Macroeconomic Crises since 1870

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Abstract

We build on the Maddison GDP data to assemble international time series from before 1914 on real per capita personal consumer expenditure, C. We also improve the GDP data in many cases. The C variable comes closer than GDP to the consumption concept that enters into usual asset-pricing equations. We have essentially full annual data on C for 24 countries and GDP for 36 countries. For samples that start as early as 1870, we apply a peak-to-trough method for each country to isolate economic crises, defined as cumulative declines in C or GDP by at least 10%. The principal world economic crises ranked by importance are World War II, World War I and the Great Depression, the early 1920s (possibly reflecting the influenza epidemic of 1918-20), and post-World War II events such as the Latin-American debt crisis and the Asian financial crisis. We find 95 crises for C and 152 for GDP, implying disaster probabilities around 3-1/2% per year. The disaster size has a mean of 21-22% and an average duration of 3-1/2 years. A comparison of C and GDP declines shows roughly coincident timing. The average fractional decline in C exceeds that in GDP during wartime crises but is similar for non-war crises. We simulate a Lucas-tree model with i.i.d. growth shocks and Epstein-Zin-Weil preferences. This simulation accords with the observed average equity premium of around 7% on levered equity, using a "reasonable" coefficient of relative risk aversion of 3.5. This result is robust to a number of perturbations, except for limiting the sample to non-war crises, a selection that eliminates most of the largest declines in C and GDP.

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An earlier study (Barro [2006]) used the Rietz (1988) insight on rare economic disasters to explain the equity-premium puzzle introduced by Mehra and Prescott (1985). Key parameters were the probability, p, of disaster and the distribution of disaster sizes, b. Because large macroeconomic disasters are rare, pinning down p and the b-distribution from historical data requires long time series for many countries, along with the assumption of rough parameter stability over time and across countries. Barro (2006) relied on long-term international GDP data for 35 countries from Maddison (2003). Using the definition of an economic disaster as a peak-to-trough fall in per capita GDP by at least 15%, 60 disasters were found, corresponding to p=1.7% per year. The average disaster size was 29%, and the empirical size distribution was used to calibrate a model of asset pricing.

The underlying asset-pricing theory relates to consumption, rather than GDP. This distinction is especially important for wars. For example, in the United Kingdom during the two world wars, GDP increased while consumer expenditure fell sharply—the difference representing mostly added military spending.

Maddison (2003) provides national-accounts information only for GDP. Our initial idea was to add consumption, which we approximate by real personal consumer expenditure, C, because of difficulties in most cases in separating durables from non-durables. (We discuss later the breakdown of C into durables versus non-durables for a sub-set of countries with available data for crisis periods.) We have not assembled data on government consumption, some of which may substitute for C and, thereby, affect asset pricing. However, this substitution is probably unimportant for military expenditure, which is the type of government spending that moves a lot during some disaster events.

Maddison (2003), with updates available on the Internet at www.ggdc.net/maddison, represents a monumental and widely used resource for international studies using long-term GDP data. However, although much of the information is sound, close examination revealed many problems. For our purposes, the most important shortcoming is that Maddison tends to fill in missing data with doubtful assumptions, and this practice applies especially to major crises.

As examples of problems, Maddison assumed that Belgium's GDP during WWI and WWII moved with France's; Mexico's GDP between 1910 and 1919, the period including the Revolution and Civil War, followed a smooth trend (with no crisis); GDP for Colombia moved over more than a decade with the average of Brazil and Chile; and GDP in Germany for the crucial years 1944-46 followed a linear trend. There were also mismatches between original works and published series for GDP in Japan and Austria at the end of WWII, Greece during WWII and its Civil War, and South Korea during WWII and the Korean War.

Given these and analogous problems, our project expanded to estimating long-term GDP for many countries. The Maddison information was often usable, but superior estimates or longer time series can often be constructed. In addition, results from recent major long-term national-accounts projects for several countries are now available and have not been incorporated into Maddison's Internet updates. These studies cover Argentina, Brazil, Colombia, Greece, Sweden, and Taiwan. Appendix I summarizes the key differences, by country and time period, between Maddison's and our GDP data. We will make details and a complete list of data sources available on the Internet.

The next section describes the long-term data that we have assembled on real per capita personal consumer expenditure, C, and GDP. Our main analysis uses annual data from before 1914 for 24 countries on C and 36 countries on GDP. Section II discusses the long-term data that we use on rates of return for stocks, bills, and bonds. This information comes mostly from Global Financial Data. Section III describes our measurement of C and GDP crises, based primarily on peak-to-trough fractional declines during the crises. Section IV discusses the limited information available on the breakdown of consumer expenditure into durables versus non-durables and services.

Section V compares disaster sizes and timing based on consumer expenditure with that on GDP. Section VI uses the crises data to measure disaster probabilities and frequency distributions of disaster sizes. Section VII summarizes a representative-agent Lucas-tree model that relates disaster experience to expected rates of return and the equity premium. Section VIII simulates the Lucas-tree model using the empirically estimated disaster probability and frequency distribution of disaster sizes. The simulated model with a reasonable coefficient of relative risk aversion accords reasonably well with observed equity premia. Section IX modifies the simulation to use observed real stock-price changes to gauge crisis returns on stocks. We also discuss the low average real bill returns observed during crises. Section X concludes with plans for additional research.

I. Long-term Data on Personal Consumer Expenditure and GDP

We are dealing with national-accounts data for 42 countries. This sample is the universe of countries that seem to be promising for constructing reasonably accurate annual data since before World War I. The current study focuses on the countries for which we have, thus far, assembled annual data from before 1914 to 2006 on real per capita personal consumer expenditure, C (24 countries), and real per capita GDP (36 countries). Henceforth, we sometimes refer to C as "consumption."

Table 1 has a list of included countries and starting years. Part 1 of the table applies to 21 "OECD countries" (not including Turkey or recent members)—17 of these are in our C sample, and all 21 are in our GDP sample. Part 2 covers 18 non-OECD countries—7 of these are in our C sample, and 15 are in our GDP sample. The three countries that we are studying that are omitted from Table 1 because of insufficient progress with the data are Egypt, Ireland, and Russia. We start our analysis of growth rates in 1870, although earlier data are available in some cases.

Our present analysis uses growth rates of C and GDP and does not involve comparisons of levels across countries. Therefore, we can use indexes of C and GDP; for example, setting the values of both variables to 100 for each country in 2000. However, the level comparisons matter for the construction of measures of C and GDP for groups of countries, such as the total of the OECD. To facilitate this analysis (and to allow for other uses of the data that depend on comparability of levels across countries), we set the level of per capita GDP for each country in 2000 to the PPP-adjusted value in 2000 international dollars given in the World Bank's *World Development Indicators* (WDI). For per capita consumer expenditure, we set the level for each country in 2000 to the value given by the WDI for PPP-adjusted per capita GDP multiplied by the share of nominal personal consumer expenditure in the country's nominal GDP.

Sample-selection issues particularly affect disaster studies because data tend to be absent during the worst crises, especially wars. As examples, Malaysia and Singapore have data on C and GDP since 1900 but are missing information during World War II. Inclusion of the incomplete Malaysian and Singaporean time series since 1900 in our analysis would bias downward estimated disaster probabilities. That is, the missing periods almost surely contain crises. We take the approach of excluding cases with these kinds of selected gaps in the data. Thus, aside from Malaysia and Singapore, we omit Turkey (with data on C and GDP starting in 1923, after the Ottoman Empire's crisis during World War I), India for C (where data start in 1919), and Austria for C (where data start in 1913 but information is missing toward the ends of World Wars I and II). More broadly, our main response to this selection issue has been to try to expand the set of countries with at least roughly estimated full time series.

The construction of estimates of real personal consumer expenditure relied on various procedures. In many cases, we used existing long-term national-accounts studies. Sometimes (e.g., Canada before 1926) we estimated C as a residual, starting from GDP and subtracting estimates of the components of GDP aside from C. Sometimes (e.g., Switzerland before 1948 and Germany around WWI) we constructed C from quantities of specific consumption items, using estimates of expenditure shares to calculate changes in aggregate C. The details of our procedures will be published in a separate report.

One issue is the treatment of border changes. An illustration is the reunification of Germany in late 1990. We have data on per capita C and GDP for West Germany up to 1990 (ignoring, for now, the previous border changes) and also after 1990. We have data for unified Germany from 1991 on. Since per capita C and GDP in East Germany (not well measured prior to 1991) were much lower than in the West, the raw data on per capita quantities would show sharp drops in 1991 if we combined the West German values up to 1990 with the unified Germany values thereafter. That is, this approach would treat the unification as a disaster event from the perspective of West Germans leading up to 1990. This perspective may or may not be accurate for this particular border change,[1] but we do not want to apply this approach to border changes in general. This procedure would imply that the initially richer part inevitably regards the coming combination as a disaster, and vice versa for the poorer part.

Even without border changes, the use of per capita C or GDP as a macro variable neglects the distribution of expenditure and income within a country. This macroeconomic approach, valid under some conditions,[2] assumes that we can apply a representative-agent framework to the macro variables, despite the underlying heterogeneity in productivity, wealth, and so on. In this case, the joining of West Germany with another state (East Germany) that happens to have distributions of expenditure and income with lower mean values need not invalidate the representative-agent representation. The appropriate macro-level procedure is then to smoothly paste together in 1990-91 the initial per capita series for West Germany with that for unified Germany thereafter. That is, the West German per capita growth rates apply up to 1991, and the unified Germany growth rates apply thereafter—with no discrete shift in levels of variables at the time of the reunification. We apply this methodology to all of our cases of border change because we think that this approach can yield satisfactory measures of per capita growth rates across these changes. However, this procedure can be misleading with regard to levels of variables. These issues do not affect our present analysis but

[1] As an analogy, some South Koreans view a reunification with North Korea as a pending disaster.
[2] For example, Caselli and Ventura (2000) show that the neoclassical growth model can provide a satisfactory representative-agent view of macroeconomic variables despite heterogeneity in underlying productivity and wealth.

would matter in the construction of measures of per capita C and GDP for broad groups of countries, such as the total of the OECD.

Table 2 shows means and standard deviations, by country, for annual growth rates of real per capita consumer expenditure, C, and real per capita GDP. We consider here only cases with annual data from 1914 or earlier. The sample periods end in 2006 and go back as far as possible until 1870; that is, the first observation is for the growth rate from 1869 to 1870.

Table 3 considers three sub-periods: 1870-1913 (pre-World War I), 1914-1947 (which includes the two world wars and the Great Depression of the early 1930s), and 1948-2006 (post-World War II). The table shows averages across the included countries of growth rates and standard deviations of growth rates.[3] For the full period, 1870-2006, the average of the growth rates of C for 21 countries is 0.020, with an average standard deviation of 0.060. The average for 15 OECD countries is 0.019 (s.d.=0.054), and that for 6 non-OECD countries is 0.022 (s.d.=0.075). For GDP, the average growth rate for 32 countries is 0.020 (average s.d.=0.056). The average for 21 OECD countries is 0.020 (s.d.=0.054), and that for 11 non-OECD countries is 0.020 (s.d.=0.061).

Table 3 shows that the last sub-period, 1948-2006, has higher growth rates and lower standard deviations than the first sub-period, 1870-1913. For example, for GDP growth in the OECD countries, the reduction in the standard deviation—from 0.037 in 1870-1913 to 0.028 in 1948-2006—is the kind of change found by Romer (1986) for the United States and plausibly attributed mainly to improved measurement of macroeconomic aggregates. However, the most striking difference across the sub-periods

[3] In order to have at least ten years of coverage for the 1870-1913 sub-period, Table 3 considers only countries with data back at least to 1904.

involves the turbulence of the middle interval. For C growth in the OECD group, the average standard deviation for 1914-1947 is 0.087, compared to 0.042 for 1870-1913 and 0.026 for 1948-2006. Similarly, for GDP growth in the OECD, the average standard deviation for the middle interval is 0.088, compared to 0.037 and 0.028 in the other two periods.

An important feature of the 1870-2006 samples is that they include realizations of disasters, notably those in the 1914-1947 sub-period, which featured the two world wars and the Great Depression. These realizations create fat tails indicated by excess kurtosis and lead, thereby, usually to rejection in long samples of the hypothesis of normality for growth rates of C or GDP.[4] For C growth, the only case out of 21 in which normality is accepted (by a Jarque-Bera test) at the 5% level is the United States (p-value=0.23). For GDP growth, normality is accepted among 32 cases only for Iceland (p-value=0.07), Switzerland (p-value=0.15), Brazil (p-value=0.05), and Uruguay (p-value=0.51).

Appendix II has long-term graphs of real per capita GDP and consumer expenditure, C, for the 24 countries that have annual data on both variables from before 1914. In each case, the vertical axis has a natural-log scale that ranges from 5.5 ($245 in 2000 U.S. dollars) to 11.0 ($59900 in 2000 U.S. dollars). These graphs bring out the long-term trends and show the major economic contractions. Note that a movement by 0.1 along the vertical axis corresponds to a change in the level of per capita GDP or C by about 10%.

As an example, for Germany, GDP and C fell during World War II, World War I, and the Great Depression of the 1930s. For France, the dominant contraction was during

[4] The tendency for negative skewness—disasters rather than bonanzas—is less pronounced than we anticipated. Over the long samples, for C growth, 11 of 21 countries exhibit negative skewness, and for GDP growth, 24 of 32 exhibit negative skewness.

World War II, with a lesser decline in World War I. For Spain, the main adverse event is the Civil War of the late 1930s. The United Kingdom shows declines in C during the two world wars. GDP did not fall during the wars but decreased during the war aftermaths. In the United States, the main declines in C took place during the Great Depression of the early 1930s and in the early 1920s. GDP also fell at these times, as well as in the aftermath of World War II. Unusual is the very strong behavior of U.S. GDP during World War II, while C remained fairly stable. The United States is also an outlier in the sense of passing the "ruler test"—a ruler placed along the pre-1914 data happens to lie along the observations post-1950. As noted in Cogley (1990, Table 2) and Barro (2009), the United States is almost unique in displaying this apparent tendency for the GDP data to return to a fixed trend line. In other cases (even including Canada, which comes close), the fixed-trend hypothesis is rejected by the GDP data. The full data set corresponding to the appendix figures and to the available time series for other countries will be posted on the Internet.

II. Rates of Return

Our study involves the interplay between macroeconomic variables—represented by consumer expenditure and GDP—and rates of return on various financial assets. Our present work does not make a major contribution to the construction of long-term data on asset returns. Instead, we rely mainly on existing information, primarily that provided by Global Financial Data (see Taylor [2005]). Table 4 shows the dates over which we have been able to assemble time series on real rates of return. In all cases, we compute arithmetic real rates of return, using consumer price indexes to deflate nominal-return indexes. As far as possible, the return indexes and CPIs apply to the end of each year.

