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The Global Economic Burden of Violent Conflict[1]

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Abstract:
Calculating the impact of different societal challenges, such as climate change, HIV/AIDS or cancer, uncovers the scale, distribution and structure of their economic burdens. Since violent conflict affects billions of people worldwide, the analysis of its impact is important. Using an integrated economic model accounting for multiple forms of conflict, we find that in the absence of violent conflict since 1960, global GDP in 2007 would have been 15.7% (10.9 trillion USD) larger. Furthermore, global income inequality would have been significantly lower. The largest absolute impacts are associated with domestic strife in China and India while Afghanistan suffers the largest relative burden. In contrast, many developed economies actually benefit from war. This shows that violent conflict is an integral part of the world economic structure, with a burden possibly exceeding that of climate change.

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Introduction

Public *bads* cost society: HIV/AIDS (World Bank 2000; Quinn 1996), malaria (Sachs and Malaney 2002), alcoholism (Rehm et al. 2009; Baumberg 2006) and diabetes (Yach, Stuckler, and Brownell 2006) reduce economic growth, as do ecosystem destruction (Balmford et al. 2002; Costanza et al. 1997; Kremen et al. 2000), climate change (Stern 2007), soil degradation (Pimentel et al. 1995) and even "the Soviet Empire" (Wolf 1985). Likewise, violent conflict burdens society both economically and socially (Collier 1999; Heise et al. 2002; Keynes 1920), though the scale of this burden is as yet unknown. Therefore, we set out to calculate the economic impact of violent conflict, *ceteris paribus*, placed in the Solow framework (Mankiw, Romer, and Weil 1992). In addition to the scale of the burden, we also consider how this burden is distributed between different countries in order to identify winners and losers. Furthermore, the burden's structure is disaggregated by cost sources, which sheds light on the importance of each of the contributing factors in order to help design policies to alleviate the burden. Finally, our methodology can be used for other *bads*, thus increasing the comparability between studies.

To help structure the discussion, consider the following model (summarised in Fig. 1A): Before the outbreak of a conflict at time t_0, a country's Gross Domestic Product (GDP) is equal to its potential GDP. Between t_0 and t_1, a conflict occurs. The post-conflict period is defined as the period during which previous conflict directly affects growth and finishes at t_2. After that, a period of convergence takes place. Both during the conflict period and the post-conflict period, we posit that growth rates may be affected by the conflict, although the direction of this effect is not obvious *a priori*. In accordance with existing theory (Mankiw, Romer, and Weil 1992), during the *convergence* period, the growth rate is lower (higher) in a country with a higher (lower) level of GDP. During the entire period, the difference between actual GDP (the solid line) and counterfactual GDP (the dotted line) equals the GDP loss as a result of conflict. Using this macroeconomic approach to include violent conflict (Collier 1999; Organski and Kugler 1977) yields generalizable findings (Hess 2003), rather than results valid merely for specific case studies (Abadie and Gardeazabal 2003; Bilmes and Stiglitz 2008).

The innovation in our analysis stems both from the distinction between periods and from the inclusion of spillovers from neighbouring conflicts (Murdoch and Sandler 2004). Furthermore, we distinguish between civil conflict (within countries), international conflict (between countries) and

non-territorial conflict (conflict entirely on foreign soil) and employ an indicator to recognise the differentiated effects of distinct levels of conflict intensity. These innovations are relevant both for the literature on the costs of conflict and for the literature discussing the relationship between conflict and inequality.

We find that in the absence of violent conflict since 1960, global GDP in 2007 would have been 15.7% (10.9 trillion USD) larger. Furthermore, global income inequality would have been significantly lower. The largest absolute impacts are associated with domestic strife in China and India while Afghanistan suffers the largest relative burden. In contrast, many developed economies actually benefit from war. This shows that violent conflict is an integral part of the world economic structure, with a burden possibly exceeding that of climate change.

In the following section, we discuss our methodology in more detail. Following that, we shortly discuss the data used in this study. We follow with the results and a comparison with other results on similar topics. The final section concludes.

Methodology

In line with standard economic theory, we postulate that economic growth depends on capital, labour and human capital (Mankiw, Romer, and Weil 1992) and on violent conflict (Collier 1999; Keynes 1920; Heise et al. 2002; Organski and Kugler 1977; Hess 2003; Abadie and Gardeazabal 2003; Bilmes and Stiglitz 2008; Murdoch and Sandler 2004). In many ways, the methodological path followed by previous authors in studies of growth has been useful and this paper follows in the footsteps of these contributions. There are a number of issues that need to be addressed though, in order to produce a reasonable estimate of the costs of conflict. The basis lies in the Solow growth model (Solow 1956), as employed by Mankiw, Romer and Weil (1992), Sala-i-Martin (1997) and others. In principle, the Solow growth model is based on a Cobb-Douglas production function that has diminishing returns to inputs:

$Y_t = K_t^{\alpha} \left(A_t L_t \right)^{1-\alpha}$, where $0 < \alpha < 1$

On basis of this production function, one can calculate the steady state of the economy:

$$\ln\left[\frac{Y_t}{L_t}\right] = \ln(A_0) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta),$$

in which A_0 is initial technology, *g* is the growth of technology, *n* is the growth of population, δ is depreciation and *s* is savings. Mankiw, Romer and Weil adjusted this model to include human capital, by augmenting the Cobb-Douglas production function to read:

$Y_t = K_t^{\alpha} H_t^{\beta} \left(A_t L_t\right)^{1-\alpha-\beta}$, where $0 < \alpha + \beta < 1$

This production function yields a steady state defined as:

$$\ln\left[\frac{Y_t}{L_t}\right] = \ln(A_0) + gt + \frac{\alpha}{1-\alpha}\ln(s_k) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \frac{\beta}{1-\alpha}\ln(h^*)$$

which introduces s_k as the savings rate of capital and h^* as the level of human capital. Either the original Solow model or the model of Mankiw, Romer and Weil can be transformed into a regression equation to which one may then add additional variables that explain other elements of the growth equation that are not due to such elementary variability. From a practical perspective, the second model has one disadvantage: it requires the researcher to have access to information regarding education levels. This data, unfortunately, is not widely available, particularly on an annual basis. However, as this is clearly the more appropriate model, we do employ that in this paper. This implies that we principally follow the Mankiw, Romer and Weil model, while adding our conflict variables, estimating the following regression:

$$gr_{it} = \beta_i + \beta_1 \ln(gdp_{i,t-1}) + \beta_2 \ln(invest_{it}) + \beta_3 \ln(edu) + \beta_4 (n+g+\delta) + \beta_k C_{it} + \varepsilon_{it}$$

where C_{it} is a range of conflict variables, as is explained later, and β_k are the associated coefficients. Finally, β_i are the country-specific intercepts stemming from the Fixed Effects model. All the data on growth, GDP levels, investment and population growth originate from Heston, Summers, and Aten (2009) and $(g+\delta) = 0.05$. The basic data on education levels comes from Barro and Lee (2001), but we have made a series of adjustments to increase the number of observations. The most important of these adjustments is to interpolate observations between the

five-yearly observations reported by Barro and Lee. In addition to that, we also extrapolate at the beginning and ending of different time series.

