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Essays on the Empirical Analysis of Economic and Political Development in Sub-Saharan Africa

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ABSTRACT

In Sub-Saharan Africa, non-democratic events, like civil wars and coup d'etat, destroy economic development. This study investigates both domestic and spatial effects on the likelihood of civil wars and coup d'etat. To civil wars, an increase of income growth is one of common research conclusions to stop wars. This study adds a concern on ethnic fractionalization. IV-2SLS is applied to overcome causality problem. The findings document that income growth is significant to reduce number and degree of violence in high ethnic fractionalized countries, otherwise they are trade-off. Income growth reduces amount of wars, but increases its violent level, in the countries with few large ethnic groups. Promoting growth should consider ethnic composition. This study also investigates the clustering and contagion of civil wars using spatial panel data models. Onset, incidence and end of civil conflicts spread across the network of neighboring countries while peace, the end of conflicts, diffuse only with the nearest neighbor. There is an evidence of indirect links from neighboring income growth, without too much inequality, to reduce the likelihood of civil wars. To coup d'etat, this study revisits its diffusion for both all types of coups and only successful ones. The results find an existence of both domestic and spatial determinants in different periods. Domestic income growth plays major role to reduce the likelihood of coup before cold war ends, while spatial effects do negative afterward. Results on probability to succeed coup are similar. After cold war ends, international organisations seriously promote democracy with pressure against coup d'etat, and it seems to be effective. In sum, this study indicates the role of domestic ethnic fractionalization and the spread of neighboring effects to the likelihood of non-democratic events in a country. Policy implementation should concern these factors.

Keywords: Instrumental Variables; Civil War; Civil Violence; Economic Growth; Ethnic Fractionalization; Africa; Geography; Cluster; Diffusion; Spatial Analysis; Contagion Process; Rainfall; Conflict; Coup; Commodity Prices; Spatial Econometrics

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First Paper

Civil Wars, Civil Violence and Ethnic Fractionalization

Civil Wars, Civil Violence and Ethnic Fractionalization

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Abstract In Sub-Saharan Africa, civil wars, also civil violence, destroy economic development. An increase of income growth is one of common research conclusions to stop wars and reduce violence. However, literature did not rely much on the effect of ethnic fractionalization. This paper includes interaction of ethnic fractionalization index. An IV-2SLS estimation is applied to overcome causality problem. The findings document that income growth is significant to reduce both number and degree of violence in high ethnic fractionalized countries, while there is a trade-off among them in the low ones. It shows that income growth reduces amount of wars, but increases its violent level, in the countries with few large ethnic groups. The policy implication to promote growth should consider ethnic composition as well.

Keywords: Instrumental Variables; Civil War; Civil Violence; Economic Growth; Ethnic Fractionalization

JEL Classification Numbers: C26; D74; H56.

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1 Introduction

Civil wars are the most common type of armed conflicts during the past half-century accounting for large human and economic disruption. Since 1960s about twenty percents of countries have experienced at least ten years of civil wars. The plague of violent civil strives is particularly cumbersome for Sub-Saharan Africa where more than a third of the countries experienced at least a civil war during even during the past twenty years.

The causes of civil wars have focused on ethnic divisions, fragile institutions, and economic conditions (World Bank, 2003), but the precise answers remain difficult and are still debated. One of the common answers is that civil wars are partly caused by income growth (United Nations Economic Commission for Africa, 1999; World Bank, 2003), empirically countries with a bad growth record in the region have had more civil wars. However, this does not prove that civil wars are started by worsening economic conditions because civil wars and poor economic growth might be caused by the same factors (Acemoglu, 2005).

In the past, many empirical studies estimated the likelihood of civil wars on income growth in a one-way relationship equation (Collier and Hoeffler, 1998, 2004; Sambanis, 2002; Fearon and Laitin, 2003; Hegre and Sambanis, 2006). They implicitly assumed one of these two variables as an exogenous determinant to each other. The relationship between the likelihood of civil wars and income growth estimated by single equation model produces biased and inconsistent estimators, since they do not take into account the causality problem. Miguel, Satyanath and Sergenti (2004), Ciccone and Brückner (2010) and Brückner and Ciccone (2011) have dealt with this problem by instrumental variable two-stage-least-squared estimation. They used rainfall variation and/or commodity prices growth instrumenting income growth, then estimated the correlation between instrumented growth and the likelihood of civil wars in Sub-saharan Africa. In general, these studies agreeably concluded that an income growth can significantly reduce the likelihood of civil wars.

Beyond income growth, there are some studies pointing out the effects of ethnic fractionalization to the likelihood of civil wars in Sub-Saharan Africa. On the one hand, Easterly and Levine (1997) estimated this correlation with seemingly unrelated regressions. They found that largeness of ethnic fractionalization explains African growth tragedy. On the other hand, Collier and Höeffler (1998) used probit and tobit models of income growth and ethnic fractionalization on the occurrence and duration of civil wars. They still concluded that growth has negative effect to civil wars, but wars is likely happened in the low ethnic fractionalized countries than the higher one. In other words, countries with few large ethnic groups have more chance to be suffered from civil wars than the one with many small groups. Collier and Höeffler (1998)'s conclusion contradicts to Easterly and Levine (1997)'s conclusion. Since there is a debate on the direction of the ethnic fractionalization effect, the existence of heterogeneous growth effects of ethnic fractionalization on the likelihood of civil wars in this region needs to be investigated as a contribution of this paper.

In addition, although the likelihood of civil wars, in term of its amount, has been widely studied in the literature, the degree, in term of number of deaths or level of violence, has not yet been much explored. Most of the literature has focused on whether civil wars happen, not on its degree of violence. The knowledge about the correlation between degree of civil violence, an income growth and ethnic fractionalization is very thin, so it needs to be explored as well.

This paper proposes two contributions to the literature. Firstly, this is the first paper linking the degree of civil violence not only to income growth but to ethnic fractionalization as well. They are estimated with instrumental variable two-stage-least-squared approach to overcome inconsistence and biasedness of causality problem between the degree of civil violence and income growth. The result is shown in a systematic and comparable view with the likelihood of civil wars, which has already studied widely in the literature.

Secondly, the findings point out heterogenous growth effects of ethnic fractionalization on both the likelihood of civil wars and the degree of civil violence. An increase of income growth always reduces the likelihood of civil wars going in line with literature. However, the results show heterogeneous effects. The ability of an increase of income growth to reduce the likelihood of civil wars is lower in the higher fragmented countries. Moreover, the heterogeneous growth effects on the degree of civil violence are higher than the likelihood of civil wars. An increase of income growth pushes up the degree of civil violence in the few large ethnic groups countries, while it pulls down in the many small ethnic groups countries. In other words, an increase of income growth can benefit to civil violence only in the many small ethnic group countries, not for all types of ethnic composited countries.

Next section presents data and measurement Then, Section 3 discusses the method of estimation. Section 4 provides results. Concluding remarks are proposed in Section 5.

2 Data and Measurement

The period of study ranges from 1981 to 2003. Most of Sub-saharan African countries were independent and majority ruled before 1980, then the year 1981 kicked off the second democratization wave in Africa. This paper covers 39 countries in Sub-saharan Africa.[1]

Civil War: Data on civil war is obtained from the UCDP/PRIO Armed Conflicts Dataset of the International Peace Research Institutes (PRIO) Centre for the Study of Civil War and the Uppsala Conflict Data Program (UCDP).[2] The UCDP/PRIO Armed Conflict Database defines civil war as a "contested incompatibility which 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 1000 battle deaths per year".[3] This data represents the number of civil wars by one if exceed 999 deaths and zero otherwise.

Civil Violence: Data on civil violence, which comes from Marshall (2006), Center for Systemic Peace, defines as total summed magnitudes of all societal Major Episodes of Political Violence.[4] Data is ordered from zero (no episodes) to one (highest) by one-

[1] Only four countries of Sub-saharan Africa which are Zimbabwe, Namibia, Eritrea and South Africa were independent after 1980 at different years, hence most of the studies started their analysis at 1981. There are 43 data-available countries in Sub-saharan Africa. Four omitted countries from this paper are Djibouti, Eritrea, Equatorial Guinea, Lesotho due to the absence of data [McGowan (2003)].

[2] The dataset is available at http://new.prio.no/CSCW-Datasets/Data-on-Armed-Conflict.

[3] The definition of civil wars is exactly the same as civil conflicts. Civil conflicts count 25 to 999 battle-related deaths per year, while civil wars count more than 1,000 deaths.

[4] The dataset is available at http://www.systemicpeace.org/inscr/MEPV2008.xls.

tenths on the number of deaths adjusted by other factors including state capabilities, interactive intensity (means and goals), area and scope of death and destruction, population displacement, and episode duration. So it represents the degree of violence from zero to one.

Income Growth: Data for annual real GDP per capita growth is taken from the Penn World Tables 6.2 for the 1961-2004 period (the data stops in 2004) and from the World Development Indicators (2010).[5]

Rainfall Variation. Data on rainfall variation for the 1981-2003 period comes from the NASA Global Precipitation Climatology Project (GPCP), Version 2. The GPCP rainfall data is based on data from satellites and rain gauges, but alternative rainfall data sets are based on rain gauges only. Although the rainfall data from rain gauges may be more precise than from satellites on average, the gauge coverage in many Sub-Saharan African countries is very sparse and the number of reporting stations could be affected by socio-economic conditions. Only gauge data applied therefore may produce more errors.

International Commodity Prices Growth. Data on international commodity prices growth is obtained from the International Monetary Fund (2009). The original data of 19 commodities is monthly price data, then Brückner and Ciccone (2009) averages across all observations in a calendar year to yield an annual price series for each commodity i, $P_{i,t}$ (the 1990 value is set equal to unity for all commodities). The commodity prices growth rate for country c in this paper is the 3-year average value of the annual commodity prices growth rates between t and $t-2$ to smooth their fluctuations.

Ethnic Fractionalization Index. The variable ethnic fractionalization index is defined as "the probability that two randomly selected individuals from a given country will not belong to the same ethnic group". This index is calculated by $ethfrac = 1 - \Sigma\pi_i^2 = \Sigma\pi_i(1-\pi_i)$ where i is the proportion of people that belong to the ethnic group i and the data of π_i comes from CIA - The World Fact Book. If this variable is close to zero, the country composes of few large ethnic groups. If it is close to one, it composes of many small ethnic groups.

[5] The data is available at http://data.worldbank.org/data-catalog/world-development-indicators.

3 Method of Estimation

Since civil wars and income growth have two-way relationship, this paper employs an instrument-variable two-stage-least-squared approach which is an unbiased estimation technique especially to the recursive relationship. Since this approach requires strong instruments and some specification assumptions, Sub-Saharan Africa, where is based on large agricultural sector and being a world's large commodity exporter, provides the strong and valid instruments; rainfall variation and commodity prices growth. Both instruments reasonably affect growth of the region. Moreover, they have no direct effect on the likelihood of civil wars and also no reverse direction, hence they satisfy assumptions of instrument-variable two-stage-least-squared approach.

The estimation framework consists of two equations. The first-stage equation links per capita income growth, denoted by $growth_{i,t}$, to rainfall variation, denoted by $rain_{i,t}$, and commodity prices growth, denoted by $prices_{i,t}$, controlling for cross country fixed effects, denoted by a_i, specific time trends, denoted by $b_i Year_t$, and year effects that capture common shocks, denoted by T_t,

$$growth_{i,t} = a_i + b_i Year_t + T_t + c\ rain_{i,t} + d\ prices_{i,t} + \varepsilon_{i,t} \tag{1}$$

where $\varepsilon_{i,t}$ is a disturbance term that can be correlated across years t for the country i.

The second-stage equation is the relationship between the instrumented income growth and the likelihood of civil wars, denoted by $war_{i,t}$, controlling for country fixed effects, denoted by α_i, country-specific time trends, denoted by $\beta_i Year_t$, and year effects that capture common shocks, denoted by τ_t,

$$war_{i,t} = \alpha_i + \beta_i Year_t + \tau_t + \gamma\ growth_{i,t} + \epsilon_{i,t} \tag{2}$$

where $war_{i,t}$ can be either the likelihood of civil wars or the degree of civil violence and ϵ is a disturbance term.

Furthermore, the second-stage equation dealing with index of ethnic fractionalization, denoted by $ethfrac_i$, is

$$war_{i,t} = \alpha_c + \beta_c Year_t + \tau_t + \gamma\ growth_{i,t} + \theta\ (ethfrac_i * growth_{i,t}) + \epsilon_{i,t} \tag{3}$$

where θ denotes parameter for the heterogeneous growth effect of ethnic fractionalization on the likelihood of civil wars. Moreover, this paper estimates first stage equations for this case with interactions of independent variables to comply with econometric technique.

4 Results

4.1 Descriptive Statistics

Table 1 presents descriptive statistics of Sub-Saharan Africa during 1981-2003. Along these 23 years, countries in this region have confronted 107 episodes of civil wars. On average, each country has an experience of civil war once in every ten years. This statistics is in line with the degree of civil violence from zero to one divided by one-tenth. The mean of the violence degree is around 0.1 and its range is around 0.2. Large range of deviation points out several degree of violence from the modest to the strongest ones. The correlation between the likelihood of civil wars and the degree of civil violence is at 72 percents indicating consistency between datasets from two sources.

Average income growth of the region is close to zero at -2.2 percentages annually. Its standard deviation has wide range at 8.6 percents or around 4 times of its mean, indicating the various characteristics of countries in Sub-Saharan Africa. This high range of income growth particularly comes from the high range of its determinants; commodity prices growth and rainfall variation. The average value of commodity prices growth is -1.1 percentages, while its standard deviation is around 25 times to its mean. Likewise, average value of rainfall variation is 3.4 percentages, while its standard deviation is almost 7 times. Henceforth, wide ranges of these determinants forward to high variability of income growth of the whole region.

However, wide range of Sub-Saharan African characteristics is not only based on income growth but also based on index of ethnic fractionalization. Mean of ethnic fractionalization index is reported at 0.667, while the minimum and maximum values are 0.036 and 0.925. This statistics indicates that the country composition of this region goes from almost unique-group country to almost scattered-group country.

4.2 First Stage Results

Table 2 shows the estimates of first-stage regression replicating several combinations of independent variables from the literature with the 1981-2003 dataset. Column (1) produces the link between rainfall variation at time t and $t-1$ replicating Miguel et al. (2004). The equation shows the positive statistical significance of contemporaneous and lagged rainfall variation. Ciccone and Brückner (2010) adjusted Miguel et al. (2004)'s first stage equation by adding a variable commodity prices growth. They found as shown in column (2) that all three variables are statistically significant to instrument income growth. However, Brückner and Ciccone (2011) revised their 2009 paper as shown in column (3) by eliminating rainfall variation to one variable commodity prices growth. The significance of this one instrumental variable case is still very strong.