Table 4 considers three types of assets: stocks, short-term bills (Treasury bills with maturity of three months or less and analogous claims, such as deposits), and long-term government bonds (usually ten-year maturity). For stocks, some of the information comes from total-return indexes, which combine price changes and dividends. In other cases, we estimated returns from stock-price indexes, using rough estimates of dividend yields. We hope eventually to obtain data from Dimson, Marsh, and Staunton (2008) to extend our stock-return data backwards for at least Canada, Denmark, Italy, the Netherlands, Norway, Sweden, and Switzerland.

Table 5 shows means and standard deviations of rates of return for countries with nearly continuous annual time series back at least to the 1920s.[5] The first columns show stock and bill returns, where a common sample applies in each case to the two types of returns. The last columns show analogous information for bond and bill returns. We emphasize in the present study the comparison between stocks and bills—and, hence, the customary equity premium.

For 17 countries, the mean real rates of return over long-term samples were 0.0814 for stocks and 0.0085 for bills. (For each country, we used a common sample for stock and bill returns.) Thus, the average equity premium was 0.0729. For the 15 OECD countries, the average rates of return were 0.0793 for stocks and 0.0093 for bills, with an average equity premium of 0.0699.

[5] The missing data for this group—involving 2-5 years each for 6 countries—are mainly during large wars, for which real rates of return on all three assets were probably sharply negative. This sample selection biases all measured rates of return upward, although the quantitative effect cannot be too large because of the small number of years involved. The effect on computed equity premia is likely to be even smaller.

Since the stock returns refer to levered equity, the equity premium for unlevered equity would be smaller. For example, with a debt-equity ratio of one-half (roughly that for U.S. non-financial corporations in recent years), the predicted premium for unlevered equity would be 0.0729/1.5 = 0.049. Thus, we take as a challenge for the model to explain an unlevered equity premium of around 5% per year. This type of challenge is the one taken up long ago by Mehra and Prescott (1985).

The model should also be consistent with observed levels of rates of return, including an average real bill rate of less than 1% per year. However, in the model simulations, we choose the rate of time preference, ρ, to accord with the observed average level of the real bill rate (taken as a rough estimate of a risk-free rate, although bills are not risk-free). The reasoning is that the main basis for assessing a plausible value of ρ is to consider whether the implied levels of rates of return are sensible. Therefore, matching overall levels of rates of return does not provide a test of the model.

For 15 countries (14 OECD), the average long-term rate of return on bonds was 0.0266, compared to 0.0147 for bills over common samples. Thus, the average bond-bill premium was 0.0119. The present study does not address the bond-bill premium.

Table 5 shows the familiar high annual standard deviation of stock returns—an average of 0.245 for the 17 countries with matched bill data (0.235 for the 15 OECD countries). The corresponding average standard deviation for bill returns was 0.088 (0.082 for the 15 OECD countries). Thus, bill returns had substantial volatility but not nearly as great as stocks.

III. Consumption and GDP Disasters

To isolate economic disasters for C and GDP, we first follow the procedure in Barro (2006) by computing peak-to-trough fractional declines that exceed some threshold amount. The earlier study used a lower bound of 0.15, but we broaden this limit here to 0.10. The inclusion of contractions between 0.10 and 0.15 brings in a lot of events but has only moderate implications for explaining asset returns.

The peak-to-trough method for assessing the size of contractions is reasonable if growth-rate shocks are i.i.d., so that level shocks are permanent. However, the method can be misleading when some shocks to levels are temporary. Later we modify the approach by using one-sided Hodrick-Prescott filters to attempt to gauge long-run, as opposed to transitory, economic contractions. In ongoing research with Emi Nakamura and Jón Steinsson, we are taking a formal statistical approach that uses the full time series for C and GDP for each country. This approach considers transitional probabilities for movements between normal and crisis regimes and allows for varying degrees of long-term effects of crises on levels of C and GDP.

The full results on measuring C crises are in Table A1 (in Appendix III) and are summarized in Table 6. The coverage is 21 OECD countries—17 with enough data for our subsequent analysis—and 14 non-OECD—7 in our later analysis. For GDP, shown in Table A2 (in Appendix III) and summarized in Table 7, the coverage is 21 OECD countries—all used in our subsequent analysis—and 18 non-OECD—15 in our later analysis. For the samples used later, the mean size of C contraction (95 events for 24 countries) was 21.9%, and the mean size of GDP contraction (152 events for 36 countries) was 20.7%.

To highlight some cases, the United States has been comparatively immune to crises, with C declines of 16% in 1921 (possibly influenced by the influenza epidemic of 1918-20) and 21% during the Great Depression in 1933. GDP declines were 10% in 1908 and 1914 (years affected by banking panics[6]), 12% in 1921, 29% in 1933, and 16% in 1947. The last contraction, likely precipitated by the post-World War II demobilization, did not exhibit a consumption decline. For the United Kingdom, the two C crises were during the world wars—17% in 1918 and 1943. There were no GDP disasters at these times, but GDP did contract after the two wars—by 19% in 1921 and 15% in 1947.

For France*,* we found 3 war-related disasters for C: 16% in 1871 (Franco-Prussian War), 22% in 1915 (WWI), and 58% in 1943 (WWII). For GDP, there were 6 contractions, the largest 41% in 1944. For Germany, there were 4 C crises: 42% in 1918 (WWI), 13% in 1923 (German hyperinflation), 12% in 1932 (Great Depression), and 41% in 1945 (WWII). There were also 4 crises indicated by GDP, the largest a remarkable 74% in 1946, reflecting the economic collapse late in WWII.

Many other countries had sharp contractions during World War II. For example, for C, Belgium fell by 53% up to 1942, Greece contracted by 64% up to 1944, Japan fell by 64% up to 1945, the Netherlands contracted by 55% up to 1944, and Taiwan fell by 68% up to 1945. Other noteworthy cases for C were the contractions in Spain during the Spanish Civil War by 46% up to 1937 and in Chile during the Pinochet "revolution" by 40% up to 1976.

U.S. studies often focus on the severity of the Great Depression; in fact, some researchers gauge disaster probabilities entirely from this single event (see, for example,

[6]See Cagan (1965, p. 138).

Chatterjee and Corbae [2007] and Cogley and Sargent [2008]). One reason for this focus on the Depression is that the United States happened to do well economically during the two world wars, which were major economic disasters for much of the rest of the world, including many OECD countries. Even if one's concern is limited to forecasting U.S. disasters or studying disaster probabilities as perceived by investors in the United States, it seems plausible that the global experience—particularly of comparable OECD countries—would provide a great deal of information. Our perspective is that U.S. prospects can be gauged much better by consulting the global experience, rather than overweighting the own U.S. history—for which the few observed disasters are likely to be dominated by luck.

In a global context at least since 1870, the most serious economic disaster in terms of incidence and severity of declines in C and GDP was World War II. This event was followed in terms of economic impact by World War I and the Great Depression of the early 1930s—two events with similar overall consequences.

Among the 35 countries included for consumer expenditure in Table A1, Table 6 shows that World War II had 23 crises with an average size of 34%. (This table includes non-combatant experiences as part of the war periods.) World War I had 20 crises with an average size of 24%, and the Great Depression had 18 with an average size of 21%. The 1920s had another 11 events—8 with troughs in 1920-21—with an average size of 18%. As already mentioned, the contractions at the start of the 1920s may reflect the influenza epidemic of 1918-20 (Ursúa [2008]). We also found 21 pre-1914 events (for a truncated sample because of missing data) with an average size of 16%.

The post-World War II period was remarkably calm for the OECD countries—only nine consumption crises, four of which were in Iceland (relating in part to shocks to the fishing industry). The largest outside of Iceland was 14% for Finland in the early 1990s (a crisis thought to originate from the changed economic relationship with the former Soviet Union). However, economic crises have not disappeared in the world, as is clear from the 29 non-OECD consumption events with an average size of 19%. The disasters here include the Latin-American debt crisis of the early 1980s, the Asian financial crisis of the late 1990s, and difficulties in 2001-02 in Argentina related to the collapse of the currency board.

Table 7 provides a roughly similar picture for crises gauged by per capita GDP. For the 39 countries included in Table A2, World War II had 25 events with an average size of 36% (see Table 7). World War I had 27 events with a mean size of 21%, and the Great Depression had 22 cases with an average size of 22%. The 1920s had another 15 events—10 with troughs in 1920-21—with a mean size of 18%. The pre-1914 period (more plentiful than for consumer expenditure in terms of available data) showed 45 events, with an average size of 16%. The post-World War II period featured only 6 events for the OECD; the largest were the post-World War II aftermaths for the United States (16%) and the United Kingdom (15%). Again, the situation was much less calm outside of the OECD—24 events with an average size of 17%.

IV. Consumer Durables

The consumption concept that enters into asset-pricing equations would be closer to real consumer expenditure on non-durables and services (subsequently referred to as non-durables) than to overall consumer expenditure. That is, we might want to exclude durables outlays—or, better yet, include an estimate of rental income on the slowly moving stock of durables. However, except for post-World War II OECD countries (which had few crises), we typically lack the data to divide personal consumer expenditure into durables versus non-durables.

Table A3 (in Appendix III) shows the 28 cases among the C-disasters from Table A1 for which we have been able to locate data that permit a breakdown in the decline in real personal consumer expenditure into durables versus non-durables. Among the 28 cases, 20 are in our main sample of 95 C crises. Not surprisingly, the proportionate decreases in durables were typically much larger than those in non-durables. On average for the 28 crises, the proportionate fall in real per capita personal consumer expenditure was 18.3%, that in durables was 39.6%, and that in non-durables was 15.1%. Thus, a substitution of non-durables expenditure for overall consumer expenditure would reduce the mean size of contraction among the 28 cases by about 3 percentage points.

The main reason that the adjustment for durables has only a moderate, though significant, impact is that the share of nominal durables expenditure in the total of personal consumer expenditure is usually not large—averaging 8.0% at the peaks and 5.8% at the troughs for the 28 cases considered in Table A3.[7] As an extreme example, for the United Kingdom during World War II, the measured durables share fell to only 2.3% in 1943 (with household automobiles falling to near zero). But since the durables share of nominal personal consumer expenditure at the peak in 1938 was only 4.9%, the

[7] The change in the nominal share of durables from peak to trough depends partly on the relative growth rates of real durables versus non-durables and partly on the relative growth rates of prices of durables versus non-durables.

adjustment was still only 2.5 percentage points; that is, the proportionate fall in non-durables was 14.4%, compared to 16.9% for personal consumer expenditure.

The average durables adjustment of 3 percentage points likely overstates the overall effects. The reason is that we are systematically missing data on the durables/non-durables division for the larger crises—the mean contraction in C for the 28 cases in Table A3 was 18.3%, compared to a mean of 21.9% for the 95 C contractions used in our subsequent analysis. The largest C contractions in Table A3 are 46% for Spain in 1937, 36% for Finland in 1918, 33% for Chile in 1985, and 32% for Venezuela in 1989.

Consider an arithmetic formula for the magnitude of the proportionate change in non-durables—this formula applies when durables and non-durables are both declining, with the size of the fractional decline in durables exceeding that in non-durables:

$$\left|\frac{\Delta ND}{ND}\right| = \left|\frac{\Delta C}{C}\right| - \left(\frac{D}{ND}\right)\cdot\left[\left|\frac{\Delta D}{D}\right| - \left|\frac{\Delta C}{C}\right|\right], \quad (1)$$

where C is total consumer expenditure, D is durables expenditure, and ND is non-durables expenditure. We already noted that the size of the adjustment is limited by the modest share of durables in total expenditure—this effect comes through the term D/ND in Eq. (1).

An additional effect in Eq. (1) is that, as we consider contractions with larger magnitude for ΔC/C, the difference between the size of ΔD/D and that of ΔC/C must, at least eventually, get smaller. For example, the largest possible magnitude of ΔD/D is one. In this extreme situation, the amount of adjustment in switching to non-durables has to fall as the size of ΔC/C gets larger (with the adjustment approaching zero as the size of ΔC/C approaches one). This reasoning suggests that the durables adjustment would tend to be less important (in percentage points) for the larger crises—and these are the ones that matter most for replicating the equity premium in our later analysis. We do see this pattern in Table A3—for Spain in 1937, the adjustment is from 46.1% to 45.0%; for Finland in 1918, the adjustment is from 36.0% to 35.3%; and for Venezuela in 1989, the adjustment is from 32.0% to 29.9%. However, for Chile in 1985, the adjustment is much larger—from 32.7% to 17.9%.

In any event, we lack information in most cases on the breakdown of personal consumer expenditure into durables versus non-durables. Although we may add a few cases, we will not be able to go much beyond the coverage shown in Table A3. Therefore, we apply the rest of our analysis to crises gauged by personal consumer expenditure, C, in Table A1, as well as to crises measured by GDP in Table A2.

V. Consumer Expenditure and GDP Disasters Compared

Table 8 matches disasters for personal consumer expenditure, C, and GDP for countries with full data (17 OECD and 7 non-OECD). We match the C and GDP contractions in Tables A1 and A2, respectively, by trough years—either the same or a nearby year. In some cases, a contraction by 0.10 or more in C or GDP does not pair up with a decline by at least 0.10 in the other variable (in which case, the decline in the other variable does not appear in Table A1 or A2). In those cases, we enter in Table 8 the actual decline in the other variable (where, for a few cases, a negative value means that the variable increased).

Macroeconomists, particularly those familiar with U.S. data, tend to believe that proportionate contractions in consumer expenditure during recessions are typically smaller than those in GDP. Partly this view comes from the Great Depression, and the numbers in Tables A1 and A2 bear out this perspective: as an example, the proportionate declines in the United States up to 1933 were 21% for C and 29% for GDP. The idea that C is relatively more stable than GDP reflects also the general patterns in post-WWII macroeconomic fluctuations, including those in the United States. Since 1954, the standard deviation of the cyclical part of U.S. real GDP was 1.6%, compared to 1.2% for real consumer expenditure (Barro [2008, p. 185]). The main counter-part of the smoother behavior of C than of GDP was the sharply fluctuating investment. That is, the steep declines in investment during U.S. recessions, including the Great Depression, partly buffered the decreases in consumer expenditure.[8] This buffering could also apply, in principle, to the current-account balance; that is, a procyclical current account would moderate the fluctuations in consumer spending (and investment) relative to those in GDP. However, in the post-1954 period, the ratio of the U.S. current-account balance to GDP was actually weakly counter-cyclical (Barro [2008, p. 429]).

From a theoretical standpoint (and despite the validity of the permanent-income hypothesis), it is not inevitable that consumption would fluctuate proportionately by less than GDP. These patterns depend on whether the underlying macroeconomic shocks impinge more on investment demand or desired saving. This balance depends, in turn, on the permanence of the shocks and whether they operate primarily as income effects or as shifts to the productivity of capital. In a simple AK model with i.i.d. shocks to the growth rate of productivity, A, consumption and GDP would always have the same proportionate variations.

[8] This pattern is stronger for consumption measured by expenditure on non-durables and services; that is, when expenditures on consumer durables are grouped with investment.

An important consideration during wartime is the sharp increase in government purchases for the military. This expansion of G decreases C (and investment), for given GDP.[9] In our data, many of the C and GDP crises—and a disproportionate share of the larger crises—feature these wartime expansions of G. In such circumstances, C would tend to decline proportionately by more than GDP.