Regarding the estimation consistency, Collier was often criticised for his use of Ordinary Least Squares estimations. While this criticism may be reasonable, our decision to use annual data guarantees that we are not required to employ Dynamic Panel Data. In our preferred specification we employ annual data to capture short term growth effects, and proceed with estimations using standard fixed effect panel estimators (or Least Squares Dummy Variables, LSDV). One may argue whether a Dynamic Panel Model (e.g. estimators proposed by Arellano and Bover, 1995 among others) provide estimates with more desirable properties. However, in our case we have data about 100 countries with about 40 observations each (depending on the variable of interest). In this case, the "small T" assumption that makes dynamic panel data models useful is not a serious constraint. In fact, the number of instrument in our setup becomes big enough in our sample so that inference procedures (e.g. overidentification tests) may not be reliable for model selection (Roodman 2009). One possibility is to use 5-year averages to return to the "small T" framework, but this may obscure short run dynamics. Therefore, we proceed by using an LSDV framework.

In order to see which of the variables should be included, as they cannot all be expected to be equally relevant, we employ a baseline estimate including only the adjust Solow variables. We then analyze for each type of effect separately whether there is a linear, a quadratic, linear & quadratic or no relationship. At the end, we combine all of the effects that we previously found relevant in order to come up with a full estimation[1]. For the estimation, a fixed-effects model is used to account for country-specific variables and robust standard errors are reported in the results section.

Finally, in order to interpret the results of the regression, for each country, we recreate a counterfactual on a year-by-year basis using the previously attained regression results and assuming that all conflict variables are zero. The way this is done is by following an iterative procedure that, for each year, first estimates the new counterfactual growth rate, with:

$$gr_{it} = gr_{it} - \beta_k \square C_{it} - \beta_1 [GDP_{i,t-1} - GDP_{i,t-1}]$$

[1] An alternative methodology could be to start with a full set of variables, including everything and sequentially drop the least relevant variables until only variables that fall within the 10% significance level are left. Interestingly, employing this methodology results in the exact same set of variables.

The estimated growth rate is then used to calculate the counterfactual GDP level for the year in question:

$$GDP_{i,t} = \left(1 + gr_{it}\right) \cdot GDP_{i,t-1}$$

After this, the following year can be calculated. Obviously, for each country there is a first year of observation and in those years, the growth rate of counterfactual GDP is assumed to be equal to that of real GDP.

Data

The dependent variable in this analysis is used to measure costs and for lack of a generalized measure of national welfare, GDP growth is used. The choice not to use growth of GDP per capita is on purpose here, because a decrease in GDP through a decrease in population is just as important as any other way and should thus be included. A clear disadvantage of using GDP is its exclusion of mental suffering, particularly due to mortality of loved ones. Unfortunately, it is difficult to quantify this and the literature on the valuation of life is beyond the scope of this research project[2]. However, as a variation on the results we mainly focus on, one can imagine using population size instead of GDP as an explanatory variable. That way, it is feasible to analyse what the impact is war is in terms of lost or foregone population. Interestingly, one can expect such an analysis to impact on entirely different regions from the results regarding GDP.

Other control variables are not required, because these variables are either not affected by conflict, in which case their exclusion merely increases the size of the error term, or they are affected by conflict, in which case the effects caused by them are included in the overall conflict effect. In fact,

2 Bilmes and Stiglitz (2008, pp. 93-95) document different ways of valuing lives. The Department of Defence pays out $500,000 as compensation for the death of an American soldier. In other situations, juries often reach much higher amounts, up to $269 million in one famous case. The Environmental Protection Agency estimates the value of a life lost at $7.2 million, which is in the medium range for different government departments. Bilmes and Stiglitz use this same amount, which is supposed to be represent potential future income lost. However, it is clear that the values of lives in other countries are valued much lower because of this. It is therefore not feasible to put a monetary value on the average life, but using GDP (and not GDP per capita) and discounting future lost GDP should account for these facts and in fact be able to give more differentiation in terms of productivity of a person.

the inclusion of control variables that are affected by conflict would erroneously decrease the influence of conflict.

As for the conflict variables, three types of conflict are recognized: civil conflict (conflict between a state and a non-state actor), interstate conflict (conflict taking place in a country where the other party is another state) and ex-territorial conflict (interstate conflict taking place entirely outside a country's territory. The distinction between these conflict types is important, as different types of conflict are likely to have different influences on growth. For each of the conflict types, a variable is created that takes the size of the intensity of conflict. In addition to that, there is a post-conflict variable that reflects the direct effects of previously having had conflict on current growth (in addition to a potential convergence term). As we do not know the length of such a post-conflict period, we test the different possible lengths, with a 10-year maximum. Finally, for each conflict type, there is a spillover variable that measures the average intensity of conflict in all neighboring countries. This type of spillover analysis stems from the spatial econometrics literature, which finds its basis in Anselin (1988) and is further interpreted for conflict research by Murdoch and Sandler (2004) and De Groot (2010). The way the spillover variable is included through the employment of a contiguity matrix *W*, whose elements look as follows:

$$e_{ij} = \frac{1000 - mindist_{ij}}{\sum_{i=1}^{N}\left(1000 - mindist_{ij}\right)},$$

where the contiguity variable is the distance of closest approach between nations, capped at 1000 km. The Minimum-Distance data is available from Weidmann, Kuse, and Gleditsch (2010).

The data on conflict comes from Marshall and Cole (2009) which defines violent conflict as having at least 500 directly-related fatalities and at least 100 deaths per annum. Fig. 1B shows the number of conflict years per conflict type and per region. This dataset is combined with data on growth, investment, population and education. The data is summarized in Table 1.

Results

The initial results from combining the Solow growth model with individual conflict effects leads to the selection of the relevant conflict effects. It turns out that for civil and international conflict, the linear term best captures the negative consequences for growth. In effect, these conflict types

always have a negative effect on GDP growth and more intense conflict is worse for the economy. For non-territorial conflict, the combination of linear and quadratic terms identifies the effects optimally, implying that low levels of non-territorial conflict provide a Keynesian stimulus to growth (Reitschuler and Loening 2005), but that higher levels do not.

As expected, the spillovers of international conflict follow a negative linear trend. Less clear-cut is the small but positive quadratic effect for non-territorial conflict. We hypothesize that this is a Keynesian stimulus where neighbors' conflicts increases the demand for military goods or related supplies. Surprisingly, civil conflict does not affect neighboring growth at all, which may imply that the effect of civil conflict is non-linear in distance, as argued by De Groot (2010), while we only test for nonlinearity in intensity.