Although these replicated first stage equations are statistically significance with individual hypothetical testing for each independent variables, the overall testing of hypothesis needs to be evaluated. For the two stage least squared model with only one endogenous regressor, a rule of thumb criteria is a first-stage F statistics for weak instruments at least or around 10. The F-statistics and its p-value are reported at the bottom of each column in Table 2. Column (1) and (2) shows the replication of Miguel et al. (2004)'s and Ciccone and Brückner (2010)'s first stage equations with 1981-2003 dataset. They report the value of F statistics 7.39 and 7.47, respectively, pointing out problem of weak instruments. The equation in column (3) replicating Brückner and Ciccone (2011) by one instrumental variable commodity prices growth do not suffer by weak instrument problem, since its value of F statistics is 14.43 exceeding the criteria 10. So Brückner and Ciccone (2011)'s first stage equation is one of baseline models in this paper.

According to column (1)-(3) replicated from the literature, the proper of first stage equation is based on statistical issue rather than economic issue. In Sub-Saharan Africa where is the world's large agricultural exporter, the production of these countries preliminarily depends on rainfall variation. Then rainfalls is a reasonably significant determinant of income growth. This paper produces another combination of rainfall variation and commodity prices growth as shown in column (4). Both instrument variables are statistically significant and the overall equation does not have weak instrument problem with F statistics close to 10 which can be acceptable.

In sum, this paper uses two packages of instrument variables to estimate first stage equations passing through the second stage ones. The first package is taken from Brückner and Ciccone (2011) with only one variable commodity prices growth, while the second one includes an additional variable rainfall variation.

Furthermore, the estimation including the interactions of income growth and ethnic fractionalization index needs another overall test of weak instruments problem. It is a case of more than one endogenous regressors. The criteria becomes Shea Partial R-squared. However, the formal critical value of Shea Partial R-squared has not yet academically concluded, most of the econometric papers accept this value at 0.05. These values are reported at the bottom of each column in Table 4.

4.3 Second Stage Results

Table 3 reports second stage results as baseline results. The relationship between the likelihood of civil wars and its determinants are reported in column (1)-(6), while the relationship between the degree of civil violence and its determinants are reported in column (7)-(12). The first three columns of each relationship are estimated by Brückner and Ciccone (2011)'s first stage equation, and the last three columns are done by the first stage equation proposed by this paper. Moreover, each of the three columns of first stage equation are controlled by country fixed effects, specific time trends and common time dummies for unobservable factors, additionally.

Column (1)-(3) present OLS results linking the likelihood of civil wars with income growth. An increase of income growth is statistically significant to reduce the likelihood of civil wars around 30-35 percentage points. Brückner and Ciccone (2011)'s first stage equations are employed for 2SLS estimates. The relationship of the likelihood of civil wars and income growth are still statistically significant but their values of coefficients are much higher, in absolute term, than the OLS estimation.

The estimates of this paper's first stage equations linking the likelihood of civil wars and income growth are presented in column (4)-(6). The results are strongly significant as same as the Brückner and Ciccone (2011)'s replication. These results are also tested against over-identification problem as reported at the bottom of each column indicating that they do not have this problem. In sum, income growth reduces the likelihood of civil wars as expected.

The OLS estimates of income growth on the degree of civil violence are presented in column (7)-(9). They show that an income growth decreases the degree of civil violence around 10 percentage points. After that, the 2SLS estimates based on Brückner and Ciccone (2011)'s first stage equations show the opposite sign. They point out that an income growth increases the degree of civil violence, even if they are not statistically significant. Likewise, results based on this paper's first stage equations confirm positive relationship of the degree of civil violence and income growth. They confirm the positive relationship as same as Brückner and Ciccone (2011)'s equation without any statistical significance and overid problem. In short, after the correction of biasedness from two-way relationship, an income growth seems to increase rather than decrease the degree of civil violence.

4.4 Results on Heterogenous Growth Effects of Ethnic Fractionalization

Table 4 reports results of heterogenous growth effects of ethnic fractionalization index on the likelihood of civil wars. The links of civil wars to income growth and its interaction with ethnic fractionalization index are reported in column (1)-(8), while the one of the degree of civil violence and its determinants are reported in column (9)-(16). The first four columns of each relationship are estimated by Brückner and Ciccone (2011)'s first stage equation, and the last four columns are by this paper's first stage equation.

The 2SLS result of one regressor from income growth to the likelihood of civil wars by Brückner and Ciccone (2011)'s first stage equation is shown in column (1). It indicates that an increase of income growth reduces the likelihood of civil wars . The heterogenous growth effects of ethnic fractionalization index on the likelihood of civil wars by Brückner and Ciccone (2011)'s first stage equation are presented in column (2)-(4). They show the negative coefficients of stand-alone income growth and positive coefficients of its interaction with ethnic fractionalization index. It points out that income growth decreases the likelihood of civil wars by itself while the interactions indicates that there is a reverse effect in high ethnic fractionalized countries. These positive effects of the interactions are not statistically significant. However, the less values of interaction coefficients than the values of income growth coefficients indicate that income growth always reduce the likelihood of civil wars no matter what ethnic composition is.

Column (5) shows result from this paper's first stage equation pointing out negative effects of income growth on the likelihood of civil wars . The interaction effects of income growth and ethnic fractionalization index on the likelihood of civil wars are reported in column (6)-(8). The results are almost in line with the ones with Brückner and Ciccone (2011)'s first stage equation showing the negative coefficients of stand-alone income growth and positive coefficients of its interaction. However, these results show statistical significance of interaction variables confirming heterogenous growth effects of ethnic fractionalization index. As Brückner and Ciccone (2011)'s first stage equation, the less values of interaction coefficients than the values of income growth coefficients indicating that income growth always reduce the likelihood of civil wars . The over-identification tests at the end of each column show no problem.

The link of the degree of civil violence to income growth without an interaction is reported in column (9). It shows that an income growth increases the degree of civil violence with no statistical significance. After adding the interaction with ethnic fractionalization index in column (10)-(12), the coefficients of income growth are positive and the coefficients of interactions are negative. An income growth increases the degree of civil violence by itself, while the effect of ethnic fractionalization decreases it. Due to less value of stand alone coefficients than their interactions, an increase of income growth reduces the degree of civil violence in the low ethnic fractionalized countries while it increases in the high ethnic fractionalized countries.

Column (13) shows the relationship between the degree of civil violence and income growth by this paper's first stage equation. The result points out positively statistical insignificance. After adding interactions, the results turn to be statistical significance and are in line with the case of Brückner and Ciccone (2011)'s first stage equation showing the coefficients of income growth are positive and the coefficients of interactions are negative. It indicates that an increase of income growth reduces the degree of civil violence in the low ethnic fractionalized countries while it increases in the high ethnic fractionalized countries. There is no over-identification problem.

The interpretation of these results can be probably based on market competition model. The market with few large producers may be more competitive than many small producers to be market leader. As in the political market, when economy grows, few large ethnic groups probably are more powerful and higher potential to compete for occupying government power than many small ethnic groups. Many small groups own too less resources and difficult to cooperate to clash with their big government. This is partly because the inefficient income distribution mechanisms in this region because excess benefit can be taken by the one who controls government power.

5 Concluding Remarks

The intuition of this paper is based on the question whether an increase of income growth affects the likelihood of civil wars different in ethnic fractionalization. This paper defines two dimensions of civil wars; its number and violent degree. The method of estimation is instrument-variable two-stage-least-squared technique to overcome causality problem. The commodity prices growth and rainfall variation are employed as instruments in the first stage with strongly statistical significance. Also the statistics reports that they have no over-identification problem.

Results coincide with literature that income growth always reduces the likelihood of civil wars. However, countries with few large ethnic groups get more reduction than countries with many small groups when income grows. This result is partly opposite to the result of the degree of civil violence. An income growth increases the degree of civil violence in the few large ethnic groups countries, while it decreases the degree in the many small ethnic groups ones.

In general, an increase of income growth reduces both the likelihood of civil wars and the degree of civil violence in the many small ethnic groups countries. So income growth is good in reduction of civil wars in both dimensions. In few large ethnic groups countries, an increase of income growth reduces the likelihood of civil wars and but increases the degree of civil violence. It is therefore like a trade-off between number and violent level of civil wars in these countries.

The policy implication from this paper points out that growth promotion may not always be beneficial to every country with civil wars. If the occurrence of civil wars is counted in number, income growth advancement seems to be advantageous. But in the few large ethnic groups countries, income growth creates more incentive to the other ethnic groups out of government power to grasp this power which they are high potential to defeat. The degree of violence would be higher, then countries would be more suffered from higher degree of violence even less amount of wars. Hence, effective policy to promote income growth for reducing civil wars needs to concern ethnic fractionalization.

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Table 1: Descriptive Statistics

	Obs	Mean	SD
Occurrence of Civil War (from UCDP/PRIO)	859	0.1246	0.3304
Degree of Civil Violence (from Center for Systemic Peace)	836	0.1026	0.1954
Per Capita Income Growth	859	-0.0218	0.0862
Rainfall Variation	859	0.0341	0.2374
International Commodity Prices Growth	859	-0.0110	0.2802
Ethnic Fractionalization	859	0.6666	0.2299

Table 2: First Stage Equations

	Income Growth			
	Miguel et al. (2004)	Ciccone and Brückner (2010)	Brückner and Ciccone (2011)	New Combination
	(1)	(2)	(3)	(4)
Rainfall Variation	0.053***	0.049***		0.036**
	(0.015)	(0.016)		(0.014)
Lagged Rainfall Variation	0.038***	0.035**		
	(0.013)	(0.015)		
Commodity Prices Growth		0.039***	0.038***	0.039***
		(0.01)	(0.01)	(0.01)
F-statistics (Instrument = 0)	7.39	7.47	14.43	9.88
p-value	(0.0019)	(0.0005)	(0.0005)	(0.0004)
R-squared	0.0807	0.1321	0.1199	0.1272
Cross Country Fixed Effects	Y	Y	Y	Y
Specific Time Trends	Y	Y	Y	Y
Common Time Dummies	N	Y	Y	Y

Note: The method of estimation of the first stage equations is least squares. Huber robust standard errors (in parentheses) are clustered at the country level. The models were replicated from the literature of instrumental variable approach from income growth to the likelihood of civil wars in Sub-Saharan Africa; Miguel et al. (2004), Ciccone and Brückner (2010) and Brückner and Ciccone (2011), respectively from column (1)-(3), with the dataset 1981-2003. Also this paper provides new combination of independent variables from the literature in column (4). Commodity Prices Growth is the commodity price growth rate between t and t-3, using international commodity price data from IMF. F statistics and its p value are reported to test against all instruments are controlled. Cross country fixed effects, specific time trends and common time dummies are controlled as indicated at the bottom of each column. *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

Table 3: Baseline Equations

	Occurrence of Civil Wars						Degree of Civil Violence					
	Brückner and Ciccone (2009)'s IV			New Combination's IV			Brückner and Ciccone (2009)'s IV			New Combination's IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS Estimates											
Income Growth	-0.349***	-0.334***	-0.306***	-0.349***	-0.334***	-0.306***	-0.119**	-0.103*	-0.090*	-0.119**	-0.103*	-0.090*
	(0.105)	(0.102)	(0.096)	(0.105)	(0.102)	(0.096)	(0.058)	(0.057)	(0.051)	(0.058)	(0.057)	(0.051)
R-squared	0.3777	0.4485	0.4799	0.3777	0.4485	0.4799	0.5305	0.6137	0.619	0.5305	0.6137	0.619
	Reduced Form Estimates											
Commodity Prices Growth	-0.096***	-0.103***	-0.092**	-0.096***	-0.103***	-0.091**	0.018	0.016	0.019	0.019	0.016	0.019
	(0.035)	(0.036)	(0.036)	(0.035)	(0.036)	(0.036)	(0.021)	(0.022)	(0.026)	(0.021)	(0.022)	(0.026)
Rainfall Variation				-0.035*	-0.024	0.017				-0.009	-0.001	0.007
				(0.019)	(0.019)	(0.018)				(0.013)	(0.014)	(0.015)
R-squared	0.3764	0.4487	0.4782	0.377	0.449	0.4783	0.5286	0.6123	0.6181	0.5287	0.6123	0.6182
	2SLS Estimates											
Income Growth	-2.308**	-2.441**	-2.368**	-1.706***	-1.687***	-1.200**	0.454	0.386	0.508	0.171	0.212	0.377
	(0.950)	(0.978)	(1.056)	(0.619)	(0.639)	(0.607)	(0.482)	(0.495)	(0.657)	(0.323)	(0.332)	(0.424)
Overid				1.2905	2.19828	3.4288				1.12534	0.52361	0.142054
p-value				(0.256)	(0.138)	(0.064)				(0.289)	(0.469)	(0.706)
	First Stage Estimates Income Growth											
Commodity Prices Growth	0.041***	0.042***	0.038***	0.041***	0.042***	0.039***	0.041***	0.042***	0.039***	0.041***	0.042***	0.038***
	(0.009)	(0.009)	(0.010)	(0.009)	0.010	0.010	(0.009)	(0.010)	(0.010)	(0.009)	0.010	(0.010)
Rainfall Variation				.041***	0.041***	0.036**				0.042***	0.042***	0.036***
				(0.013)	0.014	(0.014)				(0.013)	(0.014)	(0.014)
First Stage F-statistics	27.97	17467.08	67.46	19.49	98.12	106.81	13.1	17434.45	252.36	9.17	96.59	103.3
F-statistics (Instrument = 0)	18.5076	17.7785	14.4318	11.3583	10.4865	9.88	17.8702	10.2654	13.5246	11.0997	10.2654	9.446
Country Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Specific Time Trends	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
Common Time Dummies	N	N	Y	N	N	Y	N	N	Y	N	N	Y

Note: The method of estimation of the first stage equations is least squares. Huber robust standard errors (in parentheses) are clustered at the country level. The models were replicated from the literature of instrumental variable approach of Brückner and Ciccone (2011) in column (1)-(3) and (7)-(9), with the dataset 1981-2003. Also this paper provides new combination of instrument variables from the literature in column (4)-(6) and (10)-(12). Commodity Prices Growth is the commodity price growth rate between t and t-3, using international commodity price data from IMF. F statistics and its p value are reported to test against all instruments are controlled. Cross country fixed effects, specific time trends and common time dummies are controlled as indicated at the bottom of each column. *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

