International Studies Quarterly

International Studies Quarterly (2013) **57**, 1–12

Demographic and Economic Consequences of Conflict[1]

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Research on conflict traditionally focuses on its initiation, duration, and severity, but seldom on its consequences. Yet, demographic and economic recovery from the consequences of war lasts far longer and may be more devastating than the waging war. Our concern is with war losses and post-war recovery leading to convergence with pre-war performance. To test this proposition, we choose the most severe international and civil wars after 1920. We find that all belligerents recover or overtake demographic losses incurred in war. Economic assessments differ. The most-developed belligerents recover like a ''phoenix'' from immense destruction in one generation. For less-developed societies, the outcomes are mixed. The less-developed belligerents recover only a portion of their pre-war performance. The least-developed societies suffer the most and fall into lasting poverty traps. The overlapping generation growth model accounts for such differences in recovery rates based on pre-war performance challenging arguments from Solow's neoclassical growth perspective. Our results imply that foreign aid is incidental to the post-war convergence for the most-developed societies, can prompt recovery for the less-developed societies, and is not effective—unless it is massive and sustained—for the least-developed societies. World War II may provide a poor guide to current post-war challenges in Iraq and in Afghanistan.

Students of world politics have justly focused on understanding the initiation, duration, and severity of wars (Levy and Thompson 2010; Sarkees and Wayman 2010). Far less emphasis has been placed on the lasting consequence of conflict that includes casualties, forced migration, and economic devastation. These consequences are interrelated, vary in the short and long term, and differ across space or levels of economic development. Our objective is to provide a comprehensive assessment and a tentative explanation for the puzzling post-conflict recovery patterns that are still not fully understood. Two major puzzles are explored:

- Do populations recover from massive war losses and even increase their size despite substantial out-migration?
- Do nations recover like a ''Phoenix'' from the devastation of war and reach their pre-war economic status within a generation?

A more systematic accounting of recovery patterns is essential to understand both the consequences of war and the impact of foreign aid on nation building. First, we consider the patterns of demographic recovery and then assess economic consequences.

Demographic Consequences of Conflict

The percentage of a population lost in war is the most visible and direct indicator of a conflict's severity. The severity of war is measured by the number of military and civilian casualties. World War II, the most catastrophic global conflict thus far, produced battle casualties of roughly 22 million combatants and 28 million non-combatants. The worldwide losses exceed 50 million people (Urlanis 1971:294–295). Three-fourths of these casualties took place in Europe where almost 38 million people perished. Overall losses translate to approximately 3% of the population in all belligerent countries. Of course, not all belligerents were affected equally. The most-affected nations lost more than 20% of their population, the less affected suffered a 2% decline, and the least affected endured <1%. To evaluate the recovery rates, such differences need to be taken into consideration.

Assessments summarized in Figure 1 show that populations are strongly affected by war producing structural effects empirically reported in the aftermath of severe war.

Total populations recover because the immediate post-war period generates a ''baby boom'' that has an ''echo'' effect over several generations. Frumkin (1951) and the United Nations (1971) provide general assessment of post-war baby booms, showing that in the long term the overall effect of all conflicts on the global population is nil or slightly positive (Notestein, Taeuber, Kirk, Coale, and Kiser 1944).

A large baby boom occurs immediately after a severe war ends and its effects then echo across several generations. Consequently, nations devastated by domestic or international conflict not only endure immediate losses, but misshaped cohorts continue to experience such losses cyclically. Thus, not one but many generations experience the effects of war.

Cohort effects of war also linger across generations (Urlanis 1971). Figure 2 shows cohort effects on Russia, which lost approximately 20% of its population during World War II.

[1] *Author's note:* We would like to thank our two anonymous reviewers for their insights and helpful comments. The paper would not be where it is without them.

Kugler, Tadeusz et al. (2012) Demographic and Economic Consequences of Conflict. *International Studies Quarterly*, doi: 10.1111/isqu.12002

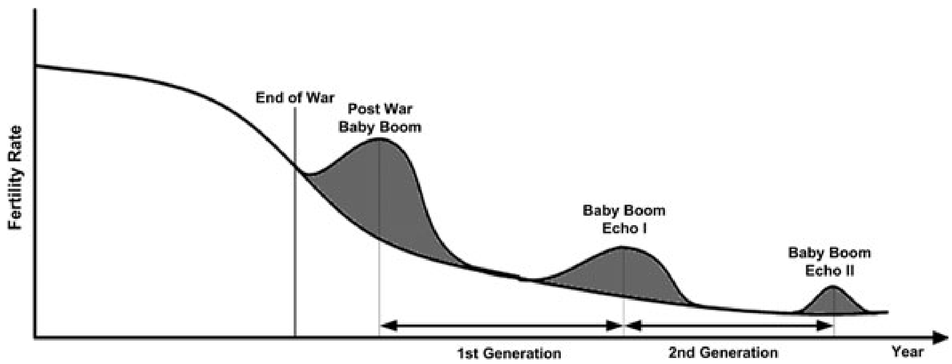

FIG 1. Effects of the Post-war ''Baby Boom'' on Populations

Battle casualties disproportionately affect male populations between 18 and 40 years of age. Unwittingly, male depletion provides women and minority groups—who are frequently drafted to support the war effort—increased opportunities for training and employment during and in the post-conflict period. Wars therefore have the unintended effect of reducing employment barriers (Olson 1982).

Far less recognized are the negative post-war effects resulting from the combination of a large increase in infant mortality and a sharp decline in life expectancy, which are then followed by dramatic rises in fertility that linger after the conflict. War-devastated societies therefore increase their young-dependent populations, but lose most of their senior-dependent population. Consequently, the potentially active population is temporarily distorted, favoring the employment of females and the very young. The baby population expands disproportionally, also distorting the provision of education. These consequences have profound effects on economic productivity.

Economic Consequences of Conflict

The classic literature before 1980 generally contends that war has devastating consequences. Angell (1933) argued that nations involved in conflict will suffer permanent losses and increase the devastation rate in the post-war period. Thorp (1941) anticipated that severe depressions would follow war. Wright (1943) suggested that war led to the misallocation of factors of production and reduced growth levels. Keynes (1920), more optimistically, argued that recovery from war was conditioned on post-war foreign aid; in its absence, nations would not recover pre-war performance. Such arguments found empirical support. Kuznets (1973) and Wheeler (1975) explored war losses within and among developing societies and reported long-term losses.[2] Arbetman and Kugler (1989) likewise show that many developing nations do not recover from war losses.

Much of the literature after 1980 generally contends that war produces short-term losses but has limited long-term consequences. Optimistically, Kugler (1973) and Organski and Kugler (1979, 1980) proposed that recovery from war would lead to convergence with pre-war productivity. The ''Phoenix Factor'' they isolated empirically shows that developed societies devastated by World Wars I and II recovered in one generation the levels of performance they would have had in the absence of conflict.[3] In the next section, we seek to account for the contradictory empirical results that emerged from the post-war destruction literature and those associated with the more optimistic ''Phoenix Factor'' dynamics.