Finally, the direct post-civil conflict period is only four years, while after international conflict it lasts five years. For both conflict types, a quadratic effect is identified, implying that growth is depressed after low-intensity conflicts and boosted after intense conflicts. This confirms Collier's (Collier 1999) argument that the legacy of conflict depends on its severity, although Collier defined severity only in terms of the length of the conflict period. As expected, non-territorial conflict does not appear to have any direct post-conflict effect at all. The speed of convergence that continues to take place after the direct post-conflict effects end is determined endogenously by our estimation.

When combining the separately identified elements, we obtain the results presented in column A of table 2. As can be seen, all individual effects continue to be significant. Column B of table S3 contains the results in which the bottleneck for data availability (education) is excluded. While the qualitative results remain the same, we can observe a significant change in the value of the convergence term. Even when using the original set of observations, but excluding education, the convergence term is still very low. This implies that the exclusion of education affects the results more strongly than the purported change in the data availability. We are therefore confident that the specification in column A is optimal. In any case, if observations are excluded in the original estimation due to a lack of data availability in, for example, education, this does not imply that these countries are excluded in the overall estimation of conflict costs. After all, the estimation of the counterfactual growth paths requires only the real GDP data and conflict indicators.

To calculate the costs of violent conflict, we employed a two-step approach in Stata using annual observations from 187 countries in a robust fixed-effects panel regression. Given the availability of data, the period of observation is 1960 to 2007. As a first step, we estimated regressions determining which individual conflict variables should be included in our analysis, while allowing for linear and quadratic effects. As a second step, all of the individually significant variables associated with violent conflict were combined into a single regression. Based on these results, we estimated counterfactual GDP paths (Fig. 1A) and compared these with actual outcomes. Note that for each country we cannot distinguish the cost-benefit distributions within countries, yielding only the net effect of conflict and underestimating the gross costs per country (see Fig. 1C for the example of China). The sum of these national net estimates is the global economic burden of violent conflict.

By 2007, global GDP would have been 10.9 trillion $ (or Tr$) larger if violent conflict had been absent since 1960, equalling 15.7% of GDP. The point estimate of the net global costs of 10.9 Tr$ consists of gross costs of 12.7 Tr$ and gross benefits of 1.8 Tr$. The gross costs, gross benefits and net costs of violent conflict during the 1960-2007 period are displayed in absolute terms (Fig. 1D) and relative to GDP (Fig. 1E). We used a Monte Carlo estimation to show that the 90% confidence interval of our results yields costs between 6.5 and 16.2 Tr$ by 2007 (Fig. 1F). As a robustness check, we included all potential conflict variables deemed insignificant in stage 1. This resulted in a minor increase of the point estimate (12.8 Tr$), but a large decrease in the precision of our estimates (90% confidence interval: 6.0-21.4 Tr$).

Our approach allowed us to calculate how, *ceteris paribus*, conflict impacts across different phases (Fig. 1A). In particular, we calculated how different types of conflict impact contemporaneously (t_0 to t_1 in Fig. 1A), in the post-conflict period (t_1 to t_2) and on neighbouring countries contemporaneously. We also calculated the convergence rate beyond t_2. Ongoing civil or international conflicts have negative impacts on growth which are linearly increasing in intensity (Fig. 1G-H). In contrast, non-territorial conflict positively affects growth at median levels of intensity (Reitschuler and Loening 2005) (Fig. 1I). Spillovers due to international conflict have a negative effect (Fig. 1H), and non-territorial conflict has a small but positive quadratic spillover effect. We propose that this observation reflects a Keynesian stimulus (Keynes 1920) where neighbours' conflicts increase the demand for military goods or related supplies (Fig. 1I). Surprisingly, civil conflict does not affect neighbouring growth at all (Fig. 1G), which may imply

that the effect of civil conflict is non-linear in distance (De Groot 2010), while we only test for nonlinearity in intensity. Finally, by comparing the explanatory power of different potential post-conflict period lengths, we found that for civil conflict, this period lasts only four years, while it lasts five years following international conflict. For both types of conflict, a non-linear effect was identified. This implies that growth is depressed after low-intensity conflicts and boosted after intense conflicts (Fig. 1G-H). This confirms the argument that the legacy of conflict depends on its severity (Collier 1999). As expected, non-territorial conflict does not appear to have any direct post-conflict effect (Fig. 1I). The speed with which countries' GDP levels converge (Mankiw, Romer, and Weil 1992; Organski and Kugler 1977) was determined by the model to be 3.1% per year.

Differentiating our results across countries, we find that the impact of conflict varies significantly in relative terms (Fig. 2A). For three countries (Afghanistan, Sudan and Israel), we estimate that total GDP would have more than doubled without violent conflict (Fig. 2B). China's costs (4.8Tr$) are the largest in absolute terms, followed by India (2.9Tr$) and the United States (1.2Tr$). Critically, even without conflict, absolute costs may continue to increase: as our cost estimate is measured relative to GDP, a rapidly rising level of total GDP continues to yield higher absolute costs of past violent conflict. China's relative costs of 43% of GDP in 2007 is below its 1992 peak of 75%, but China's fast-growing GDP led to an increase in the absolute costs from 1.9Tr$ to 4.8Tr$ over the same period. By region, China and the rest of Asia would have benefited the most from the absence of violent conflict between 1960 and 2007, whereas Europe would have lost some (Fig. 2C). From the results, it can be concluded that developing countries lost as a result of conflict, whereas developed countries instead benefited, thus exaggerating global imbalances. This gap between poor and rich countries can be captured by the global cross-country Gini coefficient that measures inequality: *Ceteris paribus*, the absence of conflict decreases the coefficient from 0.542 to 0.523. As for timing, the strongest impact on the 2007 level of GDP results from conflict occurring during the 1980s (Fig. 2D). The decomposition across conflict types shows that civil and international conflicts contribute strongly to the total costs of violent conflict, whereas non-territorial conflict occurrence actually reduces the net burden of violent conflict (Fig. 2E). A key finding is that almost half of the net conflict burden accrues during the post-conflict period (Fig. 2F).

So far, our calculations assume that violent conflict is reduced by 100 per cent. This is not a realistic policy option. We therefore simulate decreasing the intensity of violent conflict, decreasing the length of conflicts or increasing the post-conflict growth rate. We test the impact of a reduction of conflict intensity (Fig. 3A), starting at different points in time. This shows that the effect on 2007 GDP of a 100% reduction of intensity in 1989 is equal to a 47% reduction in 1979 or a 26% reduction in 1959. However, a reduction in conflict intensity after 1999 has little impact on the costs of conflict, unless the reduction is greater than ~50%. This is due to the fact that both the benefits and the costs of conflict are decreased in this scenario. Alternatively, a one-year reduction in the length of all violent conflicts strongly impacts GDP (scenario 2 in Fig. 3B), although this is mostly driven by 1-year conflicts (scenario 3 in Fig. 3B). In other words, preventing short wars may have a particularly high growth impact. Finally, we simulated scenarios in which the post-conflict rate of convergence is one percentage point higher (scenario 4 in Fig. 3B) or in which post-conflict growth is increased by one percentage point (scenario 5 in Fig. 3B). From a policy perspective, our results indicate that investing in ending wars earlier and accelerating post-conflict growth are the most effective options to reduce the economic burden of conflict.

