

Estimating Child Mortality Attributable to War in Yemen

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Abstract

Purpose

Quantifying the burden of war (BOW) beyond battle deaths is often impossible in ongoing conflicts. Consequently, indirect consequences of war can be overlooked in public BOW discussions. This paper introduces a simulation model to estimate indirect child mortality attributable to war. Yemen was chosen as the example case because indirect child mortality from war likely outpaces direct casualties in the Yemen conflict.

Data and Methodology

A fixed effects panel regression was used to estimate elasticities between child mortality rate (CMR) (the rate of deaths among children under five years of age, per 1,000 live births) and two effects of war assumed to have the greatest explanatory power toward CMR: economic deterioration (measured by changes GDP per capita) and conflict magnitude (via the Major Episodes of Political Violence dataset). These elasticities were then used in a model to estimate the CMR in Yemen up to the year 2020.

Findings

Regression results suggest that Yemen's CMR increased by more than 50% from 54.2 in 2010 to 83.9 in 2017. If this trend continues, the mean CMR will almost double from its 2010 value to 102.9 in 2020. By 2020, the model estimates cumulative child deaths at over 185,000.

Value

Lack of information about the indirect consequences of war biases the trade-off between humanitarian and military objectives towards the latter. This information asymmetry can prolong conflicts. The purpose of this paper is to contribute to more informed debate and humanitarian programming by making vital information accessible to the public and decision-makers.

I. Introduction

Hiram Johnson (1866-1945) noted that “the first casualty when war comes is truth” (quoted in Bagdikian, 2004, p. xi). This is because warring parties face a tradeoff between geostrategic objectives and humanitarian responsibilities – the higher the humanitarian costs associated with war, the more difficult it becomes politically to pursue geostrategic interests. As such, increasing the availability of information about the rising humanitarian costs of war decreases the payoff of geostrategic objectives.

While more information about the true burden of war serves to support a more informed public debate, obtaining accurate and credible information can prove challenging. This is particularly true in terms of health-related information in conflict areas. Reliable health data could be obtained from representative on-the-ground surveys; however, in addition to the safety and logistical limitations of conducting such surveys in a conflict area, these could only provide a snapshot of the health situation at a given time and could quickly be outdated as new conflict dynamics arise.

An alternative to measuring the health consequences of war in real time is to use existing data to identify a conflict-affected country’s long-run equilibrium vulnerability. For example, as opposed to asking how many children have died in an ongoing conflict, it may be more feasible to ask how many children can be expected to die if the conflict continues. The objective of this paper is to introduce the latter conflict simulation model and apply it to the case of Yemen.

Yemen is a proxy battleground for many competing external powers. Competing outside interests have long been known to prolong warfare (Elbadawi and Sambanis, 2000). Outside interventions not only increase the resources available for prolonged fighting, they also contaminate battleground information with propaganda, which complicates fact-finding. This paper argues that whether competing external players become rivals caught up in a military deadlock (as is the case in Yemen at the time of this writing) or partners who prioritize humanitarian over geostrategic goals depends on the availability of information about the true humanitarian cost of wars.

The paper is organized as follows: section two reviews some of the literature related to the estimation of the indirect burden of war; section three looks at the role of a more publicly informed debate in international relations from a simple game theoretical perspective in order to motivate the need to explore conflict assessment mechanisms beyond surveys. Section four describes the data and methodology used to develop an empirical conflict simulation framework as a second best solution when surveys are not feasible; the framework assesses mortality rates among children 0-5 years of age. Findings are reported in section five; section six concludes with a summary of the main findings and implications.

II. Background

The field of conflict economics studies the causes and consequences of the use of force by economic actors as an alternative rational choice to the peaceful exchange of goods and services (Anderton and Carter, 2009). Mercantilism was probably the first attempt to systematically rationalize the use of force for economic ends.

As for the consequences of conflict, conflict economics is concerned with understanding the economic costs of conflict in terms of the three D’s: destruction of productive resources, including human lives; diversion of productive resources from a peace to a war economy; and the disruption of productive activity, especially through the disintegration of market networks. A distinct characteristic of the economic method is that it not only looks at direct, but also indirect, costs of conflict. Measuring the mortality rate of children

indirectly attributable to the destruction, diversion, and disruption effects of war is a prime example for applied conflict economics.

