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Author(s): Reuven Glick and Alan M. Taylor

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COLLATERAL DAMAGE: TRADE DISRUPTION AND THE ECONOMIC IMPACT OF WAR

Reuven Glick and Alan M. Taylor*

Abstract—Conventional wisdom in economic history suggests that conflict between countries can be enormously disruptive of economic activity, especially international trade. We study the effects of war on bilateral trade with available data extending back to 1870. Using the gravity model, we estimate the contemporaneous and lagged effects of wars on the trade of belligerent nations and neutrals, controlling for other determinants of trade, as well as the possible effects of reverse causality. We find large and persistent impacts of wars on trade, national income, and global economic welfare. We also conduct a general equilibrium comparative statics exercise that indicates costs associated with lost trade might be at least as large as the conventionally measured direct costs of war, such as lost human capital, as illustrated by case studies of World Wars I and II.

The most successful war seldom pays for its losses.

—Thomas Jefferson

I. Introduction

WHAT are the true costs of war, and how can they be measured? One might consult the records of statesmen, the popular press, or scholarly books and journals, but approaches to this question vary as widely as the precision of the answers. Still, most analyses have at least one thing in common: a focus on the direct costs, traditionally measured by loss of life and the resources used to wage war—essentially, men and materiel. To these costs occasionally are added those of lost and damaged property, although the accuracy of these figures is much more doubtful.

In this paper, we examine some major indirect costs of war over the period 1870–1997 that have never previously been examined: the effect of belligerent conflict on the volume of international trade and, consequently, on per capita incomes and economic welfare. Using econometric methods, we find a very strong impact of war on trade volumes. Moreover these effects have two important characteristics. First, they are persistent: even after conflicts end, trade does not resume its prewar level for many years, exacerbating total costs. Second, they have a multilateral

dimension: unlike the direct costs of war, which largely affect only the belligerents, commercial losses affect neutral parties as well, meaning that wars generate a large negative externality through trade destruction. We use these results to make general equilibrium comparative statics estimates of the impact of World Wars I and II on global trade and income.

Our paper is part of the renaissance of research activity on the applied economics of international trade. A growing theoretical and empirical literature relates bilateral trade flows to measures of joint economic activity and costs of trade. These so-called gravity models have been used as benchmarks from which to assess the trade impact of economic disturbances and policy regimes, such as exchange rate variability (Thursby & Thursby, 1987), preferential trade arrangements (Frankel, Stein, & Wei, 1996), and currency unions (Rose, 2000).¹

On theoretical grounds, wars and other forms of militarized conflict should affect trade among adversaries. Military conflict between countries is often accompanied by the imposition of partial or total trade embargoes on the exchange of goods. Conflict may also reduce trade flows by raising the costs to private agents of engaging in international business. However, the relation of aggregate trade to political disturbances and conflict has not received much attention among economists. Among the few studies, Blomberg and Hess (2004) analyze the impact on trade of various forms of violence, including war and terrorism, while Martin, Mayer, and Thoenig (2008) estimate the effects of military conflicts on trade. But these analyses focus only on the latter half of the twentieth century; our data span a much longer period including the two great wars of the twentieth century.²

The interaction of conflict and international trade has been the focus of much more attention among political scientists, who have been concerned with putative reverse causation—the effect of trade (along with other political variables) on the likelihood of conflict among countries—as well as the impact of conflict itself on trade.³ Among papers in this literature estimating gravity models, Pollins (1989a, 1989b) finds that less friendly bilateral political relationships dampen trade, Mansfield and Bronson (1997) find that wars reduce trade, and Kesht, Pollins, and Reuveny (2004)

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* Glick: Federal Reserve Bank of San Francisco; Taylor: University of California, Davis, NBER, and CEPR.

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¹ In all three cases, the literature is vast; we cite only one important example in each case.

² The sample periods of Blomberg and Hess (2004) and Martin, Mayer, and Thoenig (2008) span 1968–1999 and 1950–2000, respectively.

³ For literature reviews, see McMillan (1997), Barbieri and Schneider (1999), Reuveny (2000), Mansfield and Pollins (2001), Schneider, Barbieri, and Gleditsch (2003), and the papers in Mansfield and Pollins (2003).

find that conflicts, defined as militarized interstate disputes (MIDs), dampen trade. In contrast, Morrow, Siverson, and Taberes (1998, 1999) and Mansfield and Pevehouse (2000) find that the effect of MIDs on trade is not statistically significant.⁴ Time-series event studies for selected country pairs have also yielded ambiguous results; for example, Barbieri and Levy (1999) find no evidence that war involving nonmajor power countries reduces bilateral trade over time, while Anderton and Carter (2001) find that wars involving major powers dampen trade with both other major powers and minor powers.

The absence of any uniform conclusions in these studies may be attributable to methodological differences in terms of sample characteristics. Typically they restrict their samples to short time series samples in the post-World War era or to politically relevant cases, defined as country pairs involving one or more major powers or geographically contiguous states. The rationale is to exclude country pairs that are especially unlikely or unable to engage in conflict. While this sample restriction limits data collection needs and raises the frequency of conflicts in the data set, it introduces the possibility of bias in the selected sample.⁵ More recent studies using longer data sets and all available country pairs have generally concluded that militarized disputes do reduce trade (see Russett & Oneal, 2001; and Oneal, Russett, & Berbaum, 2003, where the sample period spans 1885–1992).

Past studies suffer from several other design defects. First, most of these studies do not take account of the possibility that war may have lagged as well as contemporaneous effects on trade.⁶ If the end of a war resolves disputes and allows for exchange, trade may resume rapidly.

⁴ This literature analyzes the effects of other political variables on trade as well. For example, Gowa (1994), Gowa and Mansfield (1993), and Mansfield and Pevehouse (2000) argue that national security interests influence commercial ties and find that alliances promote trade.

⁵ Comparisons across these studies are hampered by differences in various dimensions, including the measure of conflict and sample characteristics. For example, Pollins (1989a, 1989b) uses a continuous measure of conflict constructed from the Conflict and Peace Data Bank (COPDAB) and a sample consisting of 25 countries over the periods 1955–1978 and 1960–1975. Mansfield and Bronson (1997) analyze the effects of war using a sample of cross-sections of countries with available data at five-year intervals over the period 1960–1990. Mansfield and Pevehouse (2000) examine the effects of MIDs, including wars, over the period 1950–1985 for country pairs that are contiguous or included a major power, while Morrow, Siverson, and Taberes (1998, 1999) study the effects of threats to use force, short of actual war, on pairs involving seven major powers over the period 1907–1990.

⁶ Martin et al. (2008) and Oneal, Russett, and Berbaum (2003) are exceptions; both estimate gravity models with distributed lags of conflict as explanatory variables. However, the former consider only the postwar period in their study, while the latter find that the effects of militarized disputes on trade over the period 1885–1992 are short-lived, lasting for only one or two years. This finding is the combined result of several factors: (a) the inclusion of the effects of all MIDs, including low-intensity disputes as well as war events; (b) the omission from the sample of all but the first years of conflict and the specific exclusion of the aftermath years of both world wars (1915–1920 and 1940–1949), which they regard as dramatically atypical; and (c) the inclusion of a lagged dependent variable in the gravity equation. All of these factors work to dampen the effects of lagged conflict on trade. Reuveny and Kang (1998) and Reuveny (2001)

However, depending on the destruction of production capacity and trading capabilities, it may take a while to exploit these opportunities. In addition, if the threat of military conflict remains, trade may recover only slowly.⁷ Thus, even with the end of war, trade may remain depressed for several years after due to the costs and inconveniences of postwar reconstruction, diplomatic tensions, explicit price or quantity controls on trade, and other forms of disruption. How quickly and how much trade rebounds is an empirical question that should be of interest in understanding the overall effects of conflict on trade and economic welfare. In this paper we find that, on a present discounted basis, the costs of war in terms of lost trade are three to four times higher when lagged effects are added to purely contemporaneous effects.

Second, these studies do not take account of the third-country effects of bilateral conflicts. Wars affect not only bilateral trade between belligerent parties but also trade between war-involved countries and neutral countries. These negative externalities of war can be substantial. In this paper we find cases where, on a global basis, the losses to neutrals are of the same order of magnitude as losses to belligerents.

Third, most studies use pooled, rather than panel, estimators that may not adequately control for omitted country- or pair-specific attributes or distinguish between the effects of conflict on trade across country pairs and the effects over time. We use a gravity model with panel data using country-pair fixed effects, so that our identification of war's impact depends only on the time dimension, with full control for any time-invariant pair characteristics.⁸

Fourth, none of these studies compute the aggregate costs of wars due to lost trade. In a novel comparative statics modeling exercise with the gravity model, we account for the possibility that war may endogenously affect the level of multilateral resistance, and hence the adjustment of aggregate world trade, through both trade destruction and trade diversion. This approach allows us to compute the general equilibrium effects of war on trade and income.

Our paper is organized as follows. In the next section, we describe our annual data set covering a large number of countries over the period 1870–1997. We find that wars are relatively rare events, yet roughly 60% of countries have been involved in a war at some time in our sample period. In section III, we estimate the effect of war on international trade. We compare bilateral trade among belligerent and neutral countries during and after conflicts (holding fixed

also estimate gravity trade equations with distributed lags of conflict, but only for a small set of country pairs.

⁷ An exception is when victorious countries choose to help rebuild the economies of the losers after war, as in the case of the Allied treatment of Germany and Japan after World War II.

⁸ Oneal and Russett (2001) and Green, Kim, and Yoon (2001) are exceptions, though they focus on the effect of trade interdependence (and democratic similarity) on the likelihood of conflict among country pairs rather than the reverse effect of war on trade, which is the focus of this paper.

other factors) to estimate the contemporaneous and lagged effects of war on trade. Our results are robust in the face of numerous perturbations to the specification and the sample, and we find that reverse causality is statistically insignificant and quantitatively unimportant for our analysis.

In section IV, we use our coefficient estimates in various counterfactual experiments to calculate the aggregate effects of conflict on world trade, particularly the costs of the two world wars of the twentieth century. We present estimates of the welfare costs of lost trade using an income metric (following Frankel & Romer, 1999). These costs are then compared to traditional direct costs, such as the valuation of the loss of life (following Goldin & Lewis, 1975). The costs of war due to trade disruption, although typically ignored, are found to be large and shared by belligerents and neutrals alike. Our estimates of the costs of lost trade due to World War I are twice as large as the considerable costs of lost human capital. For the bigger, longer, and deadlier conflict of World War II, estimated trade costs are about equal to the estimated human costs. Section V concludes the paper, stressing that the effects of wars on trade should not be neglected and are an important channel through which military conflict affects income and welfare.

II. Methodology and Data

A. Gravity Model Methodology

The effects of war on international trade are estimated using a conventional gravity model of international trade. This is now the benchmark empirical model for this kind of exercise, and the specification can be derived formally from a general equilibrium model of production, consumption, and trade, as in Anderson and van Wincoop (2003).⁹

For empirical purposes, we model the average level of trade between any two countries as a function of the log distance between them, the log of the product of their GDPs, and other control variables, as well as the current and lagged effects of countries at war:¹⁰

$$\ln(\text{Trade}_{ijt}) = \beta_0 + \sum_k \gamma_k \text{War}_{ij,t-k} + \sum_k \lambda_k \text{Neutral}_{ij,t-k} + \beta_1 \ln(Y_i Y_j)_t + \beta_2 \ln(Y_i Y_j / \text{Pop}_i \text{Pop}_j)_t + \text{tttttt}$$

⁹ Anderson and van Wincoop presume separability between the production and consumption decisions, on the one hand, and bilateral trade allocation, on the other, while also assuming symmetric bilateral trade barriers. An alternative approach to deriving the gravity equation (e.g., Bergstrand, 1989; Eaton & Kortum, 2002) presumes that these decisions are inseparable and solves for equilibrium production and consumption as well as trade.

¹⁰ Our specification is a log-linearization representation of Anderson and van Wincoop's theoretical gravity equation in which trade flows depend on incomes, bilateral trade barriers, and (unobserved) multilateral resistance effects. As discussed in the text, we obtain consistent estimates of the coefficients of the trade equation through the use of fixed effects for the multilateral resistance terms. In the comparative statics calculations in section IV, we take account of the general equilibrium dependence of trade flows on the multilateral resistance effects by perturbing and solving the nonlinear system of equations for trade and resistance.

$$+ \beta_3 \ln \text{Dist}_{ij,t} + \beta_4 \text{Lang}_{ij} + \beta_5 \text{Border}_{ij} + \beta_6 \text{Landl}_{ij} + \beta_7 \text{Island}_{ij} + \beta_8 \ln(\text{Area}_i \text{Area}_j) + \beta_9 \text{CurCol}_{ijt} + \beta_{10} \text{EverCol}_{ijt} + \beta_{11} \text{CurUGold}_{ijt} + \varepsilon_{ijt}$$

where i and j denotes countries, t denotes time, and the variables are defined as:¹¹

- Trade_{ijt} is the average value of real bilateral trade between countries i and j at time t .
- War is a binary variable which is unity if i and j were engaged in a war against each other (directly or via colonial relationships) in period $t - k$, for $k = 0, 1, \dots, M$.
- Neutral is a binary variable that is unity if either i or j is neutral while the other is engaged in a war against some third country in period $t - k$, for $k = 0, 1, \dots, M$.
- Y is real GDP.
- Pop is population.
- Dist is the (great circle) distance between the capital cities of i and j .
- Lang is a binary variable that is unity if i and j have a common language.
- Border is a binary variable that is unity if i and j share a land border.
- Landl is the number of landlocked countries in the country pair (0, 1, or 2).
- Island is the number of island nations in the pair (0, 1, or 2).
- Area is the land mass of the country.
- CurCol is a binary variable that is unity if i and j are colonies at time t or vice versa.
- EverCol is a binary variable that is unity if i ever colonized j or vice versa.
- CurUGold is a binary variable that is unity if i and j are engaged in a currency union or, before 1945, if they are on the gold standard at time t .
- $\gamma_k, \lambda_k, \beta_i$ are coefficients.
- ε_{ijt} represents the myriad other influences on bilateral trade, assumed to be well behaved.

The coefficients of main interest to us are γ_k and λ_k , which have not been studied before. In fact, in what follows, all the other coefficients take on typical values that are consistent with the large empirical gravity literature.

The γ_k coefficients describe the impact of war on log trade levels for adversarial belligerent-belligerent (BB) country pairs; the λ_k coefficients describe the same impact on belligerent-neutral (BN) country pairs. The contempora-

¹¹ Our set of control variables include the usual suspects, following Rose (2000) and Glick and Rose (2002), but is not meant to be exhaustive. Other studies have estimated the effects of such factors as participation in free trade arrangements as well as membership in international governmental organizations, such as the World Trade Organization (see Rose, 2004).

neous effect of war on trade between countries at war with each other is captured by γ_0 , while the lagged effects of a war ending k periods previously is captured by γ_k , $k = 1, \dots, M$, where M is the maximum lag length. The coefficients λ_0 and λ_k analogously capture the contemporaneous and lagged effects of war on trade between belligerents and neutral countries.¹²

The model is estimated with a number of techniques below to test robustness. The coefficients of main interest to us, the γ_k and λ_k , are qualitatively similar under different estimators. For our main conclusions, we rely on the more conservative and robust fixed effects “within” estimator, which adds a set of country-pair fixed effects (CPFE) or intercepts to the equation and controls for omitted country characteristics that do not vary across time, including any time-invariant component of multilateral resistance (Anderson & van Wincoop, 2003, 2004). Regrettably, serious data limitations, including a severely unbalanced data set over more than a century, preclude the inclusion of a full set of time-varying multilateral resistance terms.

B. Data Set

The bilateral trade data were assembled from three main sources: the IMF, Barbieri (1996a), and Mitchell (1992, 1993, 1998).

The IMF Direction of Trade (DoT) data cover bilateral trade between 217 IMF country-code geographical units between 1948 and 1997 when our sample ends. Measures of FOB exports and CIF imports are recorded in U.S. dollars; we deflate these data by the U.S. CPI (based to 1985). Since exports and import figures may be available from both countries, there are potentially four measured bilateral trade flows: exports from i to j , exports from j to i , imports into i from j , and imports into j from i . An average value of bilateral trade between a pair of countries is created by averaging all of the four possible measures potentially available. Observations where all four figures have a 0 or missing value are dropped from the sample.¹³ The Barbieri (1996a) data set contains bilateral trade data in current U.S. dollars for some sixty countries during the period 1870–1947.¹⁴ Her data typically measure bilateral trade between countries i and j by summing imports into i from j and into

j from i ; we divide these figures in half to construct an average value of bilateral trade. We again deflated using the U.S. CPI index. We used data from Mitchell (1992, 1993, 1998) to fill missing observations among major trade partners during the period 1870–1947 and to correct errors in Barbieri’s data. The data are typically reported in local currency. We converted to current U.S. dollar terms using exchange rate data and then deflated by the U.S. CPI.¹⁵ (Further details are provided in the data appendix in the Supplemental Content section of this journal’s Web site, available at <http://www.mitpressjournals.org/doi/suppl/10.1162/rest.2009.12023>.)