We are interested in reconciling these contradictory empirical results about post-war recovery and convergence, and look to theories of economic growth for plausible specifications that can account for these differences.

Neoclassical Solow Model

The standard neoclassical growth model by Solow (1956) and Swan (1956) proposes an explanation for the accelerated post-war recovery and convergence to pre-war performance disclosed by the ''Phoenix Factor.'' In this growth model, the economic recovery process is associated with change in the capital stock per period (for derivations, please see Appendix 1). The economic growth rate is expressed in terms of the relationship between current capital stock (k_t) and future capital stock (k_{t+1}).

$$(1+n)k_{t+1} = sA(t)f(k_t) + (1-\delta)k_t \tag{1}$$

n = population growth rate
s = constant saving rate
$A(t)$ = technology
δ = depreciation factor
t = time

Based on the equation (1), the dynamics of the post-war recovery derived by Solow in the plane $\{k_t, k_{t+1}\}$ are represented in Figure 3.

The recovery path for the economy is characterized with a graph of k_{t+1} that is increasing and strictly con-

[2] A number of alternative propositions to account for differential recovery have been proposed. Abramovitz (1986) focuses on technology within the Solow model but does not address convergence. Olson (1982) argues that the destruction of political coalitions generates added growth in the post-war period, but there is no empirical confirmation of this plausible insight. Flores and Nooruddin (2009) focusing on short-term recovery link democracy to the speed of post-war recovery in civil wars but do not consider catchup to pre-war expectations. Collier and Hoeffler (2000), following on Angell (1933), raise the possibility of a poverty trap following civil wars, but again do not focus on convergence.

[3] These results had important implications for our understanding of world politics. The Power Transition theory (Organski 1965; Organski and Kugler 1980) postulated that power overtaking among contenders sets the preconditions for major conflict. To achieve such an overtaking prior to World War II required that Germany and its allies defeated in World War I would recover within a generation their productivity to once more reach parity with the dominant British–French alliance that previously defeated them. If the prevailing wisdom that nations were devastated by war was correct, belligerent losers would either not recover from war or suffer permanent decline. Under such conditions, the possibility of a power overtaking among enduring rivals was implausible. World War II was waged at parity lends needed credibility to existence of the Phoenix Factor dynamics (Organski and Kugler 1980).

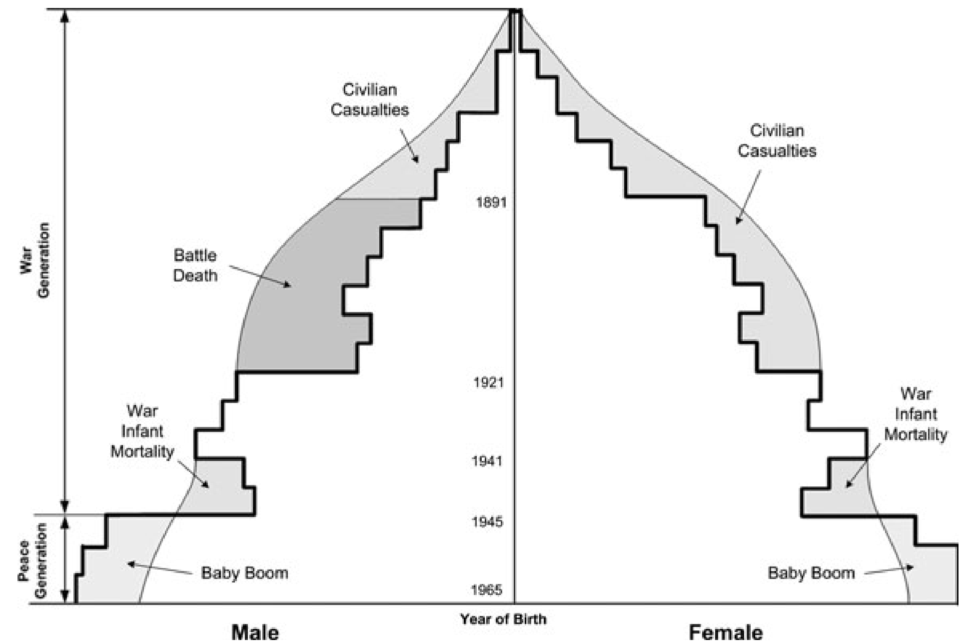

Fig 2. Conflict Effects on Demographic Structures (Source: Adapted from Urlanis 1971 based on Russia's population losses)

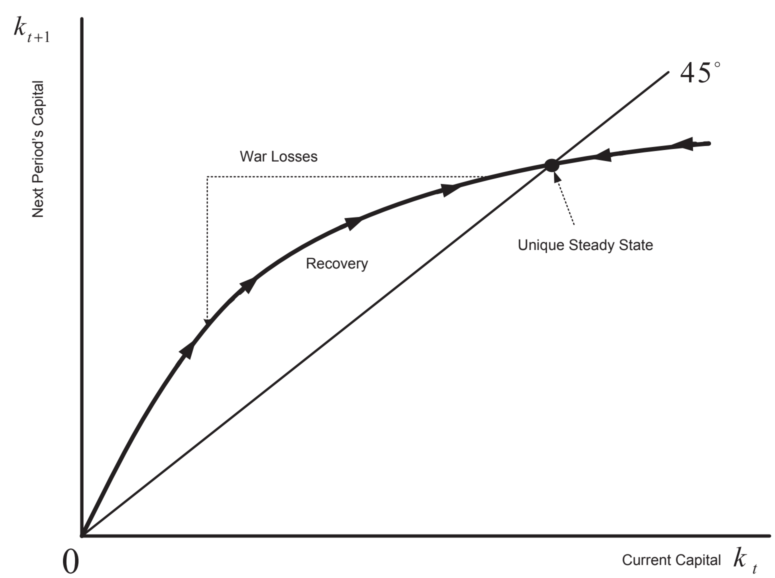

Fig 3. Post-Conflict Recovery in the Neoclassical Solow Model

cave in k_t, empirically represented by income measured by GDP *per capita*. The steady state where an economy maintains a stable size is defined by the intersections of the recovery trajectory with the 45° line. At this point, there is no difference between current capital and future capital ($k_{t+1} = k_t$). The arrows show that if an economy moves away from its steady state, it will gradually return to it. Thus, a recovering economy grows above the 45° line (($k_{t+1} > k_t$), as capital stock grows; while when it overheats below the 45 line ($k_{t+1} < k_t$), the economy will contract.