Generally, methodological challenges to estimating the indirect burden of war can be classified as either research-philosophical or operational challenges. In terms of the research-philosophical aspect, Thoms and Ron (2007), for example, argue that “[m]ore often than not, information on the civilian impacts of conflict is based on informed guesses by NGOs and multilateral organizations, rather than rigorously assembled scientific data” and that greater interdisciplinary collaboration could improve the quality of conflict assessments. In respect to operational challenges, Rossiter (1916) asserts that it is difficult to accurately assess the economic cost of ongoing conflict, noting that:

[w]hile the current literature relating to war costs is important and often illuminating, no analysis of such costs made during the progress of a conflict can be accepted as other than a study, enlightening but incomplete, and generally possessing no permanent value. (p. 95)

In other words, the costs of war are best understood only after the dust has settled.

To illustrate the issues related to data from areas currently experiencing conflicts, consider the following two examples. The first example refers to data available from the World Bank World Development Indicator Database. According to the database, while the prevalence of both wasting and severe wasting among children under five have increased in Yemen since 2011, the mortality rate in this age group is surprisingly on the decline. These two trends appear to be contradictory.

[INSERT TABLE 1 HERE]

The second example relates to the statement, issued by UNICEF in April 2017 that “In Yemen, a child dies every ten minutes from preventable causes” (UNICEF Ireland, 2017). The exact methodology underlying this finding is unclear and only adds to the environment of uncertainty when considered in relation to the counter-intuitive data referenced above. As such, estimates about the direct and indirect costs of war must be handled with care and ideally only presented with precise methodological explanation. With these considerations, burden of war information could play a critical role in shaping stakeholder and public debate.

While studies related to the indirect burden of war differ widely in terms of methodology, conflicts covered, and indicators of indirect war costs, public health indicators are popular measurement choices. Studies examining the relationship between war and public health have often found a strong relationship between conflict and indirect, long-term negative health consequences in affected populations. For example, Ghobarah et al. (2003) estimate that in 1999, deaths and disabilities attributable to the lingering and indirect consequences of wars occurring from 1991-1997 were nearly equal to the direct deaths and disabilities attributable to all wars in 1999. The International Rescue Committee estimates that non-battlefield deaths related to civil war in the Democratic Republic of the Congo from 1998-2001 outnumber combat deaths by a ratio of 6:1; this is primarily driven by disease (Roberts et al., 2001). Furthermore, Poole (2012) was able to link exposure to war to an increase in cardiovascular diseases and Lyk-Jensen et al. (2015) find evidence that deployment to war zones undermines soldiers’ mental health.

Macroeconomic performance implications constitute another indirect cost category of conflict. Ismail and Amjad (2014) find a long-run equilibrium relationship between key macroeconomic indicators and terrorism in the case of Pakistan. Bullock (1903), on the other hand, is an early example of a more focused study, finding a positive relationship between war and the growth of public expenditures.

Other research addressing socioeconomic factors as indirect costs of war, includes a study by Ganepola and Thalaysingam (2004), that reviewed the literature on the interaction of war and poverty. Bieber (2005), focused on the effect of Yugoslavia’s war on ethnicity, inequality, and public sector governance in Bosnia.

Most studies on the indirect costs of war are retrospective in nature; studies examining ongoing conflicts are scarce. Yet, while retrospective studies of war may be more accurate, scholars should not abandon attempts to assess ongoing conflict. This paper asserts that such a surrender would be wrong for two reasons. First, historical data on the relationship between conflict and its indirect consequences could be used to simulate “likely” events on the ground from conflict zones about which information is scarce. If such a simulation stands on a sound scientific methodology, it surely will contribute to a more informed public debate. Secondly, contributing to a more informed public debate is an important humanitarian service that might tilt public opinion in favor of pursuing humanitarian over military objectives. This logic is illustrated in the next section.

III. Burden of War Information and Trade-Off Between Military and Humanitarian Objectives

Figure 1 represents a standard prisoner’s dilemma. For the purpose of this illustration, the players are external interveners in a conflict; for example, the roles played by Iran and Saudi Arabia in the Yemen conflict. The payoffs can be thought of as political support by domestic and allied constituents.

In this game, if one country pursues humanitarian objectives, the other country is tempted to pursue geostrategic goals. This may occur because if one country prioritizes humanitarian objectives, it inevitably is less involved in active warfare. Yet, warfare inactivity by one player presents the other player with the opportunity to realize important military geostrategic objectives at a lower humanitarian cost than would be the case if both players were involved in warfare.

If both countries pursue geostrategic interests, both countries receive a non-cooperation punishment. This non-cooperation punishment is the result of a military stalemate rather than concern for the humanitarian burden associated with the fighting. For a prisoners’ dilemma to occur, the temptation reward must, in absolute terms, be smaller than the sucker payoff.