Other standard variables were then added to estimate a gravity model; these include real GDP, population, and various country-pair characteristics, such as contiguity and distance. Real GDP and per capita GDP data (in constant 1985 dollars) for the 1948–1997 period are obtained from three sources. Wherever possible, data from the World Bank’s *World Development Indicators* (WDI, from the 2000 CD-ROM) are used. When the WDI data are unavailable, missing observations are filled in with comparables from the Penn World Table (PWT) Mark 5.6, Maddison (1995), and (when all else fails) from the IMF’s *International Financial Statistics*.¹⁶ For the 1870–1947 period, we draw primarily from Maddison (1995, 2001), supplemented by Mitchell (1992, 1993, 1998) and individual country sources. The resulting series are then put into constant 1985 dollars and linked to the 1948–1997 series (for details, see the data appendix).

The CIA’s *World Factbook* (2000) is used to provide a number of country-specific variables, including latitude and longitude, land area, landlocked and island status, physically contiguous neighbors, language, colonizers, and dates of independence.¹⁷ These data are used to create great-circle distance and the other controls. Whenever appropriate, we make adjustments to land area to reflect territorial changes based on historical sources.

For the 1948–1997 period we use the currency union variable constructed by Glick and Rose (2002), defined as country pairs whose monies are either common or interchangeable at 1:1 par for an extended period of time.¹⁸ For the pre-1948 period, we set *CurUGold* equal to 1 for counties on the gold standard, allowing for a similar currency effect, following Estevadeordal, Frantz, and Taylor

¹² In the case of multiyear wars, the lags of war are dated from the last year of the conflict. We assume that for a war ending at time t , if a new war occurs at time $t' > t$, the values of the war variable lags of the first war are “reset” to 0 at the time the subsequent war begins: $War_{t-k} = 0$ for $k \geq t' - t$.

¹³ The data set is essentially the same as that used by Glick and Rose (2002). Using the average of bilateral exports and imports (rather than just exports) as the dependent variable in a gravity model requires some restrictions on the theoretically grounded model, as specified by Anderson and van Wincoop (2003), for example. Specifically, trade barriers should be symmetric across country pairs. This may be less of a problem for a large shock, such as war, which likely affects exports and imports equally.

¹⁴ We use version 1.1 of Barbieri’s data set obtained from the http://pss.la.psu.edu/trd_data.htm. These data actually extend to 1992; we rely on the original source data reported by the Direction of Trade for the 1948–1997 period. Note that Barbieri reports only combined exports plus

imports between countries, not exports and imports separately. This gives another reason for expressing our dependent variable as average trade.

¹⁵ Our results would not be affected by deflating by some other common price measure, such as the price of traded goods, since the difference would be absorbed by the time dummies we include in our estimation.

¹⁶ Maddison calculates his historical series on GDP and GDP per capita for constant 1990 territorial areas and borders. Whenever possible we make adjustments to GDP to take account of such factors as territorial size changes due to wars. See the appendix for details. The IFS-based series are calculated by converting national currency GDP figures into dollars at the current dollar exchange rate and then dividing by the U.S. CPI.

¹⁷ The Web site is <http://www.odci.gov/cia/publications/factbook>.

¹⁸ Hard fixes at non-1:1 rates (e.g., Hong Kong, Estonia, Denmark) do not qualify as currency unions under this definition.

(2003), and using data on gold standard arrangements from Meissner (2005) and Obstfeld and Taylor (2003).¹⁹

Our measure of war is constructed from the database on militarized interstate disputes (MID) collected by the Correlates of War Project (COW) at the University of Michigan. We use Maoz's dyadic data set DYMID1.1, a revised version of the COW data set MID2.1 compiled by Jones, Bremer, and Singer (1996).²⁰ This data set codes the level of hostility reached in a given country's conflict with opposing state(s), where 2 = threat of force, 3 = display of force, 4 = use of force (short of war, but including formal declarations of war not accompanied by fatalities), and 5 = war. We code our war variable as conflicts with hostility level 5 (which generally involve conflicts with more than 1,000 battle deaths), as well as declarations of war (hostility level 4, and HiAct = 20). The data set is extended from 1992 through 1997 with information on "Major Episodes of Political Violence, 1946–1999" from the University of Maryland's Center for Systemic Peace (CSP) and *The Statesman's Yearbook*.²¹ Countries at war with a colonial power are treated as being at war with its current colonies; if country pair $i-j$ are at war, and $j-k$ are in a colonial relationship, then $i-k$ are also assumed to be at war.²²

Table 1 presents some summary statistics on the number of observations and the frequency of war for the full sample 1870–1997, as well as for the two subsamples: 1870–1938 and 1939–1997. These statistics are conditional on the availability of data on bilateral trade and GDP, the main constraints for the inclusion of observations in our gravity model estimation. Our full sample contains 251,902 bilateral trade observations involving 172 countries and 11,535 different country pairs. Not surprisingly, the bulk of these observations are in the later sample, as the number of countries proliferated and more data on trade and GDP have become available.

War is a relatively infrequent occurrence in our sample. Conditional on the availability of contemporaneous trade and GDP data, only 75 different country-pairs with 206

TABLE 1.—SAMPLE CHARACTERISTICS

	1870–1997	1870–1938	1939–1997
<i>Total</i>			
Number of pair-year observations	251,902	13,799	238,103
Number of country pairs	11,535	739	11,476
Number of countries	172	50	171
<i>War, contemporaneous</i>			
Number of pair-year observations	206	59	147
Number of country pairs	75	25	64
Number of countries	48	19	44
<i>War, contemporaneous and lagged</i>			
Number of pair-year observations	2,143	410	1,733
Number of country pairs	338	72	296
Number of countries	104	29	96

Note: "Total" refers to pair-year observations with data on bilateral trade and GDP (per capita). "War, contemporaneous" refers to pair-year observations with contemporaneous data on bilateral trade and GDP and also currently at war ($War = 1$). "War, contemporaneous and lagged" refers to pair-year observations with data on trade and GDP at war currently or in the preceding 10 years ($War_t = 1$ or $War_{t-k} = 1$ for $k = 1, \dots, 10$).

country-year observations (since a conflict involving a particular pair may last more than one year) involve war adversaries. However, many countries at war lack contemporaneous trade or GDP data while engaged in conflict. When we extend the count by including observations of (up to ten years of) lagged war, while still conditioning on trade and GDP data availability for these years, the number of country-pairs at war (contemporaneously or in the previous ten years) in the sample rises to 338. Correspondingly, the number of pair-year observations rises to 2,143, amounting to 0.85% ($= 2,143/251,902$) of the total sample. While the frequency of war observations in the pre–World War II period is somewhat higher ($2.97\% = 410/13,799$), wars are still rare events. Nevertheless, it is worth noting that although major conflicts are infrequent, most countries in the sample have been involved in war at one time or another. Of the 172 countries, over 60% (104) were engaged in war sometime during our sample period.

III. Gravity-Based Estimates of the Effect of War on Trade

We now proceed to show that wars, while relatively infrequent, have had large effects on trade.

A. Benchmark Estimates

We begin by estimating our gravity equation using a country-pair fixed effect (CPFE) panel estimator with a full set of year effects included. Robust standard errors are clustered at the country-pair level to address potential problems of heteroskedasticity and autocorrelation in the error terms.²³

²³ All estimation is done with Stata. Clustering at the country-pair level allows the variance to differ across pairs and permits an unstructured covariance within the clusters to control for correlation across time. Bertrand, Duflo, and Mullainathan (2004) suggest clustering as the best way to handle autocorrelation in panel differences-in-differences estimation, which can be viewed as a variant of fixed-effect panel estimation. This approach has been followed in other applications of CPFE estimators to the gravity model (see, e.g., Klein & Shambaugh, 2006).

¹⁹ On the gold standard and trade, see also López-Córdova and Meissner (2003) and Flandreau and Maurel (2005).

²⁰ The Maoz data set was taken from <http://spirit.tau.ac.il/zeevmaoz>.

²¹ The COW data arbitrarily limit the length of conflict at six months for countries that declared war but did not actually fight against their declared adversaries (e.g., in World War II, various Latin American countries declared war against the Axis powers but did not actually send troops to the war theaters). We assume that countries declaring war during World Wars I and II were at war until the state of war was formally revoked or the declared adversary was deemed defeated. "HiAct" is short for "highest action in dispute." This is an index representing the type of conflict and supplements the 1–5 hostility level index; the higher the number, generally the more intense the conflict. We have cross-checked our conflict coding with version 3.0 of the COW data set, which was released after our data set was assembled; no changes were deemed necessary. Extending the sample beyond 1997 would have little effect since there have been no major wars until the U.S. actions in Afghanistan in 2001 and Iraq in 2003. See the MID code book at <http://cow2.la.psu.edu>. The CSP Web page is <http://members.aol.com/CSPmgm/cspframe.htm>.

²² We do not consider other forms of conflict, such as civil wars. See, for example, Bayer and Rupert (2004).

TABLE 2.—POOLED PANEL GRAVITY ESTIMATES, 1870–1997: ALTERNATIVE ESTIMATORS

	Country Pair FE	Random Effects	Country FE	Poisson	Bonus Vetus
War	-1.78 (0.22)***	-1.78 (0.22)***	-2.06 (0.23)***	-1.72 (0.24)***	-1.14 (0.32)***
War1	-1.28 (0.27)***	-1.24 (0.26)***	-1.59 (0.30)***	-0.72 (0.22)***	-1.23 (0.35)***
War2	-1.32 (0.22)***	-1.28 (0.22)***	-1.53 (0.25)***	-0.70 (0.18)***	-1.23 (0.30)***
War3	-1.12 (0.15)***	-1.09 (0.15)***	-1.26 (0.17)***	-0.51 (0.17)***	-0.79 (0.24)***
War4	-0.70 (0.13)***	-0.68 (0.13)***	-0.81 (0.17)***	-0.68 (0.14)***	-0.44 (0.22)**
War5	-0.55 (0.09)***	-0.51 (0.09)***	-0.47 (0.12)***	-0.55 (0.11)***	-0.32 (0.16)**
War6	-0.37 (0.08)***	-0.33 (0.08)***	-0.38 (0.09)***	-0.45 (0.10)***	-0.24 (0.12)**
War7	-0.22 (0.07)***	-0.20 (0.07)***	-0.26 (0.08)***	-0.42 (0.09)***	-0.11 (0.10)
War8	-0.24 (0.08)***	-0.21 (0.08)***	-0.24 (0.08)***	-0.36 (0.08)***	-0.11 (0.10)
War9	-0.11 (0.06)*	-0.09 (0.06)*	-0.14 (0.08)*	-0.35 (0.08)***	-0.10 (0.09)
War10	-0.03 (0.06)	-0.01 (0.06)	-0.05 (0.07)	-0.32 (0.08)***	-0.04 (0.09)
Log distance	—†	-1.38 (0.03)***	-1.20 (0.03)***	-0.84 (0.04)***	-1.16 (0.03)***
Log product real GDPs	0.36 (0.04)***	0.72 (0.02)***	-0.19 (0.06)***	0.13 (0.10)	-0.14 (0.06)**
Log product real GDP/capita	0.64 (0.04)***	0.43 (0.03)***	1.09 (0.06)***	0.92 (0.10)***	1.06 (0.06)***
Common language	—†	0.33 (0.06)***	0.44 (0.04)***	0.14 (0.08)*	0.52 (0.04)***
Common land border	—†	0.42 (0.14)***	0.10 (0.11)	0.35 (0.10)***	0.16 (0.11)
Number landlocked	—†	-0.35 (0.04)***	-0.47 ††	-5.06 (1.00)***	0.82 (0.15)***
Number islands	—†	0.08 (0.05)	-1.33 ††	-3.83 (1.11)***	0.95 (0.14)***
Log product land areas	0.24 (0.08)***	0.03 (0.02)	0.15 (0.12)	0.14 (0.12)	0.33 (0.01)***
Current colony	0.62 (0.16)***	0.56 (0.16)***	1.06 (0.22)***	1.23 (0.35)***	0.59 (0.28)**
Ever colony	—†	2.22 (0.13)***	1.09 (0.13)***	0.61 (0.14)***	0.96 (0.12)***
Currency union	0.21 (0.06)***	0.17 (0.06)***	0.92 (0.09)***	0.27 (0.10)***	1.11 (0.11)***
R ²	0.45	0.62	0.70	N/A	0.70
Number of observations	251,902	251,902	251,902	325,844	251,902
Number of country pairs	11,535	11,535	11,535	11,649	11,535
Pair dummies	Yes	Yes	No	No	No
Country dummies	No	No	Yes	Yes	Yes
Average effect, War–War5	-1.12	-1.09	-1.29	-0.81	-0.86

† Variable dropped due to collinearity with country pair fixed effects. †† Standard error too large to be reported.

Year dummies and constant not reported. Robust standard errors clustered at the country-pair level in parentheses. Significance at 1%, 5%, and 10% indicated by ***, **, and *, respectively.

Results are shown in table 2, column 1. Pair and year effects are not reported. The *War* dummy is allowed to enter contemporaneously and with up to ten lags (denoted *War1* to *War10*). The *Neutral* variable and its lags are initially excluded from the regressor list. Since some traditional gravity variables like distance, shared land borders, or island status, are both time invariant and pair specific, they are collinear with the pair fixed effects and drop out.²⁴ However, they will reappear in alternative specifications that we employ for robustness checks later.

²⁴ Note that because we adjust for changes in territory over time, the land area variable does not drop out.

The model proves successful on a number of dimensions. The model fits the data well, explaining almost half of the variation in bilateral trade flows. The added control variables are economically and statistically significant with sensible interpretations. For instance, economically larger and richer countries trade more. A common currency encourages trade, as does a common, ongoing colonial relationship.²⁵

²⁵ We follow Rose (2000, 2004) in including (log) per capita GDP as well as GDP as separate control variables. Note that the individual effects of these variables are sensitive to the estimator employed, since the two variables are collinear in log terms. The net effect of GDP on trade, given

The key variables of interest in table 2 are the γ_k estimates of the “trade destruction” impact of war. The CPFE “within” estimator measures γ_k by comparing trade for a pair of countries at war to trade for the same pair of countries when not at war. It exploits variation over time and answers the time series question: “What is the effect on trade (now and in the future) of a country being at war?”

The coefficients in table 2, column 1 indicate that the contemporaneous and lagged effects on trade are all negative, with statistically significant effects persisting for eight years (at the 5% significance level). The effects are also qualitatively large. The contemporaneous effect of war on log trade is -1.78 , implying that the level of trade between two adversaries at war falls by over 80% (since $1 - e^{-1.78} \approx .83$) relative to its peacetime prewar counterfactual level, a very large reduction.

Once a war ends, the extent of “trade destruction” declines roughly monotonically over time, and trade returns to its peacetime level about a decade later. Trade is still 42% below the peacetime level five years after the cessation of war and 21% below even after eight years.²⁶ For lags 1 to 5, the coefficients average $-.99$, implying a 63% destruction of trade ($1 - e^{-.99} \approx .63$), while for lags 6 to 10, they average $-.19$, implying an 18% destruction of trade ($1 - e^{-.19} \approx .18$).

What are the consequences of this persistence? Although they have been overlooked hitherto, we think the persistent effects of wars on trade are quantitatively significant. For example, when a 5% discount rate is used, the present discounted sum of lost trade is about 3.7 times larger when lagged effects for years 1 through 10 are added in as compared to the contemporaneous effect alone.

Why is there such persistence? If the end of conflict allows commercial exchange to resume smoothly and promptly, trade may resume rapidly, but this is not always the case. In fact, in unreported results, we find less persistence for lower intensity and shorter conflicts, where most of the effects on trade are contemporaneous. However, for particularly destructive and long-lasting conflicts, such as World Wars I and II—which wreaked havoc on human capital, infrastructure, production capacity, and international cooperation—recovery evidently took much longer. Thus, even with the end of war, trade can remain depressed for several years thereafter due to the costs of postwar reconstruction, diplomatic tensions, residual price or quantity controls on trade, and other factors that raise the variable or fixed costs of engaging in trade. All of these different channels are captured in our average lagged war effects.²⁷

by the sum of these two coefficients, is generally near the theoretically expected value of unity. Dropping GDP per capita would not affect any of the salient results of our analysis concerning the effects of wars.