Table 4: Equations with the Heterogeneous Growth Effect

	Number of Civil Wars								Degree of Civil Violence							
	Brückner and Ciccone (2009)'s IV				New Combination's IV				Brückner and Ciccone (2009)'s IV				New Combination's IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	2SLS Estimates															
Income Growth	-2.368**	-3.928*	-4.021*	-3.942*	-1.200**	-3.827***	-3.953***	-3.105**	0.508	2.749***	2.782***	2.913***	0.377	1.898**	1.882**	1.984**
	(1.056)	(2.258)	(2.277)	(2.151)	(0.607)	(1.524)	(1.500)	(1.274)	(0.657)	(0.978)	0.990	(1.073)	(0.424)	(0.908)	(0.921)	(0.899)
Income Growth x Indicator for:		2.628	2.552	2.440		3.336*	3.579**	3.084*		-3.749***	-3.895***	-3.743***		-2.540**	-2.430**	-2.334**
Ethnic Fractionalization		(3.174)	(3.155)	(2.875)		(2.008)	(1.950)	(1.890)		(1.338)	(1.353)	(1.238)		(1.213)	(1.226)	(1.132)
Overid						1.08224	2.16947	4.09969						3.63732	4.49568	4.17308
p-value						(0.582)	(0.338)	(0.129)						(0.162)	(0.106)	(0.124)
	First Stage Estimates															
	Income Growth															
Commodity Prices Growth	0.038***	0.050***	0.049***	0.047***	0.039***	0.051***	0.049***	0.048***	0.038***	0.051***	0.049***	0.047**	0.038***	0.051***	0.049***	0.047***
	-(0.010)	(0.016)	(0.016)	(0.018)	(0.010)	(0.016)	(0.016)	(0.017)	(0.103)	(0.016)	(0.016)	(0.018)	(0.424)	(0.016)	(0.016)	(0.018)
Commodity Prices Growth x		-0.014	-0.010	-0.014		-0.015	-0.010	-0.014		-0.014	-0.010	0.026		-0.015	-0.010	-0.014
Indicator		(0.024)	(0.025)	(0.026)		(0.024)	(0.024)	(0.025)		(0.024)	(0.025)			(0.024)	(0.025)	(0.026)
Rainfall Variation					0.036**	0.019	0.018	0.022					0.036**	0.018	0.017	0.02
					(0.014)	(0.043)	(0.044)	(0.044)					(0.014)	(0.043)	(0.044)	(0.045)
Rainfall Variation x						0.033	0.035	0.021						0.037	0.039	0.025
Indicator						(0.068)	(0.071)	(0.071)						(0.069)	(0.071)	(0.072)
First Stage F-statistics	67.46	19.23	11768.22	104.66	106.81	12.3	342566.92	623.06	90.49	27.6	11749.99	280.7	103.3	6.32	342785.27	392.29
Shea Partial R-squared		0.037	0.0364	0.0322		0.0445	0.0438	0.0421		0.0371	0.0365	0.0322		0.0447	0.044	0.0424
	Income Growth x Indicator															
Commodity Prices Growth		-0.001	-0.002	-0.002		-0.001	-0.002	-0.002		-0.001	-0.002	-0.002		-0.001	-0.002	-0.002
		(0.007)	(0.007)	(0.009)		(0.006)	(0.007)	(0.009)		(0.007)	(0.007)	(0.009)		(0.006)	(0.007)	(0.009)
Commodity Prices Growth x		0.042***	0.045***	0.043***		0.042***	0.045***	0.043***		0.042***	0.045***	0.044***		0.042***	0.045***	0.044***
Indicator		(0.014)	(0.015)	(0.014)		(0.014)	(0.014)	(0.014)		(0.015)	(0.015)	(0.015)		(0.014)	(0.015)	(0.015)
Rainfall Variation						-0.010	-0.011	-0.010						-0.012	-0.013	-0.012
						(0.018)	(0.019)	(0.022)						(0.018)	(0.019)	(0.022)
Rainfall Variation x						0.06	0.062	0.052						0.063	0.065	0.055
Indicator						(0.039)	(0.042)	(0.043)						(0.040)	(0.042)	(0.045)
First Stage F-statistics	67.46	17.48	14686.68	323.4		5.46	717596.02	1247.17		26.68	5502.79	433.8		5.23	718815.55	1183.55
Shea Partial R-squared		0.0339	0.0344	0.0359		0.0443	0.0446	0.0443		0.0339	0.0345	0.0359		0.0449	0.0453	0.0456
Country Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Specific Time Trends	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	Y	Y
Common Time Dummies	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y

Note: The method of estimation of the first stage equations is least squares. Huber robust standard errors (in parentheses) are clustered at the country level. The models were replicated from the literature of instrumental variable approach of Brückner and Ciccone (2011) in column (1)-(4) and (9)-(12), with the dataset 1981-2003. Also this paper provides new combination of instrument variables from the literature in column (5)-(8) and (13)-(16). Commodity Prices Growth is the commodity price growth rate between t and t-3, using international commodity price data from IMF. F statistics and its p value are reported to test against all instruments are controlled. Cross country fixed effects, specific time trends and common time dummies are controlled as indicated at the bottom of each column. *Significantly different from zero at the 90 percent confidence level, ** 95 percent confidence level, *** 99 percent confidence level.

Second Paper

The Diffusion of Civil War and Peace in Sub-Saharan Africa

The Diffusion of Civil War and Peace in Sub-Saharan Africa

Thanee Chaiwat*

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Abstract

This paper investigates the clustering and contagion of civil conflicts in Sub-saharan Africa using spatial panel data models. The results document that onset, incidence and end of civil conflicts spread across the network of neighboring countries while peace, the end of conflicts, diffuse only with the nearest neighbor. In term of space, these results also confirm the clustering of civil war incidence. Finally, there is an evidence of indirect links from regional income growth, without too much inequality, of neighbor countries to reduce the likelihood of civil wars.

JEL-classification: C23, D74, R12

Keywords: Civil War; Africa; Geography; Cluster; Diffusion;
Spatial Analysis; Contagion Process

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1 Introduction

Civil wars are the most common type of armed conflicts in the last half-century accounting for large human and economic disruption. Since 1960s about twenty percents of countries have experienced at least ten years of civil wars. The plague of violent civil strives is particularly cumbersome for Sub-Saharan Africa where more than one third of the countries experienced at least a civil war during even the past twenty years.

A large body of empirical literature, discussed in more detail in Section 2, investigates the determinants of civil wars. Most of the available investigations have concentrated their attention to the study of country specific characteristics that and/or the role of short term climatological and economics shocks increase the likelihood of conflicts and more recently some studies has turned to the investigation of the "non domestic" determinants of civil conflicts with a special attention to the role of clustering and diffusion among neighboring countries. The results of these investigations deliver mixed findings. The available investigations mostly favor territorial neighboring concept, focusing on war onset as a dependent variable.[1]

This paper investigates the clustering and contagion of civil conflicts in both space and time using recently developed spatial panel data techniques. The results complement the existing literature in four main dimensions. First, the role of spatial connections between countries is accounted for by using several methods to define the relevant neighbor network.[2] The consideration of different possible network structures allows to investigate different possible patterns of clustering and contagion. By employing these several concepts with the same model specification, the paper provides systematic and comparable estimates. The results suggest that the definition of the relevant network may play a key role with respect to the pattern styles of diffusion process.

[1] The results in the literature, reviewed in more details below, use different data, alternative definitions of conflict and explanatory variables, different spatial weighting schemes and time periods such as post WWII or post Cold War.

[2] As discussed in detail in Section 4.2, the first neighboring method is traditional definition accounting for countries who share common borders. The second method, called distance-based, is based on distant area. Countries within circular area from the centroid of each country are included as neighbors. The last method, called one-nearest, takes into account for one country which locates the nearest, in term of distance among centroids, to each other.

Second, the paper investigates different dimensions of conflicts including their onset, incidence and end. This allows for a first test of the different pattern of clustering and contagion of the different phases of conflicts which, to our knowledge, was not investigated in the literature. The findings provide evidence of asymmetric diffusion patterns. While the start, and incidence of civil wars tend to diffuse in circular directions, the end of conflicts, or alternatively if we want the start of peace, tends to diffuse only to the nearest neighbor. This paper suggests that war diffuse more widely than peace does.

Third, the analysis explicitly studies role of time by including the different lagged spatial variables in the panel data estimation. A variety of specifications is considered to investigate the time it takes to diffuse and the duration of the effects. The asymmetry between start (or incidence) and end of conflicts emerges not only in terms of space but also in terms of time. The civil wars need only one year to diffuse and they significantly spread for about two years. In contrast, peace need two years to diffuse and the effect last less (only one year).

Finally, this paper also studies the possibility of indirect diffusion channel across countries. In particular, the analysis allows for the possibility that better economic conditions in neighboring countries may indirectly help limiting conflicts. The findings document that while income growth in a country has negative correlation with the likelihood of civil war, there is an evidence that effects of economic well-being on conflicts diffuse to other countries as well. The models show significant links from neighbors' income growth both onset and end phases of civil wars. This results provide a set of novel insights and may have relevant policy implications.

2 Related Literature

Most of the studies of civil war investigates domestic socio-economic conditions as its determinants, for example, per capita income growth, quality of political institutions, accessibility of natural resources, ethnic fractionalization and climatological shocks. Probably, the most acceptable key factor reducing civil wars is income growth [Collier and Höeffler (1998); Collier and Höeffler (2002); Miguel, Satyanath and Sergenti (2004) and Brükner and Ciccone (2010)]. According to Blattman and Miguel (2010), "the correlation between low per capita incomes and higher propensities for war is one of the most robust empirical relationships in the literature". Other factors beyond socio-economic condition were also related to domestic concept such as political regime type, governmental instability and population density [Benson and Kugler (1998); Collier and Höeffler (2004); Sambanis (2004); Gleditsch (2007)]. These aspects are not very different in the case of civil war onset, incidence, and termination.

Early works in the spatial analysis of civil war focus how neighboring states influence the propensity to the spread of international wars. This analysis is the consequence of merger of international relations theory and spatial analysis which rediscovered the importance of contiguous effects in the diffusion of conflict, as elaborated in Most and Starr (1980). In their formulation, country's borders offer opportunities for conflict (more borders, more conflict possibilities); the sense of vulnerability from multiple borders can lead to military preparations and a willingness to fight. Most and Starr's diffusion analyses relied on simplified contiguity scores for states (the so-called checkerboard measure in spatial autocorrelation analysis). Their analyses of global and African wars [Starr and Most (1983)] found high correlation between international wars among border sharing countries. Kirby and Ward (1987) also confirms that in Africa neighboring influence is stronger than the effect of domestic characteristics in determining war risk.

Later, the studies extended their analysis to the impact of neighbors on the likelihood of civil wars by neighboring state factors. The results, to date, have been inconclusive partly due to different empirical specifications including different data sets, with different definitions of conflict and explanatory variables, use of different spatial weighting schemes and time periods. While a number of researchers dismiss the effect of neighbors in increasing or decreasing civil war risk [Fearon and Laitin (2003)], others find strong support for neighboring effects on civil war risk when controlling for the usual explanatory variables including GDP, political regime type, governmental instability and population density [Benson and Kugler (1998); Collier and Höeffler (2004); Sambanis (2004); Gleditsch (2007)].

Gleditsch (2002) found that neighboring and regional relationships set the trajectory (peaceful or conflictional) for individual states. States in high-risk regions experience "double jeopardy", as their unstable domestic politics result in high civil war risk that neighbors with high domestic risk compound. Hence, within developing countries, domestic politics are as much influenced by external relationships as by internal political, economic and social dynamics. Gleditsch (2007) extended his work that transnational linkages between states and regional factors strongly influence the risk of civil conflict such as trans-border groups, regional trade and regional democracy.

Buhaug and Gleditsch (2008) also tested whether conflicts are clustered by themselves or due to the agglomeration of poverty in some regions. data on civil conflicts at the country level around the world and found that conflicts are still clustered by themselves even if the poverty was controlled for. Similarly, the study of disaggregate level by Buhaug and Rød (2006) detected spatial conflict clusters in the disaggregate level using data on civil conflicts for Africa using 100x100 km grid cells and regional conflicts' location during 1970-2001. Therefore these studies make conclusion about the existence of cluster, but they don't clarify its contagion process. The occurrence of cluster may not be necessary to point out the phenomenon of diffusion. The existence of diffusion need to be supported by contagion process in which the role of time must be involved, nevertheless the cluster may exist by the cluster of exogenous factors.

Scutte and Weidmann (2011) theoretically points out two types of diffusion pattern. How civil wars diffuse can be either moving or expanding themselves. They interpret contemporaneous spatial variables together with the lagged ones to identify each type of diffusion pattern. If wars are contagious among neighbors, either the existence of cluster can identify the escalation diffusion or the existence of checkerboard can identify the relocation diffusion. This study finds some cases proven by this theoretical point of view and will discuss later in section 4.1.

Section 2 and 3 provide a detail of spatial econometric methodology; data measurement and empirical strategy. The fifth section is empirical results and the last section is concluding remarks.

3 Data and Measurement

The period of analysis ranges from 1981 to 2003. Most of Sub-saharan African countries were independent and majority ruled before 1980 [McGowan (2003)], then year 1981 kicked off the second democratization wave in Africa. This paper covers a sample of 37 countries in Sub-saharan Africa.[3]

Civil Wars: Data on civil wars is extracted from the UCDP/PRIO Armed Conflicts Dataset of the International Peace Research Institute's (PRIO) Centre for the Study of Civil War and the Uppsala Conflict Data Program (UCDP).[4] The UCDP/PRIO Armed Conflict Database defines civil war as a "contested incompatibility which 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 1000 battle deaths per year".[5]

This paper studies the occurrence of civil wars based on PRIO's definition and categorized into three variables. The first variable is **civil war incidence**, denoted by *incidence* as defined in PRIO. It takes value one in year of civil wars occurred, otherwise it is coded zero. Hence the variable civil war incidence represents the whole period of war events.

The second variable is **civil war onset**, denoted by *onset*. The definition of this variable indicates the year wars start, so it is coded by the year changing values of the variable war incidence from zero to one, otherwise it is coded zero. It registers a shift from no war to war events at the first year. The definition of variable war start is different from the definition of war onset used in many papers. The variable war onset equals to one at the first year wars start, missing values at the year of war ongoing and zero at the year without war. But the spatial panel data analysis does not allow for missing values due to float of diffusion effects, the variable war start must not have any missing values. Hence the difference between variable war onset and variable war start is how to code at the years war ongoing with missing values and zero values respectively. However, the alternative way is to code 0 for all country-years with no war, 1 for the year that a war started, and missing for periods of ongoing war, but countries with ongoing wars will lose a lot of observations and this coding is not allowed in spatial panel data analysis.

[3]Only four countries of Sub-saharan Africa which are Zimbabwe, Namibia, Eritrea and South Africa were independent after 1980 at different years, hence most of the studies started their analysis at 1981. There are 43 data-available countries in Sub-saharan Africa. Six omitted countries from this paper are Djibouti, Eritrea, Equatorial Guinea, Lesotho (due to incomplete data), Somalia (due to unavailable information) and Madagascar (due to island-being isolation).

[4]The dataset is available at http://new.prio.no/CSCW-Datasets/Data-on-Armed-Conflict.

[5]The definition of civil wars is exactly the same as civil conflicts. Civil conflicts count 25 to 999 battle-related deaths per year, while civil wars count more than 1,000 deaths.

The variable **civil war end**, denoted by *end*, is the third dependent variable in this paper. This variable is the opposite of the variable war onset. It takes value one in years of incidence shifting form one to zero, otherwise it is coded zero. It means the situation shifting from war events to no war at the first year. In this paper, peace is defined as the absence of wars, so the variable peace start is identified by the first year after war has stopped.

Descriptive statistics of the variable civil wars are reported in Table 1. They are for the whole region and for the classification by the occurrence of wars. It categorized into two groups; countries with no war and countries with some wars. On average for the whole region, the incidence of civil wars in Sub-saharan Africa was about 0.13 over the period 1981-2003. The mean values of variable war onset and war end are around 0.02 and 0.03 respectively.

Partitioning countries with and without civil wars, 23 out of 37 countries had not experience any war while 14 countries have at least one such war. The mean value of variable war incidence only the case of war countries appears much higher being at 0.35. It means that the probability of wars exists for each of such 14 countries at 35 percents per year. In the meantime, the mean probability of war start and war end increase at 0.06 and 0.07 respectively. For instance, the country Sudan, which has the maximum value of variable civil war incidence (0.83), had experienced civil wars almost the whole length of the study.