Figure 1: Geostrategic Outside Intervention as a Prisoners’ Dilemma

| | | Saudi Arabia | |
|------|---------------------------------------|------------------------------------|---------------------------------------|
| | | Geostrategic Interests (Defect) | Humanitarian Interests (Cooperate) |
| Iran | Geostrategic Interests (Defect) | 1, 1 (P, P) | 3, -4 (T, S) |
| | Humanitarian Interests (Cooperate) | -4, 3 (S, T) | 2, 2 (R, R) |

Note: **P**=Punishment Payoff, **T**=Temptation Payoff, **S**=Sucker’s Payoff, **R**=Cooperation Reward

The prisoner’s dilemma in this scenario (Scenario 1), in which both countries pursue their geostrategic interests, is implicitly subject to “Burden of War Information” (BOWI). In terms of political support for a government, more information about the humanitarian costs of war reduces the payoff of geostrategic objectives and increases the payoff of a greater humanitarian commitment.

Assume that BOWI affects the payoffs linearly, meaning that additional information about civilian casualty and hardship decreases the payoff of geostrategic interests in absolute terms as much as it increases the payoff of humanitarian goals. Suppose that relative to Scenario 1 there is now additional BOWI, for example, $\Delta\text{BOWI}=3$.

Figure 2: Geostrategic Outside Intervention and the Role of Burden of War Information

| | | United States | |
|--------|------------------------|--------------------------------------|--------------------------------------|
| | | Geostrategic Interests | Humanitarian Interests |
| Russia | Geostrategic Interests | 1-3=2, 1-3=2 (P-ΔBOWI, P-ΔBOWI) | 3-3=0, -4+3=-1 (T-ΔBOWI, S+ΔBOWI) |
| | Humanitarian Interests | -4+3=-1, 3-3=0 (S+ΔBOWI, T-ΔBOWI) | 2+3=5, 2+3=5 (R+ΔBOWI, R+ΔBOWI) |

In this case, a prisoners’ dilemma would be transformed into a socially optimal Nash equilibrium. With the above mind, providing estimates on the burden of war beyond direct fatalities could play a vital role in impacting the dynamics of conflict.

IV. Data and Methodology

In lieu of household surveys, one plausible alternative to estimating the burden of war is to develop a simulation model based on available historical data. Overall, conflict occurrence and child mortality rates are well documented. The same does not yet necessarily hold for many other public health indicators such as, micronutrient deficiency and anthropometric variables.

The simulation described below assumes that two effects of war account for the lion’s share of explanatory power towards child mortality rates: (1) the deterioration of real income associated with war’s destruction and diversion of productive resources and the disruption of economic activity, and (2) the magnitude of the conflict itself.

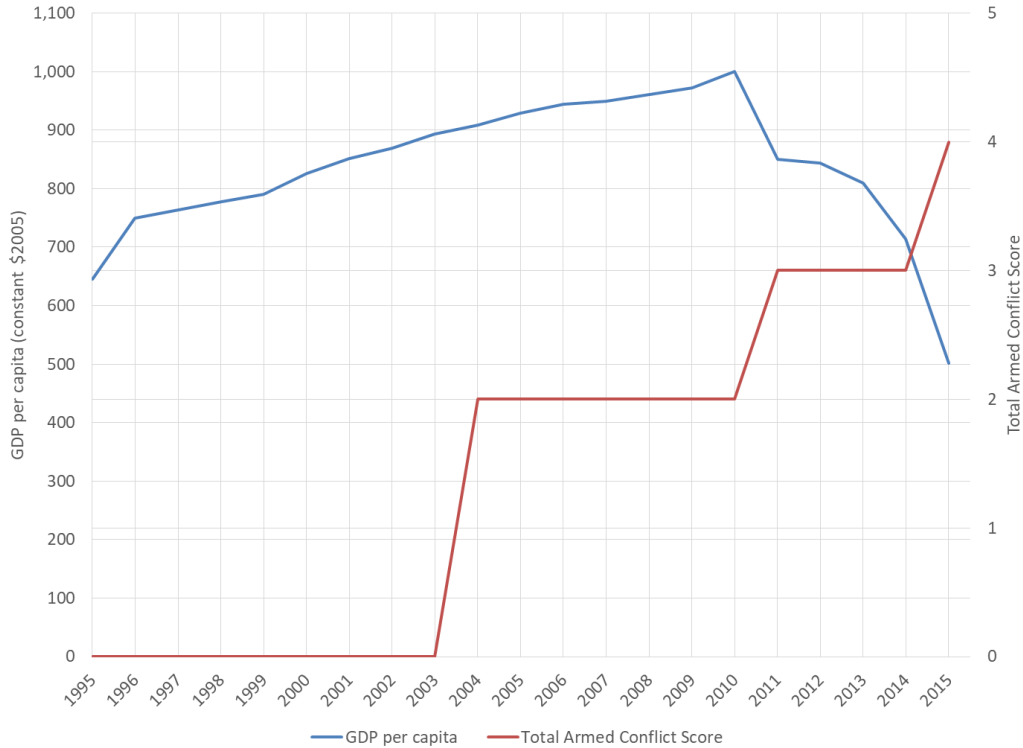
The income and war elasticities of child mortality are calculated using a fixed effects panel regression. The dependent variable is the under-5 mortality rate (per 1,000 live births) and the independent variables are GDP per capita in constant 2005 USD and an armed conflict total magnitude score (ACTOTAL). Table 2 summarizes the data and sources included in the simulation model. The final dataset consists of all available observations for the 217 countries listed in the World Bank World Development Indicators database for the 57 years between 1960 and 2017.

