host nation and 0 otherwise. Additionally, a border length approach is used, where border distance between countries is used as a matrix element. For the primary neighbour weights, the dummy variable and border length are divided by the sum of all primary neighbours and the total distance of the host country's border length respectively. In the border length matrix, this means the longer the border length between two countries, the larger the potential spillover effect. For secondary neighbours, a dummy variable is used to capture all secondary neighbours (not directly contiguous) within a 1000 kilometre radius, with an alternative measure using the exact geographical distance of the closest route between the host country and all secondary neighbours.

Specifically, with the minimum distance method, secondary neighbour weights are constructed by taking the 1000 kilometre radius, less the minimum distance between the two countries. This is then divided by the sum of the minimum distances of all secondary neighbours to the host country. That is:

$$W_{\text{sec}} = \frac{1000 - \delta_{ij}}{\sum_j \delta_{ij}} \quad (5)$$

where δ represents the distance between countries i and j, country i would be the host nation and j a secondary neighbour. Thus, the further a secondary neighbour is from the host nation, the smaller is the spillover effect.[6]

To introduce the more general concept of distance, democracy and trade measures were taken from the Polity IV database and World Bank's World Integrated Trade Solution (WITS), respectively.[7] Combining these mean that larger trading partners and politically similar countries are weighted more heavily than smaller trading partners or countries with little political similarity. Countries with larger weights are considered closer to the host nation's conflict and would experience a larger spillover effect from conflict. These measures are used in conjunction with geographic distance matrices to create row standardised weight matrices that account for economic and political similarities across geographical space.

4 Data and Empirical Methods

Data for the empirical analysis are taken from four sources. GDP per capita, investment and population from the Penn World Tables version 7.1; education data from Barro and Lee (2012) and Penn World Tables version 8.0; and measures of armed conflict comes from the UCDP/PRIO Armed Conflict Database 4, updated to 2010 by Themner and Wallensteen (2011). A panel of annual data for the period 1960 to 2010 was constructed featuring 36 countries. The dependent variable is annual per capita GDP growth and as in other studies $(g + \delta)$ is assumed to equal 0.05 and added to population growth to form the term $(n + g + \delta)$. Amalgamating the Penn World Table 8.0's index of human capital, which is measured annually, with the Barro and Lee (2012) education database, which is measured every 5 years, gave an annual measure of education attainment in secondary schooling as a percent-

[6]Refer to figure 1 in the appendix for a graphical example of how neighbours are defined.

[7]As suggested by Jaggers and Gurr (1995) the Polity IV variable is reworked to a full 21 point institutionalised democracy scale and trade is measured as average bilateral trade between host and neighbouring countries.

age of the population over the age of 25. The conflict indicator variable was split into three. The first variable "*conflict*" contains all conflicts (civil and interstate) recorded in the dataset, the second variable "*intense*" includes only those conflicts that have at least 1 000 battle related deaths per year and finally, "*civil*" comprise only intrastate conflicts. Conflict duration was measured in months of conflict in a calendar year.

A combination of the CIA World Factbook and Gleditsch and Ward (2001)'s minimum distance dataset, was used to construct the different geographical weight matrices and these weight matrices were also checked for consistency with those used in de Groot (2010). The political and economic weight matrices are constructed using Polity IV and World Bank's WITS dataset. Table 2 presents summary statistics of the key variables used in the regression analysis, while Table 12, in the appendix, provides a country list and years of conflict per country between the period 1960 and 2010.

In undertaking empirical analysis within the field of conflict and economic growth, data limitations are a problem. Countries that have experienced war are likely to have the worst data and even though data quality has improved, issues do remain. Some of the data issues relate to missing data (e.g. growth, education and investment) for periods where a country was in war (e.g. Angola and Sudan in the 1960's) and no data for countries such as Libya and Somalia, leaving us with a sample of 36 countries. This, however, still represents a reasonable coverage of African countries and is consistent with the other studies.