Income Growth: Data for annual real GDP per capita growth is taken from the World Development Indicators (2010).[6] Table 1 provides some descriptive statistics of per capita income growth. The average income growth for the whole region was around -2 percents and ranged between -7 to 3 percents. When statistics are disaggregated between countries with no war and countries with some wars, the average values of growth are significantly different. Countries with no war grew at 2 percents on average per year, in contrast countries with some wars grew of (-2) percents per year.

[6]The data is available at http://data.worldbank.org/data-catalog/world-development-indicators.

4 Empirical Strategy

4.1 Estimation Framework

The benchmark equation links the likelihood of civil wars to per capita income growth, country characteristics, country specific time trends and common time dummies;

$$war_{i,t} = \beta_{i,t} growth_{i,t} + \mu_i + \gamma_i t + \delta_t + u_{i,t}, \tag{1}$$

where i indicates country of interest and t indicates year. The variable civil war, stated *war* from now on, can be replaced by the variable war incidence, war start or war end in each of specific models. The variable *growth* is per capita income growth rate, μ_i is time-invariant dummies, $\gamma_i t$ is a specific time trend, δ_t is common shock for each specific year, and $u_{i,t}$ is an error term.

This estimation technique aims to overcome one of the traditional assumptions of ordinary least squares which presumes no correlation between error terms ($corr(\varepsilon_i, \varepsilon_j) \neq 0$), particularly, among locations. In accordance with the literature, a civil war event is one case which violates this assumption. War in a specific location can affect and be affected by surrounding wars. However the effect among these locational spreads may take time, and the diffusion may not be observed at the static analysis. Inclusion of time will illustrate the escalation or movement of civil wars among spaces, then the main advantage of spatial panel data model is a capability to estimate the effects of space and time dimensions at the same time.

Therefore, the benchmark model is extended to Durbin spatial panel data model to propose space-time filter and allows for the spatial error correlation;

$$war_{i,t} = \psi_0 W_{ij}.war_{j,t} + \psi_s W_{ij}.war_{j,t-s} + \beta_{t-1} growth_{i,t-1} + \theta_s W_{ij}.growth_{j,s} + \mu_i + \gamma_i t + \delta_t + \epsilon_{it}, \tag{2}$$

where $\epsilon_t = \nu_{i,t} + \lambda W'_{ij}.\epsilon_{j,t}$ and $\nu_t = \rho\nu_{t-1} + e_t$. The spatial weight matrix, denoted by W_{ij}, is to identify neighbors and their weights inside. The spatial weight matrix for error term is denoted by W'_{ij}, and the lagged year is indicated by s ranging from one to three.

In equation (2), the variable domestic income growth at time $t-1$ is linked to the likelihood of civil wars at time t. This is to limit causality problem of two-way relationship between contemporaneous income growth and the occurrence of civil wars. Additionally, if the spatial weight matrix is equal to the spatial weight matrix for error term, that is $W_{ij} = W'_{ij}$, there might be an identification problem. The values of interaction between W'_{ij} and the disturbances may correlate with the values of interaction between W_{ij} and other independent variables. The estimation will be under the correlation between some regressors and error term, therefore the identification problem emerges. This paper contrives the spatial weight matrix for error term different from the spatial weight matrix for other regressors, indeed $W'_{ij} \neq W_{ij}$. The concept of spatial weight matrices in the model will be discussed in the next chapter.

Moreover, the presence of the variable *war* on both the left and right sides complies that least-squared estimates will be biased and inconsistent. The maximum likelihood estimation method used in this paper for evaluating the diffusion effects is therefore more suitable than the ordinary least square (LeSage (1998) and Bivand (2008)). According to LeSage and Pace (2009) and Elhorst (2010), the coefficient ψ is interpreted as "direct diffusion effect" linking neighbors' war to our war in this case. The impact of domestic growth on the likelihood of civil wars is estimated by the coefficient β. The coefficient θ is defined as "indirect diffusion effect" linking neighbors' income growth to our war.

The coefficient ψ_0 indicates the probability of the existence of wars both in countries and neighbors in the same year. This coefficient is interpreted as the likelihood of the cluster of civil wars. The concept of cluster is the agglomeration of similar events in space. A positive value of the coefficient ψ_0 means high or low values of the variable civil war events tend to cluster in space. That is countries either with or without civil wars are likely surrounded by similar neighbors. Yet a negative value of the coefficient ψ_0 means that our location tends to be surrounded by neighbors with dissimilar values, like a checkerboard. In other word, countries with civil wars are likely to be surrounded by neighbors without civil wars, or vice versa.

Since the diffusion process needs time to be contagious, the cluster coefficient ψ_0 which is based on static period does not necessary allow to draw conclusion about the existence of the diffusion effect. The coefficient ψ_s measures the relationship between the likelihood of civil wars between countries and neighbors over time. For example, in the case of s equals to one, the contagion coefficient ψ_1 can be interpreted as the probability of our country to be infected this year by wars going on neighboring countries in previous year to be infected wars of our country this year from surrounding wars last year. The statistical significance of this coefficient in each period indicates how long the likelihood of civil wars spreads among neighbors.

The contagion coefficient variable is very important to confirm the presence of diffusion effects. The statistical significance of the cluster coefficient alone does not always point out the diffusion effect, because other independent variables may lead to the clustering of civil conflicts. For example, the cluster of war may exist due to the cluster of low income countries, not by war itself. In contrast, if the contagion coefficient is statistically significant and the cluster coefficient is not, diffusion can still be explained.

As in Schutte and Weidmann (2011), diffusion processes refer to dynamic changes both spatially and temporally, since the process of infection typically takes time. The spatial diffusion by this concept somehow is divided into two patterns. Firstly, the *escalation diffusion pattern* implies the expansion of the geographic scope from one location to a new location expanding from previous locations. This pattern emerges if the existence of the cluster of wars together with the positive contagion process. In equation (2), the statistical significance should appear on both a positive value of cluster coefficient ψ_0 and a positive value of contagion coefficient ψ_s. Secondly, the *relocation diffusion pattern* is generated by the movement of wars beyond the original location with later ending of wars at the previous locations. This pattern is observed if the existence of the contagion process at the same time with the checkerboard of wars because the previous wars had to stop later. To detect such a pattern, a positive value of contagion coefficient ψ_s and a negative value of cluster coefficient ψ_0 need to be statistically significant in the equation (2).

4.2 Spatial Weight Matrix

To define neighboring countries, this paper uses three methods.

The first one is the **Contiguity Queen Neighboring Method**.[7] Countries sharing common borders are defined neighbors. The particular definition of border applies to country not only connected by land, but also to country divided by river, lake, mountain

[7]This method is called Queen because it is referred to the queen in chess playing which can move in every direction. There are also Rook and King concepts to differentiate direction of movement.

or any other partitions. This concept focuses on the territorial line of each observation, but varies in the number of links and distance.

Second, the **Distance-based Neighboring Method** counts countries as neighbors if their centroid points are within distant band. To avoid that some countries have no neighbor, this paper specifies the maximum distance between the centroid of two border-sharing countries as the distant band. Distance-based neighbors implies the constantly distant radius from specific location, but varies in the number of links without concerning any contiguity.

The third method is the **Nearest Neighboring Method**. This method counts as neighbor only the nearest country measuring the distance between two centroids. Hence it specifies the exact amount of links which is one in this paper, but varies in distance without concerning contiguity. Besides this method can specifies any numbers of nearest neighbors and this paper specifies only one, so from now on it is called one-nearest neighbor.

This paper applies all three methods to create spatial weight matrix in each specific equation. However the models also need another spatial weight matrix to allow for spatial diffusion of error term. At the same time, the estimation has to be aware of a potential identification problem which is the correlation between spatial error term and other regressors. This paper employs second-degree contiguity queen neighbors, two layers of border sharing countries for the spatial weight matrix of error term.

Figure 1 shows the links resulting for each type of neighbor matrix. Each of the nodes represents the centroid of each country, so one country has only one node. Each line shows the links among neighboring countries. Within distant band, smaller countries tend to be clustered more than bigger ones. There are more numbers of neighbors for smaller countries in the distance-based neighboring method, while size of the countries does not affect the number of links in other neighboring methods.

The summary statistics of the number of links is presented in Table 2. There are 37 countries in each neighboring matrix. The average number of border sharing neighbors for one country is 4.3, while the average for distance-based method is 5.9 neighbors. Since the distance-based neighboring method covers larger area than the other methods, it includes as much as 220 neighbor links. Contiguity queen and one-nearest neighboring methods result in 160 and 37 links, respectively.

To specify spatial weights to neighbor relationship, this paper uses row standardized method. This method identifies each weight by the average value across the total amount of neighbors of each country. For example, countries with four neighbors will have the value one-forth for each weight. The concept behind this weighting method is the lower is the number of neighbors a country has, the more powerful the diffusion effects can be. That is high diffusion effects in case of countries with very few neighbors. According to the three neighboring method, the value of weights would not be the same for each of the weight matrices. Countries under the one-nearest neighboring method has only one neighbor, so their values of weights are always equal to one. The values of each weight specified under the contiguity queen and distance-based neighboring concepts are less and the least due to the number of neighbors included.

These three methods may be complementary in theirapplication. One-nearest neighbor concept has the strongest link with value one in every link but just only one link per country. Distance-based is the broadest concept, so it has the most links with the lowest value per link. There is a trade-off between number and strength of links. Contiguity-queen concept relies on common border, then it is likely in between the range of trade-off.

5 Results

Contiguity-queen neighboring matrix is estimated as a benchmark specification in Table 3, while results on distance-based and one-nearest are also presented in Table 4 and 5, respectively. Three specifications are presented with dependent variables; *incidence* in column (1)-(6), *onset* in column (7)-(12), and *end* in column (13)-(18).

Each of the tables reports the coefficients of the variables of interests categorized into four main groups. The first group is domestic coefficient which is domestic per capita income growth. The second to forth groups are spatial autoregressive coefficients which indicate diffusion effects. Direct diffusion effect from war to war is presented in the second and third group. The coefficient of contemporaneous spatial correlation, denoted by $W_{ij}.war_{i,t}$, is informative on existence of clusters of the likelihood of civil wars, while the coefficients of lagged spatial correlation, denoted by $W_{ij}.war_{i,t-s}$, is informative on the contagion effect. The last group is spatial independent coefficients, denoted by $W_{ij}.growth_{i,t-s}$, to report indirect diffusion effect, sometimes called spillover effect, from neighbors' income growth to our likelihood of civil wars. All equations include fixed cross-country effects, specific time-trends and common time dummies to capture path and fluctuation of an African economy.

5.1 Results with Contiguity Queen Neighbors

Civil War Incidence. Column (1)-(6) in Table 3 report results civil war incidence as a dependent variable. As expected, domestic coefficients show significant correlation between income growth and the likelihood of civil wars. Lagged growth continues war in the consequent year. This result may be effected by endogeneity problem because growth is negative during war incidence period, so it cannot be interpreted in the direction of causality.

Focusing on a cluster of coefficients, our results show a significant clustering effect between neighbor countries. The likelihood of civil war incidence in our country is increased almost 25 percentage points if our neighbors experience wars in current year. Consequently, Civil war incidences are also contagious from neighbors to our country. The likelihood of civil war incidence in our country is increased around 15 percentage points if our neighbors had wars in previous year. These coefficients are robust in different specifications. However, it may be difficult to reach conclusion on the contagion process from this evidence. Most of civil war incidences take times more than one year, then they are possibly correlated to each others. The contagion effects of civil war incidence neither int he second nor third year do not exist.

The indirect diffusion effects of neighbors' income growth do not play any significant role to reduce the likelihood of civil war incidence. This suggests that neighbors' economic growth do not spillover to lessen our war incidence during war time.

Civil War Onset. Column (7)-(12) in Table 3 report results on the likelihood of civil war onset. Domestic income growth shows negative correlation with respect to the likelihood of civil war onset. The statistical insignificance of this correlation roughly suggests that the outbreak of civil wars probably does not depend on the rate of income growth.

The contagion coefficients of civil war onset are positive and strongly significant. War onset in neighbors' countries in the year $t-1$ increase the likelihood of civil war onset in our country of approximately 20 percentage points. This evidence clearly indicates war epidemic in the region. Countries have around 20 percentage points of possibility of facing a new war if their neighbors are already experiencing it. The negative but insignificant cluster coefficients indicate that wars among countries nearby do not start simultaneously. It looks like there is a movement of civil war onset from one country to near countries in subsequent year.

Results show an indirect diffusion effect from income growth to civil war onset. Negative spillover coefficients of current neighbors' income growth are not significant and may not much useful to explain the likelihood of civil war onset due to correlation, not causality, issue. However the results show positive and strongly significant spillover coefficients from lagged neighbors' income growth to contemporaneous civil war onset. This suggests that differences in growth among countries nearby may be harmful for peace. Civil war is war between government and citizens, then income inequality in one country and his neighbors may push citizens to make a demand to their government. Economic development along with equity is necessary to stop wars.

Civil War End. Column (13)-(18) in Table 3 report results for civil war termination. Domestic coefficients of income growth and direct spatial coefficients of civil war end are not statistically significant. The positive coefficients of both clustering and contagion point out that several countries can end wars at the same time and they can escalate ending wars around. Even if there is not clear interpretation, this conclusion can be accepted on average. It is obvious that an increase of income growth of countries nearby correlates with the likelihood of civil war end. This suggests that peace start or war end has economic benefits for the region.

5.2 Results with Distance-based Neighbors

Civil War Incidence. Distance-based neighboring concept goes further beyond contiguity queen neighboring. Column (1)-(6) in Table 4 report results with civil war incidence. The results go in line with contiguity queen neighboring concept. Domestic income growth is negatively correlated with the likelihood of civil war incidence, and there is evidence of clustering and contagion effects of civil war incidence. Their values of distance-based coefficients indicate higher concentration of civil war incidence in the region comparable to the contiguity queen.

The spillovers of contemporaneous civil war incidence and neighbors' income growth are clear and negative. This implies the negative effects of civil wars with respect to economic growth of countries within distant band.

Civil War Onset. Column (7)-(12) in Table 4 report results on the likelihood of civil war onset. The results of civil war onset with distance-based neighbors get along with contiguity-queen neighbors. They show a contagion effect of civil war onset around 15 percentage points. The distance-based coefficient values of contagion process are smaller than the contiguity-queen ones, around 20 percentage points, so this suggests that the power of war onset contagion is lower when distance increases. The results also indicate relocating diffusion of war onset by negative clustering coefficients together with contagion ones as in the case of contiguity-queen concept. No spillover effect of neighbors' income growth is detected.

Civil War End. Column (13)-(18) in Table 4 report results with civil war end. Domestic coefficients of income growth and direct spatial coefficients of civil war end do not significantly affect the likelihood of civil war end. Nevertheless the contagion effect of war end is positive significant at the second year which is difficult to explain. Significant and positive neighbors' growth spillovers from previous year point out that regional economic growth may be beneficial to stop war. The significance of the spillovers shown in distance-based concept probably because the countries which are too close are suffering from wars and promoting growth in those countries may not be so helpful.