The steady state will be reached for any positive initial value of capital. The straightforward implication illustrated in Figure 3 is that regardless of the size of war losses suffered, all devastated economies will converge to a steady state or balanced growth path. Consistent with the ''Phoenix Factor,'' Solow's model predicts that nations devastated by war will recover pre-war productivity patterns.

Solow's neoclassical growth model accounts for the dynamics of recovery and explains why belligerents that suffer the most drastic reductions in capital and labor will *accelerate* the most. Indeed, as Figure 3 shows, economies that experience larger capital losses from war will extract greater marginal returns from each unit of capital stock. Thus, an economy devastated by conflict is expected to achieve a proportionally steeper growth rate *after war* commensurate to the costs of conflict. In the long run, all nations converge back to their natural growth path.

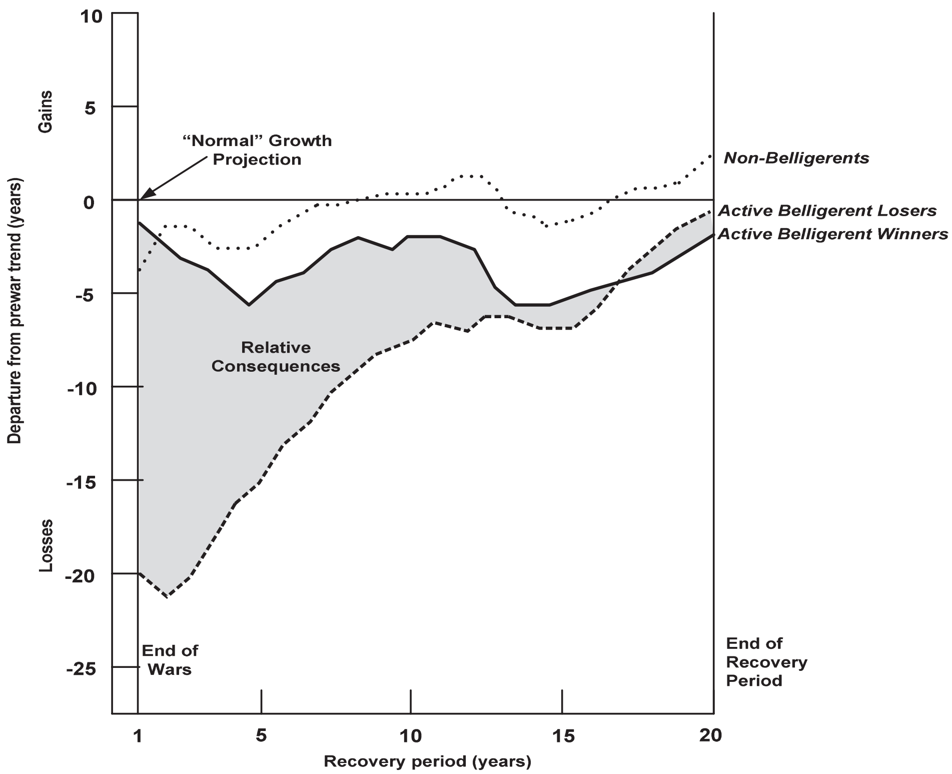

FIG 4. The Economic Consequences of War (Organski and Kugler 1980)

The quasi-experiment set up by Kugler (1973) and Organski and Kugler (1979, 1980) confirmed the expectations of the Solow's neoclassical growth model. Figure 4 displays general results found based on a large sample of belligerents and non-belligerents in World Wars I and II.

The ''Phoenix Factor'' emerged among developed nations devastated by war. Indeed, on average, they recovered previous wealth and productivity levels within 15–18 years after the end of each conflict. This optimistic assessment of post-war dynamics of recovery was thought to be a general finding. Post-war recovery was a well-understood process, but more recent empirics challenge this position.

Overlapping Generation Model

Not all scholars assessing the recovery from conflict found homogeneous patterns consistent with the ''Phoenix Factor.'' As the reliability of data improved, larger discrepancies were noted. Maddison (1994), consistent with Keynes (1920), found that many least-developing societies failed to regain levels of performance following devastating wars. Even more puzzling, some developing societies followed patterns that Angell (1933) described, continuing to lose ground after the conflict. The question is why?

The overlapping generation (OLG) growth model introduced by Samuelson (1958) and Diamond (1965) can model variations in the recovery process and convergence.[4] Recall that Solow's view on economic recovery is monotonic because he analyzes the economy at the aggregate level without permitting individuals to re-optimize when the environment changes. In response, Lucas (1976) proposed that aggregate economic phenomenon should be modeled by adding up the behavior of individuals who rationally react to new economic environments. Following the Lucas critique, we build the OLG growth model with a general equilibrium condition in which all market demand equals supply within the price mechanism, and all economic agents optimize profits. Since individual optimization problems now change at every point in time, the dynamic path of economic recovery is shown to be non-monotonic during the post-war recovery.

The OLG model allows multiple steady states. At one extreme, the model permits rapid recovery, and at the other, it allows a post-war loss or further collapse leading to a poverty trap. The optimization process of economic actors produces to a single non-linear dynamic equation (See Appendix 2 for derivations):

$$k_{t+1} = \frac{\beta\chi}{1+n}[\ln(1+k_t) - \frac{k_t}{1+k_t}] \tag{2}$$

β = time preference for saving factor
χ = political capacity
n = population growth rate
t = time

Like in the Solow model, equation (2) captures the dynamic evolution of the economy in terms of the relationship between the capital stock of the current period (k_t) and the capital stock of the next period (k_{t+1}). For this reason, we can directly compare the path of the post-war recovery characterized by the OLG framework to the results derived by the neoclassical Solow framework. Figure 5 details the consequences of a devastating conflict at different levels of initial capital in the plane $\{k_t, k_{t+1}\}$. Contrary to the Solow, the OLG model anticipates an S-

[4] This model is extended by Galor and Ryder (1989), Azariadis and Drazen (1990), and Galor and Weil (1996), who investigate global dynamics of capital including poverty traps. More recently, Feng, Kugler, and Zak (2000) and Feng, Kugler, Swaminathan, and Zak (2008) incorporated political factors. Our OLG variant is based on these works.