As Table 2 shows, for the 36 countries with available data, 17% of all observations fall under episodes of conflict, which occurred in 29 of the 36 countries (81% of all countries in the sample have experienced some form of armed conflict), with 76% being in the form of civil conflict and the remainder recorded as interstate conflicts. Between 1960 and 2010, of all the observed conflicts, 35% were considered intense conflicts with annual battle deaths of over 1 000. Such widespread conflict, over time and space, suggest why Africa

Table 2: Variable Description and Summary Statistics

Variable	Variable Description	Mean	Std. Dev
gdp	Real GDP per capita	1290	1605
inv	Investment as a share of GDP	16.62	10.69
edu	Percentage of secondary education attained in the population older than 25	11.93	12.64
pop	Population in 000's	11663	17810
conflict	Conflict indicator	0.17	0.37
intense	Intense conflict indicator	0.06	0.23
civil	Civil war indicator	0.13	0.33
Δgdp	Growth rate of real GDP per capita	0.010	0.070
Δinv	Growth rate of investment as share of GDP	0.014	0.250
Δedu	Growth rate of education attainment	0.053	0.052
$n+g+\delta$	Population growth rate + 0.05 used in Solow-style regressions	0.075	0.060

has struggled to maintain any form of improvement in income, education and investment. Average income ($1290) and education attainment (11.9 percent of population over the age of 25) remain the lowest in the world, with their average growth rates (1 and 5.3 percent respectively) equally dismal.

5 Empirical Results

Taking the specification in equation (4) and introducing dynamics gives the estimation equation:

$$\Delta \ln y_{i,t} = \alpha \ln y_{i,t-1} + \sum_{j=1}^{3} \beta_j \Delta \ln x_{j,i,t} + \sum_{k=1}^{2} \beta_k \ln x_{k,i,t-1} + \theta_1 (conf_{i,t})$$

$$+\theta_2 W_{pri}(conf_{pri,i,t}) + \theta_3 W_{\text{sec}}(conf_{\text{sec},i,t}) + \eta_t + \nu_i + \varepsilon_{i,t} \qquad (6)$$

where y is GDP per capita, x_1 is investment as a share of GDP, x_2 is secondary educational attainment as a share of population over the age of 25 and x_3 is the population growth + 0.05 or $(n+g+\delta)$. All non-dummy variables are in logs, with Δ representing the change in the dependent and

explanatory variables. There is also a lagged dependent variable and lagged levels of physical and human capital. W_{pri} and W_{sec} are the contiguity matrices for primary and secondary neighbours, varying in the type of contiguity matrix (e.g. geographical, political or economic similarities), which are interacted with neighbour conflict indicators to generate the spillover variables. Finally, η_t and ν_i capture time and country fixed effects respectively, while $\varepsilon_{i,t}$ is the error term.[8]

Table 3 provides estimation results for the benchmark growth model before spillovers are considered. In column 1, the results without the conflict dummy show investment and initial income to be of the expected sign and statistically significant, but human capital is negative and significant, while population growth plus 0.05, which theoretically should have a negative impact on per capita GDP growth, is positive and statistically significant. This result for population growth is not unusual within the literature, particularly for low-income developing regions, such as Africa or Asia and it certainly does not seem unreasonable in post conflict economies (Grier and Tullock, 1989).

Similarly, the negative result for human capital is not uncommon within the literature and Islam (1995) attributes it to the discrepancy between the theoretical variable H (measuring quality) used in the model to the actual variable (measuring quantity) used in regressions. Likewise, the education variable in Murdoch and Sandler's papers and de Groot (2010) vary in sign and significance. In the case of Africa and many other low-income countries, the true levels of human capital may not have increased much since 1960 and statistically this leads to a negative temporal relationship between human capital and economic growth. Moreover, it is often the case that education attainment does not translate into increased productivity and in many African countries the quality of education is a major concern.

[8]The empirical equation contains a lagged dependent variable which can bias the estimates. Empirically this biases down the OLS estimators, but there is also potentially a case of heterogeneity bias in any panel data techniques. This will likely bias the estimates upwards. By using our approach of a dynamic panel with fixed effects, the estimates, the bias is small since the two biases work in opposite directions and cancel each other out. A robustness check without the lagged dependent variable can be found in Table 10 in the appendix.