Putting the results in perspective

It is interesting to see how these results measure up against other cross-country estimates on the costs of conflict, but also to see whether they are comparable to specific case studies. Finally, since we are interested in comparing societal *bads*, we compare these results to other global challenges.

Comparison with other cross-country indicators of conflict impact

Our results can be compared to two other indicators that look at conflict and violence across countries and years: The Global Peace Index (Vision of Humanity 2012) and the Burden of Violence by the Small Arms Survey (Geneva Declaration Secretariat 2011).

The Global Peace Index (GPI), released by Vision of Humanity, is a composite of 23 indicators "ranging from a nation's level of military expenditure to its relations with neighboring countries and the level of respect for human rights." (Vision of Humanity 2012). The range of possible values that the GPI could take for a given country goes from 1 to 5, with higher values representing "less peaceful" countries.

When compared with panel 2B of our paper, the GPI index appear to deliver similar results. The top 5 countries that ranked as least peaceful in 2007, according to GPI are Iraq, Sudan, Israel, Russian Federation and Nigeria. There are three countries that also appear on our top 5 ECBI 2007 Index (panel 2B), namely Sudan, Israel and Iraq.

The other countries in panel 2B (Afghanistan and Somalia) did not have information in 2007 to provide an estimation of the GPI. However, in the GPI 2011 index, Somalia appears as the least peaceful country considered, and Afghanistan is country 150 of 153 in terms of peace (when ordered from most to less peaceful countries).

The ECBI index provides data since 1960, so comparisons can be made across a large period of time, whereas the GPI Index has data for the period 2007-2011 only. The ECBI is an indicator derived from the impact of war on the economy, and in that, it may yield different results than GPI, that "ranks the nations of the world by their peacefulness and identifies some of the drivers of peace" (Vision of Humanity 2012). Moreover, because the ECBI in each year tends to depend on previous conflict (the gap in GDP created by conflict takes time to be overcome after the conflict ends), it reflect current conditions and legacies of war, which may not be so visible in an index such as GPI that is composed of current indicators. However, as the comparison made above suggests, there is a certain commonality in results between both indexes.

The other index, the Global Burden of Armed Violence (GBAV) index is focused on violent death rates over a period of time. It is not released on an annual basis, and the 2011 report is based on violence related death rates in 2004-09. Top 5 violent countries in 2011 according to GBAV are El Salvador, Iraq, Jamaica, Honduras and Colombia, suggesting a geographic cluster (4 countries are in the Americas). The disparity with panel 2B arises because deaths directly related to conflict (one type of violent death) only represented about 10% of all violent deaths (Geneva Declaration Secretariat 2011). As we measure the effects of violent conflict, rather than of violence in general, there is a likely difference in findings.

Comparison with case studies

Comparing our results for single countries with those of case studies of single is not necessarily very informative for multiple reasons (Bozzoli, Brück, and de Groot 2011). First, case studies often aim to measure something completely different (say the impact of a conflict on a single sector or

on trade). Second, they rarely do account for spillover effects or for benefits of conflict. Third, they may employ methodologies that are not consistent across studies. Finally, they may even include double counting of costs within a single study. However, it may be interesting to know nevertheless whether case studies and our results differ significantly.

Nicaragua is a country of interest because three different studies estimate the costs of conflict over the same time window (1981-85). Furthermore, these studies aim to provide a comprehensive measure of the costs, hence making them somewhat comparable across studies and with our approach. The Instituto Latinoamericano de Planificacion Economico y Social (ILPES) provided a first estimate of the economic consequences of the war, backed by the United Nations (DiAddario 1997). A second study is that of FitzGerald (FitzGerald 1987). DiAddario further expanded the study by ILPES and arrived to a new estimate of the costs (DiAddario 1997). The results of all these different studies are displayed in table 3.

Comparison with other global challenges

Finally, we assess the relative importance of violent conflict compared to different societal challenges, drawing on other quantitative studies (Fig. 4A). Since no framework for analysing global challenges existed, comparability is limited. We ranked different studies according to three criteria: Use of a macroeconomic model, its global focus, and econometric consistency. The number of matched criteria indicates the degree of comparability. Our analysis suggests that violent conflict is detrimental to growth and that its impact is comparable to the consequences of climate change, which has been suggested to reduce GDP by up to 20% by 2100 (Stern 2007). Our results can also be interpreted as the Economic Burden of Conflict Indicator (EBCI), measuring the burden of violent conflict across countries per year, expressed in the percentage difference of GDP resulting from the absence of conflict. The EBCI correlates with other common indicators of socioeconomic and health outcomes. Maternal and infant mortality and the Human Development Index are correlated with our indicator for the burden of conflict (Fig. 4B-D). Given the continued occurrence and severity of violent conflict today, the reduction of its socioeconomic impact should be a global priority (World Bank 2011).

Conclusion

We find that in 2007 the world in would have been approximately 16% wealthier in the absence of conflict since 1960. This is clearly a very large sum, but given the enormous impact of conflict, we believe this to be a very reasonable and appropriate estimate. While trying to see what happens to our results under a series of general robustness checks, it turns out that our estimate is on the conservative side of the spectrum of cost estimations. The largest contributing factor to the total Global Economic Costs of Conflict is the legacy of conflict. More specifically, the legacy of conflict contributes to a reduction of GDP, which can is only reduced slowly through convergence. So even if we were able to abolish conflict immediately, it will never be able to compensate for the total losses the world has already suffered.

While it turns out that in Europe and North America, the impact of conflict is rather limited, or even positive, our results should present a strong incentive for policymakers to see that the reduction of conflict deserves a place very high on the global list of priorities. After all, while it is difficult to compare across studies, we show that the occurrence of conflict is an even bigger drain on global resources than, for example, climate change is[3]. One important caveat, however, is that we do not look at what the costs of preventing conflict is. However, while these costs may be high in the short run, with a long-run perspective, governments and international organizations alike should be able to recognize that such an investment is worthy and appropriate. One must, after all, compare the one-off cost of preventing conflict to the continuous stream of future costs resulting from the occurrence of conflict.

[3] The Stern Report (Stern 2007) estimates that unabated climate change will cost at least 5% of global GDP per year.

Bibliography

Abadie, Alberto, and Javier Gardeazabal. 2003. “The Economic Costs of Conflict: A Case Study of the Basque Country.” *American Economic Review*: 113–132.