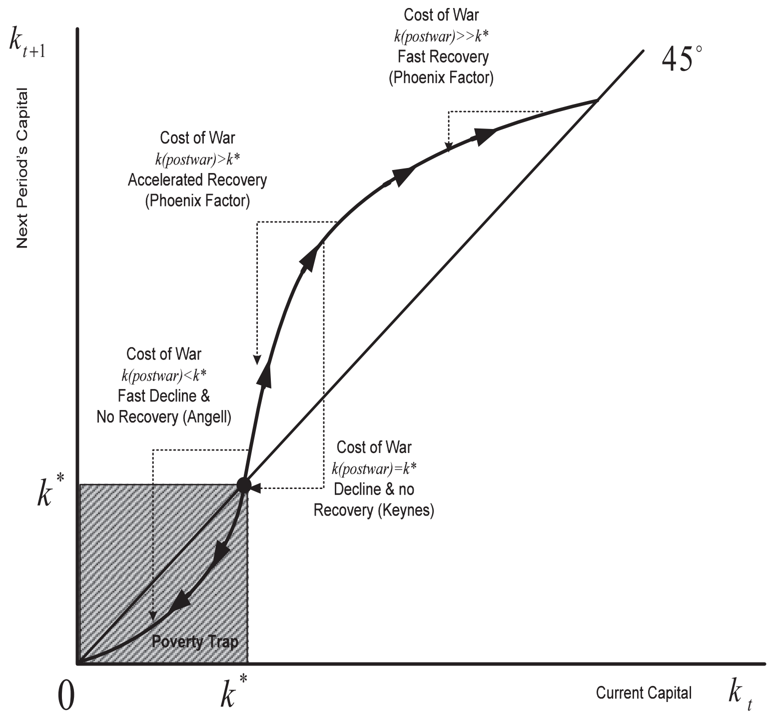

Fig 5. S-Shaped Transitional Trajectory during Post-Conflict Recovery

shaped transition path conditioned on pre-war levels of productivity.

The trajectory of recovery from war follows the S-shaped to arrive at growth paths that contain multiple steady states. Above a threshold (k^*), the OLG model offers the same predictions as those derived from the neoclassical Solow growth model. Below the threshold (k^*), the story is quite different. The OLG model explanation of recovery among less-affluent societies depends on the level of economic development that a society achieved *prior* to the war or insurrection and the costs of war.

Figure 5 shows that, consistent with the neoclassical model, developed emergent societies follow the *Fast Recovery* path from war and converge to previous levels of productivity. A developed society traumatized by war with $k(\text{postwar}) \gg k^*$ will rebuild successfully because economic growth will accelerate based on a pre-existing high level of technology. Further, developed nations recover from the ravages of war in proportion to war losses. Foreign aid adds to this recovery.

A positive recovery pattern does not always generalize among developing societies. Patterns of recovery are conditioned by pre-war performance and the size of the war loss. Two main different patterns emerge.

First, a less-developed society with $k(\text{postwar}) > k^*$ will follow the *Accelerated Recovery* path consistent with the ''Phoenix Factor'' pattern. This recovery is even faster than that of a developed society since the slope of the recovery trajectory is steeper. Developing societies in this path will recover very fast with foreign aid because they augment their capital flows.

Second, least-developed societies may face the *Fast Decline and No Recovery* path. Such societies will increase economic losses incurred during conflict as nations below $k(\text{postwar}) < k^*$ will fall into the poverty trap, consistent with Angell (1933). Foreign aid is ineffective unless massive infusions overcome the anticipated ''corruption'' spillage.[5]

In sum, the economic consequences of conflict are conditioned by pre-war level of development and are far more complex than postulated in the classic framework. The reason is that a large loss in current capital levels induces growth if it falls above the threshold k^*, but when it falls below the threshold k^*, the effect can inhibit growth or, at the extreme, preserve losses and *reverse* the growth rate. Thus, for developed societies and some developing societies, wars are costly in the short term, but positive in the long term. On the other hand, for some developing and the least-developed societies, war effects are permanent and can turn into protracted declines even with a great deal of external aid.

Empirical Assessment

A natural experiment is used to test whether nations follow the recovery paths predicted by the Solow or the OLG model. For our purposes, international and civil wars generate manmade destruction. Definitions of war as ''civil,'' ''total,'' ''global,'' ''world,'' or ''limited'' are not useful. We are interested in analyzing whether nations can recover their expected population and productivity from serious conflicts and whether in the post-war period populations and productivity converge to pre-war patterns within a generation (20–25 years). Growth patterns beyond that period can hardly be attributed directly to war effects.

To provide a hard test, we selected the most severe civil

[5] A very rare case for least-developed nations follows the *Decline and No Recovery* path anticipated by Keynes (1920). Nations located at exactly $k(\text{postwar}) = k^*$ will retain war losses but will not endure further losses or fall into the poverty trap. Infusion of foreign aid would be beneficial for it can jump start the economy and accelerate the recovery.

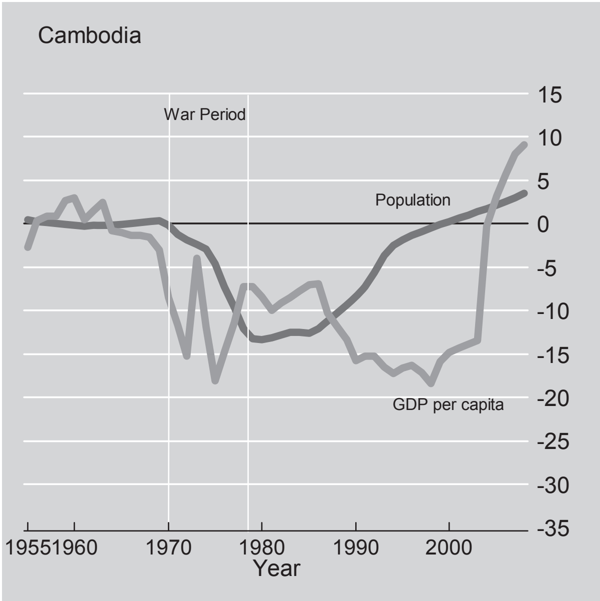

Fig 6. Costs of War: Cambodia

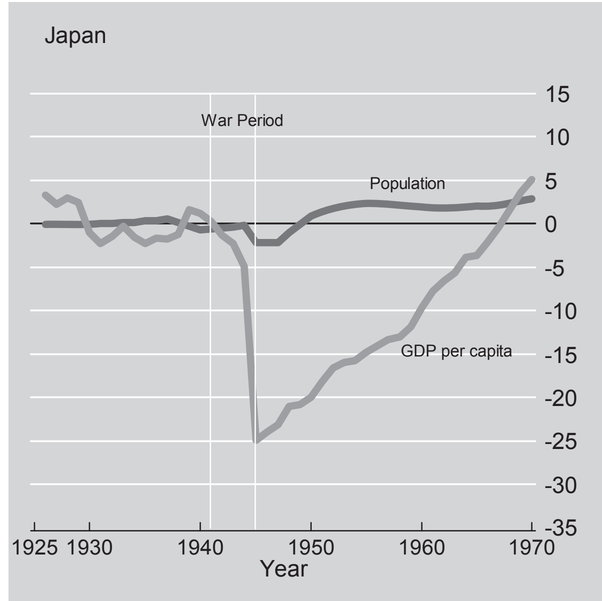

Fig 7. Costs of War: Japan

and international wars waged since 1939. Final estimates of war initiation and termination and total population losses are based on Urlanis (1971), Clodfelter (2002), Lacina and Gleditsch (2005), Lacina (2009), and Cunningham and Lemke (2009) (for details, see Appendixes 3 and 4). We initially included all wars that produced overall losses in excess of 5% of the population, reasoning that recovery from such devastation should be hard indeed. Empirically, few developed societies meet this criterion. Japan, France, the UK, and the United States are added because recovery by the most-developed nations is essential in our analysis. Table 1 lists the 14 cases analyzed.