To see if the choice of the human capital variable used in the regressions matter, the Barro and Lee's education attainment variable was replaced by an index on the returns to human capital, found in Penn World Tables 8.0. This gave similar results, with human capital remaining negative and significant across all three conflict specifications (See appendix Table 6).

Table 3: Growth Effects of Conflict, Varying Over Conflict

	(1)	(2)	(3)	(4)
Conflict Type		Conflict	Intense	Civil
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\Delta \ln(inv)$	0.036**	0.036**	0.036**	0.036**
	(0.006)	(0.006)	(0.006)	(0.005)
$\Delta \ln(edu)$	-0.090**	-0.086**	-0.083**	-0.087**
	(0.031)	(0.031)	(0.031)	(0.031)
$\ln(n+g+\delta)$	0.093**	0.089**	0.091**	0.093**
	(0.012)	(0.012)	(0.012)	(0.012)
$\ln(y0)$	-0.024**	-0.026**	-0.025**	-0.024**
	(0.005)	(0.005)	(0.005)	(0.005)
$\ln(inv_{t-1})$	0.018**	0.018**	0.018**	0.018**
	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu_{t-1})$	-0.023**	-0.022**	-0.022**	-0.022**
	(0.004)	(0.004)	(0.004)	(0.004)
Conflict		-0.015**	-0.023**	-0.012*
		(0.005)	(0.007)	(0.005)
Year	0.001**	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.941**	-1.885**	-1.923**	-1.924**
	(0.540)	(0.539)	(0.538)	(0.539)
Observation	1765	1765	1765	1765
R-squared	0.096	0.102	0.101	0.100

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Armed conflict in the host country has a significant negative influence on economic growth and this is true for all three conflict types (Columns 2 to 4). Not surprisingly, intense conflict (Column 3) has the largest negative impact on growth, decreasing growth on average by 2.3 percentage points, while all conflicts and civil conflicts decrease growth by 1.5 and 1.2 percentage points respectively. The growth model results are impressively consistent across these specification changes and remained so with the introduction of the continuity measures. For this reason Table 4 only reports the coefficient estimates for the conflict and contiguity variables, using geographical distance. The results for the entire model can be found in Table 7 and 8 in the appendix. rather than the whole model. These were the best fitting models, in terms of R squared, from a range of regressions run on conflict type and different weighted contiguity matrices, using three different measures of conflict (all types of conflict, intense conflict and civil conflict) and considering both uni-dimensional and multi-dimensional spillover effects.[9]

Uni-dimensional effects are observed when only one set of neighbours is considered, primary or directly contiguous neighbours, while multi-dimensional effects involve both primary and secondary neighbours. Specifications 1, 3 and 5 represent uni-dimensional spillovers, while 2, 4 and 6 are multi-dimensional. In all six specifications, conflict in a host country is estimated to have a negative and significant effect on host nation growth, with the spillover effects of conflict on neighbouring countries' growth rates differing. While a host country conflict – irrespective of type – negatively affects primary neighbour growth, no such influence was found on secondary neighbours.

The results in Table 4 show a host-country conflict to have negative growth effects on primary neighbours of between 1.2 to 2.0 percentage points across the specifications. Interestingly, the coefficients for primary neighbours are

[9]The difference between the reported regressions and regressions with a lower R-squared was negligible, with all variables of the same sign and significance. Moreover, the R-squared between the different regressions do not vary by more than 0.02. Of the different contiguity matrices, border lengths for primary neighbours and minimum distance for secondary neighbours provided the best fit.

only marginally smaller when multi-dimensional spillover effects are added. This may be indicative of a small 'bounce back' effect primary neighbours experience from its neighbours (e.g. a host nations secondary neighbour).