5.3 Results with One-nearest Neighbor

Civil War Incidence. One-nearest neighboring concept is to narrow neighboring area from contiguity queen concept. Column (1)-(6) in Table 5 report results with civil war incidence. The results significantly indicate negative effects of domestic income growth to the likelihood of civil war incidence and positive cluster of civil war incidence. Other effects, contagion and spillover, do not exist.

Civil War Onset. Column (7)-(12) in Table 5 report results on the likelihood of civil war onset. Domestic income growth has negative correlation with the likelihood of civil war onset. The results of civil war onset with one-nearest neighbor clearly point out relocating diffusion by the significance of both negative clustering and positive contagion effects. This suggests the important role of the nearest neighbor as a channel to incur a war onset one to two year later, while the results with contiguity-queen concept find similar but insignificant. Results on growth does not show spillover effect in this one-nearest case, then the effects of neighbors' growth may need more concentration of countries nearby.

Civil War End. Column (13)-(18) in Table 5 report results with civil war end. Similar to civil war onset, the nearest neighbor plays a significant role in inducing the end war, and this effect is estimated around 11 percentage points. Civil war ends with one-nearest neighbor are relocating diffusion process meaning that termination of civil war can move from our nearest country to ours. Hence the nearest country is very important both to start war and build peace. Domestic coefficients of income growth and indirect spatial coefficients do not significantly matter with respect to the likelihood of civil war end.

6 Concluding Remarks

This paper has investigated how the different phases of civil wars in a country, the incidence, the onset and the end, are affected by those of their neighbor countries. The analysis exploits the state of the art techniques in spatial panel data analysis. The estimation framework is based on Durbin spatial panel data model with maximum likelihood estimation to avoid the correlation among variables in the left- and right-side of the equation. Spatial diffusion of the error term is allowed to capture the unobservable diffusion effects, and consider different methods to define the relevant neighboring network (contiguity-queen neighbors, distance-based neighbors and one-nearest neighbor). The first definition limits attention to countries sharing borders, the second allows to consider more distant areas while the last considers narrow to only the nearest country.

The findings confirm clustering of civil war incidence among border-sharing countries as suggested in the literature. They document asymmetric contagious patterns for onset and end of civil wars. Civil war onset is contagious among countries around borders, while civil war end or peace start is not. If the area covers beyond border to distant band, the power of contagion effects of civil war onset decline. Contrarily, if the area is narrowed to one-nearest neighbor, diffusion patterns are more clear. They suggest relocating diffusion of civil war onset with one-nearest neighbor, and the results are the same for civil war termination. So one-nearest neighbor is a key channel to propose both war and peace start. However the effects crucially depend on the definition of network applied.

Domestic growth is negatively correlated to every steps of civil wars, while neighbors' growth spillovers to our country. Under contiguity-queen concept, neighbors' growth plays an important role to increase the likelihood of civil war onset due to pressure from income inequality. However if the area goes further beyond border-sharing countries, under distance-based concept, neighbors' income growth can reduce the likelihood of civil war incidence and increase the likelihood of war end. This case is different from contagion of civil war onset. Civil war onset can be contagious by just one-nearest neighbor, while, interpreting from contiguity-queen and distance-based concepts, growth spillovers need concentration of countries nearby.

These findings put a warning on possible contagion of civil wars, some (limited hope) that also peace can be contagious and the nearest neighbor is a key channel for both. Some positive news for the view that growth promotion in Sub-saharan Africa should help to reduce war incidence and increase the end of civil wars at the regional level. Concerning with growth inequality among border-sharing countries is necessary.

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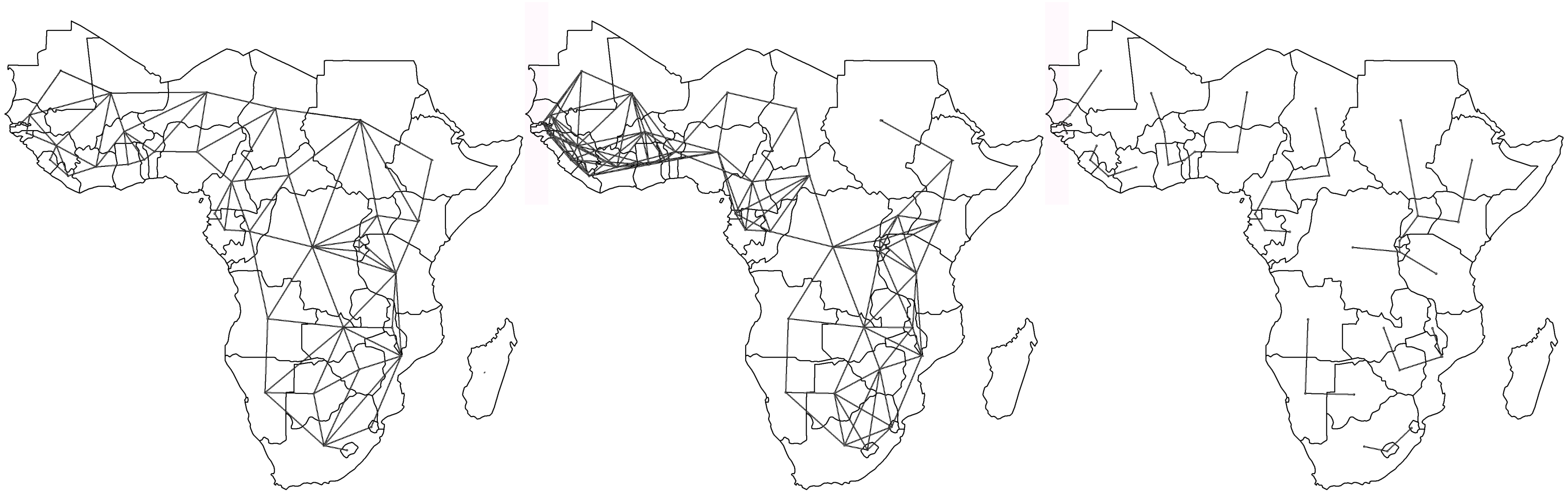

(a) Contiguity Queen Neighbors

(b) Distance-based Neighbors

(c) One-nearest Neighbor

Figure 1: Nodes and Links of Neighbors

Table 1: Summary Statistics of Main Variables of Interest

		Civil War Incidence	Civil War Onset	Civil War End	Income Growth
All Countries	Obs	37	37	37	37
	Mean	0.13	0.02	0.03	-0.02
	Std. Dev.	0.23	0.04	0.04	0.02
	Min	0	0	0	-0.07
	Max	0.83	0.13	0.13	0.03
Countries with No War	Obs	23	23	23	23
	Mean	0	0	0	-0.02
	Std. Dev.	0	0	0	0.02
	Min	0	0	0	-0.05
	Max	0	0	0	0.03
Countries with Some Wars	Obs	14	14	14	14
	Mean	0.35	0.06	0.07	-0.02
	Std. Dev.	0.24	0.04	0.04	0.02
	Min	0.04	0.00	0.04	-0.07
	Max	0.83	0.13	0.13	0.03

Statistics based on 851 observations from 37 countries between 1981 and 2003. Civil war is either one if war exists and zero otherwise. Individual level statistics demonstrates that each country for each year contains one information, while country level means each country for the whole period contains one information.

Table 2: Summary Statistics of Neighbor Matrix

	Contiguity Queen	Distance-based	One-nearest
Number of regions:	37	37	37
Number of nonzero links:	160	220	37
Percentage nonzero weights:	11.6	16.7	2.7
Average number of links:	4.32	5.94	1.00

Table 3: Contiguity-queen Neighbors: Spatial Panel Data Estimates of Diffusion

	War Incidence						War Onset						War End					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Domestic Coefficient:																		
$growth_{i,t-1}$	-0.388***	-0.390***	-0.381***	-0.391***	-0.388***	-0.389***	-0.087	-0.088	-0.084	-0.079	-0.086	-0.079	-0.032	-0.033	-0.029	-0.036	-0.039	-0.036
	(0.096)	(0.096)	(0.095)	(0.097)	(0.096)	(0.097)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)
Clustering Coefficient:																		
$W_{ij}.war_{j,t}$		0.212**	0.235***	0.245***		0.242***		-0.160	-0.154	-0.113		-0.155		0.019	0.019	0.014		0.011
		(0.087)	(0.084)	(0.082)		(0.082)		(0.107)	(0.107)	(0.108)		(0.107)		(0.104)	(0.113)	(0.069)		(0.079)
Contagion Coefficients:																		
$W_{ij}.war_{j,t-1}$			0.120**	0.155***		0.195**			0.192***	0.192***		0.190***			0.055	0.053		0.054
			(0.060)	(0.060)		(0.082)			(0.067)	(0.067)		(0.067)			(0.072)	(0.072)		(0.072)
$W_{ij}.war_{j,t-2}$						-0.028						0.064						0.140*
						(0.102)						(0.074)						(0.077)
$W_{ij}.war_{j,t-3}$						-0.043						-0.032						-0.016
						(0.083)						(0.078)						(0.079)
Spillover Coefficients:																		
$W_{ij}.growth_{j,t}$				-0.241	-0.192	-0.226				-0.048	-0.05	-0.046				0.253**	0.254**	0.235**
				(0.185)	(0.196)	(0.186)				(0.113)	(0.113)	(0.113)				(0.119)	(0.119)	(0.119)
$W_{ij}.growth_{j,t-1}$				0.142	0.029	0.152				0.235**	0.234**	0.232**				0.112	0.113	0.097
				(0.194)	(0.2)	(0.194)				(0.115)	(0.115)	(0.115)				(0.112)	(0.122)	(0.122)
Statistical Reports:																		
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
log likelihood	-57.5	-54.897	-54.304	-53.356	-57.041	-52.945	446.62	447.8	451.8	453.9	448.71	454.39	373.89	373.91	374.2	377.06	376.77	378.74
Observations	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with standard error (shown in parentheses). Civil war incidence is either one if war happens and zero otherwise. Contiguity queen neighbors is concept of border sharing, distance-based neighbors is concept of distant band and one-nearest neighbor is concept of nearest country. All models are controlled by individual country dummies, specific time trend and common time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Table 4: Distance-based Neighbors: Spatial Panel Data Estimates of Diffusion

	War Incidence						War Onset						War End					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Domestic Coefficient:																		
$growth_{i,t-1}$	-0.390***	-0.399***	-0.407***	-0.407***	-0.394***	-0.408***	-0.087	-0.084	-0.082	-0.083	-0.088	-0.084	-0.035	-0.035	-0.034	-0.034	-0.036	-0.029
	(0.096)	(0.096)	(0.095)	(0.097)	(0.097)	(0.097)	(0.054)	(0.054)	(0.054)	(0.054)	(0.055)	(0.054)	(0.059)	(0.059)	(0.060)	(0.059)	(0.059)	(0.059)
Clustering Coefficient:																		
$W_{ij}.war_{j,t}$		0.171*	0.231***	0.241***		0.238***		-0.175	-0.172	-0.180		-0.179		-0.050	-0.050	0.038		-0.054
		(0.092)	(0.079)	(0.078)		(0.078)		(0.109)	(0.109)	(0.113)		(0.111)		(0.102)	(0.069)	(0.096)		(0.097)
Contagion Coefficients:																		
$W_{ij}.war_{j,t-1}$			0.375***	0.421***		0.349***			0.146*	0.146*		0.144*			0.036	0.023		0.020
			(0.060)	(0.059)		(0.083)			(0.075)	(0.075)		(0.075)			(0.076)	(0.076)		(0.076)
$W_{ij}.war_{j,t-2}$						0.157						0.031						0.238***
						(0.098)						(0.092)						(0.081)
$W_{ij}.war_{j,t-3}$						-0.079						-0.045						-0.020
						(0.082)						(0.096)						(0.084)
Spillover Coefficients:																		
$W_{ij}.growth_{j,t}$				-0.395**	-0.067	-0.379*				0.001	0	-0.001				0.166	0.175	0.126
				(0.199)	(0.227)	(0.200)				(0.131)	(0.13)	(0.131)				(0.139)	(0.139)	(0.14)
$W_{ij}.growth_{j,t-1}$				0.043	-0.340	-0.002				-0.076	-0.047	-0.077				0.268*	0.269*	0.267*
				(0.213)	(0.233)	(0.216)				(0.135)	(0.133)	(0.135)				(0.143)	(0.142)	(0.142)
Statistical Reports:																		
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
log likelihood	-58.165	-56.576	-48.411	-46.718	-57.073	-45.447	446.64	447.97	449.82	449.97	446.7	450.16	371.98	372.11	372.22.	374.49	374.37	378.81
Observations	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with standard error (shown in parentheses). Civil war incidence is either one if war happens and zero otherwise. Contiguity queen neighbors is concept of border sharing, distance-based neighbors is concept of distant band and one-nearest neighbor is concept of nearest country. All models are controlled by individual country dummies, specific time trend and common time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Table 5: One-nearest Neighbor: Spatial Panel Data Estimates of Diffusion

	War Incidence						War Onset						War End					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Domestic Coefficient:																		
$growth_{i,t-1}$	-0.387***	-0.389***	-0.386***	-0.384***	-0.389***	-0.386***	-0.089	-0.088	-0.087	-0.093*	-0.093*	-0.098*	-0.038	-0.037	-0.044	-0.044	-0.038	-0.044
	(0.096)	(0.096)	(0.096)	(0.096)	(0.096)	(0.096)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)
Clustering Coefficient:																		
$W_{ij}.war_{j,t}$		0.13	0.149*	0.143*		0.147*		-0.188*	-0.196*	-0.201*		-0.197*		-0.069	-0.095	-0.098		-0.1
		(0.087)	(0.088)	(0.086)		(0.087)		(0.102)	(0.102)	(0.103)		(0.103)		(0.091)	(0.093)	(0.096)		0.1
Contagion Coefficients:																		
$W_{ij}.war_{j,t-1}$			0.056	0.047		0.029			0.069*	0.065*		0.072**			0.113***	0.114***		0.117***
			(0.034)	(0.035)		(0.043)			(0.035)	(0.035)		(0.035)			(0.037)	(0.037)		(0.037)
$W_{ij}.war_{j,t-2}$						0.027						0.065*						0.034
						(0.051)						(0.037)						(0.040)
$W_{ij}.war_{j,t-3}$						0.014						0.007						0.002
						(0.047)						(0.039)						(0.039)
Spillover Coefficients:																		
$W_{ij}.growth_{j,t}$				-0.068	-0.058	-0.064				0.029	0.025	0.039				0.036	0.025	0.032
				(0.099)	(0.099)	(0.1)				(0.056)	(0.056)	(0.056)				(0.061)	(0.061)	(0.061)
$W_{ij}.growth_{j,t-1}$				-0.076	-0.103	-0.076				-0.059	-0.065	-0.06				-0.016	-0.007	-0.013
				(0.101)	(0.101)	(0.102)				(0.057)	(0.057)	(0.057)				(0.062)	(0.062)	(0.062)
Statistical Reports:																		
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
log likelihood	-58.228	-57.167	-56.491	-56.063	-57.55	-55.728	447.5	449.29	451.15	451.82	448.26	453.37	371.76	372.03	376.3	376.5	371.85	376.87
Observations	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with standard error (shown in parentheses). Civil war incidence is either one if war happens and zero otherwise. Contiguity queen neighbors is concept of border sharing, distance-based neighbors is concept of distant band and one-nearest neighbor is concept of nearest country. All models are controlled by individual country dummies, specific time trend and common time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Third Paper

The "Coup Contagion Hypothesis" Revisited in Sub-Saharan Africa

The "Coup Contagion Hypothesis" Revisited in Sub-Saharan Africa

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Abstract

After Li and Thomson (1975) had studied the "coup contagion hypothesis", the literature of coup mainly focus on domestic factors. This paper revisits the diffusion of coup d'etat in the most coup occurring area, the Sub-Saharan Africa, during 1981-2003. The coup events in this paper are categorized into all types of and only successful coups under spatial fixed effects model. The results find the existence of both domestic and spatial determinants. Domestic income growth play major role to reduce the likelihood of coup before the end of cold war, while spatial effects also do negative afterward. The results of probability to succeed coup is similar. This suggests the pressure to open democracy from third parties.