Table 8 covers 112 contractions overall, 70 for OECD countries and 42 for non-OECD. Of the 112 contractions, 31 featured participation as a war combatant and 81 were non-war (where the label "non-war" includes non-combatants during major wars). In the 81 non-war cases, the average proportionate decrease in C was slightly greater than that in GDP—14.6% versus 12.9% (12.6% versus 12.4% for the OECD countries). In the 31 war cases, the margin was greater—31.8% versus 27.2% (32.0% versus 27.6% for the OECD countries).

In terms of timing patterns, Table 8 shows for the full sample of 112 crises that 66 have the same trough years for C and GDP. The trough year for C comes later in 26 cases, whereas that for GDP comes later in 20 cases. Thus, at least in the annual data, there is no clear pattern as to whether C or GDP reaches its trough first during crises. If we consider only wartime cases, 15 of the 31 have the same trough year, whereas C reaches its trough later in 7 and GDP reaches its trough later in 9. Thus, there is also no clear result on the timing pattern during wars.

One concern is that the apparent excess of the average size of C contractions over GDP contractions might reflect greater measurement error in the C data. In our planned formal statistical analysis of the C and GDP time series, we will allow for measurement

[9] The declines in consumption and investment could be moderated by falls in the current-account balance. However, the option of borrowing from abroad tends to be severely limited during a global conflict. Moreover, even in localized conflicts, combatants are likely to be cut off from international borrowing.

error that might differ across countries, over time, and between the C and GDP data. For now, we can get some idea about the role of measurement error by redoing the analysis using trend values of log(C) and log(GDP) calculated from Hodrick-Prescott filters. We use a conventional smoothing parameter for annual data of 100. Unlike the standard setup, we use one-sided filters; that is, we considered only current and past values at each point in time when estimating "trends." (This procedure avoids the implication that people knew in advance of a coming destructive war or depression, so that they knew that a major decline in trend C or GDP was about to happen.) Instead of computing proportionate peak-to-trough decreases in C or GDP during crises, we calculate here the proportionate peak-to-trough decreases in the HP-trend values. This procedure downplays short-lived contractions and tends to count only the more persistent declines. The procedure also tends to filter out downturns that are just a response to a previous upward blip in C or GDP. Most importantly in the present context, the HP-filter tends to eliminate "crises" that reflect mainly temporary measurement error in C and GDP.

The HP-filtering procedure substantially reduces the estimated number of disasters—from 95 to 43 for C and from 152 to 70 for GDP. The full results are in Tables A4 and A5 in Appendix III. We matched the C and GDP crises, as before. There are 30 non-war pairs, 17 OECD and 13 non-OECD. There are 23 wartime pairs, 19 OECD and 4 non-OECD. In the non-war sample, the average size of C decline was 12.0%, compared to 14.0% for GDP (8.8% versus 13.4% for the OECD countries). In the war sample, the mean size of C decline was 28.9%, compared to 23.8% for GDP (27.4% versus 21.7% for the OECD countries). Thus, the HP-filtered data generate wartime patterns that are similar to those found before—the average magnitude of C decline was larger than that for GDP. However, the findings for non-war samples are reversed, with the average size of C decline smaller than that for GDP. Thus, overall, the main robust finding is that C tends to fall proportionately more than GDP during wartime crises. The relative magnitude of decline during non-war crises is less clear.

VI. Disaster Probability and the Frequency Distribution of Disaster Sizes

This section considers the sample of countries with essentially complete annual time series since before 1914. We use 24 countries (17 OECD) on per capita consumer expenditure, C, and 36 countries (21 OECD) on per capita GDP.[10] For the C-sample of 24 countries, we isolated 95 disasters (Table A1). The upper panel of Figure 1 plots the frequency distribution of these C-declines. The bottom panel shows the frequency distribution of the duration of these disasters (gauged, in each case, by the number of years from "peak" to "trough"). The average size was 22%, and the average duration was 3.6 years. For the GDP-sample of 36 countries, we found 152 disasters (Table A2). The upper panel of Figure 2 plots the frequency distribution of these GDP-declines, and the bottom panel shows the frequency distribution of the disaster durations. The average size was 21%, and the average duration was 3.5 years.

In our subsequent simulation of a model of the equity premium, using the disaster data to calibrate the model, the results depend mainly on the probability, p, of disaster and the frequency distribution of proportionate disaster size, b. With substantial risk aversion, the key aspect of the size distribution is not so much the mean of b but, rather, the fatness of the tails; that is, the likelihood of extremely large disasters.

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[10] We include Greece and the Philippines in the GDP sample. Although GDP data are missing for Greece in 1944 and for the Philippines in 1941-45, we can compute the peak-to-trough GDP declines during WWII in each case: 66% for Greece from 1939 to 1942 and 57% for the Philippines from 1939 to 1946.

Suppose that there are two states, normalcy and disaster. With probability p per year (taken here to be constant over time and across countries), the economy shifts from normalcy to disaster. With another probability π per year (also constant over time and across countries), the economy shifts from disaster to normalcy. As mentioned before, we found 95 disasters for C and 152 for GDP. Also as noted before, we measured disaster-years by the interval between peak and trough for each event. This calculation yields 343 disaster-years for C and 530 for GDP. The total number of annual observations is 2963 for C and 4653 for GDP. Therefore, the number of normalcy years is 2620 for C and 4130 for GDP. We estimate p as the ratio of the number of disasters to the number of normalcy years. This calculation yields p=0.0363 for C and 0.0369 for GDP.[11] We estimate π as the ratio of number of disasters (all of which eventually ended) to the number of disaster-years. This computation gives π=0.277 for C and 0.287 for GDP. Therefore, whether we gauge by C or GDP, we can think of disasters as starting with a probability of around 3.6% per year and ending with a probability of about 28% per year.

The frequency distributions for disaster size, b, shown for C and GDP, respectively, in the upper panels of Figures 1 and 2, turn out to be well approximated by Pareto or power-law forms. These representations have been found to apply to an array of economic and physical phenomena, including amounts of stock-price changes and sizes of cities and firms—see Mandelbrot (1963), Fama (1965), and Gabaix (1999). We plan to work out the application of power-law distributions to disaster sizes in future research.

[11]The main reason that these disaster probabilities exceed those in Barro (2006) is the inclusion of disaster sizes between 0.10 and 0.15. If we consider only disasters of 0.15 or greater, the probabilities are p=0.0218 for C and 0.0192 for GDP.

VII. A Lucas-Tree Model of Rates of Return

The estimates of p and the b-distribution can be matched with rates of return determined in a representative-agent Lucas-tree setting (Lucas [1978]). Our theoretical framework, summarized briefly here, follows Barro (2009), which extends Barro (2006) to use the Epstein-Zin-Weil (EZW) form of consumer preferences (Epstein and Zin [1989] and Weil [1990]). That is, we allow for two distinct preference parameters: γ, the coefficient of relative risk aversion, and θ, the reciprocal of the intertemporal elasticity of substitution (IES).

We set up the model, for convenience, in terms of discrete periods. However, the formulas derived later apply as the length of the period approaches zero. The log of real GDP evolves exogenously as a random walk with drift:

$$\log(Y_{t+1}) = \log(Y_t) + g + u_{t+1} + v_{t+1}. \qquad (2)$$

The random term u_{t+1} is i.i.d. normal with mean 0 and variance σ^2. This term reflects "normal" economic fluctuations due, for example, to productivity shocks. The parameter $g \geq 0$ is a constant that reflects exogenous productivity growth. Population is constant, so Y_t represents per capita GDP, as well as the level of GDP.

The random term v_{t+1} in Eq. (2) picks up rare disasters, as in Rietz (1988) and Barro (2006). In these rare events, output and consumption jump down sharply. The probability of a disaster is the constant $p \geq 0$ per unit of time. In a disaster, output and consumption contract by the fraction b, where $0<b<1$. The distribution of v_{t+1} is given by

probability 1-p: $v_{t+1} = 0$,

probability p: $v_{t+1} = \log(1\text{-}b)$.

The disaster size, b, follows some probability distribution, which we gauge by the empirical densities shown in Figures 1 and 2.

In the baseline Lucas-tree setting—a closed economy with no investment and no government purchases—the representative agent's consumption, C_t, equals output, Y_t.[12] Given the processes that generate u_{t+1} and v_{t+1}, the expected growth rate of C_t and Y_t, denoted by g*, is given by

(3) $$g^* = g + (1/2)\sigma^2 - p\cdot Eb,$$

where Eb is the expected value of b. (Note that we have allowed for disasters but not for "bonanzas.")

A key simplification—which allows for closed-form solutions—is that the shocks u_{t+1} and v_{t+1} in Eq. (2) are i.i.d.; that is, they represent permanent effects on the level of output, rather than transitory disturbances to the level. An important part of our ongoing research is to reassess this i.i.d. assumption; in particular, to allow for transitory effects from disasters, such as wars and financial crises. (Another important extension, needed to match observed volatility of stock prices and rates of return, is to allow for time variation in uncertainty parameters, particularly the disaster probability, p.)

In general, EZW preferences do not yield closed-form solutions for asset-pricing equations. However, Barro (2009) shows that, with i.i.d. shocks (as in the present model), the first-order optimizing conditions generate asset-pricing equations of familiar form:

(4) $$C_t^{-\gamma} = (\frac{1}{1+\rho^*})\cdot E_t(R_t \cdot C_{t+1}^{-\gamma}),$$

[12] We can readily incorporate wartime related government purchases, G_t, which do not substitute for C_t in household utility but do create a wedge between Y_t and C_t. In this case, an increase in G_t amounts to a decrease in productivity. Results on asset returns are similar in an AK model with endogenous investment and stochastic (i.i.d.) depreciation shocks—see Barro (2009). In this setting, a disaster amounts to a large-scale destruction of Lucas trees.

where R_t is the one-period gross return on any asset. The differences from the standard power-utility model (γ=θ) are, first, the exponent on consumption is the negative of the coefficient of relative risk aversion, γ (not θ), and, second, the effective rate of time preference, ρ*, differs from the usual rate of time preference, ρ, when γ≠θ. The formula for ρ* is

$$(5)\qquad \rho^* = \rho - (\gamma - \theta) \cdot \left\{ g^* - (1/2) \cdot \gamma\sigma^2 - (\frac{p}{\gamma - 1}) \cdot [E(1-b)^{1-\gamma} - 1 - (\gamma - 1) \cdot Eb] \right\},$$

where E is the expectations operator and g^* is the expected growth rate given in Eq. (3).

The formulas for the expected rate of return on equity (unlevered claims to Lucas trees), r^e, and the risk-free rate, r^f, can be derived from Eq. (4), given the process that generates Y_t and C_t in Eq. (2). The results are

$$(6)\qquad r^e = \rho^* + \gamma g^* - (1/2)\cdot\gamma\cdot(\gamma-1)\cdot\sigma^2 - p\cdot[E(1-b)^{1-\gamma} - 1 - (\gamma-1)\cdot Eb],$$

$$(7)\qquad r^f = \rho^* + \gamma g^* - (1/2)\cdot\gamma\cdot(\gamma+1)\cdot\sigma^2 - p\cdot[E(1-b)^{-\gamma} - 1 - \gamma\cdot Eb].$$

Hence, the equity premium can be expressed as

$$(8)\qquad r^e - r^f = \gamma\sigma^2 + p\cdot E\{b\cdot[(1-b)^{-\gamma}-1]\},$$

which depends only on γ and the uncertainty parameters (σ, p, and the distribution of b). The first term, $\gamma\sigma^2$, is negligible and corresponds to the no-disaster equity premium of Mehra and Prescott (1985). The second term brings in disasters and is proportional to the disaster probability, p. The disaster size, b, enters as the expectation of the product of b (the proportionate decline in consumption) and the proportionate excess of the "marginal utility of consumption"[13] in a disaster state, $[(1-b)^{-\gamma} - 1]$. This second term tends to be large.

[13]This interpretation would be precise for power utility (γ=θ).

The formulas for rates of return and the equity premium in Eqs. (6)-(8) depend on a number of assumptions. The baseline model assumes that property rights in assets are perfectly maintained; in particular, there are no possibilities for default on stocks or risk-free claims. The analysis can be extended, as in Barro (2006), to allow for partial defaults during crises. Aside from formal repudiation of claims, default can involve erosion of the real value of nominal claims through surprise jumps in the price level. This type of default tends to apply to government bills and bonds (which are typically nominally denominated), rather than stocks. If we interpret the "risk-free" claim as a government bill, a higher probability of default on bills, conditional on a crisis, lowers the equity premium in a revised version of Eq. (8).

The model also neglects government rationing of consumption during crises, notably wars. Rationing can be viewed as a tax on consumption in crisis states. The more effective the system, in the sense of precluding black markets, the higher the effective tax rate on consumption beyond some rationed quantity—thus, a fully enforced system has an infinite tax rate at the margin. (In practice, the situation is complicated because the rationing and, hence, the tax is likely to be temporary—lapsing once the crisis is over.) Rationing can be viewed as a form of partial default on assets, as above, but one that applies equally to gross returns on stocks and bills. Therefore, although rationing tends to lower the equity premium in an extended version of Eq. (8), the effects are weaker than those from crisis-contingent defaults that apply only to bills.

Another issue for empirical implementation is that the model does not deal with the duration of disaster states—a disaster is a jump that takes place in one period, which amounts to an instant of time. Our research with Nakamura and Steinsson will deal explicitly with the time evolution of the economy during disaster states. For present purposes, we assume that the important aspect of a disaster is the cumulative amount of contraction, b, which we gauge empirically by the numbers shown for C and GDP, respectively, in Tables A1 and A2. That is, we assume that, for a given cumulative decline, the implications for the equity premium do not depend a great deal on whether this decline occurs in an instant or is, more realistically, spread out over time.

To illustrate our assumption, Figure 3 depicts two possible time paths for the log of consumption, C. Each case has two normalcy intervals, denoted A and B. These paths reflect growth at 0.025 per year and (different) realizations of normal shocks with standard deviation, σ, of 0.02 per year—these parameters apply in our subsequent simulations. In each case, a single disaster event with a cumulative fractional decline in C by 0.4 happens to occur in the middle of the sample. We are unsure at present how to model disaster states that last for more than an instant. The mean growth rate is likely to be much lower than normal, and the volatility is likely to be much higher than normal. In Figure 3, the only difference between the two cases is that the fractional decline by 0.4 for the Case I disaster occurs over one period (which could be one year or one second), whereas the Case II disaster stretches over four periods. The graphs assume, unrealistically, that crises have the usual amount of volatility—that is, normal shocks with $\sigma=0.02$ per year.

Our key assumption is that the determination of expected rates of return during normalcy periods (A and B in the two panels of Figure 3) is roughly the same whether disasters look like Case I or Case II. This conclusion holds in an extension of the model pursued in Barro (2006, section V), which assessed the effects from variations in the period length, T. (This extension was feasible in a model with i.i.d. growth shocks.) In this setting, T represents the fixed duration of a disaster. Variations in T between 0 and 5 years did not have much impact on the implied equity premium (measured per year).