Table 4: Spillover Effects of Conflict with Geographical Contiguity Matrices

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict:	Conflict		Intense		Civil	
Weight:						
Pri	Border	Border	Border	Border	Border	Border
Sec		Dist		Dist		Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.015**	-0.014**	-0.023**	-0.023**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.013*	-0.012†	-0.020**	-0.019*	-0.016*	-0.015*
	(0.007)	(0.007)	(0.009)	(0.009)	(0.007)	(0.007)
$W_{sec}Conf_{sec}$		-0.008		-0.010		-0.017†
		(0.009)		(0.013)		(0.010)
Constant	-1.882**	-1.874**	-1.827**	-1.789**	-1.951**	-1.994**
	(0.538)	(0.538)	(0.540)	(0.542)	(0.539)	(0.539)
Observations	1765	1765	1765	1765	1765	1765
R-Squared	0.104	0.104	0.104	0.104	0.102	0.104

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Interpreting the coefficients for neighbours is slightly different to that of the host nation, as the coefficients are measuring a neighbourhood effect, which takes into account that each country has several neighbours. This means dividing the coefficients of $W_{pri}Conf_{pri}$ by the average number of primary neighbours. A host nation has on average 4.25 primary neighbours, translating to a per country influence of 0.235 ($\frac{1}{4.25}$), which implies that a

host country conflict (column 2) will on average reduce a primary neighbour's growth by 0.28 (0.235*-0.012*100 = -0.28) percentage points. Depending on the types of conflict, this negative effect varies from 0.45 percentage points for intense conflicts to 0.35 for civil wars. The spillover effect from a conflict to primary neighbours is calculated to be roughly 20%((0.28/1.4)*100) of the host country effect, with intense and civil wars approximately 20 and 29% of the host country effect, respectively. These results are in line with Murdoch and Sandler's but differ from de Groot (2010) in finding no positive spillover effect on secondary neighbours.

Reweighting the geographic distance contiguity matrices to capture economic and political distances and re-estimating gave the results in Table 5. Specifications 1, 3 and 5 provide a measure of democratic distance (a 21 point democratic variable), while specifications 2, 4 and 6 use a measure of economic distance (average bilateral trade). The results for conflict affected countries are identical to those in Table 3 and 4, with coefficients ranging between 1.2 and 2.3 percentage points across the specifications. Again, there seems to be no significant spillover effect of conflict on secondary neighbours. The coefficients for primary neighbour conflict, weighted first with democratic distance (columns 1, 3 and 5) and second with bilateral trade (columns 1, 3 and 5), are negative and significant, but smaller than the non-reweighted matrix results in Table 4. On average, the difference in coefficient sizes varies from the marginally lower 8% for all conflicts to 16% for intense conflicts.[10] This is an interesting result, suggesting that studies which only use geographical distance alone could be overestimating the negative spillover effects of conflict.

[10]This dissimilarity is calculated by taking the difference of the coefficients in Table 4 and 5, and divided by the coefficient in Table 4 (e.g. $(0.13 - 0.12)/0.13 = 0.077$).

Table 5: Spillover Effects of Conflict with Political, Economic and Geographical Contiguity Matrices

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict:	Conflict		Intense		Civil	
Weight:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.015**	0.014**	-0.023**	-0.023**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.012*	-0.010*	-0.016*	-0.010†	-0.013*	-0.012*
	(0.006)	(0.005)	(0.008)	(0.006)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.005	-0.008	-0.017	-0.003	-0.014	-0.001
	(0.009)	(0.006)	(0.012)	(0.009)	(0.009)	(0.006)
Constant	-1.867**	-1.846**	-1.781**	-1.872**	-2.015**	-1.928**
	(0.538)	(0.538)	(0.541)	(0.540)	(0.539)	(0.539)
Observations	1765	1765	1765	1765	1765	1765
R-Squared	0.104	0.105	0.105	0.103	0.103	0.104

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Using these political and economic distance measure means that the weights are reallocated in such a way that countries that may be close geographically are now 'further away' and vice versa. To get a better idea of what this means, consider the case of Mali in 2007, which has seven primary neighbours, two of which were involved in conflicts (e.g. the Algerian and Niger civil wars). Using only the geographic distance weighting, conflicts in Mali's primary neighbours is estimated to have a negative spillover effect on economic growth of 0.36 percentage points. By adjusting the contiguity matrix to allow for political and economic similarities with neighbours, the spillover

effect is reduced to 0.31 and 0.26 percentage points respectively, while a combination of the trade and polity weights would lower it to 0.28 percentage points. Estimates for the combined effect can be found in Table 9 in the appendix. This negative effect is expected to be between the weighted trade and polity coefficients since the combined effect is a normalised weight of the two separate matrices.