To calculate the convergence of populations and productivity, we need to generate an objective common unit to capture the discrepancy between pre-war extensions that measure what could have been if war had not happened, and then contrast that with what in reality did happen. Moreover, we must control for the large variation in the sizes of countries. The standardized measure used to account for war losses is foregone years that provide an impartial evaluation of war costs regardless of size or unit.

First, to calculate expected performance, we assume that without war, nations would have had continuous normal growth patterns. To extrapolate normal growth trajectories, we argue that each nation would sustain pre-war period demographic or economic paths for 20–25 years beyond the conflict. Second, we estimate the net demographic and economic losses in terms of forgone years.

To forecast demographic trajectory, we use a linear extrapolation. The basic reason is fit. Our forecast excludes possibilities of acceleration or unanticipated declines that may take place during the expansion process and hide distortions resulting from a fast demographic transition. More complex estimates would require a full modeling of demographic structures—and we reserve that task for the future.

To extrapolate the economic trajectory, we follow the logarithmic trend of GDP per capita. This estimation is justified by Kaldor (1961) and Mankiw, Romer, and Weil (1992), who observed that constant growth rates capture the balanced growth path of normal economies. Again, we cannot account for accelerations and possible depressions during war periods. To compensate in part for the Great Depression prior to World War II, we follow Romer's (2003) suggestion of extending estimates to 20 years and excluding selected years (see Appendix 5).

The process used to standardize estimated war costs in foregone years is as follows:

$$\text{Time} = b0 + b1(\text{Population}) \quad (3)$$

$$\text{Time} = b0 + b1 \ln(\text{GDP per capita}) \quad (4)$$

Based on (equation 3) and (equation 4), we estimate the Predicted Time. Finally, the population and economic loss due to war in the post-war period is then estimated as

$$\text{Time Loss during the Post-War Period} = \text{Predicted Time} - \text{Time} \quad (5)$$

The data on population and GDP per capita used are from Maddison (1982, 1991, 2009) and his earlier estimates in Kugler (1973) that contain unpublished estimates.

Let us illustrate this process with two examples. Consider first Cambodia, which illustrates the patterns for the least-developed societies and had two disastrous wars (see Figure 6).

Notice that the pre-war fit for the population is very close to reality and provides a useful post-war assessment. Within 20 years following the official end of the war in 1979, Cambodia recovered and even gained a little in overall population after suffering an astonishing 15-year decline. This population recovery was made despite very intense instability associated with activities by the Khmer Rouge regional control and the Vietnamese occupation.

Table 1 Severe Population Loss in Conflicts: 1939–2000*

Belligerents	*War Years*	*Civilian & Battle Population Losses*	*Pre-war Population*	*Loss Ratio (%)*
Cambodia (Khmer Rouge)	1970–1979	1,675,000	6,991,000	24.0
Rwanda (Civil War)	1990–1994	868,500	6,804,000	12.8
Mozambique (Civil War)	1976–1992	1,066,850	10,433,000	10.2
USSR (World War II)	1941–1945	18,833,333	195,970,000	9.6
Angola (Civil War)	1975–1994	508,500	5,987,000	8.5
Liberia (Civil War)	1989–1996	187,667	2,340,000	8.0
Germany (World War II)	1939–1945	5,210,000	68,558,000	7.6
Afghanistan (Soviet War)	1979–1989	1,131,000	15,269,000	7.4
Vietnam War	1965–1975	2,039,902	36,099,000	5.7
Hungary (World War II)	1941–1945	464,656	9,287,000	5.0
Japan (World War II)	1941–1945	2,541,959	72,967,000	3.5
France (World War II)	1939–1945	587,533	41,960,000	1.4
UK (World War II)	1939–1945	408,453	47,494,000	0.9
The United States (World War II)	1941–1945	358,989	132,637,000	0.3

(*Notes.* *Omitted cases that lack data but meet the 5% criterion are Poland (WW2), North Korea (1950), Yugoslavia (WW2), Austria (WW2), Greece (WW2), Lebanon (1975) and Sudan (1983).)

Again, the pre-war fit to economic performance is close to reality. The economic picture in the post-war period was far less promising. The economy collapsed and 20 years after war ended, Cambodia reached a low of 20 years of foregone growth (GDP per capita was at 1959 levels!). Consistent with OLG expectations, the poverty trap emerges in the first two decades of the post-war period. The costs of war were severe and lasting. Cambodia was unable to rebuild. The national GDP per capita only starts to recover after 2000 because of a massive infusion of foreign aid disbursed by the international community.[6] The only optimistic implication from this assessment is that even nations devastated by war can be rescued with massive technical and financial foreign aid.

Consider the second example, Japan, that illustrates the path most-developed societies followed after World War II (see Figure 7). The population pre-war fit is very good, suggesting a stable post-war forecast. Compared to Cambodia, Japan suffered relatively low population losses. This is a common characteristic among the most-developed belligerents, which suffer far more economically than demographically. A significant post-war baby boom overtakes within 3 years war losses. Higher than expected fertility rates are sustained for an additional 3 years, but then fertility stabilizes to anticipated low pre-war patterns. Japan experiences a low population expansion during the post-war period.

The pre-war economic fit is reliable. Consistent with the OLG and the Solow model, Japan recovers within 20 years the level of GDP per capita anticipated by the pre-war performance. This is a radically different story from Cambodia's. Japan recovers fully from the economic shock of war.

In Appendix S1, we provide estimates of post-war recovery for all cases in this study. General insights are hard to obtain from such a small sample. Perhaps fortunately, war is not a common event, and very severe wars are even rarer. The best way to summarize these results is with a graph that aggregates the few cases available along pre-war levels of development. We present the overall results divided into three levels of pre-war development and try to identify consistent general patterns.

Figure 8 shows that in all societies, population recovery is remarkably swift. Consistent with the findings of Frumkin (1951) and the United Nations (1971), war does not reduce the size of populations—but still affects their structure. Population recovers faster than GDP per capita.[7] Aggregating the productivity of a larger population produces a larger GDP. For this reason in part, previous analysis of post-war recovery using GDP overestimates the real rate of recovery and exaggerates convergence. Consider now recovery of populations by levels of development. The most- and the least-developed societies gain substantially following wars. Surprisingly, the less-developed societies only recover pre-war populations. Further exploration of migrations may clarify the reason for such differences.