Anselin, Luc. 1988. *Spatial Econometrics: Methods and Models*. Vol. 4. Springer. http://books.google.com/books?hl=en&lr=&id=3dPIXClv4YYC&oi=fnd&pg=PR13&dq=anselin+spatial+econometrics&ots=gTNEC9_oLP&sig=izPM1TwepxQkCdeyF1wMiuHuybo.

Arellano, Manuel, and Olympia Bover. 1995. “Another Look at the Instrumental Variable Estimation of Error-components Models.” *Journal of Econometrics* 68 (1): 29–51.

Balmford, Andrew, Aaron Bruner, Philip Cooper, Robert Costanza, Stephen Farber, Rhys E. Green, Martin Jenkins, Paul Jefferiss, Valma Jessamy, and Joah Madden. 2002. “Economic Reasons for Conserving Wild Nature.” *Science* 297 (5583): 950–953.

Barro, Robert J., and Jong-Wha Lee. 2001. “International Data on Educational Attainment: Updates and Implications.” *Oxford Economic Papers* 53 (3): 541–563.

Baumberg, Ben. 2006. “The Global Economic Burden of Alcohol: a Review and Some Suggestions.” *Drug and Alcohol Review* 25 (6): 537–551.

Bilmes, Linda J., and Joseph E. Stiglitz. 2008. *The Three Trillion Dollar War: The True Cost of the Iraq Conflict*. WW Norton & Company.

Bozzoli, C., T. Brück, and O. J. de Groot. 2011. “How Many Bucks in a Bang: Calculating the Global Costs of Conflict.” *Oxford Handbook of Peace and Conflict, Forthcoming. Institute of Development Studies, Brighton, UK. Retrieved from Http://www. Socsci. Uci. Edu/~ mrgarfin/OUP*.

Collier, Paul. 1999. “On the Economic Consequences of Civil War.” *Oxford Economic Papers* 51 (1): 168–183.

Costanza, Robert, Ralph d’ Arge, Rudolf De Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O’Neill, and Jose Paruelo. 1997. “The Value of the World’s Ecosystem Services and Natural Capital.” *Nature* 387 (6630): 253–260.

De Groot, Olaf J. 2010. “The Spillover Effects of Conflict on Economic Growth in Neighbouring Countries in Africa.” *Defence and Peace Economics* 21 (2): 149–164.

DiAddario, Sabrina. 1997. “Estimating the Economic Costs of Conflict: An Examination of the Two-gap Estimation Model for the Case of Nicaragua.” *Oxford Development Studies* 25 (1): 123–141.

FitzGerald, Edmund Valpy Knox. 1987. “An Evaluation of the Economic Costs to Nicaragua of US Aggression: 1980-1984.” *The Political Economy of Revolutionary Nicaragua*: 195–213.

Geneva Declaration Secretariat. 2011. “The Global Burden of Armed Violence”. Geneva Declaration Secretariat on Armed Violence and Development.

Heise, Lori, Claudia Garcia-Moreno, E. G. Krug, L. L. Dahlberg, J. A. Mercy, A. B. Zwi, and R. Lozano. 2002. “World Report on Violence and Health.” *World Report on Violence and Health*.

Hess, Gregory. 2003. “The Economic Welfare Cost of Conflict: An Empirical Assessment.” http://papers.ssrn.com/sol3/papers.cfm?abstract_id=382929.

Heston, Alan, Robert Summers, and Bettina Aten. 2009. “Penn World Table V. 6.3.” *Center for International Comparisons of Production, Income and Prices (Philadelphia: University of Pennsylvania)*.

Keynes, John Maynard. 1920. *The Economic Consequences of the Peace*. Vol. 178. London.

Kremen, Claire, J. O. Niles, M. G. Dalton, G. C. Daily, P. R. Ehrlich, J. P. Fay, D. Grewal, and R. P. Guillery. 2000. “Economic Incentives for Rain Forest Conservation Across Scales.” *Science* 288 (5472): 1828–1832.

Mankiw, N. Gregory, David Romer, and David N. Weil. 1992. “A Contribution to the Empirics of Economic Growth.” *The Quarterly Journal of Economics* 107 (2): 407–437.

Marshall, Monty G., and Benjamin R. Cole. 2009. *Global Report 2009: Conflict, Governance, and State Fragility*. Center for Systemic Peace.

Murdoch, James C., and Todd Sandler. 2004. “Civil Wars and Economic Growth: Spatial Dispersion.” *American Journal of Political Science* 48 (1): 138–151.

Organski, A. F. K., and Jacek Kugler. 1977. “The Costs of Major Wars: The Phoenix Factor.” *The American Political Science Review*: 1347–1366.

Pimentel, David, C. Harvey, P. Resosudarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, and Ri Saffouri. 1995. “Environmental and Economic Costs of Soil Erosion and Conservation Benefits.” *Science-AAAS-Weekly Paper Edition* 267 (5201): 1117–1122.

Quinn, Thomas C. 1996. “Global Burden of the HIV Pandemic.” *The Lancet* 348 (9020): 99–106.

Rehm, Jürgen, Colin Mathers, Svetlana Popova, Montarat Thavorncharoensap, Yot Teerawattananon, and Jayadeep Patra. 2009. “Global Burden of Disease and Injury and Economic Cost Attributable to Alcohol Use and Alcohol-use Disorders.” *The Lancet* 373 (9682): 2223–2233.

Reitschuler, Gerhard, and Josef L. Loening. 2005. “Modeling the Defense-growth Nexus in Guatemala.” *World Development* 33 (3): 513–526.

Roodman, David. 2009. “A Note on the Theme of Too Many Instruments*.” *Oxford Bulletin of Economics and Statistics* 71 (1): 135–158.

Sachs, Jeffrey, and Pia Malaney. 2002. “The Economic and Social Burden of Malaria.” *Nature* 415 (6872): 680–685.

Sala-i-Martin, Xavier X. 1997. “I Just Ran Two Million Regressions.” *The American Economic Review*: 178–183.

Solow, Robert M. 1956. “A Contribution to the Theory of Economic Growth.” *The Quarterly Journal of Economics* 70 (1): 65–94.

Stern, N. Nicholas Herbert. 2007. *The Economics of Climate Change: The Stern Review*. Cambridge University Press. http://books.google.com/books?hl=en&lr=&id=U-VmIrGGZgAC&oi=fnd&pg=PA1&dq=stern+economics+of+climate+change&ots=9ctY5wgsn9&sig=vAsKKEvCbBFyE7OmXcmPUXoye6Y.

Vision of Humanity. 2012. "What Is the GPI All About?" Vision of Humanity. www.visionofhumanity.org.

Weidmann, Nils B., Doreen Kuse, and Kristian Skrede Gleditsch. 2010. "The Geography of the International System: The Cshapes Dataset." *International Interactions* 36 (1): 86–106.

Wolf, Charles. 1985. "The Costs of the Soviet Empire." *Science* 230 (4729): 997–1002.

World Bank. 2000. "Project Appraisal Document". World Bank Report no. 20727 AFR. Washington DC: World Bank.