Computing spillovers using only border distance, the weight of Algeria and Niger on Mali is 0.19 and 0.11 respectively, this combines to give a weight of 0.30, which translates to a conflict spillover of -0.36 (0.30*-0.012*100 = -0.36) percentage points, where the -0.012 is the coefficient of $W_{pri}Conf_{pri}$ from Column 2, Table 4. Similar exercises can be done for the polity, trade and a combination of polity and trade weights. For example, the polity spillover weight of Algeria and Niger on Mali is 0.22 and 0.04 respectively, giving a total weight of 0.26. This translates to a conflict spillover effect on growth of -0.31 percentage points.

The main source of the spillover reduction when moving beyond the geographical distance measure is Niger, 0.04 using the polity weight, compared to 0.11 when using geographical weights. Although, sharing a reasonably sized border with Mali (11 percent of Mali's total border distance), relative to other primary neighbours, it is very different politically and trade between the two countries is tiny. While it **is** also possible that introducing the political and economic distance measure could increase spillover estimates, it would appear that for these African countries the estimated spillover effects of conflict are reduced.

To evaluate the robustness of the results, the regressions were rerun using different datasets, removing outliers, replacing the dynamic panel approach with Murdoch and Sandler (2002) and de Groot's (2010) estimation method and substituting the conflict indicator with conflict duration. Using different datasets for population growth, investment, per capita GDP and education did not change the significance or sign of the results, while the main estimation results were unchanged when country outliers such as Botswana, Lesotho and Sudan are removed. As Table 10 in the appendix shows, chang-

ing the estimation method led to a slight decrease in the significance of primary neighbour spillovers, but the estimate remains statistically significant and negative. In terms of spillover effects onto secondary neighbours, the estimation result remains negative and insignificant. Finally, replacing the conflict indicator variables with conflict duration led to changes in the results, (see Table 11 in appendix) decreasing the significance of neighbour country spillover effects to the point where a host-country conflict has no regional spillover effects. As in other studies, a conflict duration variable was outperformed by the conflict dummy variable for all specifications suggesting that it is the mere presence and not the duration of conflict that matters.

6 Conclusion

Conflict can be a major barrier to development and yet despite a large literature on the determinants of conflict, there has been relatively little empirical analysis of its economic effects and an even smaller literature dealing with the spillover effects it can have on neighbours. This paper has added to the limited literature by providing an analysis of the spillover effects of conflict using a balanced panel of 36 African countries for the period 1960 to 2010. It provides results that show consistency with previous studies, in finding a negative effect of conflict on the host economy and negative effects of spillovers on neighbours. Using weighted matrices for the conflict variable based on distance measures and distinguishing primary and secondary neighbours, suggested that primary neighbours are affected by conflict, but not secondary neighbours, a result consistent with Murdoch and Sandler (2002a, b; 2004), but differing from de Groot (2010).

Recognising that when considering how close neighbours are geographic distance may not be the only relevant factor, measures of distance that incorporate political and economic factors were introduced into the weighting matrices that were used to determine 'distance'. The result of this was to decrease the estimated negative spillover effects of conflict by a consider-

able amount and this result seemed robust to data and specification changes. This does not change the finding that conflict can be devastating to both the countries engaged in the conflict and their neighbours, but suggests that care is needed to judge the effects of conflict on neighbours, as only looking at distance is not enough.

Finding results of significant primary country spillovers that are consistent with those of Murdoch and Sandler (2002a,b) provides further and updated support for their assertion that aid providers need to consider supporting entire conflict regions and not just conflict burdened countries. The results also suggest that assistance should be focused on host and close neighbours, with less emphasis on secondary neighbours or conflict duration and that the definition of close should be determined by more than just geographical distance, but also political and economic distance. Finally, aid is potentially necessary in all conflicts and not, as de Groot (2010) suggests, simply in the case of most violent forms.