The GDP per capita recovery patterns are distinct and consistent with OLG deductions. The destruction wrought by war is far more severe for societies that have lower levels of pre-war development. The relatively more affluent societies endure average losses of 15 years, while the least-developed ones suffer 25 years of foregone growth. These very meaningful differences make it so much harder for the relatively poor to recover after war.

Consistent with the OLG prediction, the most-developed societies follow different recovery patterns from those found among the less- and least-developed societies. Note that the most-developed societies recover most of what was lost within a generation and continue on that path beyond the 20-year limit artificially imposed. Initial large losses amounting to 15 years of foregone growth are reduced to <5.

Among the less-developed societies, losses exceeded those of the most-developed societies, amounting to 20 years of foregone growth. Recovery is delayed and falls short of pre-war expectations by approximately 10 years and then levels off. This is again roughly consistent with OLG expectations. Finally, among the least-developed societies, the impact of conflict is devastating. These societies endure 25 years of foregone growth, and within the 15 years available for scrutiny, recovery is not apparent. A poverty trap is in place.

[6] From 2003 to 2008, Cambodia obtained, on average, development assistance of around US $600 million a year (Chanboreth and Hach 2008).

[7] An explanation for this phenomenon is not yet available. Kugler and Swaminathan (2006) show that political capacity affects fertility, then after a significant lag economic growth, meaning that a politically capable government can decrease mortality and most importantly infant mortality. This insight is being tested.

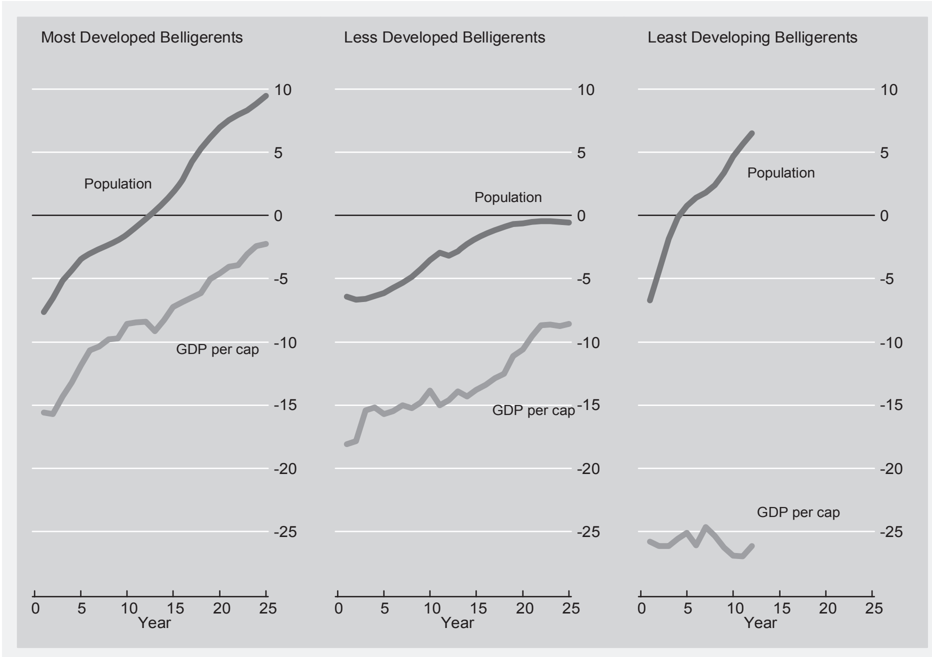

FIG 8. Consequences of War: GDP by Level of Development. Developed Belligerents: Germany, Japan, the United States, UK, France, Developing Belligerents: Vietnam, Hungary, USSR, Least-developed Belligerents: Afghanistan, Angola, Cambodia, Liberia, Mozambique, Rwanda

In sum, populations recover from war in all societies, but the economic recovery from war is conditional on previous levels of development. The ''Phoenix Factor'' clearly applies to the most-developed nations, who also endure lesser short-term losses. Less-developed societies suffer more and recover about only half of pre-war expectations. The least-developed societies endure the most-devastating and lasting costs following severe conflict. The OLG perspective helps explain the success and failure in the post-war period. Indeed, pre-war levels of economic development seemingly determine to a large degree the rate and level of post-war economic recovery.

Implications

All societies recover from population losses endured in conflicts. The story is not so consistent for economic recovery. The OLG framework provides a consistent and nuanced account for the complex process of recovery from wars. Previous optimistic estimation of full recovery guided by Solow's neoclassical model accounts for the path of most-developed societies, but does not appear to account for the more general patterns of post-war recovery. In sum, the OLG perspective that conditions post-war recovery on the level of pre-war economic development proves to be a successful indicator of the speed of recovery and convergence in the post-war period.

In sum, conditional post-war recovery from war is a more consistent explanation. The ''Phoenix Factor'' is part of that overall story for the more-developed societies. For the less- and least-developed societies, the consequences of conflict last far longer and are more severe. These preliminary but robust evaluations suggest that the OLG perspective on post-war recovery may be very productive.

The implications for foreign aid policy are substantive. Developed societies like the UK, Germany, or Japan recovered from World War II at astonishingly fast rates with the help of foreign aid (Kugler 1973). Vietnam and Hungary had only very limited aid, but still managed to recover. Similar recovery paths did not characterize Afghanistan, Angola, Mozambique, or Rwanda. Despite larger per capita foreign aid from international organizations, these nations failed to recover. Instead, these societies endure protracted economic failure. Cambodia is the lone exception. In this country, after a long 20-year pause (outside our range of interest), massive foreign aid provided by international organizations stimulated fast recovery.

We have a plausible explanation beyond our data for recovery patterns that needs verification with further analysis. We believe that there are two diverging non-linear patterns following wars. Demographic recovery takes place and enhances the size of populations following conflict, regardless of productivity. Baby booms, however, have different consequences for the more-developed and the less- and least-developed societies. Baby booms enhance the productivity of more-developed societies that preserve the levels of technology and re-enter the period of fast growth. Their high productivity at low cost is assured because the most-developed societies preserve the human capital acquired by previous generations. Their younger populations can out-produce with newer equipment their less-devastated, most-developed competitors. A war bonus is seemingly accrued only by the most-developed societies. In the least-developed societies, baby booms add poorly trained young to an already low-trained population. Population recovery ensures that the economic losses incurred in war are preserved. These societies disproportionally loose recently acquired human capital and are not able to educate their youth even to pre-war standards. For them, recovery is painful. Here, foreign aid may be the determinant factor that distinguishes between fast recovery and stagnation. The least-developed societies endure the highest costs and are also least able to recover. As their populations explode, they cannot keep up with pre-war levels of human capital.