———. 2011. *World Development Report 2011: Conflict, Security, and Development*. World Bank. http://books.google.com/books?hl=en&lr=&id=UoL0Wxniua4C&oi=fnd&pg=PR5&dq=world+development+report+2011&ots=5MjHfy2t8X&sig=v4jW9BoiSZ9IX9TEDDLtgq5Hilw.

Yach, D., D. Stuckler, and K. D. Brownell. 2006. "Epidemiologic and Economic Consequences of the Global Epidemics of Obesity and Diabetes." *Nature Medicine* 12 (1): 62–66.

Variable	Source	Average	St.Dev	Min	Max
Conflict Variables					
Probability (Civil Conflict), %	*Major Episodes of Political Violence* Project (22)	9.67			
Average Civil Conflict Intensity (Cases where Civil Conf. Intensity>0)	*Major Episodes of Political Violence* Project (22)	3.78	1.66	1	7
Probability (International Conflict), %	*Major Episodes of Political Violence* Project (22)	2.80			
Average Intl. Conflict Intensity (cases where Intl. Conf. Intensity>0)	*Major Episodes of Political Violence* Project (22)	3.07	1.79	1	6
Probability (Non-Territorial Conflict), %	*Major Episodes of Political Violence* Project (22)	4.66			
Average Nonterritorial Conflict Intensity (cases where Nonterritorial Conflict Intensity>0)	*Major Episodes of Political Violence* Project (22)	4.19	1.72	1	6
GDP Variables					
GDP (billions of 2005 USD)	Penn World Table v.6.3 (23)	204	755	0.01	12919
Average GDP per capita (2005 USD)	Penn World Table v.6.3 (23)	9100	10895	153	97297
Average annual GDP per capita growth	Penn World Table v.6.3 (23)	2.18	7.77	-65.03	131.24
Other Control Variables					
Average Investment/GDP (%)	Penn World Table v.6.3 (23)	21.5	13.3	0.5	105.7
Population (thousands)	Penn World Table v.6.3 (23)	25096	98296	9.5	1321852
Average Education (% adult population with some secondary schooling)	Barro-Lee International Data on Educational Attainment (24) and own calculations	26.8	21.5	0.2	92.7
Burden of Conflict					
Average Cost of Conflict (billions of 2005 USD)	Own calculations	21.9	181	-513	4757
Average Economic Burden of Conflict Indicator -EBCI (% GDP)	Own calculations and Penn World Table v.6.3 (23)	9.73	22.48	-21.74	259.90
N					7215

Table 1*: Descriptive statistics: whole sample.*

	A		***B***		***C***	
	Coefficient	*Standard Error*	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
constant	0.695***	(0.111)	0.412***	(0.071)	0.532***	(0.068)
l.lngdp	-0.031***	(0.005)	-0.019***	(0.003)	-0.023***	(0.003)
Ln(invest)	0.012**	(0.005)	0.015**	(0.006)	0.012**	(0.005)
N+g+delta	0.564***	(0.143)	0.584***	(0.142)	0.562***	(0.143)
Ln(edu)	0.010**	(0.005)				
Civconf	-0.841***	(0.208)	-0.861***	(0.162)	-0.812***	(0.203)
Intconf	-0.794**	(0.348)	-0.744***	(0.245)	-0.782**	(0.347)
nonconf	0.782**	(0.304)	0.365	(0.252)	0.773**	(0.300)
nonconf_sq	-0.111**	(0.056)	-0.014	(0.049)	-0.109**	(0.055)
civpost	-1.074*	(0.648)	-1.244**	(0.537)	-1.044	(0.653)
civpost_sq	0.272*	(0.164)	0.332***	(0.124)	0.273*	(0.164)
Intpost	-1.867***	(0.555)	-2.086***	(0.517)	-1.943***	(0.566)
Intpost_sq	0.414***	(0.128)	0.448***	(0.118)	0.439***	(0.130)
Nonspill_sq	0.075*	(0.042)	0.115***	(0.041)	0.072*	(0.041)
Intspill	-1.237**	(0.563)	-1.059*	(0.589)	-1.200**	(0.561)
N	5763		7518		5763	
R^2	0.084		0.073		0.082	

Table 2*: Regression results from a robust fixed-effects regression. The columns compare the full specification (A) with the specification excluding education (B) and a specification that excludes education and limits the size of the dataset (V).*

	ILPES	FitzGerald (1987)	DiAddario (1997)	This paper
Period covered	1981-85	1981-85	1981-85	1981-85
Estimated cost of conflict, in million USD (year 2000)	5647.7	2093.9	3854.9	4780
Average cost per year, in million USD (year 2000)	1129.5	418.8	771.0	956.0

***Table 3**: Estimates of the Economic Costs of Conflict for Nicaragua, 1981-85*

Using our methodology, the estimated cost of conflict for this period in Nicaragua is 5.42 billion USD (year 2005) or 4.78 billion USD (year 2000), when deflated by US CPI. This estimate is within the range established by the three country studies mentioned above (range: 2.09-5.65 billion USD, year 2000).