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Appendix

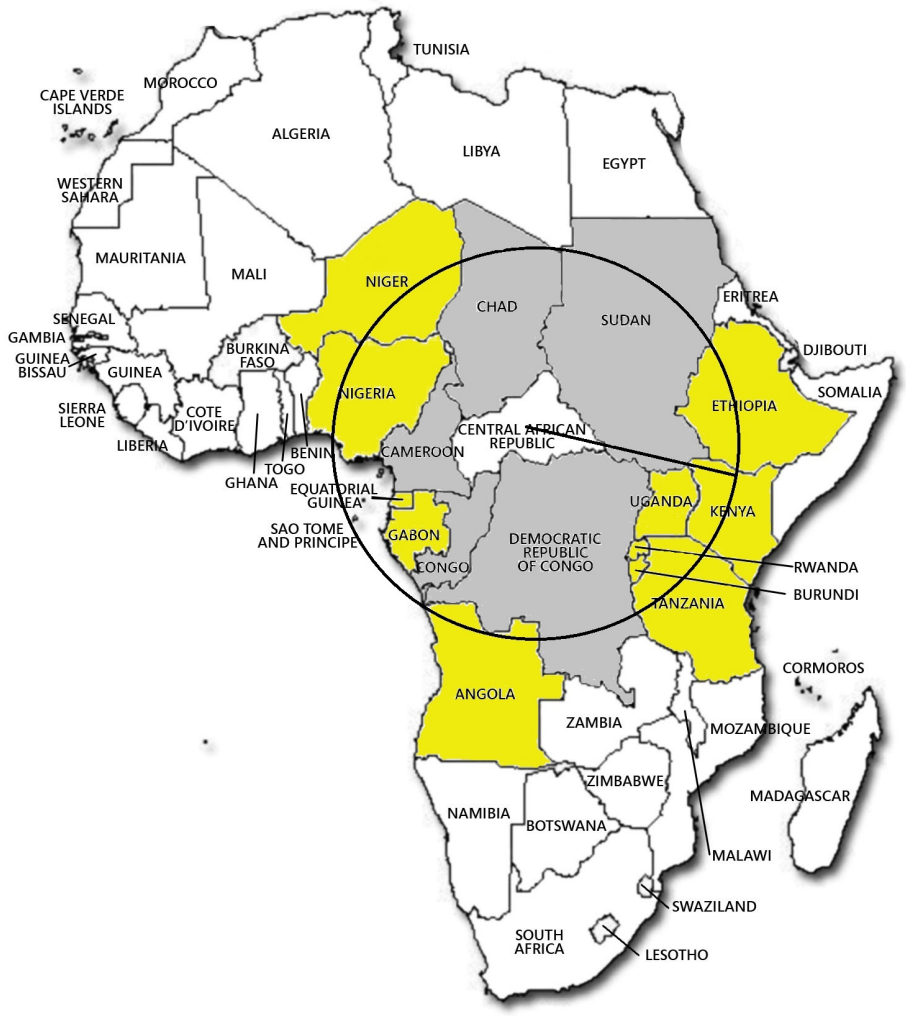

Figure 1: Map of Africa: An Example on the Choice of Primary and Secondary Neighbours

Table 6: Growth Effects of Conflict using Returns to Human Capital (Penn World Tables 8.0

	(1)	(2)	(3)	(4)
Conflict Type		Conflict	Intense	Civil
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\Delta \ln(inv)$	0.036**	0.036**	0.036**	0.036**
	(0.006)	(0.006)	(0.005)	(0.006)
$\Delta \ln(edu)$	-0.073**	-0.069*	-0.067*	-0.070**
	(0.027)	(0.027)	(0.027)	(0.027)
$\ln(n+g+\delta)$	0.092**	0.089**	0.090**	0.093**
	(0.012)	(0.012)	(0.012)	(0.012)
$\ln(y0)$	-0.024**	-0.026**	-0.026**	-0.025**
	(0.005)	(0.005)	(0.005)	(0.005)
$\ln(inv_{t-1})$	0.018**	0.018**	0.018**	0.018**
	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu_{t-1})$	-0.023**	-0.021**	-0.022**	-0.022**
	(0.004)	(0.004)	(0.004)	(0.005)
Conflict		-0.015**	-0.024**	-0.012*
		(0.005)	(0.007)	(0.005)
Year	0.001**	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.989**	-1.922**	-1.968**	-1.967**
	(0.540)	(0.538)	(0.538)	(0.539)
Observation	1765	1765	1765	1765
R-squared	0.096	0.102	0.101	0.100