²⁶ Since $1 - e^{-.55} \approx .42$ and $1 - e^{-.24} \approx .21$.

²⁷ One other study that does examine both the contemporaneous and lagged effects of war is that by Oneal et al. (2003). They also find the effects of war to be persistent, but only for one or two years—much less than we find here. Their smaller estimates are not unexpected, since their

B. Robustness Checks: Different Estimators

To provide sensitivity analysis, the last three columns of table 2 report the robustness of our results to some alternative estimators. In column 2, we present a random effects panel estimator, which assumes that the regression error terms are uncorrelated with the random country-pair specific effects. The coefficients of interest are nearly identical to column 1. In columns 3 and 4, we present estimates with individual country dummies rather than pair dummies. This specification most closely conforms to the so-called theoretical gravity model, which includes multilateral resistance trade terms for each country, since it provides a consistent estimate of “average treatment effects” for border cost variables, like war (Feenstra, 2002, 2003).²⁸ Year dummies are also included in both cases.

For the OLS estimator, shown in column 3, the coefficients of interest are again similar to column 1, and the estimated effects of war are, if anything, even larger. Our results are thus not dependent on which choice is made between the two standard ways of including fixed effects in a gravity model.

In column 4 we address the fact that in panel data for bilateral trade, many pair-year cells are typically missing or 0. This raises two questions. First, when does one treat a missing observation as missing or impute 0? Second, how should one address the existence of censoring at 0 in estimation?

In answer to the first question, in column 4, we impute a 0 for all pair-years where at least one positive-valued nonmissing trade observation has been recorded in any prior year in our data set. This augments our sample by an additional 73,942 observations.²⁹ (The results were not sensitive to several alternative ways of imputing, such as imputing all missing data as 0s or requiring two prior observations rather than one.)

In answer to the second question, we present results of a Poisson quasi-maximum likelihood estimator, as suggested by Santos Silva and Tenreiro (2006).³⁰ The coefficients of

sample excludes World Wars I and II and their aftermath, and their definition of war is broader and includes less violent disputes.

²⁸ Feenstra (2002, 2003) shows that the (exponential of the) direct trade barrier coefficient in a gravity equation corresponds to the geometric average (over countries i and j) of the impact of the barrier (e.g., war) on the bilateral international trade between i and j (relative to international trade within these countries). The fixed effect for each country captures the common element in its trade with all other countries, which reflects its average trade barrier, referred to as “multilateral trade resistance.” It should also be noted that the theoretical gravity model implies that the coefficient of GDPs should be constrained to unity. In our empirical work, we find that the magnitudes of the war coefficients are robust to imposing this constraint too.

²⁹ Including these missing data raises the number of war observations in our data set for adversaries at war contemporaneously from 206 to 450 and at war with a lag as well as contemporaneously from 2,143 to 2,925.

³⁰ To address the problem of missing (censored) observations, we also computed OLS estimates with a Heckman (1976) correction (Heckit), following Linders and de Groot (2006). The results are similar. (The Heckit estimates employ Stata’s default MLE option. The first-stage equation has the same regressors as the benchmark equation, implying that

interest are reported in column 4; they are very similar to those in column 3 and slightly larger than those in column 1.

The last column of table 2 reports the results of an alternative approach to controlling for multilateral resistance effects in gravity models, proposed by Baier and Bergstrand (2009). Their *Bonus Vetus* OLS (“Good Old OLS”) method involves taking a first-order log-linear Taylor expansion to approximate the multilateral resistance terms. The method yields theoretically motivated and observable exogenous multilateral resistance variables that can be introduced into the estimated gravity model specification.³¹ In this case, the impact of war on trade is somewhat lower than was seen in columns 1 and 3; nevertheless, the decline in trade is still quite large.³²

In sum, the results of table 2 show that the γ estimates are reasonably insensitive to all of these different estimators. The war effects remain: they are consistently large economically and statistically significant throughout.³³

C. Robustness Checks: Neutrals and Different Subperiods

We next perturb the model by including the *Neutral* regressor and its lags by dividing the sample into two subperiods (1870–1938 and 1939–1997) and by isolating the effects of World War I and World War II from other wars.³⁴ The results are reported in table 3, where the benchmark country-pair fixed effect (CPFE) estimator is employed in all cases.

The results for the full sample are presented in column 1. The war effects are very similar to those in column 1 of table 2 and are slightly larger. In columns 2 and 3, we can observe that the effects of wars are negative in both sample subperiods, with the contemporaneous effects slightly higher (in absolute value), but the lagged effects decaying more rapidly, in the 1870–1938 period as compared to the 1939–1997 period. In the first period, a significantly negative effect of war on trade lasts only four years, compared to

nine years in the latter period. Focusing on the effects of the two world wars alone indicates that their effects on trade are much larger than those of other wars. When other variables are held constant, the estimated contemporaneous coefficient for World War I of -3.29 implies a decline in trade of 96%; the corresponding coefficient for World War II of -3.46 implies a similarly high decline in trade of 97%. In the major wars, it would appear that trade between adversaries was almost totally destroyed.³⁵ Further sensitivity analysis (reported in tables A1 and A2 in the Supplemental Content section of this journal’s Web site) confirms that the effects of other wars are smaller though still very significant, but in the counterfactual analysis that follows, we focus on the two great wars.

While the *War* coefficients measuring trade declines among adversaries are essentially unaffected relative to the table 2 estimates, the negative coefficients on the *Neutral* variables imply that war also depresses trade between belligerents and neutrals. For the full sample, shown in table 3, column 1, trade with neutrals declines by 12% ($\approx 1 - e^{-0.13}$) in wartime, and the negative effect of war on trade for these pairs persists with a lag for up to seven years with statistical significance. Inspection of the subperiod results reported in the other columns of table 3 reveals the same basic pattern, though the effects on neutrals for the 1870–1938 period appear to be small and, for the most part, statistically insignificant. Isolating the effects of World War I and II alone shows much larger effects on trade between neutrals and belligerents. The *Neutral* contemporaneous coefficient for World War I of -0.54 implies a decline in trade of 42%; the same coefficient for World War II of -1.06 implies an even larger decline in trade of 65%.

The results in table 3 lead to some of the major conclusions of this paper: historically, wars have been very damaging for world trade; major wars have been especially damaging; the damage to trade is felt by neutrals as well as belligerents; and the damage is highly persistent.

The average effects for all wars are shown in figure 1 based on the “average” coefficients for all wars (from column 1 of table 3). As might seem obvious, war depresses trade between belligerents, but we can provide an estimate of this effect, and it is very large: a decline in trade of about 80% to 90%. Moreover, war creates negative externalities on trade even for neutral countries: their trade with belligerents is also adversely affected, being subject to a decline of about 5% to 12% on average, although this effect is greatly enlarged to 42% to 65% in major wars. Furthermore, both of these effects decay slowly and persist for almost ten years.

³⁵ Our country-pair, country-specific, and year dummy models represent severe specifications that control for many possible omitted variables. We do not use up degrees of freedom with a full set of time-country interactions. Focusing on various subsamples and isolating the effects of specific wars (e.g., World Wars I and II) should further alleviate concerns associated with omitted variable bias.

identification is by functional form. The estimate of the correlation of first- and second-stage error terms was -0.06 .

³¹ Under the assumption that the approximation can be taken around an equilibrium with symmetric, but nonzero, trade frictions involves effectively demeaning the trade cost variables τ as $\ln \tau_{ij} = \ln \tau_{ij} - (1/C) \sum_i^C \ln \tau_{ij} - (1/C) \sum_j^C \ln \tau_{ij} + (1/2C^2) \sum_i^C \sum_j^C \ln \tau_{ij}$, where C is the number of countries.

³² The contemporaneous coefficient estimate of -1.14 , implies a decline in trade of roughly 70% compared to 83% in the column 1 benchmark case.

³³ The theoretically grounded gravity model implies that the coefficients on the *War* variables can be used to calculate the ad valorem tariff equivalent of war as $\tau_{war} = e^{\gamma/(1-\sigma)} - 1$, where σ is the elasticity of substitution between domestic and foreign goods (see Anderson & van Wincoop, 2004, p. 713, equation 14). Thus, for example, assuming $\sigma = 5$ and setting $\gamma = -2.18$ (the estimated coefficient on the contemporaneous *War* variable reported in the last column of table 3) implies $\tau_{war} = e^{-2.18/(1-5)} - 1 = 0.72$ —war is equivalent to a 72% ad valorem tariff.

³⁴ More precisely, we isolate the effects of all wars occurring over the periods 1914–1918 and 1939–1945. The modified war variable then picks up World Wars I and II, plus some simultaneous local conflicts, such as Finland–Russia.

TABLE 3.—TRADE EFFECTS OF WAR: EFFECT ON NEUTRALS INCLUDED

	1870–1997	1870–1938	1939–1997	1870–1938: World War I Only	1939–1997: World War II Only
War	–1.87 (0.22)***	–2.12 (0.28)***	–1.92 (0.24)***	–3.29 (0.27)***	–3.46 (0.35)***
War1	–1.33 (0.27)***	–1.41 (0.44)***	–1.37 (0.26)***	–2.33 (0.48)***	–1.41 *(0.50)***
War2	–1.35 (0.22)***	–0.86 (0.30)***	–1.58 (0.25)***	–1.45 (0.34)	–2.14 (0.45)***
War3	–1.15 (0.15)***	–0.47 (0.17)***	–1.31 (0.17)***	–0.73 (0.18)***	–1.46 (0.22)***
War4	–0.74 (0.13)***	–0.38 (0.23)	–0.80 (0.15)***	–0.79 (0.30)***	–1.08 (0.19)***
War5	–0.57 (0.09)***	–0.11 (0.13)	–0.65 (0.10)***	–0.27 (0.18)	–0.75 (0.12)***
War6	–0.39 (0.08)***	–0.09 (0.14)	–0.44 (0.09)***	–0.23 (0.19)	–0.51 (0.10)***
War7	–0.24 (0.07)***	0.00 (0.11)	–0.26 (0.08)***	–0.07 (0.14)	–0.35 (0.09)***
War8	–0.24 (0.08)***	0.02 (0.10)	–0.28 (0.09)***	–0.03 (0.12)	–0.35 (0.08)***
War9	–0.11 (0.06)*	0.10 (0.08)	–0.15 (0.07)*	0.00 (0.10)	–0.26 (0.08)***
War10	–0.03 (0.06)	0.12 (0.09)	–0.07 (0.07)	0.05 (0.11)	–0.12 (0.07)*
Neutral	–0.13 (0.02)***	–0.04 (0.05)	–0.12 (0.02)***	–0.54 (0.19)***	–1.06 (0.20)***
Neutral1	–0.07 (0.02)***	–0.02 (0.05)	–0.07 (0.02)***	–0.36 (0.23)	–0.58 (0.28)**
Neutral2	–0.04 (0.02)*	0.07 (0.05)	–0.04 (0.02)*	–0.25 (0.10)**	–0.57 (0.23)**
Neutral3	–0.05 (0.02)**	0.00 (0.06)	–0.04 (0.02)*	–0.15 (0.09)	–0.18 (0.10)*
Neutral4	–0.09 (0.02)***	–0.08 (0.05)	–0.08 (0.02)***	–0.23 (0.10)**	–0.16 (0.09)*
Neutral5	–0.07 (0.02)***	–0.03 (0.05)	–0.07 (0.02)***	–0.13 (0.09)	–0.25 (0.07)***
Neutral6	–0.09 (0.02)***	–0.08 (0.05)	–0.09 (0.02)***	–0.18 (0.09)**	–0.27 (0.06)***
Neutral7	–0.04 (0.02)**	–0.08 (0.05)	–0.04 (0.02)*	–0.12 (0.08)	–0.24 (0.06)***
Neutral8	0.01 (0.02)	–0.09 (0.05)*	0.02 (0.02)	–0.07 (0.07)	–0.14 (0.06)**
Neutral9	0.02 (0.02)	–0.09 (0.04)**	0.03 (0.02)	–0.12 (0.07)*	–0.04 (0.05)
Neutral10	0.02 (0.02)	–0.01 (0.04)	0.02 (0.02)	0.01 (0.08)	–0.08 (0.05)
Average effect, War–War5	–1.17	–0.89	–1.27	–1.48	–1.72
Average effect, Neu–Neu5	–0.07	–0.02	–0.07	–0.28	–0.47
R ²	0.46	0.31	0.16	0.31	0.13
Number of observations	251,902	13,799	238,103	13,799	238,103
Number of country pairs	11,535	739	11,476	739	11,476

Note: Country-pair fixed effect estimates. Controls not reported: distance, output, output per capita, language, land border, landlocked, islands, land area, current colony, ever colony, currency union, year dummies, and constant. Robust standard errors clustered at the country-pair level are in parentheses. Significance at 1%, 5%, and 10% indicated by ***, **, and *, respectively.

In practice, what has this meant for the impact of wars on the world economy? Small wars involve few belligerents but many neutrals. These are likely to have a large global effect only if the belligerents are large countries. But the major wars in history have had catastrophic impacts on world trade: the belligerents accounted for a large share of world trade—with themselves and with neutrals.

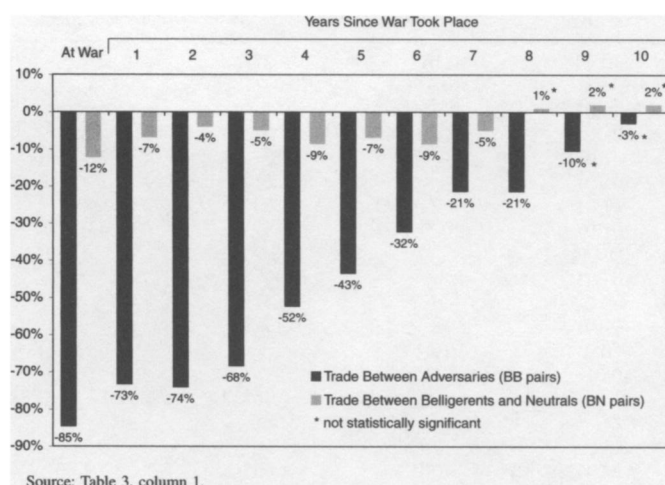
To illustrate the potential magnitude of these effects, we look at the two world wars as case studies using our model in section IV. Before doing so, we conduct a final robustness check by addressing possible concerns about the endogeneity of war and trade.

D. Robustness Check: Simultaneity Concerns

The analysis thus far has treated the occurrence of wars as events that are exogenous to trade. What if trade and war are endogenously related to each other? That is, trade may depend on war, but the occurrence of wars may depend directly on the trade interdependence between members of a country pair.

A vast political science literature addresses the question of how the likelihood of conflict among nations depends on various measures of economic interdependence, including the level of bilateral trade or trade openness, in addition to

FIGURE 1.—IMPACT OF WAR ON TRADE FOR A GIVEN COUNTRY PAIR:
CONTEMPORANEOUS IMPACT AND LAGS 1 THROUGH 10



various geographic and political regime variables.³⁶ However, the theoretical and empirical findings suggest that the effects of trade on war are mixed. The realist view argues that trade may create conflict by intensifying competition or increasing dependence on strategic goods (or both). Indeed, Barbieri (1996a, 1996b, 2002), Beck, Katz, and Tucker (1998), and Barbieri and Peters (2003) find either a positive or negligible effect of trade on the likelihood of conflict. However, a growing number of studies support the opposing “liberal peace” view that trade interdependence deters conflict and promotes peace by generating economic benefits and raising the costs of conflict. For example, Polachek (1980, 1997), Pollins (1989a, 1989b), Oneal et al. (1996), Oneal and Russett (1997, 1999, 2001), Mansfield and Pevehouse (2000), Gartzke and Li (2003), Oneal et al. (2003), all find evidence that trade reduces the incidence of conflicts. Nonetheless, in our case, we have reason to believe that simultaneity is not a serious problem for our gravity model results. Before we present the evidence, we offer some intuition.