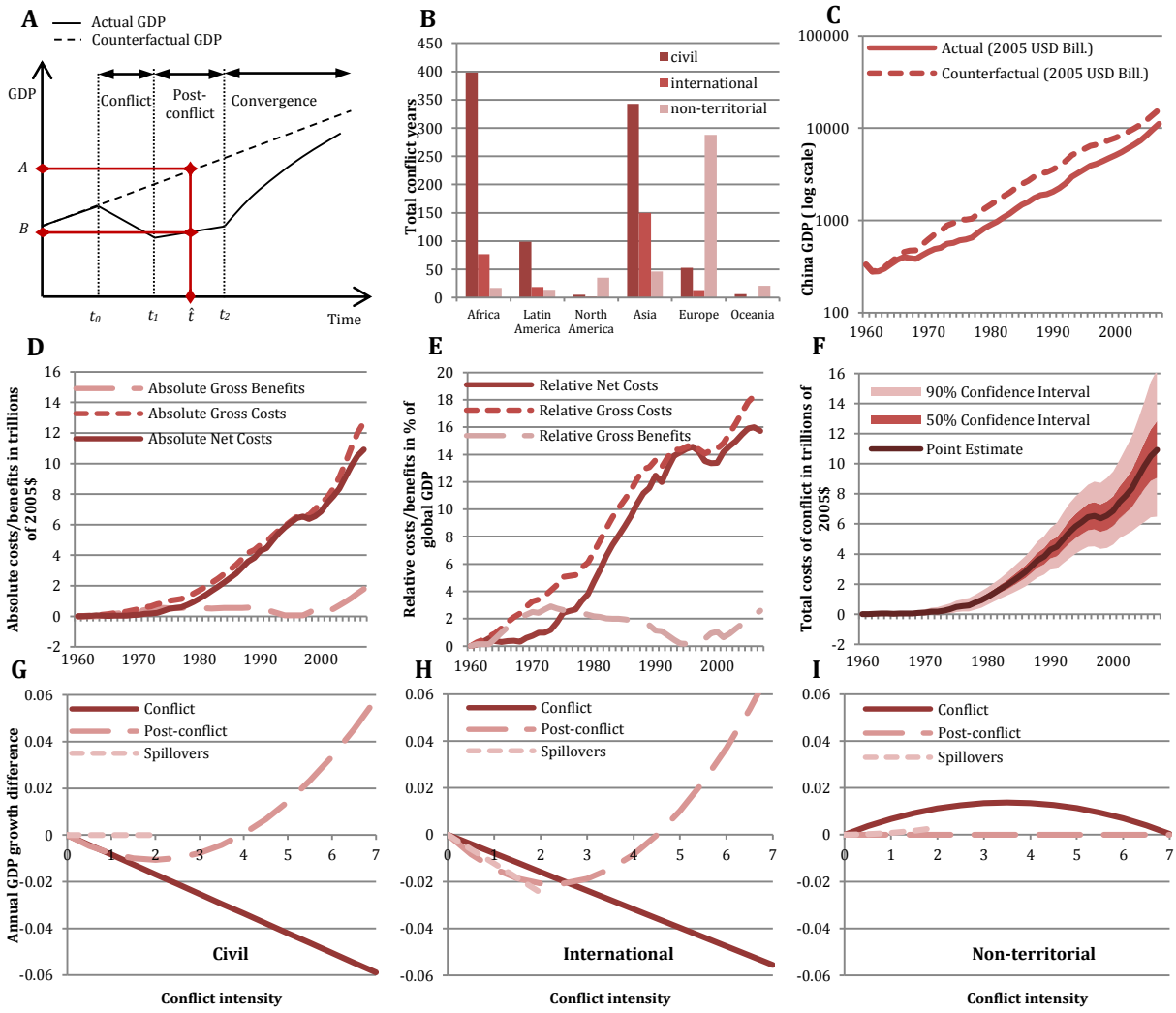

Fig. 1. The scale of the costs of violent conflict in theory and in practice. (**A**) Theoretical construct differentiating between the conflict period, the post-conflict period and the (post-post conflict) convergence period. The costs of conflict at time $\hat{t}$ is defined as the difference between *A* and *B*. (**B**) Conflict during the 1960-2007 period as number of conflict years per region for different types of conflict. (**C**) True and counterfactual GDP in China as an illustration. (**D** and **E**) Costs and benefits of conflict as difference between true and hypothetical GDP growth paths, expressed in absolute (D) and relative (E) terms. (**F**) Confidence interval on basis of Monte Carlo methodology of parameter consistency. (**G-I**) Calculated impact of different conflict aspects on civil (G), international (H) and non-territorial (I) conflict.

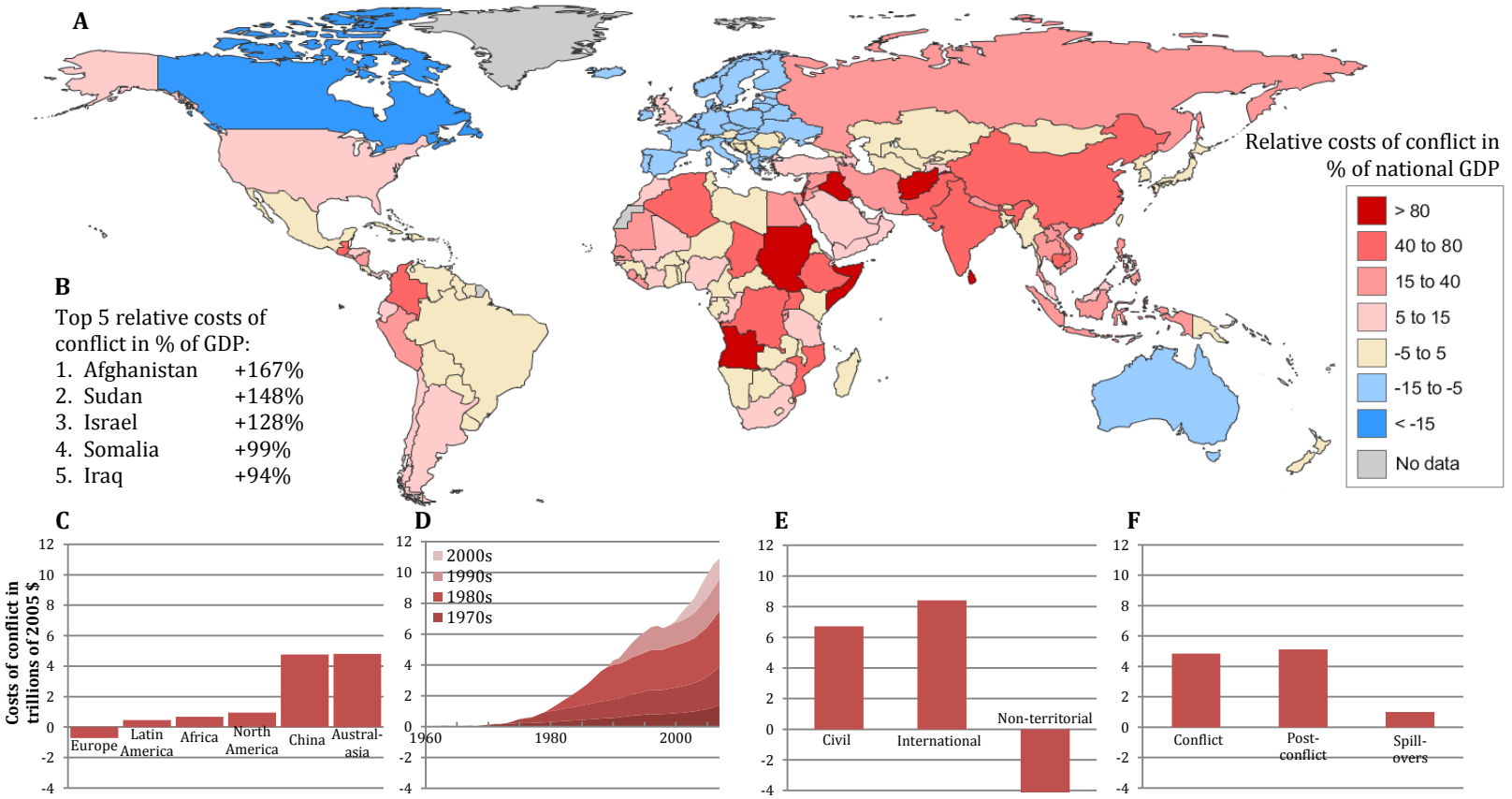

Fig. 2. The distribution and structure of the costs of violent conflict in 2007. (**A**) Disaggregation of the net costs of conflict per country worldwide, where higher numbers represent a larger burden of conflict. (**B**) Countries that would benefit most from the absence of conflict since 1960. (**C**) Disaggregation between different continents. (**D**) Disaggregation across chronologic origin of original conflict during different times. (**E**) Disaggregation across types of conflict. (**F**) Disaggregation between the different postulated effects of conflict.