In practice, the normalcy rates of return would not be exactly the same in Cases I and II of Figure 3. As an example, Case II implies low, perhaps negative short-term risk-free rates during crises and, therefore, capital gains on longer-term, risk-free bonds when a crisis starts. This pattern has implications for the term structure of risk-free rates during normal times. However, a different specification—where disasters entail higher than usual chances of default on bonds—predicts capital losses, rather than gains, on longer-term bonds when a crisis occurs. Because of this ambiguity, we are unable at this stage to go beyond our assumption that Cases I and II are approximately the same for the equity premium.

VIII. Simulating the Lucas-Tree Model

We now simulate the Lucas-tree model by viewing the Euler condition in Eq. (4) as applying to a representative agent at the country level. That is, we neglect the implications of imperfect markets and heterogeneous individuals within countries. However, we also assume that markets are not sufficiently complete internationally for Eq. (4) to apply to the representative agent in the world. In future work, we will assess how the analysis applies to multiple-country regions, rather than country by country.

In applying Eq. (4) to the determination of each country's asset returns, we neglect any implications from international trade in goods and assets; that is, we effectively treat each country as a closed economy. With this perspective, we can view each country/time-period observation as providing independent information about the relation between macroeconomic shocks and asset returns. In particular, this independence may be approximately right despite the clear common international dimensions of crises—most obviously from wars but also from financial crises, epidemics of disease, and natural-resource shocks.

We apply the full historical information on disaster probability and sizes to the simulation at each point in time. Thus, we implicitly assume that the underlying parameters are fixed over time and across countries and are known from day one to the representative agent in each country. We therefore neglect learning about disaster parameters, an issue stressed by Weitzman (2007).

We focus on the model's implications for the expected rate of return on equity, r^e, and the risk-free rate, r^f—and, hence, the equity premium. As it stands, the model is inadequate for explaining the volatility of asset prices, including stock prices. For example, the model unrealistically implies a constant price-dividend ratio and a constant risk-free rate. The most promising avenue for extending the model to fit these features—including the high volatility of stock returns—is to allow for shifting uncertainty parameters, notably the disaster probability, p. This possibility is explored in Gabaix (2008)—his results suggest that the extended model can explain volatility patterns without affecting much the implications for expected rates of return, including the equity premium. In a related vein, Bansal and Yaron (2004) pursue the consequences of shifting expected growth rates, g*.

The calibrations of the model follow Barro (2009). We set the expected normal growth rate, g, at 0.025; the standard deviation of normal fluctuations, σ, at 0.02; and the reciprocal of the intertemporal elasticity of substitution, θ, at 0.5. (For a discussion of the choice of θ, including the problematic nature of estimates computed from macroeconomic time series, see Barro [2009].) These choices of parameters either do not affect the equity premium (g and θ) or else have a negligible impact (σ). The rate of time preference, ρ, also does not affect the equity premium. However, ρ (along with g, σ, and θ) affects levels of rates of return, including the risk-free rate, r^f (see Eqs. [6] and [7]). Given the lack of useful outside information on ρ, we set ρ* in Eq. (7) to generate r^f=0.01—roughly the long-run average across countries of real rates of return on bills from Table 5.[14] Then ρ takes on the value needed to satisfy Eq. (5).

The calibrations for the disaster probability, p, and the frequency distribution of disaster sizes, b, use our multi-country study of disaster events. We can then determine the value of γ needed in Eq. (8) to replicate an unlevered equity premium of around 0.05—the long-run average across countries implied by the data in Table 5. Since we always have r^f=0.01, an unlevered equity premium of 0.05 corresponds to an expected rate of return on unlevered equity, r^e, of 0.06.

Table 9 applies to crises gauged by consumer expenditure, and Table 10 uses the crises gauged by GDP. For baseline cases, which encompass 95 observations of C crises and 152 observations of GDP crises, a coefficient of relative risk aversion, γ, of 3.5 gets the simulated results into the right ballpark for the observed equity premium; specifically, r^e=0.059 in the C case and 0.067 in the GDP case. The respective rates of time preference, ρ, are 0.045 and 0.052, and the corresponding effective rates of time preference, ρ*, are 0.029 and 0.037.

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[14]Real rates of return on Treasury Bills and similar assets are not risk-free—and tend particularly to be lower than normal during crises that involve high inflation (see Section IX). Thus, r^f may be lower than 0.01. However, pegging to a lower value of r^f would not affect our analysis of the equity premium.

The results are sensitive to the choice of γ. For example, the second lines of Tables 9 and 10 show that, if γ=3.0, the values for r^e fall to 0.042 in the C case and 0.045 in the GDP case.

The results are not very different if the sample encompasses only the OECD countries, in which case the number of C disasters falls from 95 to 57, and the number of GDP disasters falls from 152 to 75. We still get into the right ballpark for the equity premium with γ=3.5 (or slightly higher for the case of C crises).

The results do not change greatly if we truncate the b-distribution to eliminate smaller crises. Tables 9 and 10 show the results when, instead of b≥0.10, we admit only b≥0.15, b≥0.20, b≥0.30, or b≥0.40. Even in this last case—with only 11 remaining C crises and 14 remaining GDP crises— r^e is still at 0.047 in the case of C and 0.054 in the case of GDP. Thus, the larger crises are crucial for getting the equity premium into the right ballpark with a "reasonable" amount of risk aversion, such as γ=3.5.

This reasoning also applies when we examine non-war samples, a selection that eliminates the biggest crises from the sample. (We define "war" as applying only to active combatants.) For C crises, the consideration of a non-war sample—which keeps 66 of the original 95 disasters—yields r^e=0.016. For GDP crises, with 112 of the original 152 disasters retained, the result is r^e=0.017. Getting into the right ballpark here for the equity premium requires a much higher coefficient of relative risk aversion, γ. For example, Tables 9 and 10 show that γ=9 yields r^e=0.053 for C and 0.059 for GDP.

As discussed before, we redid the analysis using trend values of log(C) and log(GDP) calculated from Hodrick-Prescott filters. As already noted, this method captures in an informal way the idea that crises may have less than permanent effects on levels of C and GDP. Tables 9 and 10 show that the HP-filtering reduces the number of disasters from 95 to 43 for C and from 152 to 70 for GDP. Correspondingly, the estimated disaster probabilities fall from 0.0363 to 0.0167 for C and from 0.0369 to 0.0174 for GDP. However, the size distributions of the crises are not so different from baseline cases. For C crises, the mean of b is 0.232, versus 0.219, and for GDP, the mean is 0.224, rather than 0.207. Hence, the HP-filtering decreases the number of disasters but slightly raises the average size, contingent on the occurrence of a disaster.

If we again use a coefficient of relative risk aversion, γ, of 3.5, the HP-filtering lowers the computed r^e to 0.030 for the C case and to 0.036 for GDP. However, γ does not have to increase very much to restore a reasonable equity premium. For example, for C, γ=4.5 yields r^e=0.050, whereas for GDP, γ=4 yields r^e=0.050.

In terms of broad patterns, the results based on consumer expenditure, C, in Table 9 deliver results for the equity premium that are similar to those based on GDP in Table 10. On the one hand, this finding suggests a kind of robustness in that the results are not sensitive to measurement differences in these two main macro aggregates. On the other hand, this finding means that fitting the equity premium does not depend on our efforts in measuring consumer expenditure and, thereby, getting closer to measures of consumption.

Overall, the simulations in Tables 9 and 10 show that the model delivers reasonable equity premia with "plausible" coefficients of relative risk aversion for a variety of specifications. The main lack of robustness applies to elimination of the biggest crises from the sample; for example, by removing the war-related crises.

IX. Asset Returns during Crises

In the model in section VII, crises feature downward jumps in consumption and GDP at a point in time. More realistically, C and GDP fall gradually during crises of varying lengths, as suggested by Figure 3. In our empirical analysis, we approximated the crisis declines in C and GDP by cumulative fractional amounts over peak-to-trough intervals, as shown in Tables A1 and A2 and Figures 1 and 2. Now we carry out a preliminary analysis that considers observed returns during crises on stocks and bills.

A. Stock returns during crises

In the theory, real stock prices jump down discretely at the start of a crisis. More realistically, stock prices would fall each time negative information hits the financial markets. Since we are conditioning on crises that cumulate to at least a 10% fall in C or GDP, the crises typically feature more than one adverse piece of news (or, rather, more negative than positive news). Thus, the stock-price declines tend also to be spread out during the crises. By analogy to our procedure for measuring decreases in C and GDP, we measure the crisis changes in stock prices by cumulative fractional amounts. Specifically, the real stock-price falls shown in Tables A1 and A2 are the total fractional declines from the end of the year before the peak to the end of the year before the trough. (Negative values indicate stock-price increases.) This procedure omits changes in stock prices during the trough year—where the financial markets would likely be influenced by information that the crisis had ended.

Data on real stock prices are available for only a sub-set of the C and GDP crises—54 of the 95 C crises (Table A1) and 72 of the 152 GDP crises (Table A2). The majority of these crises show declines in real stock prices—42 of 54 (78%) of the C events and 55 of 72 (76%) of the GDP events. Figure 4 shows the size distribution of real stock-price declines during crises (where negative values correspond to stock-price rises). The left-hand panels are the full distributions, and the right-hand panels consider only the stock-price decreases. The left-hand panels have two outliers with very large price increases—Argentina in the late 1980s and Chile in the mid 1970s. In these situations, periods of economic contraction were accompanied by major contemporaneous or prospective reforms that were viewed favorably by the stock markets.[15] To admit the possibility of stock-price increases during crises into the model, we would have to expand the framework to allow for shocks to parameters, such as the expected growth rate, g*, or the disaster probability, p.

The respective mean and median of fractional stock-price declines were 0.086 and 0.172 for C crises and 0.165 and 0.294 for GDP crises. Conditioning on cases of stock-price decrease in the right-hand panels of Figure 4 shows roughly uniform shapes for the frequency distributions in the range of sizes between 0 and 0.7.[16] In this range, the respective mean and median of stock-price declines were 0.327 and 0.288 for C crises and 0.376 and 0.374 for GDP crises.

In Tables 9 and 10, we simulated the underlying asset-pricing model using the observed distributions of C and GDP crises. The underlying assumption was that the size of the fractional stock-price decline (for unlevered equity) during a crisis equaled the size of the fractional decline, b, in C or GDP. We can instead simulate the model by using the

[15]An analogous situation is Venezuela in the late 1980s—a C crisis in Table A1 that is not included in the sample currently being considered.
[16]Recall that the samples are selected by considering C or GDP declines of 0.10 or more. We could, instead, select the sample by considering real stock-price declines of 0.10 or more. Our conjecture is that the size distributions would then look like power-law functions, as in Figures 1 and 2.

actual stock-price changes during crises, as shown in Tables A1 and A2 and Figure 4. Since these stock returns refer to levered equity, these calculations apply to expected returns on levered equity.

The asset-pricing condition in Eq. (4) involves the term $E[R_t \cdot (1-b)^{-\gamma}]$, where R_t is the gross real stock return during crises, and b is the fractional decline in C (or GDP) during crises. This expression is difficult to calculate accurately because stock-price changes are highly volatile, particularly during crises.[17] In Table 11, we compute this term in four alternative ways. First, we measure contractions by either C or GDP, and second, we use either the full distributions of stock-price changes (the left-hand panels of Figure 4) or the truncated distributions that consider only stock-price decreases (the right-hand panels). This last choice is more consistent with our model and may also lessen the effects from measurement error.

The calculations using the full distributions of stock-price changes do not accord well with observed long-term average returns on levered equity of around 0.081 (from Table 5). If we use γ=3.5, as before, the simulations in Table 11 deliver an overall mean rate of return on levered equity of 0.029 based on C crises and 0.031 based on GDP crises. The results fit better if we use the truncated distributions, which eliminate cases of stock-price increases during crises. The simulated mean rate of return on levered equity is then 0.075 based on C crises and 0.034 based on GDP crises. Given the wide range of results, we cannot, at this stage, reach firm conclusions from our attempts to simulate the model using observed stock-price changes during crises.

[17] An additional difficulty is the imperfect matching of the timing of stock-price changes with the timing of the declines in C or GDP. In our data, stock-price changes are from the end of the year prior to the peak to the end of the year prior to the trough. The changes in C or GDP are from the peak year to the trough year, with C and GDP representing annual flows for each year.

B. Bill returns during crises

In the model from section VII, the risk-free rate is the same in normal times as in a crisis, which lasts an instant of time. The same pattern would apply to the expected real rate of return on short-term bills—the type of claim considered in Table 5—if we introduce a constant probability of default or, for nominal claims, a time-invariant process for inflation.

Observed returns on short-term bills deviate from these predictions. Table 12 shows means and medians for real bill returns during the C and GDP crises shown in Tables A1 and A2. (The bill returns for each crisis are mean values from the peak year to one year prior to the trough year.) These results apply to the main samples (95 C crises and 152 GDP crises) when data are also available on bill returns (58 for C and 73 for GDP). The average real bill return during crises was between -2% and -5% per year, depending on whether we use a C or GDP sample and on whether we consider the mean or the median. Hence, the average crisis return was below the long-term average of around 1% shown in Table 5.

There are two main issues to consider. The first is whether a substantially negative number, such as -2% to -5% per year, is a good measure of expected real bill returns during crises. A major question here concerns inflation. The second is whether our analysis of the equity premium would be much affected if the expected real return on bills during crises were substantially negative. Since the second issue is more fundamental, and we think the answer is no, we consider that question first.

One possible reason for a low equilibrium expected real bill return during crises, suggested by Figure 3, is that crisis states last for more than an instant, and the mean growth rate of C in these states is negative. (A supporting reason, not shown in Figure 3, is that volatility tends to be unusually high in crisis states.) In these cases, the risk-free rate and the expected real bill return would be unusually low in crises. However, the key issue for the equity premium is not the low level of the real bill return during crises (caused by a low expected growth rate or some other factor) but, rather, whether the incidence of a crisis imposes substantial real capital losses on bills. Recall that bills correspond, empirically, to claims with maturity of three months or less. Although the crisis induced changes in the real value of these claims are hard to measure accurately, substantial real capital losses can arise only if there are jumps in the price level or literal defaults on bills. Absent these effects, the pricing of bills in normal times (and, hence, the equity premium) would not be much influenced by the prospect of low equilibrium real bill returns during crises.[18] In contrast, for long-term bonds, changes in real capital values at the onsets of crises may be substantial and would have to be compared with those on stocks. Thus, it would be useful to analyze the crisis experiences of the 10-year government bonds included in Table 5. However, the measurement of crisis-induced changes in real bond values will be challenging.

A different point is that the computed averages of real bill returns during crises may understate expected real returns because of influences from inflation. Crises do feature higher than usual inflation rates—Table 12 shows that the median inflation rates[19] were 6.6% for C crises and 6.9% for GDP crises, compared to 4.2% for long samples for

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[18] An analogous result holds for paper currency. The expected real return on currency would be low during a crisis if the expected inflation rate were high. However—absent jumps in the price level or literal defaults–currency held in normal times would still provide good protection against crisis-induced stock-market crashes.

