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Conflict Fragmentation Index

Abstract: It is widely accepted that fragmentation influences conflict processes in a profound way. Multi-party conflicts with several fronts are notoriously hard to resolve. However, there is no easily computable measure to approximate conflict fragmentation. In this article, we introduce the Conflict Fragmentation Index (CFI), which is computed by adapting the Herfindahl–Hirschman Index. The CFI considers the relative prominence of each dyadic-level conflict-fronts nested in the entire civil war. The relative prominence is approximated by using available information on conflict casualties. The CFI is time-variant and highly sensitive to battlefield dynamics. The flexibility of CFI can bring several advantages. Most notably, it is possible to calculate monthly or even daily measures of conflict fragmentation by taking state-based (government vs NSA) as well as non-state based (NSA vs NSA) conflicts into account. Overall, the CFI provides a theoretically-informed and easy to compute measure to approximate conflict fragmentation.

Keywords: civil war, fragmentation, splintering, conflict duration

1 Introduction

Recent research on civil wars has moved beyond conceptualizations of conflict processes as two-party interactions between a state and a unitary challenger (Cunningham, 2006; Cunningham, et al., 2009; Pearlman & Cunningham, 2012). Disaggregated conflict studies highlighted the complexities arising from combatant fragmentation. Several researchers have argued that fragmented conflicts are harder to resolve, tend to last longer and are more likely to recur (Cunningham, 2006; Cunningham, et al., 2012; Cunningham, 2013; Rudloff & Findley, 2016).

Although fragmentation has been widely acknowledged as an important component of conflict processes, it is a challenge to conceptualize and measure it. Even when we rely on multi-dimensional definitions of fragmentation (see Bakke, et al., 2012), disaggregated information on constitutive dimensions is rarely available. As a result, the total number of actors involved in a conflict is often used as a crude proxy, especially when the interest is to control for the effects of fragmentation (e.g. Ruggeri, et al., 2012; Hultman, et al., 2014).

In this article, we propose an alternative measure, the Conflict Fragmentation Index (CFI), which takes the number of causalities in conflict-fronts into account. The CFI is computed by

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adapting the Herfindahl–Hirschman Index (HHI), which was originally proposed to measure the market fragmentation, and has been widely adapted in social science ever since, including by the Ethnic Fractionalization Index (EFI). Conceptually, we replace the market share of a company in the HHI formula by the proportion of casualties in a conflict-front to the total number of casualties in the whole conflict. In practical terms, the CFI is easily computable by relying only on the UCDP Data Family (Allansson, et al., 2017). The conflict-front is operationalized as the dyadic conflict between *Actor A* and *Actor B*, and the casualty data can be approximated by using the Battle Related Deaths dataset.

The remaining of the article briefly discusses ways of conceptualizing conflict fragmentation and introduces the CFI. We present an empirical application by analyzing civil conflict duration and highlight the limitations of the CFI in our concluding remarks.

2 Conceptualizing Conflict Fragmentation

Data advances allowed researchers to approximate conflict fragmentation by looking at the number of rebel groups and by distinguishing actors emerging through splintering.[2] When fragmentation is conceptualized as actor splintering it primarily refers to fission; an entity disintegrates into some of its components (Findley & Rudloff, 2012; Rudloff & Findley, 2016). Rebel-groups often emerge by breaking apart from another organization. However, splintering is not the only source for fragmentation. Multiple entities can emerge independently from each other during a conflict process. For example, rather than an "original"[3] organization breaking apart into splinter groups, several rebel organizations were independently formed in Colombia in the 1960s.

The dyadic approach to civil wars, which opens the black-box category of "the rebels" to disaggregate NSAs, still uses the "unitary actor" assumption (Pearlman & Cunningham, 2012). Yet, actors are never unitary and they vary in terms of their level of coherence. The concept of fragmentation, ideally, should also capture the internal coherence of actors by looking beyond the number of NSAs and splintering. Bakke et al. (2012) propose the most comprehensive conceptualization of fragmentation by identifying three dimensions; "(1) the number of organizations in a movement; (2) the degree of institutionalization across these organizations; and (3) the distribution of power among them". Bakke et al. (2012) focus primarily on ethno-political movements but their approach is transferable to civil conflict processes in general.