Most of the evidence of a significant effect of conflict on trade involves cross-pair variation in the data (“between” estimation), not within-pair variation across time (“within” estimation). The former is of no concern to us since we use CPFEs as our preferred model, a “within” estimator. Whether a given country pair is, on average, more or less likely to engage in war is factored through fixed effects. Our identification of the effect of war on trade is purely in the time dimension. Since levels of trade between countries are very slowly varying over time (and, to a large degree, explained by slowly changing or unchanging covariates such as country size and distance), the use of trade levels to forecast the timing of war is a priori a hopeless cause. Trade measures may tell us something about which pairs are more

or less likely to go to war, but they tell us nothing about when those countries will actually go to war.³⁷

To establish this result, we proceed by estimating a model of the likelihood that country pairs engage in war in the spirit of the literature. The likelihood of war is specified as a function of bilateral trade dependence, the number of years of peace since the last war (*YrsPeace*), the major power status of one or more of the pair (*MajPower*), joint alliance membership (*Alliance*), as well as of common land borders (*Border*) and (log) distance:

$$\begin{aligned} War_{ijt} = & \alpha_0 + \alpha_1 \ln(Trade_{ij}/Y_i Y_j)_{t-2} + \alpha_2 YrsPeace_{ijt-2} \\ & + \alpha_3 MajPower_{ij} + \alpha_4 Alliance_{ijt-2} + \alpha_5 Border_{ij} \\ & + \alpha_6 LnDist_{ij} + \varepsilon_{ijt}. \end{aligned}$$

Countries that trade more bilaterally should—if the liberal argument holds—have a lower likelihood of war because of the opportunity cost associated with the loss of trade gains. The expected effect of major power status is a priori ambiguous. On the one hand, major power states are more likely to engage in military conflict since they have wide-ranging interests that potentially bring them into conflict with a large number of states. On the other hand, their military capabilities may work to deter actual conflict. The likelihood of conflict should be lower for countries participating in alliances and higher for countries that are adjacent or closer together, since geographic proximity facilitates confrontations over such matters as land borders and enhances the ability to bring military force to bear.³⁸

We measure bilateral trade dependence as the log of bilateral trade relative to the product of the pair’s GDP levels.³⁹ *MajPower* is a dummy variable = 1 if any member of the pair includes the United States, the United Kingdom, Germany, France, Japan, or USSR/Russia. The *Alliance* variable is a binary dummy based on data from the COW project, which codes three types of alliances or pacts in order of decreasing level of commitment: 1 = defense, 2 = nonaggression/neutrality, 3 = entente. We code *Alliance* = 1 whenever countries are linked by any of these

³⁷ Some papers in the political science literature use simultaneous systems methods to take account of the interdependence between trade and conflict—for example, Polachek (1980, 1997), Reuveny and Kang (1998), Reuveny (2001), Keshk et al. (2004), and Kim and Rousseau (2005). However, none controls for fixed-pair effects. As is typical of this literature, these studies utilize different measures of conflict, sample definitions, and explanatory variables, making comparisons difficult. It should be noted that Keshk et al. (2004) and Kim and Rousseau (2005) find that conflict affects trade, but they do not find evidence that trade interdependence reduces the incidence of conflict. However, these results have been shown to be sensitive to the inclusion of additional explanatory variables, such as distance and relative power.

³⁸ Of course, distances between potential adversaries can be overcome to a great extent by the ability to project power by naval and air forces.

³⁹ Martin et al. (2008) suggest that although countries trading more bilaterally have a lower probability of conflict, countries that are more open to trade overall have a higher probability of war because multilateral trade openness decreases dependence on trade with any given country.

³⁶ For a survey of the political science literature on links between trade and conflict, see the citations in note 3.

TABLE 4.—ESTIMATES OF LIKELIHOOD OF WAR, 1870–1997

	Logit	Panel Logit, Fixed Effect	Logit	Panel Logit, Fixed Effect	Logit	Panel Logit, Fixed Effect
$\ln(\text{Trade}_{ij}/Y_i Y_j)_{t-2}$	−0.40*** (0.02)	0.05 (0.09)	−0.40*** (0.03)	0.16 (0.11)	−0.27*** (0.04)	0.03 (0.10)
YrsPeace_{t-2}	−0.01*** (0.00)	0.11*** (0.01)	−0.01*** (0.00)	0.12*** (0.01)	−0.01*** (0.00)	0.09*** (0.01)
MajPower	−1.06*** (0.17)	—†	−1.07*** (0.18)	—†	0.73*** (0.26)	—†
Alliance_{t-2}	−0.71** (0.29)	−0.69 (0.43)	−1.01*** (0.30)	−2.05*** (0.58)	−0.83** (0.33)	−0.60 (0.43)
Border	0.89*** (0.34)	—†	0.91** (0.38)	—†	1.02** (0.43)	—†
Log Distance	0.01 (0.09)	—†	−0.02 (0.10)	—†	−0.31** (0.15)	—†
PolityL_{t-2}			−0.01 (0.01)	−0.40*** (0.07)		
RelCap_{t-2}					−0.35*** (0.08)	−0.42 (0.28)
Pseudo R^2	0.51		0.54		0.45	
Log likelihood	−4,335.49	−309.19	−3,827.82	−205.19	−1,937.27	−254.50
Number of observations	187,844	14,522	149,482	12,126	148,500	6,730
Number of country pairs	9,942	329	7,812	275	8,646	115

Note: Year dummies and constant not reported. Estimates for *YrsPeace* divided by 100. Standard errors in parentheses. Significance at 1%, 5%, and 10% indicated by ***, **, and *, respectively.

† Variable dropped in fixed effects regression.

forms of pacts or alliances.⁴⁰ Given the binary nature of conflict observations, the probability of conflict among any particular country pair should also depend on how much time has elapsed since the pair was last in conflict. To control for this temporal relation, we include the variable *YrsPeace* that measures the number of years since the previous war between the pair.⁴¹ Time-varying variables are lagged two years to limit simultaneity issues. A full set of year dummies is also used in our specification.

Table 4 presents estimates of the war model using pooled logit and conditional fixed-effect panel logit estimators. Standard errors robust to clustering for common country-pair observations are provided throughout. The pooled logit results reported in column 1 indicate that the likelihood of conflicts increases when country pairs are contiguous, decreases when an alliance relation exists or a major power is involved, and decreases the longer the period of peace between any pair of countries (the coefficients for *YrsPeace* are divided by 100 to improve readability of results). These effects are all statistically significant, typically at better than 1%, for the full sample and the more recent subperiod. Most important, table 4 indicates that trade dependence significantly decreases the risk of war at better

than 1% for the full sample. This suggests that there may indeed be some reverse causality between the extent of bilateral trade relations and the possibility of war.

However, the results in column 2 with CPFE show exactly what is driving the pooled results, and they reveal a markedly different picture of the effects of trade on war. (Note that fixed effects exclude all country pairs where there are no wars during the sample—there is no within-unit variation in the regressand—and this reduces the sample size accordingly.) The CPFE estimator indicates no effect of trade on war.⁴² It is also worth noting that the years-of-peace variable is positive with the fixed effect estimator, implying that the longer the period of time since a particular country pair has engaged in war, the higher the likelihood of a future war between them is. These results cast doubt about the extent to which trade interdependence affects variations in the likelihood of conflict for any given individual country pair. That is, the explanatory power of trade in our war equations is entirely attributable to fitting variations across country pairs (between effects) rather than explaining variations across time for individual pairs (within effects).⁴³

⁴² These results hold for 1870–1938 and 1939–1997 subperiod regressions as well.

⁴³ This is confirmed in between-effects estimates by (a) pooled logit war regressions in which the trade dependence ratio for each country pair is replaced by the corresponding intrapair mean (without time averaging the other explanatory variables) and (b) an OLS cross-section regression of the average frequency of war across pairs on the intrapair mean of the trade dependence ratio as well as the time averages of all other explanatory variables. In these regressions the differences in trade across pairs exert a significant, negative effect on the likelihood of conflict. Zorn (2001) also distinguishes between-pair effects and within-pair effects in pooled regressions and draws similar conclusions for a sample of politically relevant pairs over the period 1950–1985 (and in fact finds that the over-time effect of trade on conflict is significantly positive). Oneal and Russett (2005) claim that trade significantly reduces conflict across both

⁴⁰ Our data source is the file “AllianceData_July2000.txt” distributed by the Expected Utility Generation and Data Management Program (EUGENE), v 2.013, available at <http://eugenesoftware.org>. This file extends the original COW data from 1984 to 1992. We have augmented the data set to include missing members of the Arab League, Council of Independent States, Gulf Cooperation Council, Organization of African Unity, Organization of American States, and Organization of East Caribbean States. We assume that all alliance relationships in effect in 1992 extend through 1997.

⁴¹ For countries in existence in 1870, the years-of-peace variable begins counting from 1812 or the most recent occurrence of war prior to 1870. Former colonies and other states newly independent after 1870 inherit the war memory of their parent colonizers.

The remaining columns of table 4 report the results of including other explanatory variables commonly employed in the political science literature to explain the likelihood of conflict. These include the level of democratization (*PolityL*) and relative power capabilities (*RelCap*). The “democratic peace” proposition hypothesizes that countries sharing similar democratic values are less likely to engage in war (e.g., Oneal & Russett, 1997, 1999, 2001; Oneal et al., 2003). Our measure of democracy is drawn from the Polity IV data set (Jaggers & Gurr, 1995, updated by Marshall & Jaggers, 2000), which codes democracy levels and autocracy for individual countries on a 0–10 point scale. A political regime score for each country is constructed from its democracy score minus its autocracy score plus 10, giving a variable that ranges from –10 for the most autocratic regime to +10 for the most democratic regime. Following Russett and Oneal (2001), we define our democratization measure, *PolityL*, as the lowest democracy score among a country pair (the “weakest link”) and hypothesize that the probability of war declines as this variable rises.

Realists argue that a preponderance of power deters military action (e.g., Russett & Oneal, 2001). Our measure, *RelCap*, is defined as the absolute value of the log difference between country indices of military capability for based on industry, population, and military forces, as constructed by Singer and Small (1993).⁴⁴ Note that limited data availability for these variables severely restricts the sample size usable for estimation, particularly with fixed effects.

As shown in table 4, greater democratization and a larger preponderance of power each lowers the likelihood of conflict (though this effect is significant only in the former case with fixed effects and in the latter case without fixed effects). Most important, our earlier conclusion about the effects of trade on the incidence of conflict is unaltered by the inclusion of these additional variables: trade reduces the likelihood of wars in pooled regressions, but not when fixed effects are included.

The estimated war equation provides helpful insights as we turn back to our original problem of estimating a trade equation. We conclude this discussion by reporting in table 5 the results of a panel instrumental variable gravity regression, where we now instrument for contemporaneous war with those variables found to be useful in explaining the likelihood of war in table 4: the number of years since peace, major power status, alliance relationships, and dis-

TABLE 5.—TRADE EFFECTS OF WAR, 1870–1997: TREATING WAR AS ENDOGENOUS

	Actual War	Instrumented War
War	–1.80*** (0.09)	–2.01*** (0.67)
War1	–1.29*** (0.16)	–1.30*** (0.17)
War2	–1.32*** (0.15)	–1.33*** (0.15)
War3	–1.12*** (0.13)	–1.13*** (0.13)
War4	–0.71*** (0.12)	–0.72*** (0.12)
War5	–0.55*** (0.10)	–0.56*** (0.10)
War6	–0.37*** (0.09)	–0.37*** (0.09)
War7	–0.22*** (0.08)	–0.23*** (0.08)
War8	–0.24*** (0.08)	–0.24*** (0.08)
War9	–0.11 (0.08)	–0.12 (0.08)
War10	–0.03 (0.07)	–0.03 (0.07)
Log distance	—†	—†
Log product real GDP	0.36*** (0.01)	0.36*** (0.01)
Log product real GDP/capita	0.64*** (0.01)	0.64*** (0.01)
Common language	—†	—†
Common land border	—†	—†
Number landlocked	—†	—†
Number islands	—†	—†
Log product land areas	0.25*** (0.03)	0.25*** (0.03)
Current colony	0.62*** (0.07)	0.62*** (0.07)
Ever colony	—†	—†
Currency union	0.20*** (0.03)	0.20*** (0.03)
Average effect, War–War5	–1.13	–1.17
R ²	0.45	0.39
Number of observations	251,736	251,736
Number of country pairs	11,535	11,535
Year dummies	Yes	Yes
Pair dummies	Yes	Yes
Country dummies	No	No

Note: First column reports pooled panel estimates with fixed effects; second column reports pooled panel estimates with fixed effects while instrumenting out War. Instrumental variables are *YrsPeace*, *MajPower*, and *Alliance*, as well as variables in the gravity regression. Year dummies and constant not reported. Standard errors in parentheses. Significance at 1%, 5%, and 10% indicated by ***, **, and *, respectively.

† Variable dropped due to collinearity with country-pair fixed effects.

tance (in addition to all of the regressors previously seen in the gravity estimates).⁴⁵

For comparison, in column 1 of table 5, we report the corresponding fixed effect (CPFE) results when not instru-

country pairs and time in a larger data set spanning 1885–2001. However, the latter effect is significant in their analysis only at a 10% level (using an appropriate two-tailed test).

⁴⁴ We downloaded version p4v2000 of the Polity IV data set for Political Regime Characteristic and Transitions, 1800–1999 from www.bsos.umd.edu/cidcm/inscr/polity at the Center for International Development and Conflict Management, University of Maryland. Our data source for the military capability indices was the file “Cap93.csv” from the EU-GENE program. These data extend only to 1993.

⁴⁵ We instrument only for contemporaneous war, not its lags. Note that the first stage of this procedure involves estimation of a linear probability, rather than a probit, equation for war, with fixed effects. Not surprisingly in view of the results in table 4, the explanatory power of these first-stage regressions is poor; R² values are less than .10. Other regressions (not shown) show that the result in table 5 is robust to the inclusion of *PolityL* and *RelCap* as additional instruments. Indeed, the war coefficient is even larger when these instruments are added.

menting for war.⁴⁶ Year dummies are included but are not reported in both estimations. Without loss of generality, neutral effects are excluded. The coefficient on war is slightly higher (in absolute value) in the results from the instrumental variable procedure (2.02 versus 1.80), but all other coefficients are virtually unchanged. Thus, controlling for simultaneity has a qualitatively insignificant effect on our analysis. A Hausman test confirms that the differences are also statistically insignificant; the hypothesis of a systematic difference between the two sets of results in table 5 can be rejected at better than 1%.⁴⁷

In sum, our estimates of war equations imply that the level of trade interdependence may help to answer the question of which countries engage in conflict rather than when countries engage in conflict. Trade does not explain much of the time series variation in war for individual country pairs when CPFE estimation is used. Thus, simultaneity does not appear to be a serious problem for our trade equations, and hence for our estimates of the effects of war on trade.

IV. Counterfactuals for World Wars I and II

Clearly war depresses world trade both between adversaries and with neutral countries. By how much did World Wars I and II reduce aggregate world trade? In this section, we answer this question through use of our estimated gravity equations.

A. Counterfactual Methodology

To construct a counterfactual “normal” benchmark level for trade in the absence of war, we assume that trade for each country pair would have stayed at the same level as that in the year before the outbreak of war (1913 for World War I, 1938 for World War II), which we denote here as year 0.⁴⁸ That is, we set $Trade_{ijt}^{normal} = Trade_{ij0}$ for all $t > 0$ in

⁴⁶ These results are slightly different from those in column 1 of table 2 because the sample has been constrained by the availability of instruments.

⁴⁷ Our IV estimates do not address possible bias due to selection on observables, that is, where the decision to go to war is determined by particular variables that also influence trade. As an example of positive bias, if “bad” government institutions (say, autocracy) increase the likelihood of war while also dampening commercial trade ties, the estimated effect of war on trade may be biased up in absolute value. As an example of negative bias, a common border should bias this effect down in absolute value since it typically raises the likelihood of war, while also enhancing trade. The border effect is dealt with here by including the observable control in the trade “outcome” equation (see Heckman & Hotz, 1989). A different way to address this issue, outside the scope of this paper, would be to employ a nonparametric technique with propensity scoring in order to construct and compare the trade levels of matched samples of grouped observations with similar characteristics, where the treatment group contains countries at war and the control group those at peace (see Rubin & Thomas, 1992).

⁴⁸ We have tried other approaches to check the sensitivity of this assumption. For example, we also tried a definition of normal that is based on the trend level of trade between the first year before the war and the tenth year after the cessation of war (i.e., 1928 for World War I, 1955 for World War II). From these end points, we can linearly interpolate “nor-

mal” bilateral trade levels for the years 1914–1927 and 1939–1954 for all country pairs and use that as the counterfactual reference level of trade in the absence of war. This made negligible difference to the subsequent calculations, so we elected to use the constant level of trade as a simple benchmark for illustration.

mal” bilateral trade levels for the years 1914–1927 and 1939–1954 for all country pairs and use that as the counterfactual reference level of trade in the absence of war. This made negligible difference to the subsequent calculations, so we elected to use the constant level of trade as a simple benchmark for illustration.