[19] The inflation rate for each crisis in Tables A1 and A2 is the mean value from the peak year to one year prior to the trough year.

all countries taken together. Hence, one possible explanation for the low average real bill return during crises is that the greater incidence of high inflation corresponds to high unanticipated inflation and, thereby, to a shortfall of realized real returns on nominally denominated bills from expected returns. A shortcoming of this argument is that it requires inflation to be systematically underestimated during crises (which are presumably recognized contemporaneously).

A second possibility is that the reported nominal yields at times of high inflation systematically understate the true nominal returns and, therefore, lead to under-estimates of real returns. The reason is the understatement of the implications of compounding for calculating true nominal returns.[20] We think that this issue is quantitatively important, and we are attempting to improve our calculations in this regard.

X. Plans

We plan to expand the 24-country sample for consumer expenditure and the 36-country sample for GDP. Promising candidates are Malaysia and Singapore, with gaps around WWII. Also promising are Russia back to the pre-WWI Tsarist period and Turkey/Ottoman Empire, for which we currently have data since 1923. We are considering Ireland, particularly whether we can isolate macroeconomic data for southern

[20]As an example, Peru's crisis in 1987-92 featured very high inflation. In 1989, the price level increased by a factor of 29. The IMF's *International Financial Statistics* reports, on a monthly basis, nominal deposit yields for 1989 averaging 1100% per year. The IFS people tell us that an annual rate of 1100% means that the nominal value of funds held as deposits would rise over a year by a factor of 12. This nominal return, in conjunction with the inflation experience, produces a real rate of return for Peru in 1989 of -0.58 per year. Suppose, alternatively, that a nominal yield of 1100% per year means that returns are compounded monthly at a rate of 92% (=1100%/12) per month. In this case, the nominal value would rise over a year by a factor of 2500, implying an astronomically positive real rate of return. The point is that, when the inflation rate is high, compounding errors of this type have large implications for calculated real rates of return—and we think that these errors are regularly in the direction of understating true returns.

Ireland from U.K. statistics for the period prior to Irish independence in 1922. We plan also to reexamine the pre-1929 U.S. data, focusing on the Civil War years.

We will try to go further in measuring the division of personal consumer expenditure between durables versus non-durables and services. Table A3 shows the data that we have been able to compile, thus far, for crisis periods. We may also attempt to add data on government consumption. A key issue here is the separation of military outlays from other forms of government consumption expenditure.

We plan to construct time series for C and GDP per capita at the levels of regions that include multiple countries—the OECD, Western Europe, Latin America, Asia, the "world," and so on. These regional aggregates can be relevant when countries are integrated through financial and other markets. There are tricky aspects of this exercise involving changes in country borders, and we are working on this issue. Once we have these super-aggregate variables, we will examine C and GDP crises at regional levels.

In joint work with Rustam Ibragimov, we will use the method of Gabaix and Ibragimov (2007) to estimate the distribution of disaster sizes, b, within a power-law context. Preliminary analysis shows good results when treating the transformed variable 1/(1-b) as subject to a power-law density function with exponent α. With these results, we can compute the key expectations that enter into the theoretical model, such as $E(1-b)^{-\gamma}$, as functions of γ and α. Preliminary results suggest that the estimated α, around 5, is consistent with a finite value of $E(1-b)^{-\gamma}$, when γ is around 3.5. With these results, we can redo the simulation of the model using the fitted density function for b, rather than the observed histogram.

We are working with Emi Nakamura and Jón Steinsson on a formal statistical model of the evolution of per capita consumer expenditure and GDP. We will use the full time series on C and GDP to estimate disaster probability (possibly time varying), evolution of economic contractions during disaster states, probability of return to normalcy, and long-run effects from disasters on levels and growth rates of C and GDP. We will also allow for trend breaks in growth rates, as well as for some differences in uncertainty parameters across countries and over time.

We are working with Emmanuel Farhi and Xavier Gabaix on a different approach to measuring time-varying disaster probabilities. Our plan is to use U.S. data since the early 1980s on prices of stock-index options to gauge changing market perceptions of the likelihood of substantial adverse shocks. Aside from considering the equity premium, we will apply this analysis to the bond-bill premium, which we found to be about 1% per year.

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Table 1 Starting Dates for Consumer Expenditure and GDP				
Part 1: OECD Countries				
Country	**Starting Dates**		**Missing Values**	
	C	**GDP**	**C**	**GDP**
Australia	1901	1820		
Austria	1913*	1870	1919-23, 1945-46	
Belgium	1913	1846		
Canada	1871	1870		
Denmark	1844	1818		
Finland	1860	1860		
France	1824	1820		
Germany	1851	1851		
Greece	1938*	1833**		1944
Iceland	1945*	1870		
Italy	1861	1861		
Japan	1874	1870		
Netherlands	1814	1807		
New Zealand	1939*	1870	1940-43, 1945-46	
Norway	1830	1830		
Portugal	1910	1865		
Spain	1850	1850		
Sweden	1800	1800		
Switzerland	1851	1851		
U.K.	1830	1830		
U.S.	1869	1869		

Table 1, part 2: Non-OECD Countries				
Country	**Starting Dates**		**Missing Values**	
	C	**GDP**	**C**	**GDP**
Argentina	1875	1875		
Brazil	1901	1850		
Chile	1900	1860		
Colombia	1925*	1905		
India	1919*	1872		
Indonesia	1960*	1880		
Malaysia	1900*	1900†	1940-46	1943-46
Mexico	1900	1895		
Peru	1896	1896		
Philippines	1950*	1902††		1941-45
Singapore	1900*	1900†	1940-47	1940-49
South Africa	1946*	1911		
South Korea	1911	1911		
Sri Lanka	1960*	1870		
Taiwan	1901	1901		
Turkey	1923*	1923†		
Uruguay	1960*	1870		
Venezuela	1923*	1883		

Note: C represents real per capita personal consumer expenditure. GDP represents real per capita GDP. Missing values apply to period between country starting date and 2006. OECD is defined to exclude recent members and Turkey. Criterion for inclusion in samples is presence of continuous annual data back before World War I.

*Excluded from analysis for C sample because of insufficient coverage.
†Excluded from analysis for GDP sample because of insufficient coverage.
**Greece is included in the GDP sample with data for log(GDP) in 1944 interpolated between values for 1943 and 1945. This interpolation does not affect the estimated decline in GDP during World War II.
††The Philippines is included in part of the analysis of GDP data despite the gap in information for 1941-45. This gap does not prevent our estimating the cumulative contraction in GDP associated with World War II.

Table 2 Growth Rates of Consumer Expenditure and GDP Means and Standard Deviations by Country (since 1870 or later)				
	C		GDP	
	mean	s.d.	mean	s.d.
Part 1: OECD countries				
Australia	0.0154	0.0506	0.0159	0.0423
Austria	--	--	0.0217	0.0709
Belgium	0.0189	0.0904	0.0203	0.0838
Canada	0.0192	0.0474	0.0212	0.0511
Denmark	0.0163	0.0538	0.0190	0.0370
Finland	0.0239	0.0568	0.0237	0.0449
France	0.0162	0.0674	0.0191	0.0642
Germany	0.0189	0.0570	0.0212	0.0811
Greece*	--	--	0.0210	0.1013
Iceland	--	--	0.0254	0.0506
Italy	0.0173	0.0370	0.0213	0.0471
Japan	0.0261	0.0704	0.0277	0.0611
Netherlands	0.0190	0.0854	0.0188	0.0757
New Zealand	--	--	0.0143	0.0517
Norway	0.0194	0.0380	0.0231	0.0361
Portugal	0.0272	0.0448	0.0207	0.0431
Spain	0.0204	0.0727	0.0200	0.0453
Sweden	0.0208	0.0458	0.0230	0.0362
Switzerland	0.0150	0.0623	0.0150	0.0399
U.K.	0.0147	0.0283	0.0157	0.0293
U.S.	0.0185	0.0360	0.0217	0.0498
Part 2: Non-OECD countries				
Argentina	0.0189	0.0823	0.0164	0.0674
Brazil	0.0277	0.0780	0.0192	0.0507
Chile	0.0191	0.0905	0.0204	0.0596
Colombia	--	--	0.0236	0.0229
India	--	--	0.0140	0.0487
Indonesia	--	--	0.0160	0.0556
Mexico	0.0176	0.0655	0.0187	0.0421
Peru	0.0174	0.0463	0.0207	0.0482
South Africa	--	--	0.0130	0.0485
South Korea	0.0293	0.0689	0.0352	0.0743
Sri Lanka	--	--	0.0144	0.0455
Taiwan	0.0344	0.0872	0.0386	0.0807
Uruguay	--	--	0.0143	0.0787
Venezuela	--	--	0.0251	0.0893

Note: Growth rates are for real per capita personal consumer expenditure, C, and real per capita GDP. Countries included are those with full data from before World War I, as indicated in Table 1. Periods are from 1870 (or the later starting date with available data) through 2006. *Value of log(GDP) for Greece in 1944 is interpolated between values for 1943 and 1945.

Table 3 Growth Rates of Consumer Expenditure and GDP						
Means across Countries, Various Periods*						
	C			GDP		
Sample	**Number countries**	**mean of growth rates**	**mean of standard deviations**	**Number countries**	**mean of growth rates**	**mean of standard deviations**
OECD						
1870-1913	15	0.0141	0.0415	21	0.0141	0.0373
1914-1947	15	0.0111	0.0871	21	0.0145	0.0885
1948-2006	15	0.0266	0.0259	21	0.0287	0.0284
1870-2006	15	0.0187	0.0539	21	0.0205	0.0544
non-OECD						
1870-1913	6	0.0135	0.0837	11	0.0159	0.0668
1914-1947	6	0.0147	0.0886	11	0.0132	0.0704
1948-2006	6	0.0264	0.0544	11	0.0257	0.0436
1870-2006	6	0.0225	0.0750	11	0.0198	0.0606
All countries						
1870-1913	21	0.0140	0.0536	32	0.0147	0.0475
1914-1947	21	0.0121	0.0875	32	0.0140	0.0823
1948-2006	21	0.0265	0.0341	32	0.0276	0.0336
1870-2006	21	0.0198	0.0599	32	0.0202	0.0565

*Samples limited to countries from Table 1 with complete data on growth rates from 1904 or earlier, so that each country has at least ten observations for 1870-1913.

Note: Growth rates are for real per capita personal consumer expenditure, C, and real per capita GDP.

Table 4 Starting Dates for Real Rates of Return				
Part 1: OECD Countries				
Country	**Stocks**		**Bills**	**Bonds**
	Total Returns	**Stock Indexes**		
Australia	1883	1876	1862*	1862*
Austria	1970	1923 [1939-44]	1885* [1938-44]	1946
Belgium	1951	1898 [1914-18, 1940, 1944-46]	1849 [1945-46]	1836* [1945-46]
Canada	1934	1916	1903 [1914-34]	1880*
Denmark	1970	1915	1864	1822
Finland	1962	1923	1915*	1960
France	1896 [1940-41]	1857 [1940-41]	1841*	1841*
Germany	1870 [1917-23]	1841	1854	1924
Greece	1977	1929 [1941-52]	1915* [1944-45]	1993
Iceland	2003	1993	1988 [2004-07]	1993 [2004-07]
Italy	1925	1906	1868	1862
Japan	1921	1894	1883	1871
Netherlands	1951	1920 [1945-46]	1881*	1881*
New Zealand	1987	1927	1923	1926
Norway	1970	1915	1819	1877
Portugal	1989	1932 [1975-77]	1930*	1976
Spain	1941	1875 [1936-40]	1883	1941
Sweden	1919	1902	1857	1922
Switzerland	1967	1911 [1914-16]	1895	1916
U.K.†	1791	1791	1801	1791
U.S.	1801	1801	1836	1801

Part 2: Non-OECD Countries				
Country	Stocks		Bills	Bonds
	Total Returns	Stock Indexes		
Argentina	1988	1939 [1958-66]	1978	--
Brazil	1988	1955	1995	--
Chile	1983	1895	1864	--
Colombia	1988	1928	1986	--
India	1988	1921 [1926-27]	1874	1874*
Indonesia	1988	1925 [1940-77]	1970	--
Malaysia	1973	1974	1960	1961
Mexico	1988	1930	1962	1995
Peru	1993	1927	1985	--
Philippines	1982	1953	1950	1997
Singapore	1970	1966	1960	1988
South Africa	1961	1911	1936	1896
South Korea	1963	1963	1951	1957
Sri Lanka	1993	1953 [1975-84]	1951	--
Taiwan	1988	1968	1962	1990
Turkey	1987	1987	1973	1996
Uruguay	--	**	--	--
Venezuela	1988	1930††	1948	1984

Note: Years in brackets are missing data. Rates of return are computed on an arithmetic basis using end-of-year values of total-return indexes divided by consumer price indexes. Stock returns computed from stock-price indexes include rough estimates of dividend yields (or use actual dividend yields in some cases). Bill returns are from short-term government bills (maturity of three months or less) or, in some cases, for overnight rates, deposit rates, or central bank discount rates. Bond returns are typically for 10-year government bonds but sometimes for other maturities. Data are mostly from Global Financial Data. Stock-price indexes for Japan 1893-1914 are from Fujino and Akiyama (1977). Bill data for Colombia, Indonesia, and Peru are from IMF. In some cases, CPI data come from sources other than Global Financial Data.

*Starting date limited by missing CPI data.
**Uruguay has stock-price data starting in 1925 but no estimates of dividend yields.
†U.K. data before 1790 were not used. U.K. bond data are for consols up to 1932 and 10-year government bonds thereafter.
††January 1942 stock-price index used to approximate year-end value for 1941.