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table 7: Spillover Effects of Conflict with Geographical Contiguity Matrices - Full Model

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict:	Conflict		Intense		Civil	
Weight:						
Pri	Border	Border	Border	Border	Border	Border
Sec		Dist		Dist		Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\Delta \ln(inv)$	0.037**	0.037**	0.035**	0.035**	0.037**	0.037**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$\Delta \ln(edu)$	-0.083**	-0.083**	-0.083**	-0.080*	-0.084**	-0.083**
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
$\ln(n+g+\delta)$	0.093**	0.093**	0.095**	0.096**	0.096**	0.096**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
$\ln(y0)$	-0.026**	-0.027**	-0.025**	-0.025**	-0.026**	-0.026**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$\ln(inv_{t-1})$	0.019**	0.019**	0.018**	0.018**	0.019**	0.019**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu_{t-1})$	-0.021**	-0.021**	-0.021**	-0.021**	-0.022**	-0.022**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Conflict	-0.015**	-0.014**	-0.023**	-0.023**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.013*	-0.012†	-0.020**	-0.019*	-0.016*	-0.015*
	(0.007)	(0.007)	(0.009)	(0.009)	(0.007)	(0.007)
$W_{sec}Conf_{sec}$		-0.008		-0.010		-0.017†
		(0.009)		(0.013)		(0.010)
Constant	-1.882**	-1.874**	-1.827**	-1.789**	-1.951**	-1.994**
	(0.538)	(0.538)	(0.540)	(0.542)	(0.539)	(0.539)
Observations	1765	1765	1765	1765	1765	1765
R-Squared	0.104	0.104	0.104	0.104	0.102	0.104

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table 8: Spillover Effects of Conflict with Political, Economic and Geographical Contiguity Matrices - Full Model

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict:	Conflict		Intense		Civil	
Weight:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\Delta \ln(inv)$	0.037**	0.037**	0.035**	0.035**	0.036**	0.037**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$\Delta \ln(edu)$	-0.083**	-0.081**	-0.080*	-0.081**	-0.084**	-0.080*
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
$\ln(n+g+\delta)$	0.093**	0.093**	0.096**	0.093**	0.095**	0.097**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
$\ln(y0)$	-0.027**	-0.026**	-0.025**	-0.025**	-0.026**	-0.025**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$\ln(inv_{t-1})$	0.019**	0.019**	0.018**	0.018**	0.019**	0.019**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu_{t-1})$	-0.021**	-0.021**	-0.021**	0.022**	-0.022**	-0.022**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Conflict	-0.015**	0.014**	-0.023**	-0.023**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.012*	-0.010*	-0.016*	-0.010†	-0.013*	-0.012*
	(0.006)	(0.005)	(0.008)	(0.006)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.005	-0.008	-0.017	-0.003	-0.014	-0.001
	(0.009)	(0.006)	(0.012)	(0.009)	(0.009)	(0.006)
Constant	-1.867**	-1.846**	-1.781**	-1.872**	-2.015**	-1.928**
	(0.538)	(0.538)	(0.541)	(0.540)	(0.539)	(0.539)
Observations	1765	1765	1765	1765	1765	1765
R-Squared	0.104	0.105	0.105	0.103	0.103	0.104

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table 9: Spillover Effects of Conflict with Combined Political and Economic Contiguity Matrices

	(1)	(2)	(3)
Conflict:	Conflict	Intense	Civil
Weight:	Polity + Trade	Polity + Trade	Polity + Trade
Pri	Border	Border	Border
Sec	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.014**	0.022**	-0.012**
	(0.005)	(0.007)	(0.005)
$W_{pri}Conf_{pri}$	-0.010*	-0.014*	-0.013**
	(0.005)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.007	-0.006	-0.010
	(0.006)	(0.009)	(0.006)
Constant	-1.838**	-1.851**	-2.045**
	(0.538)	(0.540)	(0.540)
Observations	1765	1765	1765
R-Squared	0.105	0.104	0.104

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** $p<0.01$,* $p<0.05$,† $p<0.1$