Although we agree with Bakke et al. (2012) that information on all three dimensions of fragmentation is desirable, such information is rarely available. Measuring the degree of institutionalization and the distribution of power might not be possible for many cases. While

[2] The UCDP Data Family can be used for these purposes (e.g. Rudloff & Findley, 2016; see Allansson, et al., 2017 for the UCDP).

[3] Cunningham (2006) uses the terms *original groups* and *splinter factions* to distinguish *multiple actors emerging independently* from *multiple actors emerging through disintegration*.

the multidimensional approach aims to relax the "unitary actor" assumption by looking beyond concrete entities in a conflict, it might be inevitable to require strong assumptions defining what constitutes a unit of analysis; for example, an ethno-political movement consisting of multiple identities and cross-cutting cleavages. In the next section, we use available data to approximate important dimensions of conflict fragmentation.

3 Building the Conflict Fragmentation Index

We start with the premise that the distribution of combat activity among conflict-parties is a relevant measure to proxy fragmentation. Civil wars may have core actors responsible for most of the fighting, and tangential groups that marginally take part in the conflict. The total number of actors being equal, a conflict is less fragmented if most of the fighting is concentrated between particular actors, compared to conflicts that have the fighting more equally dispersed across conflict-parties. Therefore, depending on the concentration of combat activity, conflicts with equal number of actors can have different levels of fragmentation. To use the fragmentation through splintering as an example, if an NSA divides into two equally prominent entities, then fragmentation should increase more than a situation in which a relatively small component of the NSA disintegrates to form a new entity.

Based on this conjecture, we propose the Conflict Fragmentation Index (CFI), which is constructed by adapting the Herfindahl–Hirschman Index. Conceptually, the CFI takes the information on the prominence of conflict-fronts into account, and is calculated by the following formula;

$$CFI = 1 - \sum_{i=1}^{n} (s_i^2)$$

where s_i is the relative prominence of a conflict-front. It can be approximated as;

$$s_i = \frac{casualties\ in\ dyad\ i}{total\ casualties}$$

The underlying idea is that, a conflict can have many battlegrounds that their relevance varies across cases and time. We can operationalize a conflict-frontline as a dyadic conflict between *Actor A* and *Actor B*. In this sense, a conflict-frontline does not refer to a geographical space but a *dyad*. To approximate the relative prominence of a conflict-frontline, we can use information on the battle related deaths. If the fighting intensity is concentrated on a front, then that battle zone is more prominent compared to other fronts.

Using the CFI to proxy conflict fragmentation brings several advantages. Most importantly, the CFI can be easily computed by relying only on the UCDP Data Family. No additional information apart from the conflict intensity is needed. Second, the measure is time-variant and highly sensitive to changes in the battlefield dynamics. Third, it allows researchers to consider in-fighting between NSAs as conflict fragmentation. For example, it can be argued that a conflict is more fragmented if NSAs fight with each other compared to a conflict where fighting only takes place between government forces and NSAs.

It is possible to replace the battle related deaths in the CFI formula by an alternative measure. For example, Butcher (2015) also adapts the Herfindahl–Hirschman Index to compute concentration of military capabilities across actors within a conflict. Butcher's (2015) Fractionalization measure plugs-in number of troops instead of battle-related deaths; yet, we maintain that causalities in a conflict is the most appropriate measure for conflict fragmentation. Causalities capture how the conflict activity is dispersed among actors in a dynamic manner. As such, the CFI can account for complexities of conflict behavior of multiple actors by requiring minimal information on conflict intensity of dyads.