JEL codes: O0, P0, Q0

Keywords: Rainfall, Conflict, Coup, Commodity Prices, Diffusion, Contagion, Cluster, Spatial Econometrics

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1 Introduction

Since the years of independence, Africa has experienced more than 200 military coups, counting both successful and failed coup attempts. The political and economic conditions prevailing in different African countries and the foreign influences during different periods (post-independence, Cold War, and post-Cold War eras) have all partly affected coups in this region. The destabilizing factors have been many and varied, depending on the national context: warring factions seeking to gain power in the aftermath of independence; established and stable states burdened by poor quality of governance and by corrupt officials; autocratic regimes repressing any form of opposition but with sociopolitical discontent and instability seething below the surface.

This paper focuses on underlying factors of coups in Sub-Saharan Africa, including both domestic factors like low levels of income growth, associated with high levels of poverty, and spatial factors like coups in neighboring countries. This paper also pays particular attention on pre- and post-end of cold war periods which provide different major determinants of coups. Domestic determinants play major role to increase the likelihood of coup d'etat before the end of cold war, while spatial determinants are key factors to reduce the likelihood of coup d'etat after the end of cold war.

There is a growing literature that political institutions matter for economic outcomes. Political changes often take place through coups d'etat, but coups remain a little understood political phenomenon. The economic studies of coup were kicked off at the world level. Li and Thomson (1975) studied the "coup contagion" hypothesis whether military coup in one country could influence in some fashion to the occurrence of coups in other countries. They applied stochastic model to 1946-1970 aggregated data at the world and selected regional levels. Since this paper aimed to study the contagion by coup itself, no any other independent variables were included in the model. Statistical evidence indicated that the occurrence of earlier coups did affect the subsequent occurrence of coups elsewhere but only some periods and only in Latin American and the Arabian regions. However the result did not confirm the coup contagion phenomenon in Sub-Saharan Africa.

After Li and Thomson's conclusion about unclear contagion process of coup d'etat, most papers about coup d'etat focused on domestic factors instead of neighboring factors. The studies can be divided into two main groups; the effect and the cause. To the effect of coup d'etat, Fosu (2002) examined the differential roles of various coup events—successful coups d'etat, abortive coups, or coup plots—in the growth of Sub-Saharan Africa for 31 countries over the 1960–1986 period. They augmented production function framework with labor and capital and found that abortive coups, rather than successful coups and coup plots, had the greatest adverse impact on economic growth. Also the question about an impact on subsequent military spending was asked by Zuk and Thompson (1982). They analyzed of military spending patterns in 66 less-developed states by a GLS equation to the 1967-1976 relationships between two measures of military spending and several predictor variables, including regime type, coup occurrences, level of conflict, economic development, arms imports, and previous military spending. The result, in general, was that military coups is not very helpful in predicting post-coup military spending policies.

To the cause of coup, Belkin and Schofer (2003) developed a structural understanding of coup risk as distinct from the actual events of coup. They used data on coup d'etat around the world estimating with random effects logistic regression and resulted that recent coup, wealth, regime type and conflict are key roles increasing coup risk. This finding coincided with Collier and Höeffler (2005) who aimed to investigate coup traps in Sub-Saharan Africa. They investigated proneness to coups by drawing on their previous work on proneness to civil war and their results are similar. Standard indicators such as political repression and economic inequality do not feature as significant influences while a common core of economic factors underpins proneness to coups are low income and a lack of growth.

Londregan and Poole (1990) studied two-way effects of coup and growth by simultaneous estimation. They found that the probability of coup d'etat is substantially influenced by the rate of economic growth, while coup does not have much effect on the rate of economic growth. To the former relation the negative association income is more pronounced than any of the interrelationships among the political variables.

Some recent studies still attempted to analyze internal factors leading to a coup, McBride (2004) and Collier and Höeffler (2007) focused their analyses on the military itself. According to McBride, the military intervenes in political affairs mainly for reasons of personal greed, being motivated by rents they hope to extract once they control over the state. Collier and Höeffler have highlighted the interdependence between the risks of a coup (plotted, attempted, or successful) and the level of military spending at the time. They found that in countries with a low coup risk, governments respond by reducing military spending, whereas in countries with a high coup risk, governments tend to increase military spending.

This paper turns literature to consider beyond domestic factors by investigation of spatial factors. Coups in neighboring countries may increase domestic military budget. Under a lot of conflicts in Sub-Saharan Africa, an increase of arm budgeting in one country induces incentives to power group in another country to make a coup.

The next section is definition and sources of data, then the third is estimation framework. The forth is to interpret results and the last is conclusive remarks.

2 Definition and Sources of Data

The period of analysis ranges from 1981 to 2003. Most of Sub-Saharan African countries were independent and majority ruled before 1980 [McGowan (2003)], then year 1981 kicked off the second democratization wave in Africa. This paper covers a sample of 37 countries in Sub-Saharan Africa.[1]

Coup d'etat. Coup d'etat is a kind of irregular and unofficial change of government. Most of the papers use the word "coup d'etat" instead of successful coup only, while this paper separates successful coup, denoted by *success*, from all types of coups, denoted by

[1] Only four countries of Sub-Saharan Africa which are Zimbabwe, Namibia, Eritrea and South Africa were independent after 1980 at different years, hence most of the studies started their analysis at 1981. There are 43 data-available countries in Sub-Saharan Africa. Six omitted countries from this paper are Djibouti, Eritrea, Equatorial Guinea, Lesotho (due to incomplete data), Somalia (due to unavailable information) and Madagascar (due to island-being isolation).

coup. Both of them are estimated as dependent variables in this paper. The dataset on the variable coup d'etat is taken from Marshall and Marshall (2009), Center for Systemic Peace. A coup d'état is defined as a forceful seizure of executive authority and office by a dissident/opposition faction within the country's ruling or political elites that results in a substantial change in the executive leadership and the policies of the prior regime. This dataset provides four types of coup which are 1) successful coup; 2) attempted (failed) coup; 3) plotted (or planned) coup; and 4) alleged coup plot. According to the dataset, the first type is coded to the variable *success* and the summation of all types is coded to the variable *coup*.

International Commodity Prices Growth. The variable international commodity prices growth, denoted by *ind*, is obtained from Brückner and Ciccone (2010). The starting point is monthly international commodity price data for 19 commodities starting in 1980 from the International Monetary Fund. Averaging across all observations in a calendar year yields an annual price series for each commodity i, $P_{i,t}$ (the 1990 value is set equal to unity for all commodities). The commodity prices growth rate for country c in this paper is the 3-year average value of the annual commodity prices growth rates between t and $t-2$.

Rainfall Variation. The variable rainfall variation, denoted by *rain*, for the 1981-2003 period is taken from Brückner and Ciccone (2010).

Democratic Transition. Transitions to democracy are collected by the Polity IV project defining countries being democracy if their Polity2 score is strictly positive; otherwise they are non-democracy. To capture transitions to democracy, this paper assigns a change of Polity2 score between year $t-1$ and t, denoted by $\Delta polity2$. This variable aims to capture spread of democracy in Sub-Saharan Africa during period of study.

Real Income Growth. Data for annual real GDP per capita growth is taken from the World Development Indicators (2010).[2] It is denoted by *growth*. This varaiable was adjusted by the terms-of-trade since the short-run effect of commodity prices on income could come through a terms-of-trade effect.

[2] The data is available at http://data.worldbank.org/data-catalog/world-development-indicators.

3 Method of Estimation

3.1 Estimation Framework

The benchmark equation links the likelihood of coup, called *coup* from now on, to rainfall variation, commodity prices growth, change of polity2, country characteristics, specific time trends and common time dummies. The independent variables rainfall variation and commodity prices growth link to the likelihood of coup at time t to instrument income growth of Sub-Saharan Africa. This is to avoid causality problem of two-way relationship between contemporaneous income growth and the occurrence of coup.;

$$coup_{i,t} = \beta_1 rain_{i,t-1} + \beta_2 ind_{i,t-1} + \beta_3 \Delta polity2_{i,t-1} + \mu_i + \gamma_i t + \delta_t + u_{i,t},$$

where i indicates country of interests and t indicates year. The variable coup can be replaced by the variable coup d'etat, denoted by *coup*, or successful coup, denoted by *success*, in each of specific models. The variable *rain* is rainfall variation, *ind* is international commodity prices growth, $\Delta polity2$ is change of polity2 in the consecutive years, μ_i is time-invariant dummies, $\gamma_i t$ is a specific time trends, δ_t is common time dummies, and $u_{i,t}$ is an error term.

This estimation technique aims to overcome one of the traditional assumptions of ordinary least squares which presumes no correlation between error terms ($corr(\varepsilon_i, \varepsilon_j) \neq 0$), particularly, among locations. In accordance with the literature, a coup event is one case which violates this assumption. Coup in a specific location can affect and be affected by surrounding coups. However the effect among these locational spreads may take time, and the diffusion may not be observed at the static analysis. Inclusion of time will illustrate the escalation or movement of coups among spaces, then the main advantage of spatial panel data model is a capability to estimate the effects of space and time dimensions at the same time.

Therefore, the benchmark model is extended to Durbin spatial panel data model to propose space-time filter and allows for the spatial error correlation;

$$\begin{aligned} coup_{i,t} &= \psi_0 W_{ij}.coup_{j,t} + \psi_s W_{ij}.coup_{j,t-s} + \beta_1 rain_{i,t-1} + \beta_2 ind_{i,t-1} \\ &\quad + \beta_3 \Delta polity2_{i,t-1} + \theta_1 W_{ij}.growth_{j,t-1} + \theta_2 W_{ij}.\Delta polity2_{j,t-1} \\ &\quad + \mu_i + \gamma_i t + \delta_t + \varepsilon_{i,t}. \end{aligned}$$

The spatial weight matrix, denoted by W_{ij}, is to identify neighbors and their weights inside.

In the equation, the presence of variable *coup* on both the left and right sides therefore means a correlation-between-errors-and-regressors problem. The resulting least-squared estimates will be biased and inconsistent. The maximum likelihood estimation method for evaluating the diffusion effects is more suitable than the ordinary least square. (LeSage (1998) and Bivand (2008)) Indeed the estimation in this paper is done by maximum likelihood method.

According to LeSage and Pace (2009) and Elhorst (2010), the coefficient ψ is interpreted as **direct diffusion effect** linking neighbors' coup to our coup in this case. The role of domestic variables to the likelihood of coup is value of the coefficient β. The coefficient θ is defined as **indirect diffusion effect** linking neighbors' income growth to our coup. The coefficient ψ_0 indicates the probability of the existence of coup among our country and neighbors at the same year. This coefficient is interpreted as the likelihood of the cluster or checkerboard of coup. The concept of cluster is the agglomeration of similar events in space. A positive value of the coefficient ψ_0 means high or low values of the variable coup event tend to cluster in space. Yet a negative value of the coefficient ψ_0 means that our location tends to be surrounded by neighbors with dissimilar values like a checkerboard. In other word, countries with coup are likely surrounded by neighbors without coup, or vice versa.

Since the diffusion process needs the role of time to be contagious, only the cluster coefficient ψ_0 which is based on static period may not be enough to conclude about the existence of diffusion. The coefficient ψ_s represents the relationship of the likelihood of coup between countries and neighbors over time. For example, in case of s is equal to one, the contagion coefficient ψ_1 can be interpreted as the probability to be couped of our country this year from surrounding coups last year.

The contagion coefficient variable is very important to confirm diffusion effect. Only the statistical significance of the cluster coefficient does not always point out the diffusion effect, because the other independent variables may lead to cluster by chance. For instance, the data of coup around the world may suggest that there are some obvious clusters of coup. It is probably not because of the diffusion of coup itself but it is because of the cluster of low income countries which low income generates coup d'etat. In contrast, if the statistical significance turns to be the contagion coefficient and the cluster coefficient does not, the diffusion can still be explained.

3.2 Spatial Weight Matrix

To define neighboring countries, this paper uses three methods.

The first one is the **Contiguity Queen Neighboring Method**.[3] Countries sharing common borders are defined neighbors. The particular definition of border applies to country not only connected by land, but also to country divided by river, lake, mountain or any other partitions. This concept focuses on the territorial line of each observation, but varies in the number of links and distance.

Second, the **Distance-based Neighboring Method** counts countries as neighbors if their centroid points are within distant band. To avoid that some countries have no neighbor, this paper specifies the maximum distance between the centroid of two border-sharing countries as the distant band. Distance-based neighbors implies the constantly distant radius from specific location, but varies in the number of links without concerning any contiguity.

The third method is the **Nearest Neighboring Method**. This method counts as neighbor only the nearest country measuring the distance between two centroids. Hence it

[3]This method is called Queen because it is referred to the queen in chess playing which can move in every direction. There are also Rook and King concepts to differentiate direction of movement.

specifies the exact amount of links which is one in this paper, but varies in distance without concerning contiguity. Besides this method can specifies any numbers of nearest neighbors and this paper specifies only one, so from now on it is called one-nearest neighbor.

This paper applies all three methods to create spatial weight matrix in each specific equation. However the models also need another spatial weight matrix to allow for spatial diffusion of error term. At the same time, the estimation has to be aware of a potential identification problem which is the correlation between spatial error term and other regressors. This paper employs second-degree contiguity queen neighbors, two layers of border sharing countries for the spatial weight matrix of error term.

Figure 1 shows the links resulting for each type of neighbor matrix. Each of the nodes represents the centroid of each country, so one country has only one node. Each line shows the links among neighboring countries. Within distant band, smaller countries tend to be clustered more than bigger ones. There are more numbers of neighbors for smaller countries in the distance-based neighboring method, while size of the countries does not affect the number of links in other neighboring methods.

The summary statistics of the number of links is presented in Table 1. There are 37 countries in each neighboring matrix. The average number of border sharing neighbors for one country is 4.3, while the average for distance-based method is 5.9 neighbors. Since the distance-based neighboring method covers larger area than the other methods, it includes as much as 220 neighbor links. Contiguity queen and one-nearest neighboring methods result in 160 and 37 links, respectively.