Many become ''failed states'' that cannot preserve the institutions required to maintain high levels of economic performance (Kugler and Kugler 2010).

The potential implication for the United States efforts to rebuild war-torn societies is sobering. Rebuilding Iraq is likely to be far easier than rebuilding Afghanistan, but either is a far more difficult task than that faced in Japan or Germany following World War II. These devastated, but more-developed, societies only needed to augment capital to prompt economic recovery. In less-developed societies like Iraq, substantial foreign aid and support for human capital may yet prompt a fast recovery. In a clearly least-developed society like Afghanistan, the prospects of recovery hinge far more on reconstructing education, raising political capacity, and introducing human capital than the provision of additional capital. If our analysis is further substantiated, prompting post-war recovery in the less- and least-developed environments is a very hard task.

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Appendix 1: Neoclassical Solow Growth Model

Solow proposed that growth could be accounted by the following aggregate production function:

$$Y_t = A \cdot F(K_t, L_t) \tag{A1}$$

where Y is output, K is the aggregate stock of capital, L is a number of labor, A is the technology variable, and F is a neoclassical production function exhibiting constant returns to scale. Notice the variable t for time appears in the function to allow changes in each variable across time.

In this paper, we are interested in examining possible dynamic paths of economy recovery. By mapping the capital stock of this period (K_t) to that of next period (K_{t+1}), we can characterize economic conditions in which the post-war economy grows or contracts.

The key component of the Solow model is the ''stock accounting'' method. Specifically, Solow assumes the accumulation of capital occurs at a constant saving rate (s). Then, the change in the capital stock is equal to the amount of aggregate savings (sY) that are proportional to aggregate income (Y), less the amount of depreciation (δK) that occurs during the production process. Then, the capital accumulation equation in a dynamic way is given by

$$K_{t+1} - K_t = sY - \delta K_t \tag{A2}$$

where $K_{t+1} - K_t$ is the change in capital over one period and δ is the constant depreciation rate between 0 and 1. To obtain a more explicit presentation of the capital accumulation process, we can rewrite the production function in (equation A1) in per capita terms, $k \equiv K/L$, $y \equiv Y/L$, and $y = f(k) \equiv \frac{AF(K,L)}{L}$.

If the population growth rate is given by n, then the labor force is growing $L_{t+1} = (1+n)L_t$. Now the equation (A2) can be re-expressed in per capita terms as follows:

$$(1+n)k_{t+1} = sA(t)f(k_t) + (1-\delta)k_t \tag{A3}$$

Then, the evolution of capital per person in the economy is defined in terms of the relationship between the capital stock of the current period (k_t) and the capital stock of the next period (k_{t+1}).

Appendix 2: Overlapping Generation (OLG) Growth Model

The sequence for finding solutions to the OLG models consists of three steps: First, the profit maximization problem is solved for firms. Second, the lifetime utility maximization problem is solved for consumers. Third, the capital markets are opened to permit the demand and supply to be met for some equilibrium prices.

We start with a problem of firms maximizing profits. A reprehensive firm producing at period t chooses physical capital k_t to maximize its profits that consists of the benefits (that is, output per worker, $y_t = \chi \cdot f(k_t)$) controlling for the costs (that is, the rental price of capital r_{t+1} and the real wage w_t).

$$\max_{k_t} \chi_t f(k_t) - r_t k_t - w_t \tag{A4}$$

For more concreteness, we use a specific neoclassical production function $f(k_t) = \ln(1 + k_t)$. This function satisfies all the standard properties: it is increasing, concave, twice continuously (For more detailed discussions on the property of the production function, see Azariadis 1993:94). The full dynamics of the general functional form with rigorous mathematical treatments can be found in De La Croix and Michel (2002).

Then, every firm has output per worker ($y_t = \chi \cdot \ln(1 + k_t)$) as the product of a production function ($\ln(1 + k_t)$) and a scale factor that embodies social increasing returns to scale affected by political capacity (χ) (for more detailed discussions of this specification with political capacity, see Feng et al. 2000, 2008). By adding a component of political capacity that affects the productivity of private factor inputs, we mean effective political environments can provide productive economic incentives that encourage individuals to pursue private activities that are socially profitable. This formulation allows the incorporation of insights by Kuznets (1973) and many other researchers who share his conclusion that that political factors shape the rate of growth (Rosenstein-Rodan 1943; Murphy, Shleifer, and Vishny 1991; Knack and Keefer 1995; Alesina 1997; Arbetman and Kugler 1997; Feng et al. 2000; Acemoglu 2005).

Now we consider an optimization process by consumers. In an OLG economy, the young generation overlaps with the previous old generation for one period and then overlaps with the new young generation for a second period as they become old. When they are young, individuals are endowed with one unit of labor that they supply to firms. Their income is equal to the real wage (w_t). When they are old, individuals retire and their income is assumed to come only from the return (R_{t+1}) on savings (a_{t+1}) accumulated when they are young. Receiving a wage and anticipating a return for savings, a young individual optimally allocates his income between current consumption (c_t) and future consumption (c_{t+1}). Then, the lifetime utility maximization problem for an individual anticipating return (R_{t+1}) for his saving is

$$\max_{c_t, c_{t+1}} [(1-\beta)\ln(c_t) + \beta \ln(c_{t+1})]$$
$$\text{s.t} \quad c_t = w_t - a_{t+1} \qquad c_{t+1} = R_{t+1} a_{t+1} \tag{A5}$$

where $0 < \beta < 1$ is the rate of time preference factor (that is, preference for consuming sooner than later).

Finally, we open the capital market that equates the aggregate supply of loanable funds (that is, savings) to the aggregate demand for loans of capital (that is, investment). The capital market equilibrium condition (CMEC) defined in terms of individual savings shows that

$$a_t(w_t, R_{t+1}) = (1+n)k_{t+1} \qquad (A6)$$

where $R_{t+1} = r_{t+1} + 1 - \delta$ is the rental price of capital controlling for depreciation and n is population growth rate.