Figure 1 illustrates this point. The UCDP Georeferenced Event Dataset (GED) is used to calculate the CFI scores (Croicu & Sundberg, 2017). We first limit GED to two types of conflicts; (1) government vs NSA and (2) NSA vs NSA. The GED considers non-state conflicts (type 2, according to GED) strictly separate from state-based conflicts (type 1, which includes civil wars). However, it can be argued that most NSA vs NSA conflicts are nested in state-based conflicts. For such conflicts, if at least one of the NSA is not part of more than one state-based conflict, non-state conflict is assumed to be nested in the state-based conflict.[4] This approach allows us to consider NSA vs NSA fighting as a factor increasing conflict fragmentation.

As shown in the cases of Pakistan and Afghanistan, high numbers of rebel groups do not necessarily translate into a high value for the CFI. Pakistan has the highest number of dyads nested in a conflict (10) in all of the GED but its CFI is below the median of fragmented conflicts. Similarly, Afghanistan has many active fronts but most of the fighting has been concentrated between government forces and the Taliban since the mid-2000s. Sudan has large fluctuations in the CFI score regardless of conflict intensity whereas Israel-Palestine conflict has a consistently large CFI score despite fluctuations in conflict intensity.

[4] Matching is carried out by using the NSA id number.

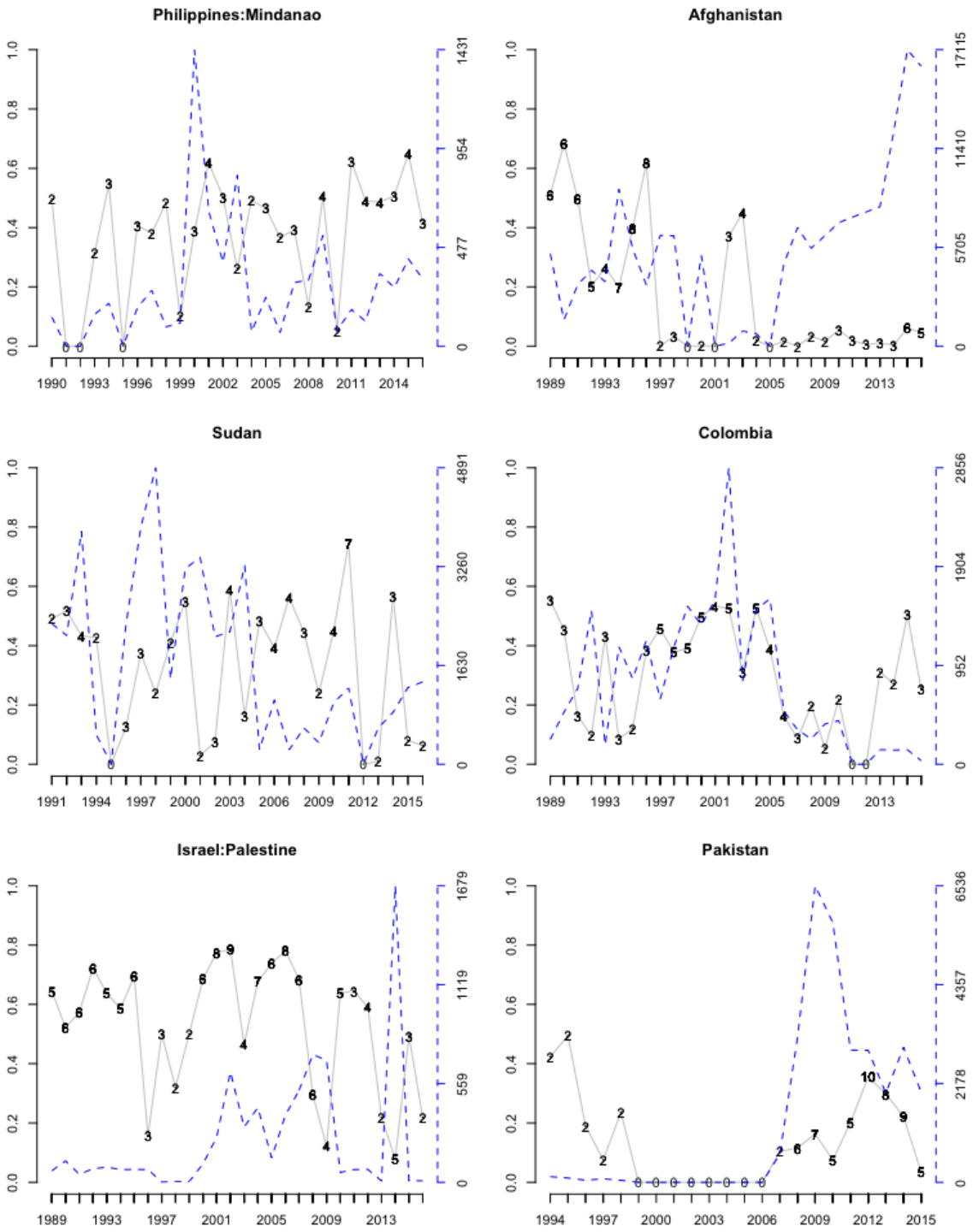

Figure 1: Black line shows the CFI score and dotted blue line shows the total number of battle deaths. How many dyads are nested in the conflict is superimposed on each CFI score.

3 Fragmentation and Conflict Duration

We demonstrate the applicability of the CFI by looking at civil conflict duration. It has been widely accepted that fragmented civil wars are harder to resolve because they involve more veto players (Cunningham, 2006). Instead of measuring the number of veto players, we will plug in the CFI. To get more conservative estimates, we use the UCDP Battle-Related Deaths Dataset (Allansson, et al., 2017), which only includes data on state-based "active"[5] conflicts.[6] For data on conflict duration, we use the UCDP Conflict Termination Dataset version 2-2015 (Kreutz, 2010).