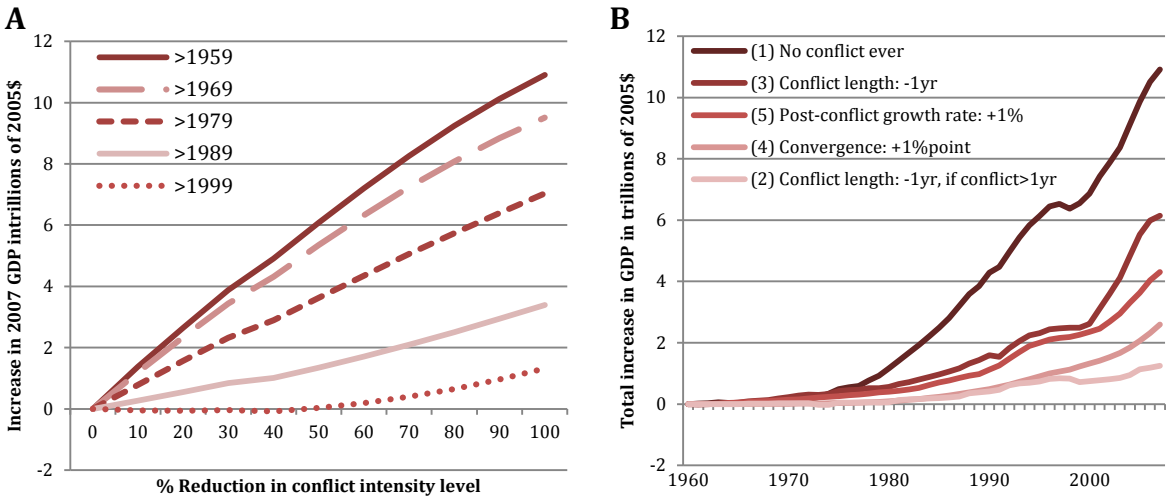

Fig. 3. The effects of different policy simulations on the total net costs of violent conflict. (**A**) Effect of a simulated reduction in violent conflict intensity starting from different years. (**B**) Effect of different policy scenarios: (1) no conflict ever takes place, (2) reduction of conflict periods by 1 year for all conflicts lasting more than 1 year, (3) a 1 year reduction of all conflict periods, (4) increase in the level of convergence after conflict periods by 1%point, and (5) increase in the growth rate during the post-conflict period by 1 percentage point.

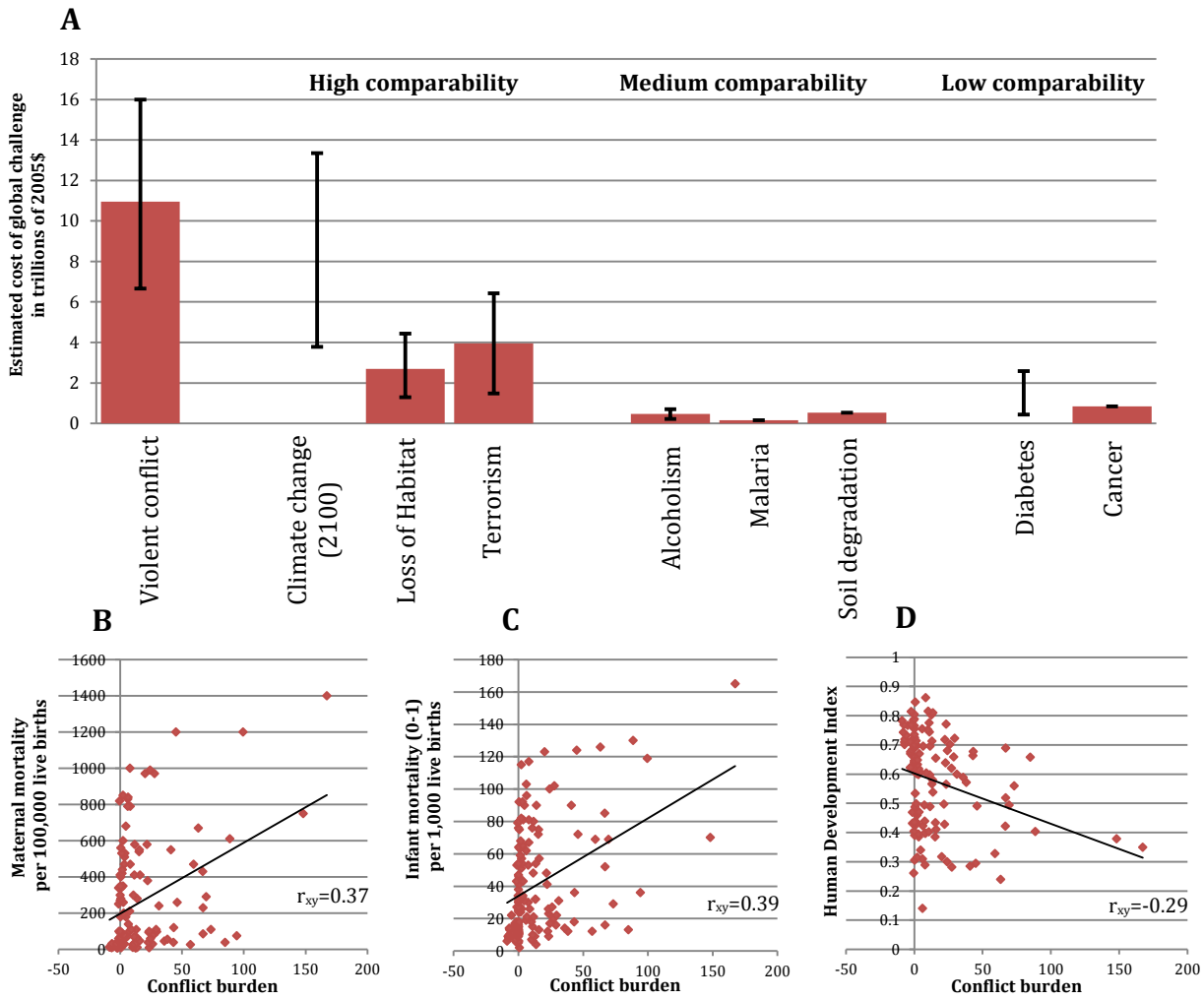

Fig. 4. The relevance of the costs of conflict in a larger perspective. (**A**) Comparison between the costs of different societal challenges, where violent conflict is in the same order of magnitude as the expected costs of climate change. The degree to which these studies are comparable is approximately indicated. (**B-D**) Correlations between the 2007 costs of conflict and socioeconomic indicators, such as the maternal mortality rate (B), the infant mortality rate (C) and the Human Development Index (D).