Table 5 Long-Period Averages of Rates of Return						
Country	**Start**	**Stocks**	**Bills**	**Start**	**Bonds**	**Bills**
Part 1: OECD countries						
Australia	1876	0.1027 (0.1616)	0.0126 (0.0566)	1870	0.0352 (0.1157)	0.0125 (0.0569)
Belgium	--	--	--	1870	0.0291 (0.1584)**	0.0179 (0.1447)**
Canada	1916	0.0781 (0.1754)	--	1916	0.0392 (0.1199)	--
Denmark	1915	0.0750 (0.2300)	0.0265 (0.0652)	1870	0.0392 (0.1137)	0.0317 (0.0588)
Finland	1923	0.1268 (0.3155)	0.0128 (0.0935)	--	--	--
France	1870	0.0543 (0.2078)*	-0.0061 (0.0996)*	1870	0.0066 (0.1368)	-0.0079 (0.1000)
Germany	1870	0.0758 (0.2976)	-0.0153 (0.1788)	1924	0.0402 (0.1465)	0.0158 (0.1173)
Italy	1906	0.0510 (0.2760)	-0.0112 (0.1328)	1870	0.0173 (0.1879)	0.0046 (0.1191)
Japan	1894	0.0928 (0.3017)	-0.0052 (0.1370)	1883	0.0192 (0.1820)	0.0043 (0.1475)
Netherlands	1920	0.0901 (0.2116)**	0.0114 (0.0474)**	1881	0.0308 (0.1067)	0.0118 (0.0512)
New Zealand	1927	0.0762 (0.2226)	0.0234 (0.0529)	1926	0.0276 (0.1209)	0.0240 (0.0529)
Norway	1915	0.0716 (0.2842)	0.0098 (0.0782)	1877	0.0280 (0.1130)	0.0204 (0.0709)
Spain	1883	0.0610 (0.2075)†	0.0173 (0.0573)†	--	--	--
Sweden	1902	0.0923 (0.2347)	0.0180 (0.0719)	1922	0.0292 (0.0941)	0.0176 (0.0448)
Switzerland	1911	0.0726 (0.2107)††	0.0083 (0.0531)††	1916	0.0218 (0.0717)	0.0065 (0.0545)
U.K.	1870	0.0641 (0.1765)	0.0179 (0.0624)	1870	0.0280 (0.1049)	0.0179 (0.0624)
U.S.	1870	0.0827 (0.1866)	0.0199 (0.0482)	1870	0.0271 (0.0842)	0.0199 (0.0482)
Part 2: Non-OECD countries						
Chile	1895	0.1430 (0.4049)	-0.0094 (0.1776)	--	--	--
India	1921	0.0514 (0.2341)***	0.0133 (0.0835)***	1874	0.0191 (0.1147)	0.0240 (0.0785)
South Africa	1911	0.0890 (0.2006)	--	1911	0.0248 (0.1165)	--
Overall means†††	--	0.0814 (0.2449)	0.0085 (0.0880)	--	0.0266 (0.1234)	0.0147 (0.0805)

*missing 1940-41, **missing 1945-46, †missing 1936-40, ††missing 1914-16, ***missing 1926-27
†††Averages of means and standard deviations for 17 countries with stock and bill data and 15 countries with bond and bill data

Notes: See notes to Table 4. Standard deviations are in parentheses. Columns for stocks and bills are for common samples with the indicated starting date. Columns for bonds and bills are for common samples with the indicated starting date. End dates are 2006.

Table 6
Consumption Disasters Grouped by Events/Periods

Pre-1914 [21, 0.16]

OECD [11, 0.15]. Canada 2 (0.15, 0.11), Finland (0.10), France (0.16), Netherlands (0.10), Spain (0.18), Switzerland 5 (0.19, 0.22, 0.14, 0.14, 0.16).

Non-OECD [10, 0.16]. Argentina 5 (0.12, 0.28, 0.20, 0.13, 0.12), Brazil 2 (0.15, 0.16), Peru (0.12), Taiwan 2 (0.22, 0.13).

World War I (includes non-combatants) [20, 0.24]

OECD [14, 0.26]. Australia (0.24), Austria (0.45), Belgium (0.45), Canada (0.13), Finland (0.36), France (0.22), Germany (0.42), Netherlands (0.44), Norway (0.17), Portugal (0.22), Spain (0.13), Sweden (0.12), Switzerland (0.11), U.K. (0.17).

Non-OECD [6, 0.18]. Argentina (0.17), Brazil (0.11), Chile (0.32), Malaysia (0.10), Mexico (0.25), Singapore (0.14).

1920s [11, 0.18]

OECD [6, 0.17]. Canada (0.20), Denmark (0.24), Germany (0.13), Norway (0.16), Sweden (0.13), U.S. (0.16).

Non-OECD [5, 0.20]. Brazil (0.15), Chile (0.18), Malaysia (0.42), Mexico (0.12), Singapore (0.13).

Great Depression (early 1930s) [18, 0.21]

OECD [7, 0.19]. Australia (0.23), Austria (0.22), Canada (0.23), Finland (0.20), Germany (0.12), Spain (0.10), U.S. (0.21).

Non-OECD [11, 0.22]. Argentina (0.19), Brazil (0.20), Chile (0.37), Colombia (0.18), India (0.22), Malaysia (0.26), Mexico (0.31), Peru (0.14), Singapore (0.10), Turkey (0.12), Venezuela (0.31).

Spanish Civil War (includes non-combatant) [2, 0.29]

OECD [2, 0.29]. Portugal (0.12), Spain (0.46).

Late 1930s [1, 0.11]

Non-OECD [1, 0.11]. Venezuela (0.11).

World War II (includes non-combatants) [23, 0.34]

OECD [17, 0.34]. Australia (0.30), Austria (0.44), Belgium (0.53), Denmark (0.26), Finland (0.25), France (0.58), Germany (0.41), Greece (0.64), Italy (0.29), Japan (0.64), Netherlands (0.54), Norway (0.10), Portugal (0.10), Spain (0.14), Sweden (0.18), Switzerland (0.17), U.K. (0.17).

Non-OECD [6, 0.34]. Colombia (0.23), India (0.13), Malaysia (0.34), South Korea (0.39), Taiwan (0.68), Turkey (0.30).

post-WWII [38, 0.18]

OECD [9, 0.14]. Denmark (0.14), Finland (0.14), Greece (0.11), Iceland 4 (0.25, 0.12, 0.11, 0.18), Portugal (0.10), Spain (0.13).

Non-OECD [29, 0.19]. Argentina 4 (0.10, 0.10, 0.16, 0.25), Brazil (0.16), Chile 3 (0.14, 0.40, 0.33), Colombia (0.10), India (0.18), Malaysia 3 (0.12, 0.14, 0.12), Mexico 2 (0.16, 0.11), Peru 2 (0.18, 0.30), Singapore 2 (0.16, 0.12), South Korea 2 (0.37, 0.14), Turkey (0.11), Uruguay 3 (0.10, 0.27, 0.22), Venezuela 4 (0.20, 0.22, 0.32, 0.15).

Note: These calculations are based on Table A1. Numbers in brackets show numbers of countries and average fractional decline in C for each group. Numbers in parentheses show fractional declines in C during each crisis.

Table 7
GDP Disasters Grouped by Events/Periods

Pre-1914 [45, 0.16]

OECD [19, 0.15]. Australia (0.27), Canada (0.12), Finland (0.12), France 3 (0.10, 0.10, 0.13), Greece 6 (0.11, 0.15, 0.23, 0.15, 0.14, 0.42), Iceland (0.12), New Zealand 2 (0.17, 0.11), Spain (0.12), Switzerland (0.16), U.S. 2 (0.10, 0.10).

Non-OECD [26, 0.17]. Argentina 3 (0.19, 0.22, 0.15), Brazil 3 (0.10, 0.26, 0.14), Chile (0.11), India 2 (0.15, 0.10), Malaysia (0.10), Philippines (0.16), Singapore 2 (0.21, 0.34), Sri Lanka 2 (0.16, 0.14), Taiwan 2 (0.21, 0.11), Uruguay 6 (0.27, 0.15, 0.14, 0.20, 0.16, 0.12), Venezuela 3 (0.24, 0.22, 0.13).

World War I (includes non-combatants) [27, 0.21]

OECD [14, 0.24]. Australia (0.12), Austria (0.38), Belgium (0.48), Denmark (0.16), Finland (0.35), France (0.29), Germany (0.36), Greece (0.18), Iceland (0.22), Netherlands (0.26), New Zealand (0.11), Norway (0.15), Sweden (0.15), Switzerland (0.19).

Non-OECD [13, 0.17]. Argentina (0.29), Chile 2 (0.10, 0.13), India (0.15), Mexico (0.12), Philippines (0.12), Singapore 2 (0.17, 0.24), South Africa (0.23), South Korea (0.11), Sri Lanka (0.14), Uruguay (0.28), Venezuela (0.17).

1920s [15, 0.18]

OECD [11, 0.16]. Canada (0.30), Germany (0.14), Greece (0.24), Iceland (0.16), Italy (0.22), New Zealand (0.12), Norway (0.11), Portugal (0.11), Sweden (0.11), U.K. (0.19), U.S. (0.12).

Non-OECD [4, 0.22]. Singapore (0.39), South Africa (0.24), Turkey (0.13), Uruguay (0.14).

Great Depression (early 1930s) [22, 0.22]

OECD [9, 0.21]. Australia (0.22), Austria (0.24), Belgium (0.12), Canada (0.35), France (0.19), Germany (0.28), Netherlands (0.13), Spain (0.10), U.S. (0.29).

Non-OECD [13, 0.23]. Argentina (0.20), Brazil (0.20), Chile (0.36), Indonesia (0.11), Malaysia (0.19), Mexico (0.31), Peru (0.26), Philippines (0.13), Singapore (0.41), Sri Lanka (0.15), Turkey (0.12), Uruguay (0.37), Venezuela (0.16).

Spanish Civil War (includes non-combatant) [2, 0.23]

OECD [2, 0.23]. Portugal (0.15), Spain (0.31).

Late 1930s [3, 0.12]

Non-OECD [3, 0.12]. Malaysia (0.12), Singapore (0.15), South Korea (0.10).

World War II (includes non-combatants) [25, 0.36]

OECD [14, 0.37]. Australia (0.14), Austria (0.59), Belgium (0.45), Denmark (0.24), Finland (0.10), France (0.41), Germany (0.74), Greece (0.66), Italy (0.41), Japan (0.50), Netherlands (0.52), Norway (0.19), Sweden (0.10), Switzerland (0.13).

Non-OECD [11, 0.35]. India (0.12), Indonesia (0.54), Malaysia 2 (0.24, 0.36), Philippines (0.57), South Korea (0.48), Sri Lanka (0.21), Taiwan (0.66), Turkey (0.40), Uruguay (0.14), Venezuela (0.16).

post-WWII [30, 0.17]

OECD [6, 0.13]. Finland (0.12), Iceland (0.14), New Zealand 2 (0.12, 0.10), U.K. (0.15), U.S. (0.16).

Non-OECD [24, 0.17]. Argentina 4 (0.10, 0.11, 0.14, 0.22), Brazil (0.11), Chile 2 (0.24, 0.18), Indonesia (0.16), Mexico (0.13), Peru 3 (0.10, 0.14, 0.32), Philippines (0.19). Singapore 2 (0.34, 0.11), South Africa 2 (0.11, 0.10), South Korea (0.15), Uruguay 3 (0.12, 0.24, 0.19), Venezuela 3 (0.15, 0.30, 0.26).

Note: These calculations are based on Table A2. Numbers in brackets show numbers of countries and average fractional decline in GDP for each group. Numbers in parentheses show fractional declines in GDP during each crisis.

Table 8 Matched C and GDP Contractions				
Part 1: OECD countries				
Country	**C contraction**		**GDP contraction**	
	Trough year	**Size**	**Trough year**	**Size**
Australia	**1918**	0.238	**1918**	0.118
	1932	0.234	1931	0.221
	1944	0.301	**1946**	0.145
Belgium	**1917**	0.445	**1918**	0.477
	1934	0.092	1934	0.117
	1942	0.530	**1943**	0.453
Canada	1876	0.152	1878	0.117
	1908	0.113	1908	0.078
	1915	0.130	**1914**	0.095
	1921	0.196	1921	0.301
	1933	0.230	1933	0.348
Denmark	**1917**	0.074	**1918**	0.160
	1921	0.241	1921	0.042
	1941	0.261	**1941**	0.239
	1948	0.144	1945	0.087
Finland	1892	0.102	1892	0.075
	1918	0.360	**1918**	0.353
	1932	0.199	1932	0.062
	1944	0.254	**1940**	0.103
	1993	0.140	1993	0.124
France	**1871**	0.158	**1870**	0.095
	1878	0.085	1879	0.102
	1884	0.085	1886	0.133
	1915	0.215	**1918**	0.289
	1936	0.062	1935	0.187
	1943	0.580	**1944**	0.414
Germany	**1918**	0.425	**1919**	0.357
	1923	0.127	1923	0.135
	1932	0.121	1932	0.280
	1945	0.412	**1946**	0.736
Italy	1919	0.026	1920	0.221
	1945	0.286	**1945**	0.413
Japan	**1945**	0.639	**1944**	0.503
Netherlands	1893	0.098	1893	0.062
	1918	0.440	**1918**	0.258
	1935	0.045	1934	0.129
	1944	0.545	**1944**	0.525
Norway	**1918**	0.169	**1918**	0.148
	1921	0.161	1921	0.110
	1944	0.100	**1944**	0.193

Table 8, part 1, continued				
Country	**C contraction**		**GDP contraction**	
	Trough year	**Size**	**Trough year**	**Size**
Portugal	1919	0.215	1918	0.086
	1928	0.062	1928	0.109
	1936	0.121	1936	0.148
	1942	0.104	1945	0.048
	1976	0.098	1975	0.085
Spain	1896	0.182	1896	0.119
	1915	0.128	1918	0.038
	1930	0.101	1933	0.096
	1937	0.461	**1938**	0.313
	1945	0.145	1945	0.084
	1949	0.131	1949	0.013
Sweden	1917	0.115	1918	0.150
	1921	0.132	1921	0.108
	1945	0.182	1941	0.095
Switzerland	1872	0.190	1870	0.052
	1878	0.225	1879	0.161
	1883	0.142	1883	0.065
	1886	0.141	1887	0.003
	1888	0.157	1887	0.003
	1918	0.108	1918	0.191
	1945	0.173	1942	0.126
U.K.	**1918**	0.167	**1918**	-0.022
	1921	0.005	1921	0.192
	1943	0.169	**1943**	-0.014
	1948	0.001	1947	0.148
U.S.	1908	0.037	1908	0.105
	1915	0.046	1914	0.095
	1921	0.164	1921	0.118
	1933	0.208	1933	0.290
	1947	0.001	1947	0.165
OECD total (70) mean		0.190		0.174
OECD war (23) mean		0.320		0.276
OECD non-war (47) mean		0.126		0.124

Table 8, Part 2: non-OECD countries				
Country	**C contraction**		**GDP contraction**	
	Trough year	**size**	**Trough year**	**size**
Argentina	1891	0.123	1891	0.189
	1898	0.283	1897	0.219
	1900	0.195	1900	0.147
	1902	0.127	1902	0.049
	1907	0.123	1907	0.025
	1917	0.172	1917	0.289
	1932	0.189	1932	0.195
	1959	0.101	1959	0.101
	1982	0.104	**1982**	0.111
	1990	0.160	1990	0.141
	2002	0.249	2002	0.220
Brazil	1905	0.148	1904	0.040
	1909	0.157	1908	0.061
	1919	0.109	1918	0.044
	1921	0.147	1921	0.002
	1931	0.201	1931	0.201
	1990	0.163	1992	0.110
Chile	1903	0.048	1903	0.111
	1915	0.322	1915	0.105
	1922	0.181	1919	0.126
	1932	0.374	1932	0.361
	1956	0.136	1956	0.038
	1976	0.401	**1975**	0.240
	1985	0.327	1983	0.180
Mexico	**1916**	0.252	**1915**	0.119
	1924	0.118	1924	0.032
	1932	0.311	1932	0.258
	1988	0.161	1988	0.128
	1995	0.113	1995	0.080
Peru	1914	0.118	1914	0.019
	1932	0.140	1932	0.258
	1979	0.179	1979	0.104
	1983	0.075	1983	0.136
	1992	0.300	1992	0.325
South Korea	1920	0.066	1919	0.111
	1939	0.068	**1939**	0.104
	1945	0.387	**1945**	0.480
	1952	0.371	**1951**	0.151
	1998	0.143	1998	0.078

Table 8, part 2, continued				
Taiwan	**1905**	0.219	**1905**	0.214
	1911	0.127	1911	0.114
	1945	0.684	**1945**	0.662
non-OECD total (42) mean		0.199		0.159
non-OECD war (8) mean		0.311		0.260
non-OECD non-war (34) mean		0.173		0.135
Full sample total (112) mean		0.194		0.168
Full sample war (31) mean		0.318		0.272
Full sample non-war (81) mean		0.146		0.129

Timing breakdowns for trough years
OECD
Total 70: 35 same year, 16 C later, 19 GDP later
War 23: 10 same year, 4 C later, 9 GDP later
Non-war 47: 25 same year, 12 C later, 10 GDP later
non-OECD
Total 42: 31 same year, 10 C later, 1 GDP later
War 8: 5 same year, 3 C later, 0 GDP later
Non-war 34: 26 same year, 7 C later, 1 GDP later
Total
Total 112: 66 same year, 26 C later, 20 GDP later
War 31: 15 same year, 7 C later, 9 GDP later
Non-war 81: 51 same year, 19 C later, 11 GDP later

Note: We consider here only the 17 OECD and 7 non-OECD countries that are in our full samples for personal consumer expenditure, C, and GDP. Contractions in C and GDP of size 0.10 or more come from Tables A1 and A2 (with additions from underlying data for cases where C or GDP contractions were of magnitude less than 0.10). The C and GDP contractions are matched by trough years (the same or nearby). Bold for trough year indicates participation as combatant in war. The timing breakdowns compare the trough years for C and GDP as to whether they are the same, C comes later, or GDP comes later.