Figure 3 illustrates the development of Yemen’s real GDP per capita at constant 2005 USD prices between 1995 and 2015. The graph shows that between 2010 and 2015, Yemen’s GDP per capita declined by exactly 50% - from \$1,000 to \$500 - after a period of growth during the early 2000s in which the country’s GDP per capita grew at a rate slightly above two percent annually, on average.

Figure 3 also shows Yemen’s armed conflict total magnitude score. While Yemen had experienced episodes of political violence since 2003, the frequency and severity of political violence increased in 2011(to coincide with the beginning of the “Arab Uprisings”) and then again in 2015 with greater internalization of the conflict.

[INSERT TABLE 2 HERE]

Figure 3: GDP per Capita and Conflict in Yemen



Source: Graphed from data available United Nations National Account and the Center for Systemic Peace

Effects of income deterioration and conflict, such as child mortality, can be estimated based on historical and hypothesized changes in income per capita and conflict scores. The following panel-fixed effects equation was used to estimate the income and war elasticity of child mortality.

$$\begin{aligned}
 Child\ Mortality(\ln)_{i_t} = & \beta_0 + \beta_1 \times GDP\ per\ capita(\ln)_{i_t} + \beta_2 \times Armed\ Conflict\ Total\ Score_{i_t} \\
 & + \beta_3 \times Time_{i_t} + u_{i_t} \tag{1}
 \end{aligned}$$

where i = country i , t = time t , ln = natural log transformation, and u = white noise. A time dummy was added to control for unobservable time specific effects such as general medical technological progress. Arellano's Heteroscedasticity and Autocorrelation Corrected (HAC) standard errors are reported as this model specification is expected to be subject to high serial correlation and heteroscedasticity which will affect the standard error and the confidence interval of the estimates. The model was run using the open source program, Gretl, whose accompanying user's guide describes the computation of Arellano's HAC standard errors (Cottrell and Luchetti, 2007).

A dynamic panel estimation model was not employed for two reasons. First, the correlation coefficient between the child mortality rate and GDP per capita is $r=0.83$, which raises major concerns around multicollinearity. Secondly, and more importantly, the addition of a lagged child mortality variable on the right hand side would absorb so much explanatory power that the remaining variance of the dependent variable would be insufficient to allow for meaningful estimates of the income and armed conflict elasticities of conflict.

Likewise, a two stage least squares model was determined to be inappropriate on theoretical grounds. It is theoretically implausible that an exogenous shock to child mortality feeds back into lower GDP per capita or armed conflict, which would be a prerequisite for the residuals of equation (1) to be correlated with GDP per capita or the armed conflict score.

Following the procedure as outlined by Cameron and Trivedi (2005, p. 348), a simple Hausman exogeneity test was conducted on the GDP per capita variable. For this purpose, GDP per capita was regressed against the one-period lagged armed conflict score and time using a panel fixed-effects model. The residuals were stored and added to the right hand side of the specification of equation (1); the coefficient for the residuals was non-significant.

As such, it was determined that for the purpose of obtaining income and armed conflict elasticities of child mortality, model specification (1) is legitimate though other specifications could be considered as well. Results of this regression are displayed in Table 3.