Using the firm's and consumer's optimality conditions found in (equation A4) and (equation A5), we substitute the current and future capital (k_t and k_{t+1}) for the labor and capital prices (w_t and R_{t+1}) in (equation A6). By doing this, we can obtain a non-linear equation that captures the dynamic path of the economy in terms of the capital stocks of the current period (k_t) and the next period (k_{t+1}) as follows.

$$k_{t+1} = \frac{\beta\chi}{1+n}\left[\ln(1+k_t) - \frac{k_t}{1+k_t}\right] \qquad (A7)$$

The value of $k^* = k_t = k_{t+1}$ represents the threshold in physical capital that determines whether the economy grows or contracts. This non-monotonic dynamics for a country's economy recovery shows that the level of capital endogenously grows or contracts depending on where the recovery process starts. If the recovery starts at a relatively high capital stocks level above k^*, then the recovery dynamics follow the pattern proposed in the ''Phoenix Factor'' argument. If recovery starts from a low capital level below k^*, the recovery dynamics converges to the poverty trap $(0 = k_t = k_{t+1})$ so that capital is reduced in the long run. Indeed, this argument reflects the characteristics of the stages of development originally proposed by Organski (1965), reinforcing the tenets of Power Transition (see also Tammen, Kugler, Lemke, Stam, Alsharabati, Abdollahian, Efird, and Organski 2000:16–18). War may change forever the destiny of economic recovery in the latter economy, but not in the former. It is also important to note that the threshold capital level of recovery $k^* = k_t = k_{t+1}$ is affected by other parameters. According to equation (A7), when social increasing returns to scale (affected by political capacity) is increasing, individuals' saving propensity (related to political stability) is increasing, and population growth rate is decreasing, the recovery trajectory eventually shifts upward. Then, the critical value of k^* becomes lowered and concurrently the size of shaded area shrinks. In other words, if a country lacks such socioeconomic fundamentals, then economic recovery after war is less likely to occur. Thus, this approach anticipates concurrently the patterns of rapid recovery and accelerated decline empirically observed. Such a view provides a plausible explanation as to why the ''Phoenix Factor'' pattern holds for developed societies, but does not apply to all developing societies: Sustained growth may not be possible at low levels but may well accelerate at high levels. Recovery is therefore conditioned by the initial capital accumulation and various socioeconomic fundamentals.

Appendix 3: Comparison of Start and End of Conflicts

	Cunningham and Lemke 2009 (Consistent with Sarkees and Wayman 2010)		*Clodfelter*		*Lacina and Gleditsch (2005); Lacina (2009)*	
Belligerents	*Start Year*	*End Year*	*Start Year*	*End Year*	*Start Year*	*End Year*
Cambodia (Khmer Rouge)*	1970	1979	1970	1979	1967	1979
Rwanda (Civil War)	1990	1994	1990	1994	1990	1994
Mozambique (Civil War)	1979	1992	1976	1992	1976	1992
USSR (World War II)	1941	1945	1941	1945		
Angola (Civil War)	1975	1994	1975	1994	1975	2002
Liberia (Civil War)	1989	1996	1989	1997	1989	1996
Germany (World War II)	1939	1945	1939	1945		
Afghanistan (Soviet War)	1979	1989	1979	1989		
Vietnam War**	1965	1975	1965	1975		
Hungary (World War II)	1941	1945	1941	1945		
Japan (World War II)	1941	1945	1941	1945		
France (World War II)	1939	1945	1939	1945		
United Kingdom (World War II)	1939	1945	1939	1945		
The United States (World War II)	1941	1945	1941	1945		

(*Notes.* *Ended with deposition of the Khmer Rouge in 1979.
**Started with direct combat involvement of the United States in 1965.)

Appendix 4: Comparison of Population Losses Estimates

Belligerents	Cunningham and Lemke	Clodfelter	Lacina and Gleditsch	Urlanis	Average
Cambodia (Khmer Rouge)	1,650,000	1,700,000			1,675,000
Rwanda (Civil War)	937,000	800,000			868,500
Mozambique (Civil War)	1,200,550	1,000,000	1,000,000		1,066,850
USSR (World War II)	17,000,000	19,500,000		20,000,000	18,833,333
Angola (Civil War)	597,000	420,000	1,500,000*		508,500
Liberia (Civil War)	163,000	200,000	200,000		187,667
Germany (World War II)	5,100,000	4,030,000		6,500,000	5,210,000
Afghanistan (Soviet War)	962,000	1,300,000			1,131,000
Vietnam War	2,022,000	2,000,000	2,097,705		2,039,902
Hungary (World War II)	473,967	490,000		430,000	464,656
Japan (World War II)	2,038,000	3,237,878		2,350,000	2,541,959
France (World War II)	567,600	595,000		600,000	587,533
United Kingdom (World War II)	379,400	495,958		350,000	408,453
United States (World War II)	363,650	413,318		300,000	358,989

(*Notes*. *Data from Estimates of Total War Death of Lacina and Gleditsch (2005): Table 4. Not included in the average.)

Appendix 5: Forecast of Post-war Performance based on Pre-War Performance

	Pre-war Period (Excluded)*	Population Intercept (*SE*)	Population Coefficient (*SE*)	GDP per capita Intercept (*SE*)	GDP per capita Coefficient (*SE*)
Cambodia	1955–1969	−30.35 (0.53)	0.0061 (0.000086)	−261.12 (34.69)	41.34 (5.35)
Rwanda	1975–1989	−24.85 (0.45)	0.0058 (0.000081)	−186.64 (59.05)	28.37 (8.65)
Mozambique	1961–1975	−35.78 (1.00)	0.0048 (0.000111)	−173.18 (47.81)	24.57 (6.52)
USSR	1926–1940	−77.01 (5.00)	0.0005 (0.000028)	−134.29 (13.27)	19.10 (1.78)
Angola	1960–1974	−46.65 (2.25)	0.0101 (0.000421)	−248.52 (36.14)	34.68 (4.90)
Liberia	1974–1988	−28.10 (0.79)	0.0183 (0.000408)	228.72 (18.14)	−31.56 (2.58)
Germany	1919–1938 (28–32)	−152.57 (2.41)	0.0025 (0.000037)	−247.15 (32.04)	31.32 (3.92)
Afghanistan	1964–1978	−32.55 (0.68)	0.0031 (0.000053)	177.51 (189.62)	−26.03 (28.94)
Vietnam	1950–1964	−30.98 (1.89)	0.0013 (0.000063)	−299.49 (15.00)	46.11 (2.26)
Hungary	1920–1939 (30–32)	−118.39 (0.79)	0.0149 (0.000092)	−300.41 (45.51)	40.11 (5.87)
Japan	1926–1940	−64.81 (1.26)	0.0011 (0.000019)	−206.53 (30.44)	27.84 (3.97)
France	1919–1938 (30–32)	−195.27 (16.66)	0.0050 (0.000407)	−256.83 (63.84)	32.09 (7.70)
UK	1919–1938 (19–21, 30–32)	−232.02 (3.34)	0.0053 (0.000073)	−459.71 (46.30)	54.76 (5.39)
The United States	1921–1940 (30–33, 34–35)	−90.18 (4.04)	0.0008 (0.000033)	−411.07 (195.37)	47.97 (22.33)

(*Notes*. Data for other possible contenders were insufficient to forecast recovery with any accuracy.
*Years of the Great Depression are excluded following Romer (2003). 1934–1935 of the United States are excluded for the Gold Reserve Act of 1934 realizing dollar devaluation of 41%. 1919–1921 of UK are excluded for Ireland Independence.)

Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix S1. Consequences War for Individual Nations—Most-Developed Belligerents.

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