With these imputed “normal” trade levels in the absence of war, we then employ the gravity model to compute the comparative statics effects of war barriers in two ways. In the first approach, we use our gravity model war coefficients from table 3 (columns 4 and 5) to calculate the war-induced year-by-year reduction in trade among adversaries as well as belligerent-neutral country pairs from year to year. We can then aggregate over all country pairs and compute the ratio of aggregate world trade in the presence of war to the counterfactual level in the absence of war.⁴⁹ Because we do not take account of possible effects on multilateral resistance terms with this method, we refer to this as a partial equilibrium (PE) approach. In a second, new, approach, we take into account the possibility that war may endogenously affect the level of multilateral resistance and hence the overall adjustment of trade. Accordingly, we refer to this second method as a general equilibrium (GE) approach.

Specifically, in our partial equilibrium approach, we calculate the fractional wartime reduction in trade for each pair as⁵⁰

$$\frac{\Delta Trade_{ijt}^{war}}{Trade_{ij0}} = e^{[\sum_k \gamma_k War_{ij,t-k} + \sum_k \lambda_k Neutral_{ij,t-k}]},$$

where Δ is the difference operator relative to the base year equilibrium ($\Delta Trade_{ijt}^{war} = Trade_{ijt}^{war} - Trade_{ij0}$). The impact of war on world trade in each year can then be computed as a weighted sum:

$$\frac{\Delta Trade_t^{war}}{Trade_0} = \frac{\sum_{(i,j)} (e^{[\sum_k \gamma_k War_{ij,t-k} + \sum_k \lambda_k Neutral_{ij,t-k}]}) (Trade_{ij0})}{\sum_{(i,j)} (Trade_{ij0})}$$

where $Trade_t = \sum_{(i,j)} Trade_{ijt}$ denotes total world trade in year t .

Although the decomposition is only approximate, we may use this formula to isolate two separate impacts. First

⁴⁹ Note that the gravity model estimates of the effect of war on trade require that we have data for actual trade and the regressor variables for at least some country pairs while at war. However, our counterfactual approach allows us to include the trade effects of war even for pairs where some or all such data are missing during these war episodes. All it requires is that actual trade data exist at the beginning of the war episodes—1913 and 1938. By assuming that the estimated war coefficients can be applied even to pair observations not in the underlying estimation because of missing data, we can infer the effect of war on the trade of these pairs as well.

⁵⁰ For multiyear wars, the contemporaneous effects of war for belligerents and neutrals— γ_0 , λ_0 —apply for years $t = 1, \dots, t^*$, where t^* is the last year of the war. The lagged effects kick in for the aftermath years $t^* + 1, \dots, t^* + 10$.

is the reduction in world trade due to lost trade among the belligerents (the BB country pairs):

$$\frac{\Delta Trade_t^{war}}{Trade_0} = \frac{\sum_{(i,j)} (e^{\sum_k \gamma_k War_{ij,t-k}})(Trade_{ij0})}{\sum_{(i,j)} (Trade_{ij0})}.$$

And second is the reduction in world trade due to the impact of war on belligerent-neutral trade (among BN pairs):

$$\frac{\Delta Trade_t^{war}}{Trade_0} = \frac{\sum_{(i,j)} (e^{\sum_k \lambda_k Neutral_{ij,t-k}})(Trade_{ij0})}{\sum_{(i,j)} (Trade_{ij0})}.$$

In our general equilibrium approach, we still use the same gravity model parameter coefficient estimates, but when calculating the wartime trade level relative to the base year equilibrium, we allow the implicit multilateral resistance effects P to change in response to the existence of trade barriers associated with war. To do this we employ the following compact form of the gravity equation based on the specification of Anderson and van Wincoop (2003),

$$Trade_{ijt} = \left(\frac{Y_{it} Y_{jt}}{Y_t} \right) \left(\frac{\tau_{ijt}}{P_{it} P_{jt}} \right)^{1-\sigma}$$

$$i, j = 1, \dots, C, (i \neq j)$$

$$(P_{it})^{1-\sigma} = \sum_j \theta_j \left(\frac{\tau_{ijt}}{P_{jt}} \right)^{1-\sigma} \quad i = 1, \dots, C,$$

where σ is the elasticity of substitution, $\theta_j = Y_j/Y_t$, $Y = \sum_j Y_j$ are income shares, τ_{ijt} denotes all bilateral trade barriers between countries i and j , and P_{it} denotes the average (unobserved) trade barriers or multilateral resistance faced by country i .⁵¹

We first determine the “no war” trade equilibrium of the model in our benchmark years, 1913 or 1938. More specifically, given observations in year 0 ($= 1913$ or 1938) of output Y_{i0} , and hence world output shares θ_{i0} , as well as of bilateral trade levels $Trade_{ij0}$, we can solve for the equilibrium set of trade barriers τ_{ijt} and multilateral resistance terms P_{it} in the base year that satisfy the system. We denote these equilibrium values as τ_{ij0}^o , P_{i0}^o , where the superscript o denotes the “no war” equilibrium.⁵² Calibration of the elasticity parameter σ is also required.

⁵¹ Note that the theoretical trade equation imposes coefficient values of unity on the trade elasticity of income changes and $1 - \sigma$ on the trade elasticity to both the bilateral and multilateral trade barriers.

⁵² In other words, we solve the set of equations $Trade_{ij0} = (Y_{i0} \cdot Y_{j0}/Y_0)(\tau_{ij0}^o/P_{i0}^o \cdot P_{j0}^o)^{1-\sigma}$, $i, j \in C \times C$ ($i \neq j$) and $(P_{i0}^o)^{1-\sigma} = \sum_j \theta_{j0}(\tau_{ij0}^o/P_{j0}^o)^{1-\sigma}$, $i = 1, \dots, C$ for the set of unknowns $\{\tau_{ij0}^o\}$, $\{P_{i0}^o\}$. For a complete panel of trade and GDP data for C countries, there are C unknown P_i and $C(C-1)/2$ unknown τ_{ij} (since trade barriers are symmetric, that is, $\tau_{ij} = \tau_{ji}$, and it is presumed that there are no internal trade barriers, i.e., $\tau_{ii} = 1$), implying a total of $C(C-1)/2 + C$ unknown variables. Given $C(C-1)/2$ bilateral trade equations and C equations for the multilateral resistance effects, the total number of equations and unknowns is equal. In actuality, the trade matrix is unbalanced because of missing observations for many trade pairs, implying that the actual number of unknowns and equations is less. For every missing

Next we perturb the τ_{ij0}^o using our gravity model estimates of the trade barrier effects of war. More specifically, we define the perturbed trade barriers for a given year t as

$$\tilde{\tau}_{ijt}^{war} = \tau_{ij0}^o \cdot e^{\sum_k (\gamma_k/(1-\sigma)) War_{ij,t-k} + \sum_k (\lambda_k/(1-\sigma)) Neutral_{ij,t-k}},$$

where the war and neutral effect coefficients γ_k , λ_k are obtained from our gravity model estimates.⁵³ We impose an assumption that all other variables in the trade cost function as well as output are constant across equilibria in this exercise, so as to isolate the direct impact of war on trade, all else equal.⁵⁴ Thus we use the same set of $\{Y_{i0}\}$ and $\{\theta_{i0}\}$ as in the base year 0, along with the now exogenously given $\tilde{\tau}_{ijt}^{war}$, to solve our system for the unknown values of trade and resistance for the war equilibrium in each year $t > 0$.

We denote these counterfactual levels as $Trade_{ijt}^{war}$, P_{it}^{war} .⁵⁵ The resulting calculations allow us to compute the counterfactual trade losses for each year t relative to the base year equilibrium levels, $Trade_{ij0}^o$. As in the partial equilibrium exercise, we can also sum up to compute the aggregate trade loss across all pairs, or subsets of pairs, at each point in time.⁵⁶

B. World War I and II Trade Losses

Figures 2 and 3 present the results of these partial equilibrium and general equilibrium exercises for World Wars I and II, respectively, with the impact on total world trade shown. The general equilibrium results use a calibrated value of $\sigma = 5$, as in Anderson and van Wincoop (2003). Our calculations are based on coefficients reported in the last two columns of table 3, which reflect the estimated effects of World Wars I and II alone. These are the correct parameters to use if the great wars were more destructive of trade than other wars, a hypothesis for which we have found support.⁵⁷

$Trade_{ij}$, we reduce the number of τ_{ij} unknowns by 1 and the number of bilateral trade equations by 1, so that there is still an equal number of equations and unknowns. For 1913, there are 55 countries with GDP and at least one bilateral trade observation, and a total of 392 observations. For 1938, the system consists of data for 66 countries with 750 total observations. The numerical solutions were performed with Matlab's equation solver.

⁵³ Note that the coefficients from the gravity estimates are divided by $1 - \sigma$ because the latter enters as an exponent of τ_{ij} in the bilateral trade equations. Since $\gamma_k < 0$, $\lambda_k < 0$, $1 - \sigma < 0$, trade barriers rise when the war (and/or neutral) dummies are “on,” that is, when $War_{ij,t-k} = 1$.

⁵⁴ Anderson and van Wincoop (2003) also take account of the valuation effects of changes in P_i on income shares, but they find this effect to be small in their comparative statics when eliminating all trade barriers. Since we find that the difference between partial and general equilibrium effects of war is relatively small, we assume that this additional effect is second order in our model and can be neglected.

⁵⁵ Here we solve the set of equations $Trade_{ijt}^{war} = (Y_{i0} \cdot Y_{j0}/Y_0)(\tilde{\tau}_{ijt}^{war}/(P_{it}^{war} \cdot P_{jt}^{war}))^{1-\sigma}$ for $i, j \in C \times C$, ($i \neq j$) and $(P_{i0}^{war})^{1-\sigma} = \sum_j \theta_{j0}(\tilde{\tau}_{ijt}^{war}/P_{jt}^{war})^{1-\sigma}$, $i = 1, \dots, C$ for the unknowns $\{Trade_{ijt}^{war}\}$, $\{P_{i0}^{war}\}$.

⁵⁶ The partial equilibrium exercise essentially is equivalent to perturbing the trade barriers relative to period 0 but holding the resistance terms P_i constant.

⁵⁷ The very destructive impacts of the great wars are apparent in columns 4 and 5 of table 5, but the decline in trade would have been only a little

FIGURE 2.—IMPACT OF WORLD WAR I ON TOTAL WORLD TRADE:
PREDICTED AGGREGATE WARTIME TRADE RELATIVE TO COUNTERFACTUAL
PEACETIME LEVEL (1913)

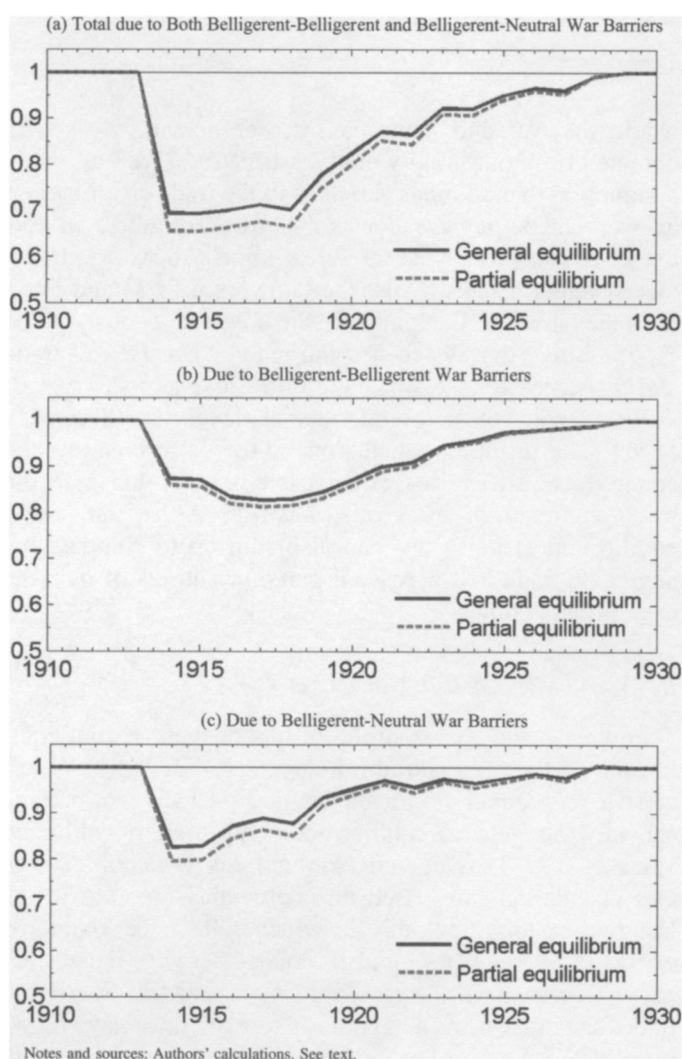
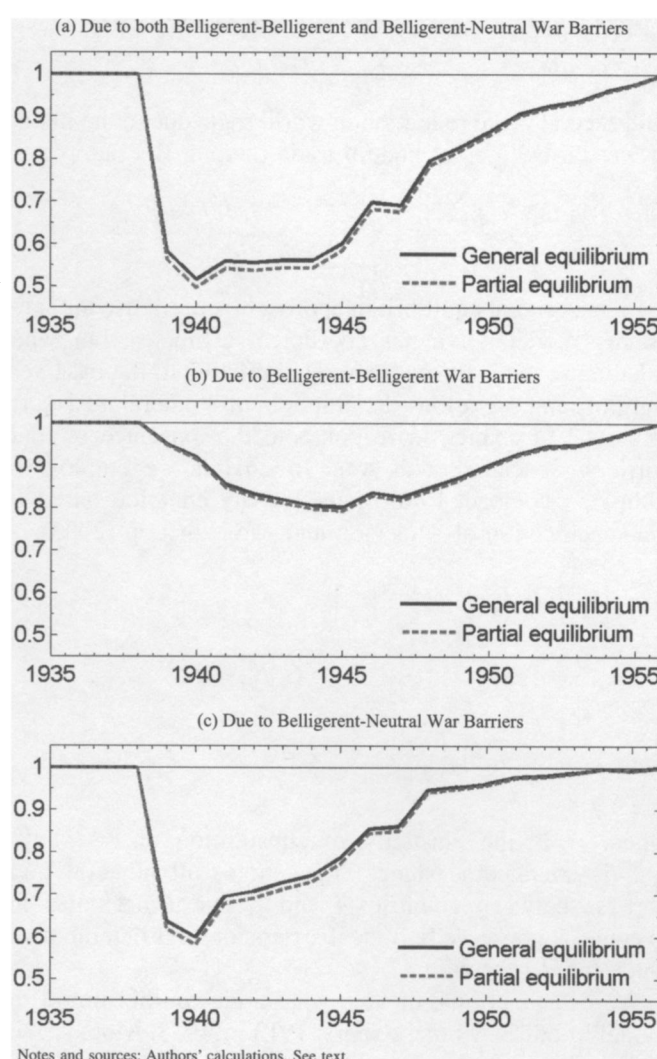


FIGURE 3.—IMPACT OF WORLD WAR II ON TOTAL WORLD TRADE:
PREDICTED AGGREGATE WARTIME TRADE RELATIVE TO COUNTERFACTUAL
PEACETIME LEVEL (1938)



Panel a in both figures 2 and 3 shows the total destructive impact on world trade of war from the war-related trade frictions captured by our γ_k and λ_k coefficients. We can also examine an approximate decomposition of these impacts, as noted above. Panel b shows the impact of war on world trade (for all pairs) resulting from just the war-related trade frictions γ_k between BB country pairs. Panel c shows the impact of war on world trade (for all pairs) resulting from the war-related trade frictions λ_k between BN pairs. In the case of the general equilibrium calculations, these decompositions include the impact of changing multilateral resistance felt by all country pairs—not just the BB and BN pairs, but also the belligerent-ally (BA) and neutral-neutral (NN) pairs. As expected, the general equilibrium decline of trade is always lower than when considering partial equilibrium effects alone.

smaller had we used the more conservative coefficients in the first column of table 5, based on all wars.

In figures 2 and 3, a ratio that is less than unity implies that trade in the presence of war is less than the (imputed) trade in the absence of war.⁵⁸ We note that the effects are, of course, smaller than those shown in figure 1 since not every pair consisted of two adversaries (or a belligerent and a neutral). Referring to the general equilibrium effects, figures 2 and 3 show that:

- In the case of World War I, war among adversaries reduced world trade by roughly 14% in 1914–1915 and almost 18% in 1916–1918. The effects then dampen monotonically. The impact on neutrals reduced world trade by an additional 10% to 15% in the period 1914–1918.

⁵⁸ Note that the ratio of trade in the presence of war to counterfactual trade in the absence of war is unity by construction in the years before and after the intervals 1914–1927 and 1939–1954.