Table 1: **Cox Proportional Hazard Estimates**

	Model (1)	Model (2)
CFI	-1.20*	-1.21*
	(0.55)	(0.58)
Incompatibility	-0.42*	-0.34†
	(0.17)	(0.18)
Real GDP p.c.	-0.04	-0.08
	(0.08)	(0.11)
Population	-0.12*	-0.06
	(0.05)	(0.07)
V-Dem Polyarchy	-0.46	-0.76*
	(0.35)	(0.37)
Battle Deaths	-0.00*	-0.00*
	(0.00)	(0.00)
Resources	-0.30*	-0.29†
	(0.15)	(0.15)
Coup	2.19***	1.87***
	(0.25)	(0.34)
External Rebel Support		-0.44*
		(0.17)
Mediation		0.41*
		(0.18)
Europe		–
Middle East		-0.28
		(0.33)
Africa		-0.42
		(0.28)
Asia		-0.38
		(0.33)
Americas		0.17
		(0.39)
Observations	873	870
Log Likelihood	-853.6	-840.9
Number of Subjects	232	232
Number of Failures	207	206

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, † p<0.10

We control for a series of possible confounding variables. First, we control for the incompatibility; whether the conflict is over governmental or territorial control. Data on population and GDP p.c. are taken from Gleditsch (2002). Incentives to acquire access to natural resources can prolong conflict. Data on natural resources is taken from (Buhaug, et al., 2009). Coups are coded following (Thyne, 2015). Data on mediation is taken from DeRouen, et al. (2011) and Ari (2017). Whether an NSA receives support from an external patron or not is coded following Cunningham, et al. (2009).

We estimate two Cox Proportional Hazard models. Results are presented in Table 1. As we report coefficients, a negative term indicates a decrease in the hazard rate, which implies longer conflicts. A positive term, on the other hand, indicates alleviation in the hazard rate, meaning shorter conflicts. *CFI* is associated with a significant decrease in the hazard rate. Therefore, higher the fragmentation, longer the conflict. Figure 2 illustrates this pattern. When we plug-in the median value for CFI (approximately 0.4), the estimated survival rate is considerably higher compared to no fragmentation.

[5] A conflict is considered active if it has produced 25 or more battle related deaths in a calendar year, according to the UCDP/PRIO Armed Conflict Dataset definition.

[6] Calculating the CFI by using the GED, as done in Figure 1, yields to a stronger association for models 1 and 2 (Table 1).