Table 9 Simulated Model based on C Disasters (r^f=0.01 in all cases)										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Specification	**no. disasters**	**no. disaster-years**	**p**	**π**	**Eb**	**$E(1\text{-}b)^{-\gamma}$**	**$E(1\text{-}b)^{1-\gamma}$**	**ρ**	**ρ***	**r^e**
baseline (b≥0.10, γ=3.5)	95	343	0.0363	0.277	0.219	3.88	2.34	0.045	0.029	0.059
γ=3.0	95	343	0.0363	0.277	0.219	2.96	1.90	0.029	0.008	0.042
OECD	57	214	0.0286	0.266	0.223	3.87	2.37	0.034	0.007	0.048
non-OECD	38	129	0.0604	0.295	0.214	3.89	2.29	0.080	0.100	0.095
b≥0.15	59	252	0.0218	0.234	0.278	5.28	2.92	0.042	0.018	0.057
b≥0.20	36	163	0.0129	0.221	0.345	7.41	3.75	0.038	0.007	0.054
b≥0.30	20	99	0.0070	0.202	0.431	11.25	5.17	0.035	-0.003	0.051
b≥0.40	11	60	0.0038	0.183	0.506	16.90	7.07	0.031	-0.015	0.047
non-war	66	208	0.0240	0.317	0.168	2.01	1.63	0.004	-0.051	0.016
non-war, γ=9	66	208	0.0240	0.317	0.168	7.70	5.87	0.037	-0.038	0.053
HP-filtered	43	271	0.0167	0.159	0.232	3.68	2.35	0.016	-0.030	0.030
HP-filtered, γ=4.5	43	271	0.0167	0.159	0.232	6.18	3.68	0.034	-0.012	0.050

Note: The baseline simulation uses the 95 consumption disasters of size b≥0.10 for the 24 included countries from Table A1. The calibrated parameters (expected normal growth rate, g=0.025; standard deviation of normal fluctuations, σ=0.02; reciprocal of intertemporal elasticity of substitution, θ=0.5) are discussed in the text, with the coefficient of relative risk aversion, γ, set at 3.5. For subsequent rows, the entry in column 1 shows how the specification differs from that for the baseline case. Column 2 shows the number of disasters in the selected sample, and column 3 shows the number of disaster-years for this sample. Column 4 shows the estimated probability per year, p, for moving from normalcy to disaster, and column 5 shows the estimated probability per year, π, for moving from disaster to normalcy. Eb in column 6 is the mean disaster size. $E(1\text{-}b)^{-\gamma}$ and $E(1\text{-}b)^{1-\gamma}$ in columns 7 and 8, respectively, are the mean values of these key determinants of the equity premium (from Eq. [8]). ρ in column 9 is the rate of time preference, and ρ* in column 10 is the effective rate of time preference, given in Eq. (5). The values of ρ and ρ* are chosen to generate r^f=0.01 in Eq. (7). r^e in column 11 is the overall expected rate of return on unlevered equity (from Eq. [6]).

Table 10 Simulated Model based on GDP Disasters (r^f=0.01 in all cases)										
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Specification	**no. disasters**	**no. disaster-years**	**p**	**π**	**Eb**	**$E(1-b)^{-\gamma}$**	**$E(1-b)^{1-\gamma}$**	**ρ**	**ρ***	**r^e**
baseline (b≥0.10, γ=3.5)	152	530	0.0369	0.287	0.207	4.03	2.31	0.052	0.037	0.067
γ=3.0	152	530	0.0369	0.287	0.207	2.99	1.86	0.032	0.010	0.045
OECD	75	263	0.0287	0.285	0.221	4.96	2.60	0.057	0.039	0.073
non-OECD	77	267	0.0509	0.288	0.194	3.13	2.04	0.043	0.033	0.057
b≥0.15	83	320	0.0192	0.259	0.278	6.08	3.09	0.048	0.022	0.063
b≥0.20	54	229	0.0122	0.236	0.338	8.31	3.90	0.045	0.014	0.061
b≥0.30	24	115	0.0053	0.209	0.453	15.32	6.23	0.041	0.001	0.057
b≥0.40	14	69	0.0031	0.203	0.532	23.13	8.63	0.038	-0.007	0.054
non-war	112	370	0.0261	0.303	0.168	2.02	1.64	0.005	-0.048	0.017
non-war, γ=9	112	370	0.0261	0.303	0.168	7.91	6.01	0.042	-0.018	0.059
HP-filtered	70	446	0.0174	0.160	0.224	4.08	2.42	0.022	-0.022	0.036
HP-filtered, γ=4.0	70	446	0.0174	0.160	0.224	5.55	3.09	0.035	-0.008	0.050

Note: The baseline simulation uses the 152 GDP disasters of size b≥0.10 for the 36 included countries from Table A2. See the notes to Table 9 for discussion and definitions.

Table 11 Simulated Model Using Stock-Price Changes during Crises				
	C-crises		**GDP-crises**	
Crisis sample	**All with stock data**	**Stock-price decreases**	**All with stock data**	**Stock-price decreases**
N: number of observations	54	42	72	55
γ: coefficient of relative risk aversion	3.5	3.5	3.5	3.5
ρ*: effective time-preference rate (Eq. [5])	0.029	0.029	0.037	0.037
g: normal growth rate	0.025	0.025	0.025	0.025
$(1+g)^{-\gamma}$	0.917	0.917	0.917	0.917
p: disaster probability	0.0363	0.0363	0.0369	0.0369
***Stock-returns*:**				
$E(R_t–1)$: overall mean (Table 5)	0.0829	0.0829	0.0829	0.0829
$E(R_t–1)$: mean in crisis sample	-0.0864	-0.3272	-0.1655	-0.3759
$E[R_t\cdot(1-b)^{-\gamma}]$: mean in crisis sample	3.446	1.964	3.545	3.235
***Model simulation*:**				
$E(R_t–1)$: implied non-crisis*	0.035	0.090	0.038	0.050
$E(R_t–1)$: implied overall mean**	0.029	0.075	0.031	0.034

*Based on approximate formula derived from Eqs. (2)-(4) (neglecting the effects from normal fluctuations, σ):

$$1+\rho^* \approx (1+g)^{-\gamma}\cdot\{p\cdot E[R_t\cdot(1-b)^{-\gamma}]_{|crisis} + (1-p)\cdot(ER_t)_{|non\text{-}crisis}\}$$

**Based on the formula:

$$E(R_t) = p\cdot(ER_t)_{|crisis} + (1-p)\cdot(ER_t)_{|non\text{-}crisis}$$

b

Note: The parameters γ, ρ*, g, and p come from Tables 9 and 10. Stock-price changes during crises are in Tables A1 and A2. The four crisis samples used are C-crises with data on stock-price changes (N=54), C-crises with stock-price decreases (N=42), GDP-crises with data on stock-price changes (N=72), and GDP-crises with stock-price decreases (N=55). "$E(R_t–1)$: mean in crisis sample" is the mean for each crisis sample of the fractional change in real stock prices. "$E[R_t\cdot(1-b)^{-\gamma}]$: mean in crisis sample" is the mean for each crisis sample of the interaction between (1+fractional change in real stock prices) and $(1-b)^{-\gamma}$, where b is the fractional decline in C or GDP.

Table 12 Bill Returns and Inflation Rates during Crises		
C crises		
	mean	**median**
Real rate of return on bills (N=58)	-0.051	-0.023
Inflation rate (N=87)	1.13	0.066
GDP crises		
Real rate of return on bills (N=73)	-0.052	-0.021
Inflation rate (N=123)	0.961	0.069

Note: The results apply to the crisis samples used in the main analysis: 95 C crises from Table A1 and 152 GDP crises from Table A2. Data for real rates of return on bills and inflation rates are for the sub- samples that also have data on bill returns or inflation rates, as indicated in Tables A1 and A2. The cells show means and medians of real rates of return on bills and inflation rates for these sub-samples.

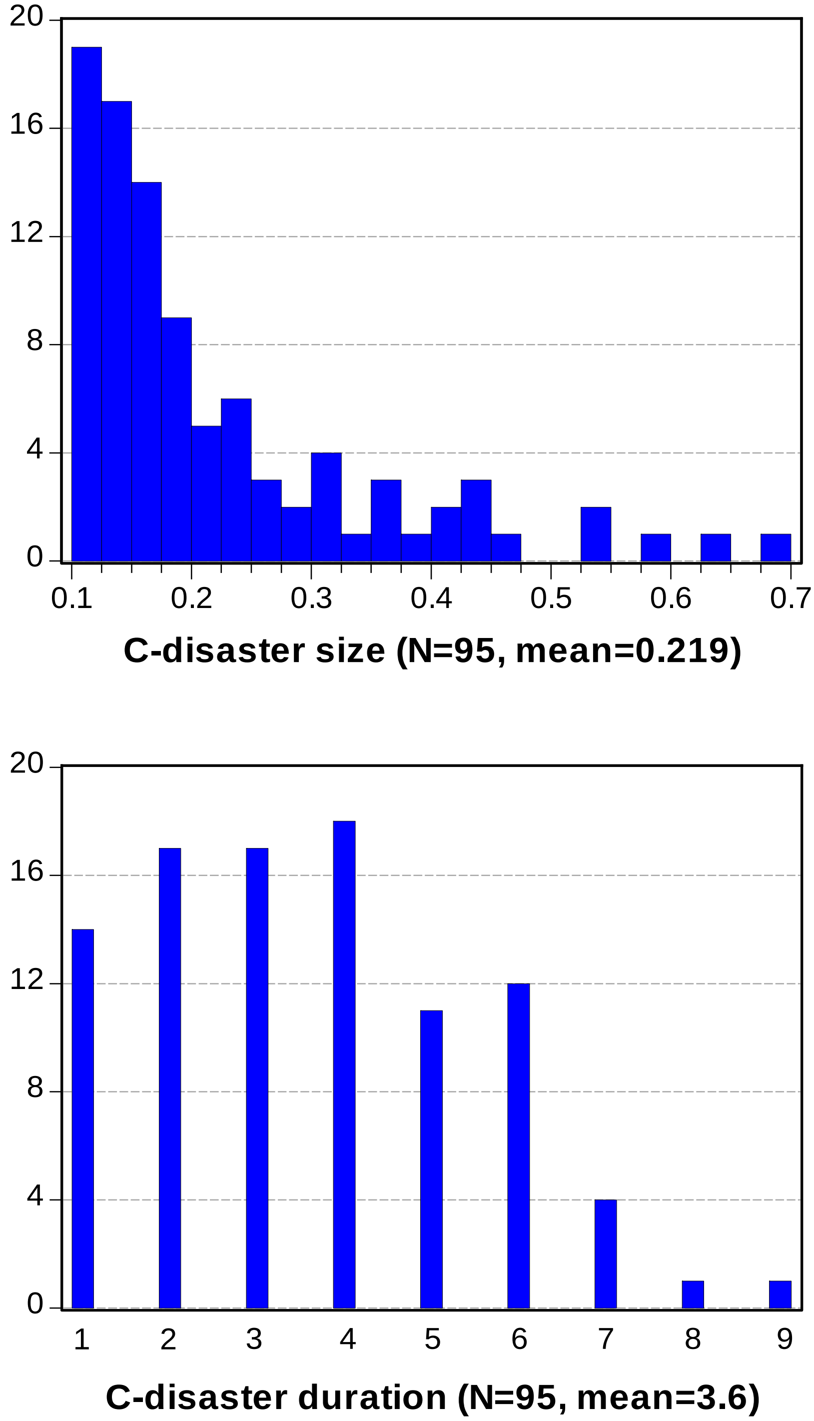


Figure 1 C-Disaster Sizes and Durations (Years)

Note: Histograms show distributions of consumption disaster sizes (fractional declines) and durations (years between trough and peak) for 95 cases for included countries from Table A1.