TABLE 6.—HUMAN COSTS OF WORLD WAR I

	Dead	Wounded	Dead Equivalent	1913 Population (mil.)	Maddison (1990\$)		Cost/GDP
					Cost (\$mil.)	1913 GDP (\$mil.)	
France	1,398,000	2,000,000	2,398,000	39.8	11,114	138,665	8.0%
Belgium	13,000	44,686	35,343	7.7	198	32,347	0.6
Italy	578,000	947,000	1,051,500	36.6	3,629	94,845	3.8
Portugal	7,000	13,751	13,876	6.0	23	7,467	0.3
Britain	723,000	1,662,625	1,554,313	47.4	10,172	233,248	4.4
Canada	60,383	155,799	138,283	7.9	818	34,916	2.3
Australia	54,890	158,199	133,990	4.8	919	24,861	3.7
New Zealand	16,500	41,432	37,216	1.1	255	5,781	4.4
India	59,296	46,969	82,781	303.7	74	204,242	0.0
Rumania	250,000	120,000	310,000	7.4	718	12,807	5.6
Serbia	45,000	133,148	111,574	3.0	157	3,205	4.9
Greece	5,000	21,000	15,500	2.7	33	4,344	0.8
Russia	1,811,000	1,450,000	2,536,000	154.0	5,017	229,143	2.2
USA	114,000	205,690	216,845	97.6	1,529	517,383	0.3
Bulgaria	88,000	152,390	164,195	4.4	335	6,792	4.9
Germany	2,037,000	4,207,028	4,140,514	65.1	20,089	237,332	8.5
Austria-Hungary	1,100,000	3,620,000	2,910,000	51.4	10,571	140,268	7.5
Turkey	236,000	400,000	436,000	15.0	703	18,195	3.9
All belligerents	8,596,069	15,379,717	16,285,928	855.5	66,354	1,945,840	3.4

Note: Dead equivalent are estimated as dead plus one-half wounded. Cost (flow cost) is calculated as real wage times dead equivalent. Real wage is proxied by real GDP per capita times labor's share (estimated as 2/3) divided by labor share of population (estimated as 1/2). Austria-Hungary: for Hungary, the Maddison GDP per capita is \$2,098; for Austria, it is \$3,465; an average between Austria and Hungary gives \$2,781.5. GDP is then computed based on a total population in 1910 of 51.356 million from Mitchell (1992). Variant estimates of the death counts were considered for several countries, as follows. We found that the above Bogart-Ferguson casualty data closely match most of the death counts for almost all countries in other studies (e.g., Broadberry & Harrison, 2005), and the consensus is usually close to the figures presented in the original U.S. War Department study of 1924. This is not surprising since Ulanis (1971) is an important original source for these studies. However, most sources show wide disagreement with Ulanis in the case of four countries (see, e.g., <http://users.erols.com/mwhite28/warstat1.htm>), where Ulanis has very high estimates of death. We cannot discount Ulanis, however, since he had special access to Soviet archives, which may lend his counts greater precision in some cases. The four countries, with corresponding ranges of alternate death toll estimates, are Belgium (low "consensus": 13,000; high, from Ulanis: 38,000), Serbia (low: 45,000–128,000; high: 278,000), Greece (low: 5,000; high: 26,000), and Turkey (low: 236,000–450,000; high: 804,000). As a sensitivity check, we recalculated costs for these four countries using the lowest of these ranges of estimates. Costs for these particular countries change markedly in this case, but the overall costs of the war do not change (since these are countries with small GDP weights). The table shows the results with the low estimates.

Sources: See text and notes. Dead and wounded: Military casualties only. Data from Ferguson (1999), except Canada, Australia, New Zealand, and India from Bogart (1919), with authors' adjustments (see below). Incomes and populations: Maddison (2004), adjusted to 1913 land borders, using Maddison (1995, 2001), except Austria-Hungary: for Hungary, the Maddison GDP per capita is \$2,098, for Austria it is \$3,465; a population-weighted average for Austria and Hungary gives \$2,731. Austria-Hungary's GDP is computed based on a total census population in 1910 of 51.356 million from Mitchell (1992).

- In the case of World War II, war among adversaries reduced world trade by 15% in 1941 and by almost 20% in 1945 as more countries entered the war. The impact on neutrals accounts for a fall-off in trade of an additional 35% to 40% during 1939–1941. This effect then decays as the United States and other countries shift from neutral to belligerent status.

On the face of it, these effects are potentially very large in terms of implied costs for the world as a whole, and even more so for the countries concerned. Cumulating a 50% loss of trade over a five- to seven-year wartime period, followed by a gradual recovery over the next 10 years, represents a significant and persistent economic burden. But this is somewhat conjectural: lost trade is not lost output. So we now attempt to measure the latter.

V. Tallying the Costs of War

Although we find evidence suggestive of large economic losses through lost trade, we cannot easily attach a welfare measure to these losses. Moreover, it may be thought that these losses would pale in comparison to the horrific losses of life that are included in the traditional direct costs of war. In the major conflicts, when millions perished, or even in the minor ones, we hesitate to place a pecuniary value on even one lost "statistical" life. Can millions of dollars of lost

trade really be compared on a balance sheet with millions of dead and wounded?

Nonetheless, to make any comparison among the different costs of war, such a cold calculus is unfortunately necessary. That said, we proceed to draw on the ideas of Goldin and Lewis (1975), who made pioneering comparisons between the cost of waging the American Civil War and the cost of alternative counterfactual schemes for settling the conflict (e.g., buying out the slaves). In the Goldin and Lewis approach to valuing lost human capital, the cost of a life lost in the war was valued at the prevailing average real wage and the cost of a wounded individual at one-half of this wage. Such losses could then be amortized at some discount rate to convert the annual lost wages every year (a flow) to a one-time cost (a stock).⁵⁹

A. The Costs of World War I

Table 6 presents rough calculations of the costs of World War I on this basis, using the best estimates for dead and wounded, proxy real wage levels based on Maddison's internationally comparable estimates of GDP per capita, and parameter assumptions for labor's share of output (includ-

⁵⁹ We can also compare the results of our calculations with other costs of war, such as government spending necessary to engage in war as well as the value of property losses, although the data are fragmentary. See below.

ing human capital) and the share of the population in the workforce. Specifically, we assumed that the share of output earned by labor and human capital was two-thirds (cf. Mankiw, Romer, & Weil, 1992), and the labor force was one-half of total population (the rough 1910 average in the sample of Taylor & Williamson, 1997). In this case, the percentage loss of output would be exactly equal to 4/3 (2/3 divided by 1/2) times the percentage dead-equivalent population loss, if all dead are assumed to be of working age.⁶⁰

As the table reports, at war's end, there were 8.6 million dead and 15.4 million wounded, for a total of 16.3 million dead-equivalent lost. The losses were unevenly spread. For the Central Powers, Germany and Austria-Hungary accounted for almost half of these losses—7 million dead equivalent. Among the Allies, France bore a heavy cost with 2.6 million, with Britain losing 1.6 million and Italy 1.1 million. However, judged with an eye to the scales of different countries, whether population or GDP, the relative costs looked rather different. Tiny New Zealand lost 37,000 (of 1.1 million) by the dead-equivalent measure; populous India lost 83,000 (of 304 million).

Applying the Goldin-Lewis metric, we find that the costs, measured as permanent equivalent flow losses to GDP, were highest on the losing side: Germany (8.5%) and Austria-Hungary (7.5%). Alternate, disputed death counts would also assign Turkey a large cost (see the notes to table 6). France (8.0%) bore a heavy burden, while the other Allies' costs were somewhat lower: Britain (4.4%) and Italy (3.8%). On a proportional basis, three U.K. dominions also paid heavily: New Zealand (4.4%), Australia (3.7%), and Canada (2.3%). Bulgaria (4.9%), Serbia (4.9%), and Romania (5.6%) witnessed large human costs on a GDP basis as well. In contrast, India's massive economy barely registered a change, and the United States was also little affected. Summing over all these belligerents, we find a total flow cost to world GDP of 3.4%. It is important to note that this cost was a significant burden for the world as well as for the belligerent countries: since they were approximately 73% of world GDP, the direct human costs as a fraction of total world GDP amounted to around 2.5% of world GDP.⁶¹ Absent demographic data for the war dead, we treat these flow costs as permanent as a first approximation, since most of the combatants were young soldiers with their whole adult working life before them, and the discounted value of their flow incomes thirty years or more into the future are of second-order importance for this type of calculation.

Now let us try to compare these direct human costs of World War I with the indirect costs arising from trade destruction using the estimates from our model. From the discussion in section IV, there is reason to believe that the

trade-related costs of war are substantial. As discussed earlier, figure 2a shows the predicted size of "lost trade" during and after the war relative to a counterfactual "no war" scenario where trade levels are assumed to persist at their 1913 benchmark levels. Total trade falls by approximately 30% during each of the five wartime years relative to the benchmark. Figure 2b attributes roughly half of the decline to war-related trade frictions arising from BB country pairs; figure 2c attributes the remainder to the effects of the BN country pairs. In each case, the model suggests that trade then recovered gradually over the next ten years before returning to its "normal" peacetime level.

Using the calculations underlying these figures for each country pair and year, we can compute the trade decline for any country or set of countries as a result of war and its lagged effects, for both our partial and general equilibrium exercises. Still, lost trade is not lost income (or lost welfare). So these loss figures are not comparable to the direct war cost measures. Can we convert lost trade into a lost output equivalent?

One way to impute the implied loss of income is by using the Frankel and Romer (1999) estimates of the partial derivative of income (or growth) with respect to trade (e.g., as in Frankel & Rose, 2002). In our notation, their basic cross-country regression model of the level of output per capita (Y/N) takes the form:

$$\ln \left(\frac{Y}{N} \right)_i = \alpha + 2\delta \left(\frac{\widehat{Trade}}{Y} \right)_i + \theta X_i + \eta_i,$$

where X is a vector of other control variables and $\widehat{Trade}/Y$ is the exogenous component of the country's trade share, which is constructed from an underlying first-stage gravity model using distance and other geographic variables as exogenous explanatory regressors.⁶² This two-stage or instrumental variable (IV) approach allows the authors to control for the endogeneity of trade in these regressions, for without this step, the OLS estimates of the coefficients are biased. The coefficient of interest to us is δ , the slope of the output-trade relationship. Frankel and Romer (1999, table 3, column 2) give an IV estimate of $\delta = 1.97$ for the trade share. We made this calibration choice because the value of 1.97 is the authors' preferred central estimate, but we should note that the above expressions show that national or global costs are simply linear in the coefficient δ , so we can quickly and easily obtain revised cost estimates under plausible alternative assumptions about the coefficient δ , and we shall discuss such perturbations below.

The Frankel-Romer (FR) specification is ideally suited for our purposes since, at least with respect to the model used here, we may reasonably treat war as exogenous.

⁶⁰ To a first approximation, the percentage loss of output would equal the "labor plus human capital" share (2/3) times the percentage loss of workforce, which would in turn be twice the percentage loss of population.

⁶¹ Maddison's estimate of world GDP for his sample of 56 countries in 1913 is \$2,554,075 (in 1990 US\$).

⁶² In our notation *Trade* is defined as the average of exports and imports. For Frankel and Romer, it is the sum. For this reason, using our definition, a factor of 2 must be added to the trade share coefficient.

Though the distance between a pair of countries never changes, the state of belligerency may fluctuate. Thus, δ is the correct parameter to use in our study to capture the impact of exogenous declines in openness, or trade share, such as would be caused by wars. We should note that this formulation of the counterfactual impact deliberately holds fixed output levels in every country, thus avoiding the question as to whether war creates a boost or a drag on the domestic economy of the belligerent, an effect that would also show up in the gravity equation but which we do not seek to estimate. Our focus on the trade channel allows us to finesse the issue, which is just as well given the scarce data on real output during wars.⁶³

We proceed to assess the permanent income loss due to war and its aftermath relative to an assumed counterfactual constant baseline level of trade corresponding to the actual trade observed in period $t = 0$ prior to the start of war, here 1913. We can estimate the fractional loss of income in country i at time $t > 0$ using a linear approximation implied by the Frankel-Romer estimated equation:

$$\left(\frac{\Delta Y_{it}}{Y_{i0}}\right) = \sum_j 2\delta \left(\frac{\Delta Trade_{ijt}}{Y_{i0}}\right) = \sum_j 2\delta \left(\frac{\Delta Trade_{ijt}^{war}}{Trade_{ij0}}\right) \times \left(\frac{Trade_{ij0}}{Y_{i0}}\right).$$

Here, as we defined it above, $\Delta Trade_{ijt}^{war}$ is the estimated change in trade for the pair at time t under wartime conditions relative to $Trade_{ij0}$, which is the assumed “normal” peacetime trade level in all years (1913 for World War I). As we have discussed, the simulation also keeps GDP levels at their peacetime constant level (Y_{i0}) to isolate the trade-destruction channel.

Denoting the set of all countries in the world as C , we next sum these GDP losses over pairs (i, j) for various (possibly time-varying) subsets of country pairs $V_t \subseteq C \times C$ and calculate their present value cost,

$$\left(\frac{\Delta Y}{Y}\right)_{\{V_t\}} = \sum_t \sum_{(i,j) \in V_t} 2\delta \beta^t (1 - \beta) \left(\frac{\Delta Trade_{ijt}^{war}}{Trade_{ij0}}\right) \times \left(\frac{Trade_{ij0}}{Y_{i0}}\right),$$

⁶³ This is not to say such effects are negligible. The magnitude of endogenous GDP shocks is the subject of considerable controversy in a parallel literature; recent research suggests they might also be quite large (Hess, 2003).

by cumulating the discounted flow costs over the interval including the contemporaneous and lagged years of war, where β is the discount factor.

In practice, we implement this cost calculation for various definitions of V_t to capture the breakdown of all costs across five mutually disjoint country-pair subsets:

- i. Costs to belligerents from lost trade with belligerent adversaries ($ij = B$ pairs)
- ii. Costs to belligerents from lost trade with allies ($ij = BA$ pairs)
- iii. Costs to belligerents from lost trade with neutrals ($ij = BN$ pairs)
- iv. Costs to neutrals from lost trade with belligerents ($ij = NB$ pairs)
- v. Costs to neutrals from lost trade with neutrals ($ij = NN$ pairs)

Some observations are required on this cost decomposition. Here $ij = BA$ means a pair where i and j are in a war as belligerents, but they are on the same (“A” for allied) side. We note that in the partial equilibrium exercises, subsets ii and v are both 0 by assumption (we did estimate effects for allies separately but, in results not reported, we found them to be small and not very statistically significant). However, in a general equilibrium calculation, all five costs can be nonzero due to changing multilateral resistance.