Table 10: Spillover Effects of Conflict Following Murdoch and Sandler (2002) and de Groot (2010)'s Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict Type:	Conflict		Intense		Civil	
Weight Type:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
$\ln(invest)$	0.022**	0.022**	0.020**	-0.020**	0.021**	0.022**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\ln(edu)$	-0.020**	-0.021**	-0.020**	-0.021**	-0.021**	-0.021**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$\ln(n+g+\delta)$	0.089**	0.090**	0.092**	0.089**	0.092**	0.093**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
$\ln(y0)$	-0.030**	-0.030**	-0.029**	-0.028**	-0.029**	-0.028**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Conflict	-0.015**	-0.015**	-0.023**	-0.024**	-0.012*	-0.012*
	(0.007)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.013*	-0.011*	-0.016*	-0.011†	-0.014*	-0.013**
	(0.006)	(0.005)	(0.008)	(0.006)	(0.006)	(0.005)
$W_{sec}Conf_{sec}$	-0.005	-0.009	-0.020	-0.005	-0.014	-0.011†
	(0.009)	(0.006)	(0.012)	(0.009)	(0.009)	(0.006)
Constant	-1.866**	-1.842**	-1.765**	-1.857**	-2.018**	-1.926**
	(0.536)	(0.535)	(0.538)	(0.538)	(0.537)	(0.536)
Observations	1768	1768	1768	1768	1768	1768
R-squared	0.097	0.098	0.098	0.095	0.096	0.097

Notes: Dependent variable: $\Delta \ln y$; Variable y_0 represents lagged dependent variable (e.g. $ln(61) - ln(60)$) and is interpreted as initial income; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table 11: Spillover Effects of Conflict using Conflict Duration, with Polity and Trade Contiguity Weights

	(1)	(2)	(3)	(4)	(5)	(6)
Conflict Type:	Conflict		Intense		Civil	
Weight Type:	Polity	Trade	Polity	Trade	Polity	Trade
Pri	Border	Border	Border	Border	Border	Border
Sec	Dist	Dist	Dist	Dist	Dist	Dist
Variables	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$	$\Delta \ln y$
Conflict	-0.015**	-0.015**	-0.023**	-0.024**	-0.012*	-0.012*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
$W_{pri}Conf_{pri}$	-0.004	-0.009*	-0.004	-0.002	-0.001	-0.004
	(0.004)	(0.004)	(0.013)	(0.012)	(0.007)	(0.006)
$W_{sec}Conf_{sec}$	-0.005	-0.002	-0.009	-0.003	-0.001	-0.003
	(0.009)	(0.006)	(0.021)	(0.022)	(0.001)	(0.007)
Constant	-1.829**	-1.748**	-1.899**	-1.915**	-1.937**	-1.891**
	(0.541)	(0.542)	(0.540)	(0.540)	(0.539)	(0.541)
Observations	1765	1765	1765	1765	1765	1765
R-squared	0.103	0.104	0.102	0.101	0.099	0.099

Notes: Dependent variable: $\Delta \ln y$; All regressions include time trend variable; Clustered standard errors in parentheses; Significance levels:** p<0.01,* p<0.05,† p<0.1

Table 12: List of Countries and Conflict Years

Country	Years in Conflict	Years in Civil War
Algeria	23	17
Benin	0	0
Botswana	0	0
Burundi	17	17
Cameroon	4	2
Central African Republic	4	3
Congo DR	17	10
Congo Republic	5	1
Cote d'Ivoire	3	3
Egypt	10	6
Gabon	1	0
Gambia	1	0
Ghana	3	3
Kenya	1	1
Lesotho	1	1
Liberia	7	7
Malawi	0	0
Mali	6	5
Mauritania	5	4
Mauritius	0	0
Morocco	17	15
Mozambique	27	10
Namibia	0	0
Niger	6	8
Rwanda	14	11
Senegal	9	9
Sierre Leone	11	0
South Africa	23	23
Sudan	39	38
Swaziland	0	0
Tanzania	1	0
Togo	1	1
Tunisia	2	1
Uganda	35	27
Zambia	0	0
Zimbabwe	9	8