To specify spatial weights to neighbor relationship, this paper uses row standardized method. This method identifies each weight by the average value across the total amount of neighbors of each country. For example, countries with four neighbors will have the value one-forth for each weight. The concept behind this weighting method is the lower is the number of neighbors a country has, the more powerful the diffusion effects can be. That is high diffusion effects in case of countries with very few neighbors. According to the three neighboring method, the value of weights would not be the same for each of the weight matrices. Countries under the one-nearest neighboring method has only one neighbor, so their values of weights are always equal to one. The values of each weight specified under the contiguity queen and distance-based neighboring concepts are less and the least due to the number of neighbors included.

These three methods may be complementary in theirapplication. One-nearest neighbor concept has the strongest link with value one in every link but just only one link per country. Distance-based is the broadest concept, so it has the most links with the lowest value per link. There is a trade-off between number and strength of links. Contiguity-queen concept relies on common border, then it is likely in between the range of trade-off.

4 Results

Given the binary coding of the dependent variables coup d'etat, denoted by *coup* and successful coup, denoted by *success*, this paper estimates spatial fixed effect model without neighbor as a benchmark specification. The country specific characteristics, specific time trends and specific time dummies are included in all equations. LM-lambda statistics is shown at the end of each equation to test specification of spatial fixed effects model.

Each of the tables reports coefficients of variables of interests categorized into three groups. The first group is domestic coefficients which are rainfall variation, international commodity prices growth and change of polity2. The second group is the spatial autoregressive coefficients which indicate the direct diffusion effects. The coefficient of contemporaneous spatial correlation, denoted by either $W_{ij}.coup_{i,t}$ or $W_{ij}.success_{i,t}$, points out the cluster or checkerboard of coups, while the coefficient of lagged spatial correlation, denoted by $W_{ij}.coup_{i,t-1}$ or $W_{ij}.success_{i,t-1}$, indicates contagion process. The third group is spatial independent coefficients to report the indirect diffusion effects from neighbors' income growth and polity2, denoted by $W_{ij}.growth_{i,t-1}$ and $W_{ij}.\Delta polity2_{i,t-1}$ respecively, to our likelihood of coup d'etat. The equations in each table are categorized into two groups; the variables coup d'etat in column (1)-(4) and successful coup in column (5)-(8), then presented through four types of neighbors in each column; with no neighbor, contiguity queen neighbors, distance-based neighbors and one-nearest neighbor.

4.1 Results for the Whole Period

The results for the whole period 1981-2003 of the likelihood of coup d'etat and successful coup are contained in Table 2.

Coup d'etat. Column (1) in Table 2 presents a result of the domestic determinants for the likelihood of coup d'etat. It replicates the benchmark specification in the literature. Some papers suggested that lower income per capita growth increases the likelihood of coup d'etat, while some others did not find any significance. This paper estimates reduced form equations replacing domestic income growth by rainfall variation and commodity prices growth to avoid causality relationship. The equation also controls for spread of democracy by the variable change of polity2. The result shows the likelihood of coup d'etat linking to prices growth around 10 percentage points and change of polity2 around -1 percentage point with statistical significance. However, the variable rainfall variation has no significant effect.

After adding neighboring effects in column (2)-(4), the results of domestic determinants do not change in term of significant level. Column (2) with contiguity queen neighbors shows the contemporaneous effect indicating the probability of coup checkerboard around 1.3 percentage points. The effect with distance based neighbors in column (3) is more negative than the previous one to 14.6 percentage points, while the effect with one-nearest neighbor in column (4) is at -6 percentage points. All three coefficients are strongly statistically significant. It confirms the occurrence of coup checkerboard pattern in this region. The lagged spatial effects indicating contagion process and the indirect effects are not significant regardless of neighboring types. This points out that when coup happens in one country, government in neighboring countries may be on the alert against coups in his countries. Later, it reduces the likelihood of coup in neighboring countries.

In summary, to the whole period commodity prices growth increases and level of democracy decreases the likelihood of coup d'etat. There is an existence of coup checkerboard in every type of neighbors, but there is no contagion process and indirect effect. This suggests that government in neighboring country may guard himself against coup.

Successful Coup. Column (5) shows a result of domestic determinants to the likelihood of successful coup. The variables rainfall variation and change of polity2 do not affect the successful coup, but only the variable prices growth does around 5 percentage points. The checkerboard patterns of successful coups exist in every type of neighbors. The probability being checkerboard patterns at contiguity queen neighbors is 12.7 percentage points, distance-based neighbors 11.6 percentage points and one-nearest neighbor 5 percentage points. This result is similar to the result of coup d'etat, since government in neighboring countries may increase monitor against coups in his countries

The indirect diffusion effect of neighbors' income growth plays role in our likelihood of successful coup. Under the contiguity queen neighbors, income growth increases its likelihood around 40 percentage points, while it increases 26.4 percentage points to the case of distance-based neighbors. The higher neighbors' economies grow, the higher the probability to succeed coup in our country. Growth in neighboring countries may induce people support for coup or, at least, righteousness for possible coup. It reduce people resistance for coup, so it increases probability to succeed coup. However, the neighbors' change of polity2 does not statistically cause the likelihood of successful coup. This result shows no effect of democracy spread to successful coup.

In sum, to the domestic factors, commodity prices growth increases the likelihood of successful coup, while rainfall variation and change of polity2 do not. To the spatial factors, there is an existence of successful coup checkerboard as same as the spread of coups. The interesting point is that neighbors' growth does increase the probability to succeed our coup because it reduces citizen's friction to succeed coup. The spread of democracy which affects the likelihood of coup seems not to cause the successful coup.

4.2 Results for the Period before the End of Cold War

The results for the period before the end of cold war, particularly 1981-1991, of the likelihood of coup d'etat and successful coup are contained in Table 3.

Coup d'etat. Column (1) in Table 3 presents the equation of the domestic determinants for the occurrence of coup d'etat. The commodity prices growth and the change of polity2 affect the likelihood of coup d'etat before the end of cold war as same as for the whole period. The coefficient value of commodity prices growth in the period before cold war end is more twice than of the whole period, while the coefficient value of change of polity2 is triple. These values of coefficients indicate the importance of domestic factors to the likelihood of coup before the end of cold war. After adding neighboring effects in column (2)-(4), the results of domestic determinants do not change in term of significant level. Interestingly, all coefficients of spatial effects are not statistically significant, both direct and indirect effects. Thus, they indicate role of domestic factors to the likelihood of coup during this period.

Successful Coup. Column (5) shows the result of domestic determinants to the likelihood of successful coup. There is no any significant coefficient in this equation. However, after adding the spatial coefficients in column (6)-(8) the domestic variable rainfall variation turns to be significant. It affects the likelihood of successful coup in negative direction around 10 percentage points, while the variables prices growth and change of polity2 do not. To the case of contiguity queen neighbors in column (6), the probability of checkerboard existence is around 12 percentage points. There is no significance of contagion process and indirect diffusion effect from income growth to the likelihood of successful coup. The spread of democracy captured by neighbors' change of polity2 reduces our likelihood of successful coup. An increase of 1 point of polity2 reduces a 3.2 percentage points of probability to succeed. Due to the one-nearest neighbor case, the probability of checkerboard turns to be insignificant. The probability of contagion process however is strongly significant at 14.1 percentage points. The indirect diffusion effect of income growth is positive but insignificant. The spread of democracy decreases the likelihood of successful coup around 1.3 percentage points. However there is no any significant spatial coefficients in the case of distance-based neighbors.

In short, the domestic factors play more important role than the spatial factors. The commodity prices growth and change of polity2 affect the likelihood of coup d'etat, while they do not to the successful coup. Likewise, the rainfall variation relates to the likelihood of successful coup, while the prices growth and change of polity2 do not. On the one hand, the coup events can be happened by some pressure groups who concentrate on their benefits. Most of their benefits depend on commodity prices. So prices are incentive to make coup for controlling government power to allocate resource. On the other hand, the success of coup needs support by citizen, at least in some aspects. Rainfall variation is a way to explain this logic. If rainfall grows, it is like a distribution of income growth to the people who mostly work in agricultural sector. They will get richer, so they do not want coup d'etat. Thus, income distribution mechanism in each country does not affect the number of coup but control the probability to succeed.

Moreover, spread of democracy, measured by change of polity2, cannot reduce the likelihood of coup d'etat. This may be because coup happens by the conflict among elites, and they are not interested in democratic development in their neighboring countries. However, the spread of democracy decreases the probability to succeed coup with statistical significance. It reduces support from citizens for that chance, so it is somehow an increase of cost of successful coup.

4.3 Results for the Period after the End of Cold War

The results for the period after the end of cold war during 1992-2003 of the likelihood of coup d'etat and successful coup are contained in Table 4.

Coup d'etat. Column (1) in Table 4 presents result of the domestic determinants on the likelihood of coup d'etat. All of the domestic coefficients rainfall variation, commodity prices growth and change of polity2 do not significantly affect the likelihood of coup d'etat. Moreover their values of coefficients are very low and close to zero, especially for commodity prices growth and change of polity2. After adding neighboring effects in column (2)-(4), results of domestic determinants do not change and they are still insignificant. All of them absolutely turn from the strong significant in the case of before the end of cold war to be insignificant in the case of after the end of cold war. It suggests that the role of domestic factors stops at the same time with cold war ends. Due to the spatial coefficients of contiguity queen neighbors, the probability of checkerboard exists around 20 percentage points, while there is no other spatial effects on the likelihood of coup d'etat. To the distance-based neighbors, the probability of checkerboard is increased to 27 percentage points. The contagion process and the indirect diffusion effect of income growth are not significant, while the indirect diffusion effect of polity2 is positively significant around 2.7 percentage points. This might be the case of coup against democracy during the period of spread of dmocracy after the end of cold war. To the one-nearest neighbor, the result is similar to the case of distance-based neighbors. The probability of checkerboard is around 8.4 percentage points and of the indirect diffusion effect of polity2 is around 1.4 percentage points. These significant contemporaneous coefficients point out the importance of coups in neighboring countries to reduce the likelihood of coup in our country.

Successful Coup. Results of domestic determinants on the likelihood of successful coup in column (5)-(8) are similar to the case of coup d'etat. All of the domestic factors are insignificant to affect the probability to succeed coup. After adding the contiguity queen neighbors coefficients in column (6) the probability of checkerboard exists around 17 percentage points. There is no significance of contagion process. The indirect diffusion effect of income growth is highly significant to increase the probability to succeed, but the one of polity2 is not. To the case of distance-based neighbors, the probability of checkerboard exists around 20 percentage points and the probability of contagion process is around -36.8 percentage points. The indirect diffusion effect of income growth is still significant to increase the probability to succeed, but the one of polity2 is not. Income growth in neighboring countries may provide future hope to the citizens, then they might support for their coup. However, the spatial results with the one-nearest neighbor are not significant in any coefficients. This may suggest the effect of regional level rather than the country level.

In brief, after the end of cold war domestic determinants do not play any role to the likelihood of coup d'etat and successful coup. The spatial effects to both the coup d'etat and successful coup in this period has increased a lot relative to before the end of cold war. They indicate that when coups happen in neighboring countries, it clearly decreases the likelihood of our coup. This might be the role of world level organisations such as United Nation to against coup diffusion in the region. After the end of cold war, a lot of international organisations create sanction or diplomatic mechanisms to pressure African countries being more democratised.

4.4 Results for the Cover Area

The next question should be tested is how far the spatial effects go beyond. Since the spatial effects have been found only the period after the end of cold war, this paper considers the length of dispersion only this period 1992-2003.

Coup d'etat. Table 5 presents results of the likelihood of coup d'etat with extensive cover area of neighbors. Column (1)-(3) indicate the different layers of neighbors' border from one to three layers respectively. Column (4)-(9) show the numbers of times of the maximum distance between the centroid of two border-sharing countries as the distant band. The values start from 1.0 increased by 0.2 to 2.0, respectively. Column (10)-(12) present the different numbers of nearest neighbors from one to three neighbors.

The results confirm the insignificant domestic factors to the likelihood of coup d'etat, the results of checkerboard however are significant and robust in every type of neighbors. The values of coefficients tend to increase when the distance increases. On the one hand, world organisations play role to pressure all countries of the whole continent against coup d'etat, so negative probability of coup d'etat is propsed to all of them. So pressure power, can be observed as an effect of negative contemporaneous coefficients, should be almost constant regardless of how far distance is. On the other hand, the closer countries should get higher probability of coup d'etat dispersion than the further ones. After combining these two effects, the final results are that the closer countries have less negative values of the probability of coup d'etat.

Successful Coup. Table 6 presents results of the likelihood of successful coup with several extensive cover area of neighbors. Column (1)-(3) indicate the different layers of neighbors' border from one to three layers respectively. Column (4)-(9) show the numbers of times of the maximum distance between the centroid of two border-sharing countries as the distant band. The values start from 1.0 increased by 0.2 to 2.0, respectively. Column (10)-(12) present the different numbers of nearest neighbors from one to three neighbors.

Again, the domestic determinants are insignificant no matter which type of neighbors. The contemporaneous effects of diffusion are negative to all neighboring types. Results of coefficient values are similar to the case of coup d'etat which is that the closer countries have less negative values. This may be by same reason of the combination between the pressure of world organisations and the dispersion of successful coups themselves. Moreover, the neighbors' income growth significantly increases the probability to succeed coup. This might be because neighbors' income growth provides future hope to citizens being higher achievement. Then it may loosen the friction to succeed coup.

5 Concluding Remarks

This paper investigates how different types of coup in a country, coup d'etat and successful coup, are affected by those of their neighbor countries. The analysis exploits the state of the art techniques in spatial panel data analysis. The estimation framework is based on spatial panel data fixed effect model with maximum likelihood estimation to avoid the correlation among variables in the left- and right-side of the equation. Spatial diffusion of both direct and indirect channels is allowed under different relevant neighboring networks (contiguity-queen neighbors, distance-based neighbors and one-nearest neighbor). The first definition limits attention to countries sharing borders, the second allows to consider more distant areas while the last considers narrow to only the nearest country.

The findings point out different key factors of the likelihood of coup d'etat and successful coup in different periods. Before the end of cold war, domestic factors which are commodity prices growth, as proxy of income growth, and change of polity2, as proxy of democratic development, show a significant effect on the likelihood of coup d'etat. An increase of commodity prices growth induces the likelihood of coup d'etat via building incentive up for pressure groups to control over government power, while democratic development is an obstacle to the possibility to make a coup. Results on the likelihood of successful coup show that an increase of rainfalls is a key role. Rainfalls variation can be interpreted as a proxy of distributed income growth, so it suggests that the probability to overwhelm government power would increase if coup is supported by citizens. However, no significance of spatial determinants is found in this period.

After the end of cold war period, domestic determinants seem not have any effect to the likelihood of coup d'etat and successful coup. None of them is statistical significant in the models. Meanwhile, spatial factors clearly play a key role to reduce the likelihood of coup d'etat and successful coup. This is because when cold war stopped international organisations and Western countries direct major functions to promote democracy to our world. They pressure countries being more democratised and seriously sanction the process against democratised like coup d'etat. Coup in one country in this period would decrease the probability of coup existence in other countries. This conclusion is robust at least for reduction of coup possibility of any country in the whole Sub-Saharan African region. Moreover, results find that change of polity2 in neighboring countries increases the likelihood of coup d'etat to prevent democracy spread in their country, and income growth in neighboring countries increases the likelihood of successful coup due to provision of future hope.