The base year (1913) levels of trade and GDP used in these calculations presume that the composition of the five country-pair subsets is fixed, with the status of a country as a belligerent determined by whether it was ever at war during the conflict period (1914–1918). If all belligerent countries are involved in war for the entire conflict period (and do not switch sides), the country-pair subsets would stay fixed over time, since no country ever switches status between being neutral and belligerent (or vice versa). In actuality, some countries become belligerents later in the conflict period (e.g., the United States entered World War I in 1917), while other countries ceased being belligerents before the overall conflict ends (e.g., Russia exited World War I in 1917). This does not affect the calculation of total world trade losses, but it does affect the decomposition of losses into the various subsets (BB, BN, BA, NB, NN). Hence, year-by-year adjustments must be made to deal with these changing composition effects of countries entering or leaving a war over time. As an example, the United States was neutral with respect to Germany during the years 1914–1916 but an adversary of Germany during the years 1917–1918. With a fixed composition, all changes in bilateral trade changes between the United States and Germany would be allocated to the BB pair set; in our adjustments, we allocate the trade changes for the years 1914–1916 to the BN and NB subsets. Similar adjustments are made for all

TABLE 7.—ECONOMIC COSTS OF WORLD WAR I: HUMAN VERSUS TRADE

	Belligerent Countries	Neutral Countries	World
Weighting data			
1913 population (million)	855	916	1,771
1913 GDP (1990\$ million)	\$1,945,840	\$780,225	\$2,726,065
1913 trade (1985\$ million) with allies	\$ 44,997	—	\$ 44,997
1913 trade (1985\$ million) with belligerents	\$ 19,671	\$ 16,403	\$ 36,074
1913 trade (1985\$ million) with neutrals	\$ 16,403	\$ 3,509	\$ 19,912
1913 trade (1985\$ million) total	\$ 81,071	\$ 19,912	\$ 100,983
Losses of Belligerents			
Losses of Neutrals			
Losses of World			
Human costs	(a)	(b)	(c)
Population loss, dead equivalent	1.90%	—	0.92%
GDP loss, permanent flow	3.41%	—	2.43%
Trade costs with belligerents	(d)	(e)	(f)
Trade loss, permanent flow, partial equilibrium	6.17%	2.60%	8.76%
Trade loss, permanent flow, general equilibrium	6.19%	2.13%	8.32%
GDP loss, permanent flow, partial equilibrium	2.59%	8.80%	4.37%
GDP loss, permanent flow, general equilibrium	2.60%	7.22%	3.92%
Trade costs with neutrals	(g)	(h)	(i)
Trade loss, permanent flow, partial equilibrium	2.60%	—	2.60%
Trade loss, permanent flow, general equilibrium	2.13%	−0.13%	2.00%
GDP loss, permanent flow, partial equilibrium	1.09%	—	0.78%
GDP loss, permanent flow, general equilibrium	0.89%	−0.43%	0.52%
Trade costs with allies	(j)	(k)	(l)
Trade loss, permanent flow, partial equilibrium	—	—	—
Trade loss, permanent flow, general equilibrium	−0.29%	—	−0.29%
GDP loss, permanent flow, partial equilibrium	—	—	—
GDP loss, permanent flow, general equilibrium	−0.12%	—	−0.09%
Trade costs, total	(m)	(n)	(o)
Trade loss, permanent flow, partial equilibrium	8.76%	2.60%	11.36%
Trade loss, permanent flow, general equilibrium	8.03%	2.00%	10.03%
GDP loss, permanent flow, partial equilibrium	3.68%	8.80%	5.14%
GDP loss, permanent flow, general equilibrium	3.37%	6.79%	4.35%

Note: Trade losses are relative to total world trade in 1913; GDP losses are relative to the total GDP for the country group (see column label) in 1913. Trade impacts are based on the gravity model in table 3, column 4. GDP impacts are based on the Frankel-Romer regression estimate of the impact of trade on GDP level. The discount factor is 0.95. The definition of belligerents in the weighting data is those countries ever involved in World War I during years 1914 to 1918. This does not correspond exactly with the gravity-model belligerent dummy at all times: some countries may be omitted, and not all were belligerents for the entire war (e.g., the United States). Partial equilibrium results hold adjustment of multilateral resistance barriers constant; general equilibrium results allow endogenous adjustment of trade flows and multilateral resistance barriers. These effects are adjusted to reflect changes in the composition of which countries were belligerent, adversarial, allied, or neutral during the period.

(a) Based on table 6 and its underlying calculations. (b) Zeros assumed. (c) Based on a weighted average of a and b. (d) See text and table 3, column 4; GDP costs depend on trade losses and elasticity of income to trade share. (e) See text and table 3, column 4; GDP costs depend on trade losses and elasticity of income to trade share. (f) Based on a weighted average of d and e using belligerent and neutral shares of world trade and GDP, respectively. (g) Trade loss as d. (h) Zeros assumed in partial equilibrium. (i) Based on a weighted average of g and h using belligerent and neutral shares of world trade and GDP, respectively. (j) Zeros assumed in partial equilibrium. (k) Zeros assumed. (l) Based on a weighted average of j and k using belligerent and neutral shares of world trade and GDP, respectively. (m) Based on a sum of d, g, j. (n) Based on a sum of e and h. (o) Based on a sum of f, i, l.

Sources: Weighting data on population and GDP from Maddison (1995). Trade data are from the authors' data; see text.

countries that change status (between belligerent and neutral) during the conflict period.⁶⁴

⁶⁴ More specifically, to account for changing composition effects on trade, we first generate year-by-year trade change results assuming both war and neutral trade barriers exist (i.e., the belligerent-belligerent and belligerent-neutral war dummies are “on”). We then allocate these trade changes across the fixed composition of the five country-pair subsets (BB, BA, BN, NB, and NN) based on whether countries were ever at war (where it should be noted that changes in BA and NN trade occur only because of general equilibrium effects on multilateral resistance). Second, we generate trade loss results assuming neutral trade barriers alone are in effect (i.e., only BN war dummies are “on”). In the absence of any composition effects from the beginning of the war, there should be no effect of these neutral barriers on trade for BB and BA pairs (aside from general equilibrium effects). Hence, any trade changes in a given year found for BB or BA pairs in this second calculation necessarily reflect trade effects for pairs in which one or both countries were neutral at that time, although they were belligerents before or after. As discussed in the text, for example, the United States was neutral with respect to Germany and the United Kingdom during 1914–1916 and an adversary of Germany and an ally of the United Kingdom during 1917–1918. Thus, the trade change in response to NB war barriers during 1914–1916 for the United States and Germany ($\Delta Trade_{US-GE}^{neutral}$) and the United States and United Kingdom ($\Delta Trade_{US-UK}^{neutral}$) captures BN/NB pair effects, while the trade change during 1917–1918 for the United States and United Kingdom

Table 7 reports the results of this exercise, applied to World War I, for both partial and general equilibrium approaches. Trade losses are shown on a present discounted basis relative to total world trade in 1913; GDP losses are shown on a present discounted basis relative to the total GDP for the country group (see column label) in 1913. Trade impacts are based on the gravity model in table 3, column 4. GDP impacts are based on the Frankel-Romer regression estimate of the impact of trade on GDP level. Present value costs are computed using an annual discount factor of $\beta = 0.95$.⁶⁵

captures a BA pair effect. We use the results from this second round of calculations (with only neutral barriers in place) to adjust the trade loss changes for our fixed composition when both war and neutral barriers are in place. Thus, for example, in the case of the United States and Germany for 1914–1916, we subtract the neutral barrier change ($\Delta Trade_{US-GE}^{neutral}$) from the trade changes for the BB set and add it to the change for the BN/NB sets. In the case of U.S. and U.K. trade, we add the neutral barrier change ($\Delta Trade_{US-UK}^{neutral}$) to the BN and NB sets for 1914–1916 and to the BA set for 1917–1918.

⁶⁵ We scale the trade losses by world trade, and not country groups, since the calculations for some country groups (e.g., BN and NN) are very

In World War I, the belligerent nations accounted for about half of the world population, three-quarters of world GDP, and 80% of world trade. According to our general equilibrium estimation method, both belligerents and neutrals suffered large economic impacts. To be conservative, we focus our discussion on the general equilibrium results (partial equilibrium results are slightly larger, as expected).

Table 7 shows that lost trade was greatest among belligerents, as expected, leading to a permanent flow loss of 2.60% of their GDP (cell d). The decline in trade involving neutrals caused a further income loss of 0.89% of GDP (cell g). There was of course some trade diversion in general equilibrium, as would be expected. The presence of war barriers between BB and BN pairs also lowers multilateral resistance between BA and NN pairs in general equilibrium. But these effects turn out to be rather small. Belligerents' losses on BB and BN trade were offset by a very small gain on BA trade of just -0.12% (cell j). The total flow loss to belligerents was 3.37% relative to the belligerents' own GDP (cell m).

Neutrals suffered greatly due to the collapse of trade with belligerents, but this was a large share of their own trade, explaining the substantial flow cost for them of 7.22% of their GDP (cell e). The offset due to trade diversion between neutrals was paltry—a flow gain of only 0.43% of GDP (cell h). The net cost to neutrals was thus a massive 6.79% on a flow basis relative to the neutrals' own GDP (cell n).

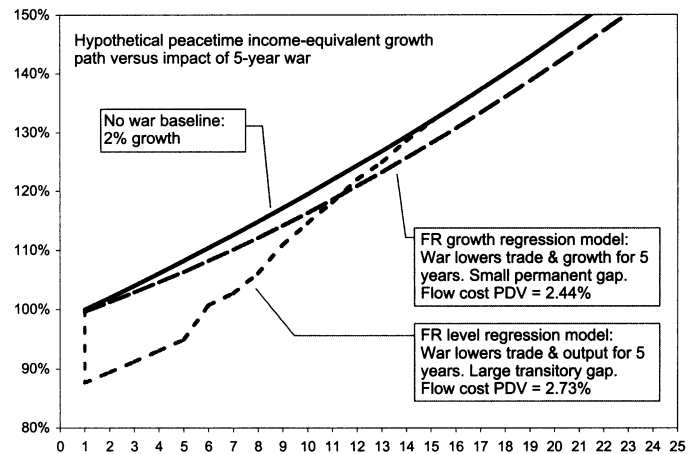
Summing up over all countries, the estimated cost to the world as a whole was 4.35% of world GDP on a permanent flow basis (cell o).⁶⁶

On first sight, it may seem odd that the small estimated impacts on neutrals seen in figure 1 can generate such relatively large losses for neutrals compared to belligerents, but this follows from two facts. First, not every pair of belligerents was an adversarial pair. Second, many belligerents were large countries (in GDP terms), while most neutrals were small countries and (in peacetime) had a large fraction of their trade with belligerents, as the gravity model

sensitive to the country group trade totals used in the denominator. It was not clear how to measure group totals in the base year when some countries (like the United States) switched from neutral to belligerent or ally over time in the two world wars. To avoid this problem, we use total world trade in the base year in the denominator. This has the added advantage of permitting the summing of effects across different groups without any need for weighted sums. However, we scale GDP losses relative to group totals because the human costs are normally computed this way—relative to country group GDP.

⁶⁶ The weighted sum of belligerent and neutral GDP losses is computed using Maddison (1913) GDP weights, as reported at the top of the table. The belligerents' weight is 71% (\$1,945.840/\$2,726.065), and the weight of the neutrals is 29%. In our counterfactuals, the implicit weight on belligerent GDP is higher, at 89%, since we have GDP data for many fewer neutral countries than are included in Maddison's world total (which includes many guesstimates). We prefer to use the Maddison weights here because they probably more accurately reflect the true weights of each country group. Use of his 71% weight is also desirable because it is conservative for our purposes and imparts a downward bias to our bottom-line estimate. Shifting to an 89% weight on belligerents would increase our estimated world losses, as it would put a greater weight on the larger percentage losses suffered by belligerents.

FIGURE 4.—IMPACT OF WAR ON TRADE AND GROWTH TRAJECTORY: COMPARISON OF PREDICTED PRESENT DISCOUNTED VALUE OF LOSSES USING THE FRANKEL-ROMER MODEL IN LEVELS VERSUS GROWTH RATES



Note: Based on partial equilibrium loss calculation and coefficients from table 3, column 1.

would predict. The same absolute (real) bilateral trade loss shared by any two trading partners must weigh more heavily on the smaller country in the pair, since it will dent that country's trade-to-GDP ratio much more, and hence have a bigger proportional impact on output using the Frankel-Romer specification.

One possible concern is whether the results would be robust if we used the FR model to estimate the effect of lost trade on GDP growth rates rather than GDP levels as above. We found that our method was robust. As a test, we used the "all-war" coefficients in table 3, column 1 and computed the implied costs of a hypothetical war two ways: first, using the above FR estimate of $\delta = 1.97$ for the impact of trade-to-GDP ratios on output levels; second, using the FR estimate of $\delta = 1.31$ for the impact of trade-to-GDP ratios on output growth rates (Frankel & Romer, 1999, table 4, column 10). Figure 4 assumes, for simplicity, a peacetime growth rate of 2% per annum, a discount rate of 5%, a trade share of 10% of GDP divided equally among allies, adversaries, and neutrals, and an initial income level of 1 in period 1 (shown as 100%). The losses are computed using the partial equilibrium method. Using the example of a five-year war (comparable to a major war like World War I), we find that the FR model in levels delivers a transitory loss to output that is fully reversed after 10 years of peace. The model in growth rates delivers a much smaller loss, but one that is permanent. It so happens that both trajectories deliver a loss of output of about 2.5% in present discounted value. Thus, by coincidence, the exact form of the FR model does not appear to matter for our welfare cost estimates.

Compared to human costs, also shown in table 7, the economic costs of lost trade were large. As a group, belligerents imposed a human cost on each other equal to 1.90% of lost population, or 3.41% of lost GDP (the GDP impact is larger due to composition effects: among belligerents, it was the richer countries that had higher casualties in World

TABLE 8.—HUMAN COSTS OF WORLD WAR II

	Dead	Wounded	Dead Equivalent	1938 Pop. (mil.)	Maddison (1990\$)		
					Cost (\$mil.)	1938 GDP (\$mil.)	Cost/GDP
Belgium	88,000	132,000	154,000	8.4	990	40,466	2.4%
Brazil	943	4,222	3,054	39.5	5	50,376	0.0%
Australia	23,365	72,196	59,463	6.9	466	40,639	1.1%
Canada	37,476	64,062	69,507	11.5	420	52,060	0.8%
India	24,338	155,597	102,137	454.2	91	303,593	0.0%
New Zealand	10,033	29,896	24,981	1.6	215	10,365	2.1%
South Africa	6,840	30,793	22,237	10.5	65	22,965	0.3%
United Kingdom*	357,116	490,996	602,614	47.5	5,022	297,619	1.7%
China	11,310,224	16,752,951	19,686,700	513.3	14,718	288,549	5.1%
Czechoslovakia	225,000	337,500	393,750	15.4	1,491	43,951	3.4%
Denmark	3,800	5,700	6,650	3.8	51	21,765	0.2%
France	563,324	925,000	1,025,824	42.0	6,093	187,402	3.3%
Greece	413,300	619,950	723,275	7.1	2,575	18,901	13.6%
Netherlands	207,900	302,860	359,330	8.7	2,509	45,593	5.5%
Norway	10,000	15,000	17,500	2.9	101	12,734	0.8%
Poland*	5,798,178	657,366	6,126,861	34.7	17,783	75,656	23.5%
Philippines	118,000	177,000	206,500	15.9	418	24,252	1.7%
United States*	298,131	811,510	703,886	130.5	5,735	799,357	0.7%
U.S.S.R.	18,000,000	27,000,000	31,500,000	168.6	90,063	362,451	24.8%
Yugoslavia	1,505,000	2,225,000	2,617,500	15.4	4,722	20,938	22.6%
Bulgaria	20,000	30,000	35,000	6.2	74	9,962	0.7%
Finland	84,000	53,000	110,500	3.7	528	13,123	4.0%
Germany*	4,280,000	8,400,000	8,480,000	67.3	50,207	299,753	16.7%
Hungary	490,000	470,000	725,000	9.2	2,560	24,342	10.5%
Italy*	395,263	416,000	603,263	44.1	2,655	145,878	1.8%
Japan*	1,972,000	4,810,000	4,377,000	71.9	14,258	176,051	8.1%
Romania	500,000	550,000	775,000	19.7	1,280	24,526	5.2%
All belligerents	46,742,231	65,538,599	79,511,531	1760.0	225,642	3,413,267	6.6%
All belligerents* (missing data = 0)	36,742,231	18,958,697	46,221,580	1760.0	166,277	3,413,265	4.9%
All belligerents (military losses only)	19,395,617	30,555,675	34,673,455	1760.0	121,640	3,413,265	3.6%

Note: Dead equivalent are estimated as dead plus one-half wounded. Cost (flow cost) is calculated as real wage times dead equivalent. Real wage is proxied by real GDP per capita times labor's share (estimated as 2/3) divided by labor share of population (estimated as 1/2).

Sources: See text and notes. Dead and wounded include both military and civilian casualties; some missing data are imputed except for rows marked *. See Table A3 for details and sources. Incomes and populations are from Maddison (2004), adjusted to 1938 borders using Maddison (1995, 2001); Czechoslovakia data are 1937 values, and South Africa data are interpolated using 1913 and 1950 values.

War I). Moreover, there were no global negative externalities in that human costs were essentially zero for neutrals. The total cost to the world as a whole, arising from the belligerents' casualties, was a flow cost of 2.43% of GDP—considerably smaller than the 4.35% attributed to lost trade. Under these assumptions and metrics, the striking conclusion is that the costs of lost trade due to World War I were somewhat higher than the horrible costs of lost human capital.

B. The Costs of World War II

We should not expect the same conclusion for World War II, which was a very different type of war. World War I and previous wars were confined essentially to battle zones, with little attention given to civilians as targets. World War II was the first high-technology total war on a global scale, involving much larger losses of life, greater suffering among civilians, and much more widespread and devastating losses of economic assets (particularly physical capital). Compared to the first war, the second was a third longer in duration, encompassed about twice as many belligerent countries, touched four continents instead of one, and mobilized 110 versus 70 million people into the armed services (Nesterov, 1990). We should therefore expect all of its attendant direct costs to have been that much higher.

Moreover, there is reason to question the magnitude of the indirect costs through damage to world trade. After all, there was much less trade at the beginning of World War II. Following World War I and the Great Depression, economic isolationism was rampant. By the late 1930s, tariffs and quotas had become widespread. In addition, transport costs had risen significantly in the 1920s and 1930s, and the disintegration of the gold standard had also had a significant impact on trade volumes. Compared to the low barriers and low costs of trade in 1913, the world of 1938 was much closer to autarky. Relative to world GDP, trade volumes were about half what they had been in 1913 and close to their 1870 levels (Estevadeordal et al., 2003).