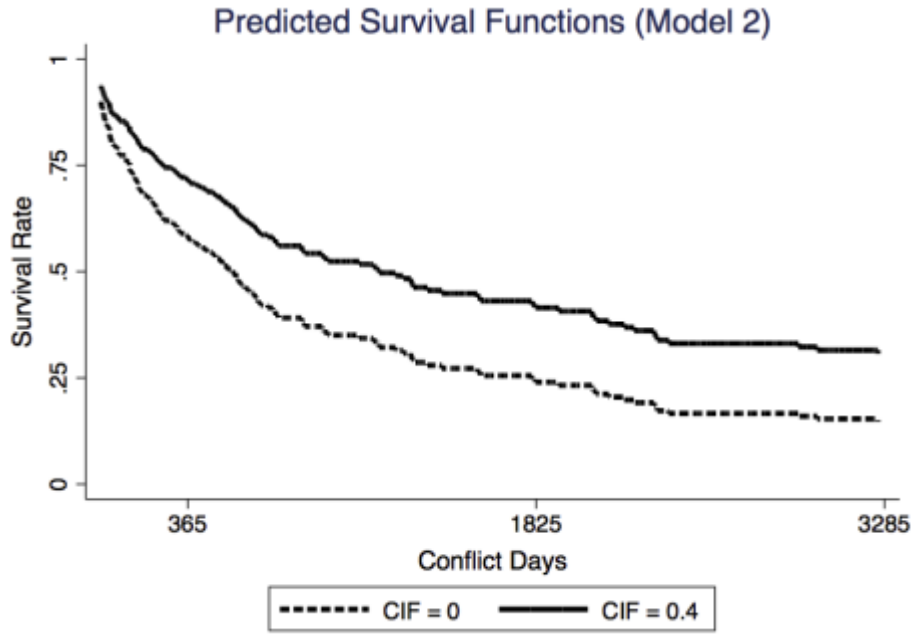

Figure 2: Survival Estimates with different CFI values

Conclusion: Limitations and Further Research

Although the CFI provides a theoretically informed way of measuring conflict fragmentation by using widely accessible data, it cannot capture the coherence of conflict-parties. This is an important limitation because the actor coherence is a central dimension of fragmentation (Bakke, et al., 2012). As a result, the CFI can measure fragmentation only after it happens. Measuring the coherence of actors and their tendency to further fragment, the causes of fragmentation in a sense, would be extremely useful, especially when the interest is to make predictions on a conflict process (Seymour, et al., 2016).

Second, the strength of CFI to capture changes in conflict intensity to estimate fragmentation in a temporally informed manner can also be a weakness. Since the CFI uses information on battle related deaths, it might be vulnerable to fluctuations in the conflict intensity patterns. The CFI might be most vulnerable when the variance of conflict intensity is high. Moreover, data on causalities might have a higher measurement error when a conflict is extremely fragmented. For example, the UCDP did not publish data on the Syrian civil war because of its highly fragmented nature. Further developing the CFI to incorporate the information on the variance of conflict-intensity across time can be beneficial to improve measurements of fragmentation. Future studies might prefer to decrease the variance in the CFI by using exponential smoothing or a moving average instead of raw calculations. Finally, the CFI is undefined when the total number of deaths is 0 in a conflict.[7] This is not an issue

[7] This is the case because the denominator of a constitutive term in the CFI is total number of deaths. If the total deaths is zero, then the CFI is undefined.

when the sample includes only ongoing conflicts, but it is problematic if the sample is a mix of both conflict and peace periods since the CFI requires casualties to measure fragmentation.

Despite these limitations, we argue that the CFI is theoretically and empirically an improvement to alternative readily-available measures, such as number of rebel groups. As such, the CFI might perform better in approximating the data generation process. Finally, the flexibility of CFI makes it possible to calculate monthly or even daily measures for conflict fragmentation by taking state-based (government vs NSA) as well as non-state based (NSA vs NSA) conflicts into account.

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