These findings confirm the important role of international organisations to promote democracy or against autocracy. Spread of democracy in the region will accelerate democracy for the whole. Regional economic development under concerning inequality is a necessary condition, nevertheless citizens may turn to support coup rather than democracy in their country.

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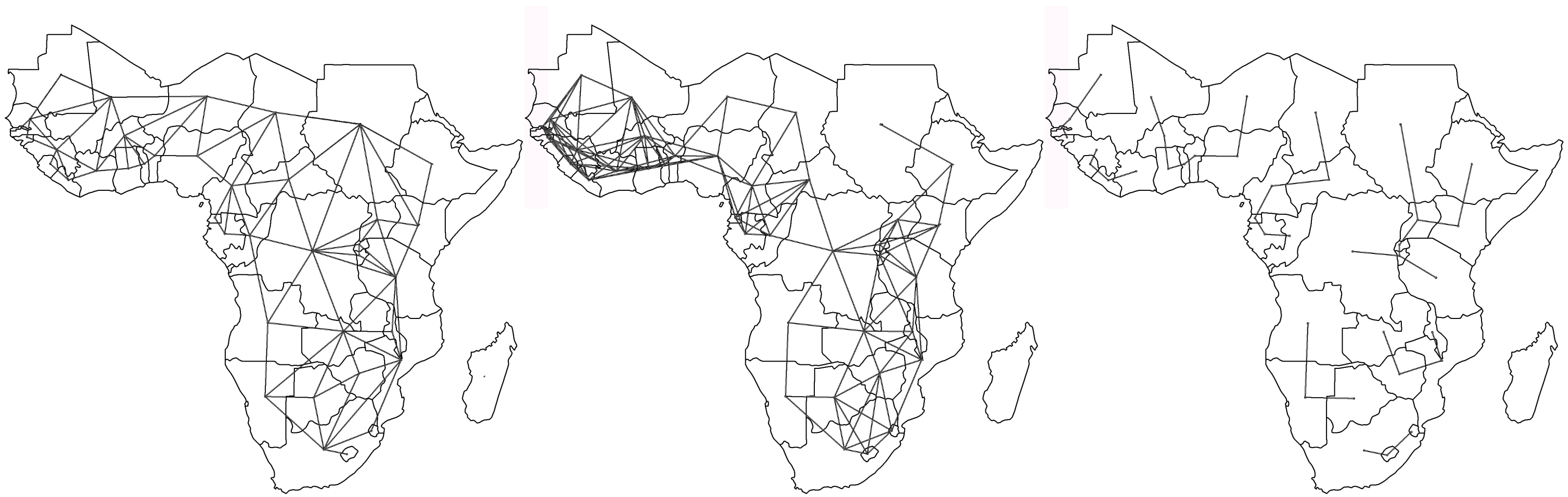
Table 1: Summary Statistics of Neighbor Matrix

	Contiguity Queen	Distance-based	One-nearest
Number of regions:	37	37	37
Number of nonzero links:	160	220	37
Percentage nonzero weights:	11.6	16.7	2.7
Average number of links:	4.32	5.94	1.00



(a) Contiguity Queen Neighbors (b) Distance-based Neighbors (c) One-nearest Neighbor

Figure 1: Nodes and Links of Neighbors

Table 2: Spatial Panel Data Estimates of Coup d'etat and Successful Coup

	Coup				Success			
	No Neighbor (1)	Contiguity Queen (2)	Distance-based (3)	K-nearest (4)	No Neighbor (5)	Contiguity Queen (6)	Distance-based (7)	K-nearest (8)
Coefficients:								
$rain_{it-1}$	-0.001	-0.005	-0.001	-0.003	-0.016	-0.028	-0.022	-0.017
	(0.063)	(0.061)	(0.061)	(0.061)	(0.034)	(0.032)	(0.032)	(0.032)
ind_{it-1}	0.098*	0.099**	0.098**	0.095**	0.056**	0.052**	0.054**	0.054**
	(0.05)	(0.048)	(0.048)	(0.048)	(0.027)	(0.025)	(0.025)	(0.025)
$\Delta polity2_{it-1}$	-0.011*	-0.010**	-0.010*	-0.011**	-0.001	-0.002	-0.002	-0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.002)	(0.002)	(0.002)
Spatial Autoregressive Coefficients:								
$W_{ij}.coup_{it}$		-0.013***	-0.146***	-0.060**				
		(0.049)	(0.056)	(0.028)				
$W_{ij}.coup_{it-1}$		0.054	0.026	0.056				
		(0.075)	(0.091)	(0.037)				
$W_{ij}.success_{it}$						-0.127***	-0.116**	-0.050*
						(0.048)	(0.056)	(0.028)
$W_{ij}.success_{it-1}$						-0.012	-0.086	0.049
						(0.074)	(0.094)	(0.034)
$W_{ij}.growth_{it-1}$		-0.012	-0.069	0.071		0.386***	0.264*	0.108
		(0.259)	(0.298)	(0.129)		(0.138)	(0.16)	(0.069)
$W_{ij}.\Delta polity2_{it-1}$		-0.002	0.020	0.009		-0.006	-0.005	-0.001
		(0.011)	(0.013)	(0.005)		(0.005)	(0.007)	(0.003)
Statistical Reports:								
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM-Lambda		3.32	4.129	2.821		0.706	0.402	0.394
		(0.000)	(0.000)	(0.004)		(0.479)	(0.687)	(0.693)
Observations	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with t-statistics (shown in parentheses). The models are spatial fixed effects controlled by both individual country and time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Table 3: Spatial Panel Data Estimates of Coup d'etat: Before End of Cold War (1981-1991)

	Coup				Success			
	No Neighbor (1)	Contiguity Queen (2)	Distance-based (3)	K-nearest (4)	No Neighbor (5)	Contiguity Queen (6)	Distance-based (7)	K-nearest (8)
Coefficients:								
$rain_{it-1}$	-0.046	-0.066	-0.062	-0.051	-0.098	-0.124**	-0.111*	-0.099*
	(0.114)	(0.108)	(0.109)	(0.107)	(0.061)	(0.058)	(0.058)	(0.057)
ind_{it-1}	0.213**	0.212***	0.215***	0.215***	0.066	0.068	0.068	0.06
	(0.086)	(0.08)	(0.081)	(0.081)	(0.046)	(0.043)	(0.043)	(0.043)
$\Delta polity2_{it-1}$	-0.034***	-0.033***	-0.033***	-0.033***	-0.002	-0.002	-0.002	-0.003
	(0.011)	(0.01)	(0.011)	(0.01)	(0.006)	(0.005)	(0.005)	(0.005)
Spatial Autoregressive Coefficients:								
$W_{ij}.coup_{it}$		-0.089	-0.061	-0.044				
		(0.069)	(0.079)	(0.040)				
$W_{ij}.coup_{it-1}$		0.148	0.041	0.063				
		(0.105)	(0.125)	(0.055)				
$W_{ij}.success_{it}$						-0.119*	-0.060	-0.042
						(0.070)	(0.079)	(0.04)
$W_{ij}.success_{it-1}$						0.077	0.123	0.141***
						(0.095)	(0.123)	(0.051)
$W_{ij}.growth_{it-1}$		-0.198	0.225	-0.129		0.247	0.239	0.078
		(0.411)	(0.423)	(0.21)		(0.222)	(0.227)	(0.112)
$W_{ij}.\Delta polity2_{it-1}$		0.005	0.016	-0.000		-0.032***	-0.020	-0.013**
		(0.021)	(0.027)	(0.011)		(0.011)	(0.014)	(0.006)
Statistical Reports:								
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM-Lambda		1.922	1.903	1.056		1.855	3.079	1.384
		(0.054)	(0.056)	(0.290)		(0.063)	(0.002)	(0.166)
Observations	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with t-statistics (shown in parentheses). The models are spatial fixed effects controlled by both individual country and time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Table 4: Spatial Panel Data Estimates of Coup d'etat: After End of Cold War (1992-2003)

	Coup				Success			
	No Neighbor (1)	Contiguity Queen (2)	Distance-based (3)	K-nearest (4)	No Neighbor (5)	Contiguity Queen (6)	Distance-based (7)	K-nearest (8)
Coefficients:								
$rain_{it-1}$	0.033	0.037	0.034	0.032	0.024	0.018	0.019	0.022
	(0.073)	(0.068)	(0.068)	(0.068)	(0.039)	(0.036)	(0.036)	(0.037)
ind_{it-1}	0.002	0.005	-0.001	-0.002	0.03	0.02	0.024	0.028
	(0.063)	(0.059)	(0.058)	(0.059)	(0.034)	(0.031)	(0.031)	(0.032)
$\Delta polity2_{it-1}$	-0.001	-0.001	-0.000	-0.001	-0.000	-0.000	-0.000	-0.000
	(0.006)	(0.005)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
Spatial Autoregressive Coefficients:								
$W_{ij}.coup_{it}$		-0.194***	-0.269***	-0.084**				
		(0.068)	(0.079)	(0.039)				
$W_{ij}.coup_{it-1}$		0.014	-0.061	0.046				
		(0.108)	(0.133)	(0.049)				
$W_{ij}.success_{it}$						-0.170**	-0.203***	-0.064
						(0.068)	(0.078)	(0.039)
$W_{ij}.success_{it-1}$						-0.147	-0.368**	-0.046
						(0.121)	(0.147)	(0.046)
$W_{ij}.growth_{it-1}$		-0.211	-0.263	0.115		0.427**	0.375*	0.126
		(0.321)	(0.404)	(0.155)		(0.173)	(0.22)	(0.084)
$W_{ij}.\Delta polity2_{it-1}$		-0.001	0.027*	0.014**		0.005	-0.001	0.002
		(0.012)	(0.014)	(0.006)		(0.006)	(0.008)	(0.003)
Statistical Reports:								
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM-Lambda		2.023	2.684	3.568		0.744	0.317	0.785
		(0.043)	(0.007)	(0.000)		(0.456)	(0.750)	(0.432)
Observations	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with t-statistics (shown in parentheses). The models are spatial fixed effects controlled by both individual country and time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Table 5: Extension of neighbors in Spatial Panel Data Estimates of Coup d'etat: 1992-2003

	No. of Contiguity Layers			Times of Distance-based Neighbors						No. of K-nearest Neighbors		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Coefficients:												
$rain_{it-1}$	0.035	0.04	0.048	0.034	0.034	0.032	0.036	0.038	0.038	0.029	0.035	0.04
	(0.068)	(0.068)	(0.068)	(0.067)	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)	(0.067)
ind_{it-1}	0.001	0.001	0.003	-0.002	0.000	0.002	0.004	0.001	-0.000	-0.000	0.001	-0.004
	(0.058)	(0.058)	(0.058)	(0.058)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.058)	(0.058)
$\Delta polity2_{it-1}$	-0.001	-0.001	-0.002	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000	-0.000
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Spatial Autoregressive Coefficients:												
$W_{ij}.coup_{it}$	-0.194***	-0.340***	-0.527***	-0.272***	-0.212**	-0.247**	-0.239*	-0.253*	-0.279*	-0.084**	-0.158***	-0.214***
	(0.068)	(0.128)	(0.186)	(0.079)	(0.099)	(0.117)	(0.126)	(0.141)	(0.152)	(0.039)	(0.052)	(0.065)
$W_{ij}.growth_{it-1}$	-0.208	0.653	-0.622	-0.261	0.097	0.264	0.118	0.225	0.171	0.097	-0.025	0.121
	(0.321)	(0.619)	(0.983)	(0.402)	(0.500)	(0.626)	(0.663)	(0.785)	(0.853)	(0.153)	(0.207)	(0.266)
$W_{ij}.\Delta polity2_{it-1}$	-0.001	0.008	-0.067**	0.027*	0.006	-0.003	-0.001	-0.018	-0.024	0.012**	0.021**	0.014
	(0.012)	(0.021)	(0.034)	(0.014)	(0.018)	(0.020)	(0.022)	(0.025)	(0.027)	(0.006)	(0.009)	(0.011)
Statistical Reports:												
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM-Lambda	2.016	2.095	1.242	2.693	2.403	2.139	2.24	1.557	1.249	3.508	2.766	2.894
	(0.043)	(0.036)	(0.214)	(0.007)	(0.016)	(0.032)	(0.025)	(0.119)	(0.211)	(0.000)	(0.005)	(0.003)
Observations	851	851	851	851	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with t-statistics (shown in parentheses). The models are spatial fixed effects controlled by both individual country and time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.

Table 6: Extension of neighbors in Spatial Panel Data Estimates of Successful Coup: 1992-2003

	No. of Contiguity Layers			Times of Distance-based Neighbors						No. of K-nearest Neighbors		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Coefficients:												
$rain_{it-1}$	0.025	0.029	0.027	0.025	0.025	0.027	0.027	0.029	0.028	0.025	0.024	0.027
	(0.037)	(0.036)	(0.037)	(0.037)	(0.037)	(0.036)	(0.037)	(0.036)	(0.036)	(0.037)	(0.037)	(0.037)
ind_{it-1}	0.028	0.031	0.031	0.031	0.03	0.031	0.032	0.028	0.029	0.03	0.035	0.035
	(0.032)	(0.031)	(0.031)	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)	(0.031)	(0.032)	(0.032)	(0.031)
$\Delta polity2_{it-1}$	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Spatial Autoregressive Coefficients:												
$W_{ij}.success_{it}$	-0.161**	-0.442***	-0.552***	-0.171**	-0.267***	-0.445***	-0.406**	-0.576***	-0.697***	-0.066*	-0.126**	-0.200***
	(0.068)	(0.130)	(0.184)	(0.078)	(0.099)	(0.123)	(0.134)	(0.159)	(0.175)	(0.039)	(0.052)	(0.065)
$W_{ij}.growth_{it-1}$	0.428**	1.221***	1.538***	0.419*	0.732***	1.127***	0.925***	1.176***	1.314***	0.133	0.222**	0.337**
	(0.173)	(0.330)	(0.534)	(0.220)	(0.269)	(0.334)	(0.357)	(0.419)	(0.452)	(0.083)	(0.113)	(0.144)
$W_{ij}.\Delta polity2_{it-1}$	0.006	-0.005	-0.032*	0.002	-0.000	-0.002	-0.003	-0.005	-0.006	0.003	0.003	0.002
	(0.006)	(0.011)	(0.018)	(0.008)	(0.009)	(0.011)	(0.012)	(0.013)	(0.014)	(0.003)	(0.005)	(0.006)
Statistical Reports:												
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Specific Time Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LM-Lambda	0.727	0.747	1.161	0.383	0.613	1.481	1.817	1.761	1.574	0.809	0.538	0.948
	(0.467)	(0.454)	(0.245)	(0.701)	(0.539)	(0.138)	(0.069)	(0.078)	(0.115)	(0.418)	(0.590)	(0.343)
Observations	851	851	851	851	851	851	851	851	851	851	851	851
Countries	37	37	37	37	37	37	37	37	37	37	37	37

Method of estimation is maximum likelihood on spatial panel data model with t-statistics (shown in parentheses). The models are spatial fixed effects controlled by both individual country and time effects. Country i is the country of interest and country j is neighbors of country i. ***, **,* indicate significance at 1-, 5-, and 10-percent level, respectively.