These concerns notwithstanding, we press ahead and repeat the exercises of figure 2, table 6, and table 7 for World War II. The results are shown in figure 3 and in tables 8 and 9. As noted earlier, figure 3 is qualitatively very similar to figure 2, although the trade losses are noticeably larger in World War II. Losses mount up a little more slowly over 1939–1941 for adversaries, as the belligerency slowly spreads to include the European Lowland countries and Italy in 1940 and the United States and Japan at the very end of 1941. Figure 3b shows that during the war, about 10% to 20% of world trade was destroyed by the BB pairs, but figure 3c shows that a further 25% to 40% was destroyed by

TABLE 9.—ECONOMIC COSTS OF WORLD WAR II: HUMAN VERSUS TRADE

	Belligerent Countries	Neutral Countries	World
Weighting data			
1913 population (million)	1,760	489	2,249
1938 GDP (1990\$ million)	\$3,413,265	\$731,461	\$4,144,726
1938 trade (1985\$ million) with allies	\$ 37,519	—	\$ 37,519
1938 trade (1985\$ million) with belligerents	\$ 18,042	\$ 8,434	\$ 26,476
1938 trade (1985\$ million) with neutrals	\$ 8,434	\$ 2,563	\$ 10,997
1938 trade (1985\$ million) total	\$ 63,994	\$ 10,997	\$ 74,991
	Losses of Belligerents	Losses of Neutrals	Losses of World
Human costs			
Population loss, dead equivalent	(a) 4.52%	(b) —	(c) 3.54%
GDP loss, permanent flow	6.59%	—	5.43%
Trade costs with belligerents			
Trade loss, permanent flow, partial equilibrium	(d) 6.98%	(e) 5.71%	(f) 12.69%
Trade loss, permanent flow, general equilibrium	7.02%	5.40%	12.42%
GDP loss, permanent flow, partial equilibrium	1.61%	11.65%	3.38%
GDP loss, permanent flow, general equilibrium	1.45%	11.89%	3.29%
Trade costs with neutrals			
Trade loss, permanent flow, partial equilibrium	(g) 5.71%	(h) —	(i) 5.71%
Trade loss, permanent flow, general equilibrium	5.40%	−0.04%	5.36%
GDP loss, permanent flow, partial equilibrium	1.09%	—	0.90%
GDP loss, permanent flow, general equilibrium	1.11%	−0.09%	0.90%
Trade costs with allies			
Trade loss, permanent flow, partial equilibrium	(j) —	(k) —	(l) —
Trade loss, permanent flow, general equilibrium	−0.16%	—	−0.16%
GDP loss, permanent flow, partial equilibrium	—	—	—
GDP loss, permanent flow, general equilibrium	−0.03%	—	−0.03%
Trade costs, total			
Trade loss, permanent flow, partial equilibrium	(m) 12.69%	(n) 5.71%	(o) 18.41%
Trade loss, permanent flow, general equilibrium	12.25%	5.36%	17.61%
GDP loss, permanent flow, partial equilibrium	2.71%	11.65%	4.28%
GDP loss, permanent flow, general equilibrium	2.53%	11.80%	4.16%

Note: Trade losses are relative to total world trade in 1938; GDP losses are relative to the total GDP for the country group (see column label) in 1938. Trade impacts are based on the gravity model in table 3, column 5. GDP impacts are based on the Frankel-Romer regression estimate of the impact of trade on GDP level. The discount factor is 0.95. The definition of belligerents in the weighting data is those countries ever involved in World War II during years 1939 to 1945. This does not correspond exactly with the gravity-model belligerent dummy at all times: some countries may be omitted, and not all were belligerents for the entire war (e.g., the United States). Partial equilibrium results hold adjustment of multilateral resistance barriers constant; general equilibrium results allow endogenous adjustment of trade flows and multilateral resistance barriers. These effects are adjusted to reflect changes in the composition of which countries were belligerent, adversarial, allied, or neutral during the period.

(a) Based on table 8 and its underlying calculations. (b) Zeros assumed. (c) Based on a weighted average of a and b. (d) See text and table 3, column 5; GDP costs depend on trade losses and elasticity of income to trade share. (e) See text and table 3, column 5; GDP costs depend on trade losses and elasticity of income to trade share. (f) Based on a weighted average of d and e using belligerent and neutral shares of world trade and GDP, respectively. (g) Trade loss as d. (h) Zeros assumed in partial equilibrium. (i) Based on a weighted average of g and h using belligerent and neutral shares of world trade and GDP, respectively. (j) Zeros assumed in partial equilibrium. (k) Zeros assumed. (l) Based on a weighted average of j and k using belligerent and neutral shares of world trade and GDP, respectively. (m) Based on a sum of d, g, j. (n) Based on a sum of e and h. (o) Based on a sum of f, i, l.

Sources: Weighting data on population and GDP from Maddison (1995). Trade data are from the authors' data; see text.

BN pairs, which provides a graphic illustration of the importance of the negative externality effect. Total trade destruction in figure 3a was about 40% to 50% overall in the wartime years, with some evening out due to the change from neutral to belligerent status by some major trading nations, notably the United States in 1941. Trade then recovers over the subsequent decade after 1945.

Table 8 shows human costs, and now includes estimates of civilian casualties in the baseline figures, since World War II involved so many killed and injured noncombatants. We should interpret these figures cautiously, as the labor content of the civilian casualties was probably less than that of military casualties, implying that our methodology will exaggerate somewhat the value of civilian losses. Given the margins of error on the casualty data, however, this need not cause undue anxiety. The total dead equivalent amounted to 79.5 million by our measure, where some missing data were imputed using the plausible assumption of a stable wounded-to-dead ratio (table A3 in the appendix supplies the details). Without imputation, the figure falls to 46.2 million (penul-

timate row, table 8), and military casualties amount to about half the total, 34.7 million (final row).

Losses for individual countries, on a population or GDP basis, are not surprising. The U.S.S.R. with 31.5 million dead equivalent tops the list with a 24.8% GDP flow loss, closely followed by Yugoslavia (22.6%) and Poland (23.5%). Germany also suffered large losses (16.7%), as did Hungary (10.5%). Japan lost about 8% and its adversary, China, 5% (but populous China suffered an absolute loss of 19.7 million dead, compared to Japan's 4.4 million). Occupied France lost 3.3%, Belgium 2.4%, and Netherlands 5.5%, but Denmark only 0.2% and Norway 0.8%. Britain's loss was 1.7%, less than New Zealand on a proportional basis. The United States lost 0.7% by this measure. The loss for all belligerents as a group was 6.6% of GDP using the full (imputed) data set, 4.9% without imputed data, and 3.6% for military casualties only. The last figure may be compared with the 3.4% figure for World War I from table 6, suggesting that it was the spread of total war off

the battlefield and into civilian life that seriously escalated the level of damage to human capital in the second war.

Using the same approach as in table 7, table 9 compares human costs to trade costs for World War II. Trade losses are shown relative to total world trade in 1938; GDP losses are relative to total GDP for the country group (see column label) in 1938. Trade impacts are now based on the gravity model in table 3, column 5. Computing human loss relative to world GDP, not just belligerents' GDP, leaves a bottom-line figure of 5.43% on a permanent flow basis. If we think the civilian component is overstated (due to its smaller labor share), the true figure might be between 4% and 5%. Trade costs appear at the foot of the table and are much smaller, as expected. Adversaries cost each other 1.45% of GDP (cell d) and also paid a further 1.11% due to trade lost with neutrals (cell g). A small gain due to trade diversion with allies of 0.03% (cell j) leaves a total loss to the belligerents of 2.53% of their own GDP (cell m). Neutrals suffered a loss in trade that we value at 11.80% of their own GDP on a flow basis (cell n), a very large loss. Again, as in World War I, neutrals were heavily hit because the countries that went to war were large, the neutrals were small and open, and belligerents accounted for a large share of neutrals' trade. Computing the weighted sum of these figures, we find an overall loss of 4.16% of world GDP for the permanent flow costs of World War II, a similar magnitude to the human costs.

These results, as compared with those for World War I, make sense. On a human level, World War II was about twice as costly (5.43% in table 9 versus 2.43% in table 7) simply because it was bigger, longer, and deadlier. With respect to the costs of trade destruction, World War II was comparable to World War I (4.16% in table 9 versus 4.35% in table 7). There are some offsetting effects at work here. On the one hand, more nations and a greater share of the world's GDP were caught up in World War II, and the estimated coefficients in table 3 suggest that the trade destruction was greater. On the other hand, overall world trade in the base year of 1938 (relative to GDP) had shrunk to about half its 1913 level.

C. *What about Other Costs of War?*

The value of lost human life is not the only cost of war. Total costs, though difficult to calculate, must also take account of the destruction of physical capital, excess military spending, looting, and many other types of loss. Yet even for wars that have been as meticulously studied as World Wars I and II, such estimates are still very rough and subject to considerable disagreement in the literature. Nonetheless, we now compare our trade-related costs to the available figures, subject to this caveat, and we will argue that the trade-related costs still look quite large, and clearly so, for World War I.

One of the most comprehensive studies of the total costs of World War I remains that of Bogart (1920), although it

has been subject to recent criticism from Broadberry and Harrison (2005). The latter object to Bogart's calculation of human costs and prefer to use a "replacement cost" approach to figuring human capital losses. However, this tends to produce a small figure for human costs (much smaller than ours above) since the latter authors do not capture lost utility but only child-rearing costs; the true cost is probably also underestimated since the gestation period for human capital (about eighteen years) is much longer than that needed to build or purchase and install a piece of physical capital, and an appropriate discount factor should be added. Since we have already computed our own human costs, using a broader utility-type measure, we avoid these problems. We capture the lost "consumer surplus" that would have been achieved by the casualties. We also avoid the potential objection that we have biased the result in our favor (of finding a relatively high trade-related cost) by using a human capital measure that looks "too small." Instead we focus on Bogart's other measures-of-war costs. Granted, these too attract objections from Broadberry and Harrison (2005), mainly due to a failure to correct for wartime inflation, since Bogart computes nominal rather than real sums. But for our purposes, this gives the right bias. If Bogart's costs are too high and our trade costs still look significant in comparison, then they would look even bigger compared to inflation-adjusted costs.

According to Bogart, what he calls the "direct" costs of World War I (excess government spending necessary to wage war) were \$186 billion in 1913 prices (Broadberry & Harrison, 2005, table 8). Excluding lost human capital, he found the "indirect" costs (property losses, for example) were \$84 billion. These are cumulative flows or stock measures. For comparison we found the trade-related costs of World War I were 4.35% of world GDP on a flow basis, which equates to a stock value of \$177 billion in 1913 prices. Our estimates of human costs were similarly \$99 billion.⁶⁷ Adding these four figures, we obtain a grand total of \$546 billion, of which trade-related costs made up 32%. Thus, including the impact of lost trade would augment standard measures of the total costs of World War I by almost 50%—a significant correction, we think.

It would be desirable to be able to replicate these calculations with at least the same (albeit limited) degree of confidence for World War II, but for the second war, the figures appear even more fragile and subject to wider suspicion. Broadberry and Harrison (2005, table 13) report an attempt by Nesterov (1990) to apply an approach similar to that of Bogart. He estimated direct losses at \$1,433 billion in 1938 prices and indirect losses (including not only property but also lost human capital, not tabulated separately) at \$2,567 billion, for a total of \$4,000 billion (a

⁶⁷ World GDP of \$2,726 billion in 1990 was deflated to 1913 dollars using a U.S. CPI of 10/133.8; the resulting flow costs for trade and human losses were multiplied by 20 to convert a flow to a stock assuming a 5% discount rate.

surprisingly round number). In these same units, we would calculate the stock value of the trade-related costs of World War II at just \$361 billion in 1938 prices, so that trade costs add less than 10% to the war's estimated total cost.⁶⁸ These provisional calculations caution that although our measures of trade costs are similar in the two wars, there are probably many other significant costs to be reckoned with in the massive conflagration of 1939–1945.

D. Sensitivity Analysis

Our results suggest that the trade-related costs of war are of the same order of magnitude as the traditional costs of war measured in terms of human capital lost through deaths and injury. Is this finding robust? We think the link from war to trade is consistently large and of the magnitude shown, given our extensive robustness checks. The link from trade losses to GDP losses depends on our use of the Frankel and Romer (1999, table 3) IV estimate of δ of 1.97 (s.e. = 0.99), the baseline coefficient we used to convert lost trade to lost income.

A wide range of values of the FR coefficient δ appears in the literature, and alternative values would alter our conclusion in a simple, proportional way given that our costs are proportional to δ . For example, if we switch from the FR full sample of 150 countries to a subsample of 98 countries with potentially more robust data (see FR, table 3, column 4), then the IV estimate is less precise, but it is also much larger, rising by 50% to 2.96 (s.e. = 1.49). An alternative to the 1985 FR cross-section analysis is the historical study by Irwin and Terviö (2002), which found similar δ coefficient magnitudes, although with low precision given smaller historical samples: IV estimates for seven cross-sections between 1913 and 1954 (Irwin & Terviö, 2002, table 4) gave an average estimate of 3.03.

Thus, we can be reassured that for the historical periods we consider, similar trade-income coefficients have been detected. Still, to augment and qualify our bottom-line results, we propose two conservative alternatives to our baseline results where we assume a smaller value for δ in the lower end of the consensus range from the literature, say, either $\delta = 1$ or $\delta = 0.5$.⁶⁹ The flow costs of World War

I (baseline estimate 4.35%) would then be revised down to 1.1% to 2.2% of world GDP, compared to the human cost estimate of 2.43%. The flow costs of World War II (baseline estimate 4.16%) would be 1% to 2% of world GDP, compared to the human cost of 5.43%. Even then, the costs remain large: 40% to 80% of the then shocking human costs of World War I or 20% to 40% of the even more shocking human costs of World War II.

VI. Conclusion

Our work estimates the economic costs of war arising from the destruction of trade. Econometric analysis suggests that these costs are quantitatively large, statistically significant, and highly persistent. Case studies of the two world wars show that these costs can be large—of the same order of magnitude as more traditional measures of the costs of conflict, such as loss of life.

War is hell: the human toll suffered by belligerents as a result of war was immense. But on narrow economic grounds, the losses due to trade were also of a significant magnitude and are not as widely appreciated. Wars kill trade too. Moreover, the negative externalities were huge. The belligerents wrecked the world economy not just for themselves but also for everyone else.

Given the large trade costs of war that we find, it might seem reasonable to hope that they would dissuade rational policymakers from armed conflict. But the two world wars certainly offer a disturbing counterpoint to this vision: they affected an extremely large fraction of world trade and engulfed some of the most open trading nations on earth. Perhaps other mechanisms are needed to avert war, such as multinational institutions. An economic rationale for such institutions might be gleaned from this paper, given the emphasis we place on the important and neglected role of external effects. The large negative trade externalities imposed on neutrals by wars ought to have encouraged neutral countries to try to set limits to the belligerent tendencies of others. After the great wars, multilateral institutions (the League of Nations, the United Nations) held out such a promise, even if they were not entirely successful. Perhaps this was the only way to save neutrals from the large negative spillovers generated by the belligerents—as well as to save belligerents from themselves.

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⁶⁸ Based on 1.54% of world GDP in 1938, using a U.S. CPI correction of 14/133.8 and again multiplying by 20 to convert the flow to a stock assuming a 5% discount rate.

⁶⁹ If one is willing to ignore endogeneity, the OLS coefficients are typically smaller in this literature. However, Frankel and Romer (1999) reported very little difference between their OLS and IV estimates and that OLS coefficients do not overstate the impact of trade on income. Also, as noted by Rodriguez and Rodrik (2002) and confirmed in Irwin and Terviö (2002), the IV coefficients can be sensitive to the inclusion of latitude. In response, additional specification checks conducted by Rose showed that latitude and other geography controls have no deleterious impact on the size or significance of the trade coefficient in the GDP equation estimations in Frankel and Rose (2002), where the basic IV estimates of δ range between 1.59 and 1.96, with an OLS estimate of 0.79. See <http://faculty.haas.berkeley.edu/arose/Rodrik.pdf>. The basic estimates may be upward-biased by omitted variables; smaller coefficients than these do appear in Frankel and Rose (2002) but only when other, probably endog-

enous and collinear, controls, such as the investment ratio, are included as regressors in the income equation resulting in a probable downward bias (see their pp. 447–448). On these grounds we argue that the "conservative consensus" estimate of δ would be in the 0.5 to 1.0 range.

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