[INSERT TABLE 3 HERE]

The coefficients for both GDP per capita and the armed conflict score in the simulation were included in equation (1) to estimate the impact of Yemen's conflict on child mortality, even though the p-value for the armed conflict score was greater than 0.05 ($p=0.126$). The statistical non-significance of the armed conflict score was attributed to multicollinearity with fixed effects rather than socio-economic irrelevance.

V. Findings

Table 4 shows the simulation parameters. Values for the 2010-2015 period are actual available observations. Values for the 2016-2020 period represent a simulation scenario, which assumes that the average GDP per capita growth rate between 2011 and 2015 also applies for the 2016-2020 period. As for the ACTOTAL score, the conflict score for 2015 was applied to the 2016-2020 period. The 2010, 2015, and 2020 values for the under-5 population were taken from the United Nations World Population Prospects; missing values were estimated from a simple quadratic curve fitting procedure.

[INSERT TABLE 4 HERE]

Tables 5 and 6 summarize Yemen's estimated child mortality rates (per 1,000 live births) and the absolute number of deaths within the under-5 cohort. While the 95% confidence intervals of the mean estimates are reported, the discussion below is limited to the mean estimates.

The estimates suggest that Yemen's child mortality rate has increased by more than 50% from 54.2 in 2010 to 83.9 in 2017. If the 2010-2015 trend continues in the 2016-2020 period, the mean child mortality rate will almost double from its 2010 value to 102.9 in 2020.

The estimation of the actual number of children deaths is slightly more complicated. As the under-5 child mortality rate applies to the entire cohort and not all children die in the same year, for simplicity, a uniform distribution of children deaths over the five years is assumed. This means, for example, if the 2017 child mortality rate of 83.9 is applied to the 4,098,571 children in the under-5 cohort, 344,053 children in this cohort are expected to die before their fifth birthday. Assuming a uniform distribution of these deaths, 68,811 children deaths would occur in 2017. Under the hypothesized simulation parameters for the 2016-2020 period, the annual number of under-5 children deaths would increase to almost 86,000 in 2020.

[INSERT TABLE 5 HERE]

[INSERT TABLE 6 HERE]

Table 7 summarizes the difference of the estimated children deaths to the baseline scenario per year while Table 8 reports the cumulative differences. The baseline scenario assumes a constant child mortality rate of 54.2 for all periods.

As shown in Tables 7 and 8, the difference to the baseline scenario increases each year. The estimates produced in this study suggest that in 2017, 24,382 excess children deaths can be attributed to the war. The estimated cumulative children deaths since the outbreak of the conflict in 2011 stands at 80,408 in 2017.

Importantly, these estimates of cumulative child mortality are greater than cumulative direct battle deaths, which newspaper reports put at an estimated number of 12,000 in 2017 (see, for example, Khan, 2018). By 2020, the number of child deaths attributable to the war will increase to 40,653, bringing the cumulative number of children deaths attributable to conflict to 185,382.

[INSERT TABLE 7 HERE]

[INSERT TABLE 8 HERE]

VI. Conclusion

The direct and indirect costs of war place a heavy burden on affected populations. Direct costs refer to the loss of life and productive resources that can be attributed to direct warfare activities such as bombardments, combats, and sieges. Indirect costs, on the other hand, refer to consequences related to the deterioration of economic activity as a result of the destruction of productive resources, the disruption of economic activity, and the diversion of scarce resources from a peace to a conflict economy.

Direct costs can be more easily measured and observed than indirect costs. Body counts can often, although not always, be verified by humanitarian assistance organizations such as the International Red Cross/Crescent. Damage to infrastructure like bridges, ports, and power plants can often be determined by satellite imagery.

Indirect costs are much more difficult and far more complex to assess, though many adverse effects of war become apparent upon examination of public health indicators. For instance, conflict often increases food insecurity and reduces access to safe water, sanitation, and health services. Beyond the deterioration of public health indicators, other negative socioeconomic effects relate to an increase in crime, child labor, and gender-based violence. Many of these indirect cost are much less visible than battle deaths and bombings, and are therefore largely absent from the public debate though the indirect costs often outweigh direct costs.

This information asymmetry can prolong the duration of conflict. Assuming that the duration of war is positively related to the ratio of geostrategic objectives to humanitarian costs, incomplete information about the true humanitarian burden biases this ratio upwards. Therefore, in order to contribute to a more informed public debate, social scientists from various disciplines can have a meaningful impact by providing increased insight into the true burden of war. This paper was motivated by such a possible contribution.

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