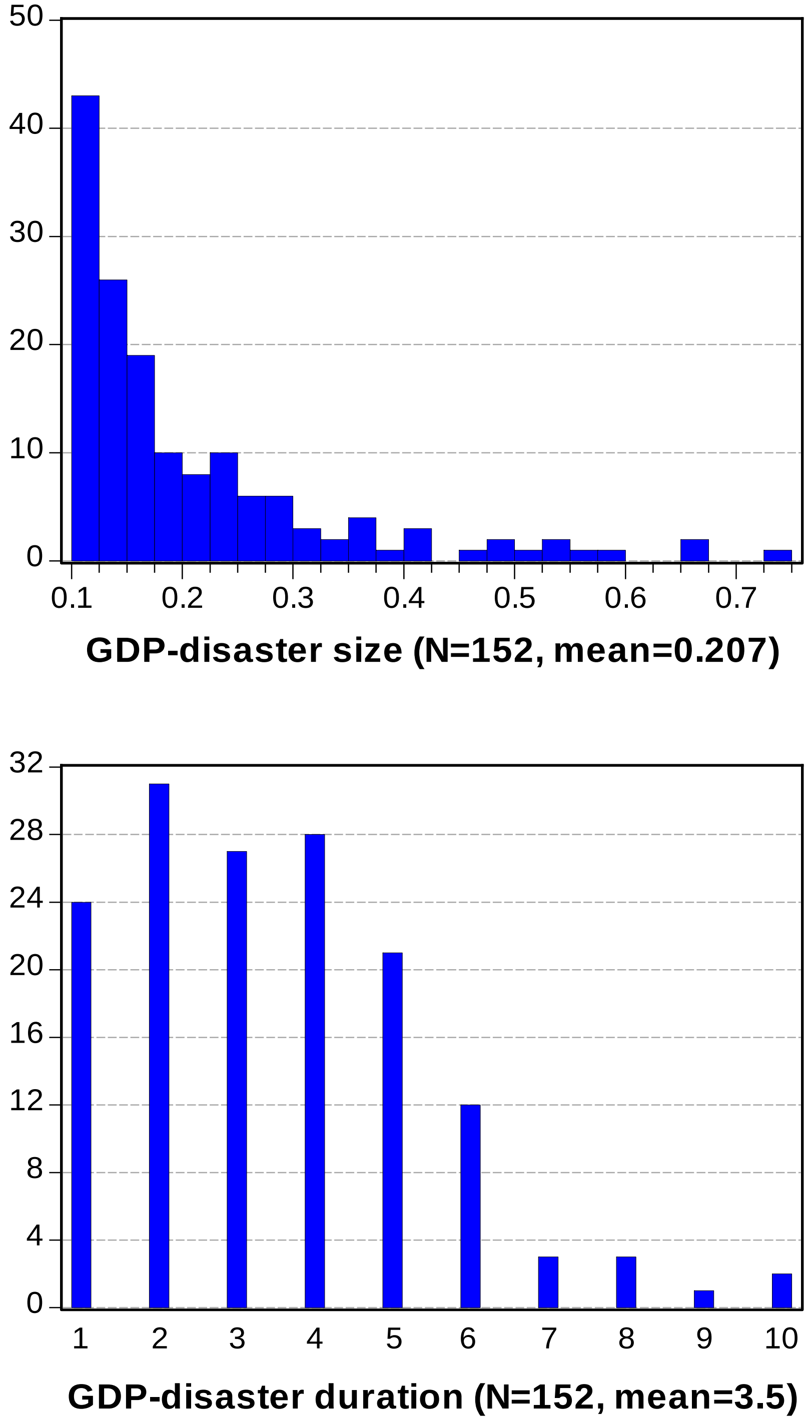


Figure 2 GDP-Disaster Sizes and Durations (Years)

Note: Histograms show distributions of GDP disaster sizes (fractional declines) and durations (years between trough and peak) for 152 cases for included countries from Table A2.

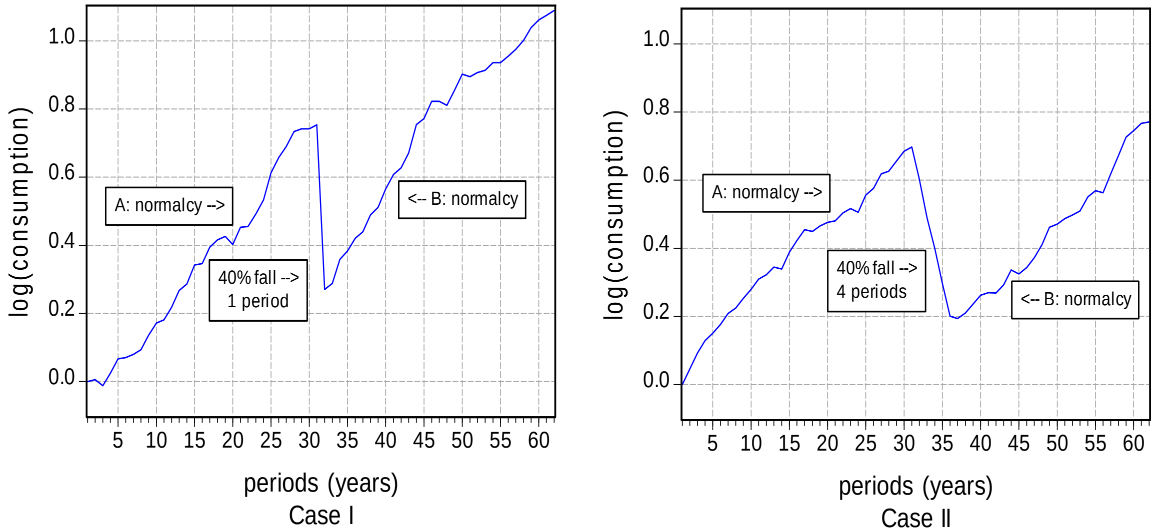


Figure 3

Paths of Consumption with Different Durations of Crises

Note: In Case I, a crisis entails a 40% decline in C over 1 period. In Case II, a crisis entails a 40% decline in C stretched over 4 periods. The normalcy periods (A and B in each panel) are generated by assuming mean growth of 0.025 per year with normally distributed shocks that have a standard deviation of 0.02 per year. The paths shown, meant only to be illustrative, reflect different realizations of random numbers in each case.

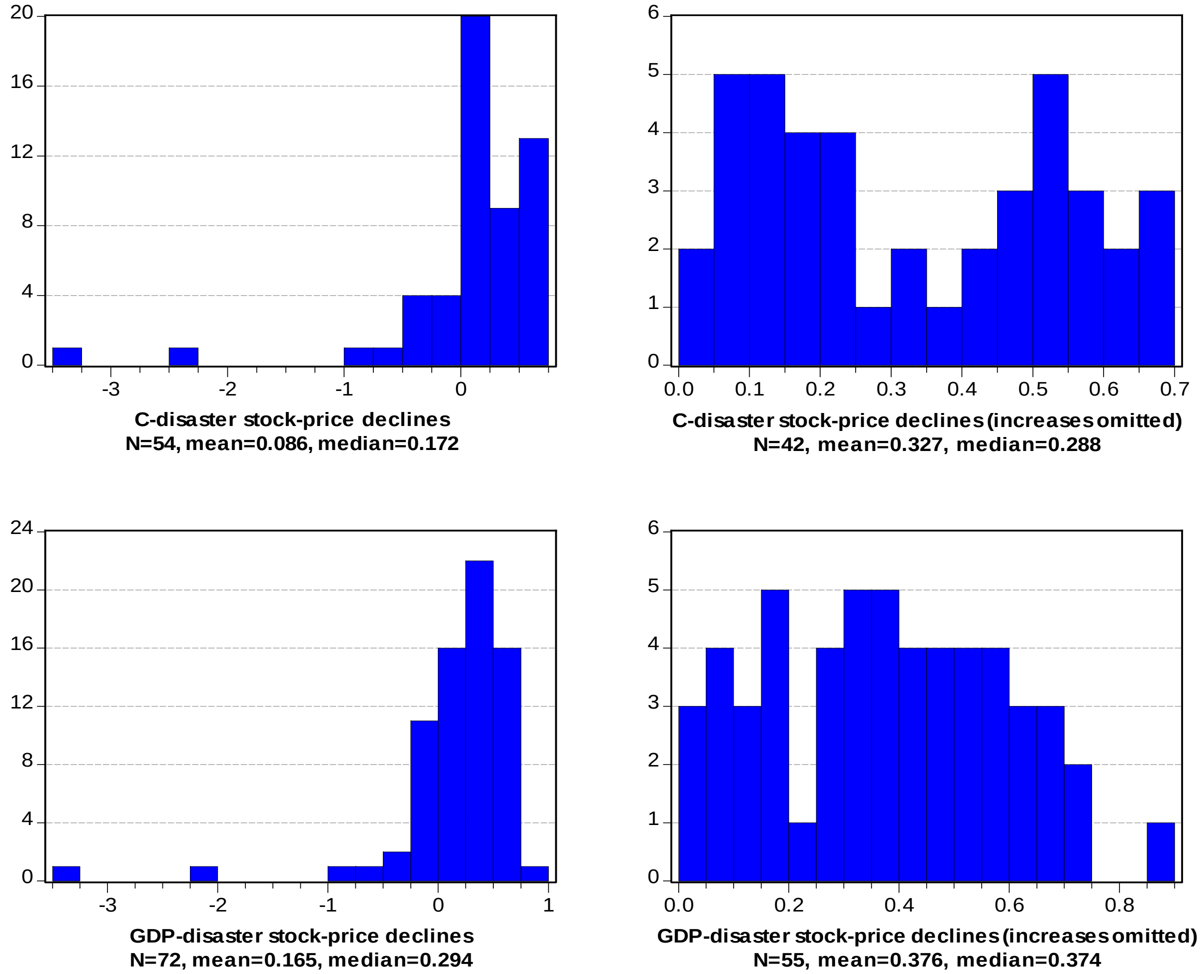


Figure 4

Stock-Price Decreases during Disasters

(horizontal axes show fractional declines in real value)

Note: The sample for consumption, C, disasters is the 54 of 95 cases for included countries from Table A1 with data on stock-price changes. The sample for GDP disasters is the 72 of 152 cases for included countries from Table A2 with data on stock-price changes. We exclude cases in which missing data cause the period for stock-price changes to deviate from that for the declines in C or GDP. A negative number on the horizontal axes in the left-hand panels indicates that real stock prices rose.

Appendix I

Main differences between Maddison's GDP Data and our GDP data

	Focus Period:	In Maddison (updated version):	Our approach:
Argentina	Late 19th C. [1870-1900]	Benchmark values provided only for 1870 and 1890; apparently calculated by assuming same growth rates as in 1900-1913.	Used various sources, including recently published series based on sectoral output for earlier decades (including agriculture, mining, manufacturing, energy, construction, trade, transports, and services). Sufficient coverage allows starting the series in 1875.
Austria	WWII [1944-1946]	Indicated source does not contain figure for 1945; estimation procedure is undisclosed.	Estimated growth rates for the years 1944-1946 using a weighted average of indexes of industrial production and livestock production (as proxy for the agricultural sector); estimates were constrained to fit the growth rate between benchmark values provided in the original source.
	19th-20th C.	Adjusted the series to present day boundaries of Austria.	Followed the criterion explained in the main text for territorial adjustment; output measures corresponding to the Austro-Hungarian Empire were used up to 1918 and to Austria from then onwards.
Brazil	19th-20th C. [1850-1890]	Presents a linear trend for 1870-1890 (divergence with respect to source is unexplained). Missing 1851-1869.	Constructed a continuous series starting in 1850 combining various sources, among them the most recent revision of Brazilian GDP for the 20th Century that is currently available and which differs from the earlier estimates used in Maddison's series.
Belgium	WWI [1914-1919]	Assumed to move as in France.	Estimated based on the weighted movement in production of carbon, cast iron, steel, and proxies for agricultural output in the form of available cattle and imported malt for breweries. Trends were matched with productivity data in the carbon industry, number of metallurgical facilities in operation, and unemployment figures.
	WWII [1939-1947]	Assumed to move as in France.	Estimated based on benchmark values constructed using data on industrial activity indexes, the production of carbon, steel and electricity, in combination with transports data. When industrial data were missing, information on railroads, vehicles, merchandise and travelers transports, among other communications indicators, were weighted to connect benchmark values.
Colombia	[1901-1912]	Interpolated with average movement in Brazil and Chile.	Used actual GDP estimates for Colombia starting from 1905 and constructed from the production side.
Denmark	19th-20th C.	Starts 1820; territorial adjustment to eliminate impact of North Schleswig.	Chose a different combination of sources (series starts in 1818). Territorial adjustment to follow criterion explained in main text.

Appendix I (cont.)	**Focus Period:**	**In Maddison (updated version):**	**Our approach:**
France	19th-20th C. (WWI & WWII)	Interpolated between 1913 and 1920 based on figures of industrial and agricultural output (assuming services remained stable). Interpolated 1938-1949 using information from a separate report on national income.	A different set of sources was chosen to have GDP measures be consistent with the Private Consumption series that would be built in parallel. More recent and revised measures of the evolution of output during WWI and WWII were preferred. These are refinements of the official series produced by the French Institute of Statistics and Economics.
Germany	WWII [1944-1946]	Assumed 1945 lay midway between 1944 and 1946; figures for these two years were linked from originally unconnected sources.	Used level-comparable anchor values for 1944 and 1946. Estimated changes for 1945 and 1946 based on recently published data on industrial production for West and East Germany, in combination with data on agricultural output (crops and livestock).
	19th-20th C.	Baseline series is adjusted to fit borders in three points in time.	Followed the criterion explained in the main text for territorial adjustment, i.e. smooth pasting of per capita growth rates during transition years of separation and unification.
Greece	19th-20th C. [1914-1920]	Five benchmark values are given for 1820-1921 (missing 1914-1920). Apparently, as in an older but continuous version of Maddison's series, these benchmarks are assumed to follow the aggregate for Eastern Europe.	Used a continuous and longer time series based on new estimates developed by a group of researchers from the Centre for Planning and Economic Research together with the Historical Archives of the National Bank of Greece, based on output in primary, secondary, and tertiary activities, sectoral weights, price deflators and measures of money supply.
	WWII [1938-1950]	Mismatch with indicated source, which seems to contain only benchmark values for 1938 and 1947; estimation for the years in between is undisclosed.	Estimated the evolution between the two benchmark years by appropriately weighting data on industrial production and agricultural production (including crops and animals), which were calibrated to match the observed evolution of aggregate GDP during overlapping years. Absolute lack of data does not allow building an estimate for 1944.
Iceland	19th-20th C.	Not considered separately, but as part of an aggregate of countries whose pre-1950 growth rates are assumed to equal the averages of larger Western European countries.	Considered as a separate country; combined sources to construct a continuous series starting in 1870.
India	19th C.	Presents continuous series starting in 1884.	Constructed a different series combining various sources that allow starting in 1872.
Indonesia	WWII [1942-1948]	Missing figures.	Built estimates following an indicators approach based on weighted movements in the following sectors: food and crops, mining, construction and housing, trade and services, public administration, oil and gas. Estimates were constrained to match actual GDP growth rates for surrounding years.

Appendix I (cont.)	**Focus Period:**	**In Maddison (updated version):**	**Our approach:**
Italy	19th-20th C.	Used previous estimates based on older official statistical series.	Constructed a series with the same starting date but a different combination of sources, some of which are recent revisions of the older statistical figures used in Maddison's series and are supported in richer estimates of industry, agriculture, and services.
Japan	WWII [1945]	Apparently, 1945 value was assumed to be half of 1944.	Used the more recent consensus figures displaying a decline in output of approximately 50% spread over both 1945 and 1946.
Malaysia	20th C.	Presents series starting in 1911. Missing 1943-1946. Territorial adjustment to fit figures to present day Malaysia.	Extended the series to 1900 using recently published revisions of older series corresponding to Malaya.
Mexico	Revolution period [1911-1920]	Used linear interpolation as done in another source.	Constructed estimates based on weighted changes in services, agriculture, and industry (including mining, energy, and manufacturing). For each of these sectors, we built sub-sector weighted indexes using an array of data from national statistical abstracts and various academic works on the Revolution. [Maddison's population series is a linear interpolation between 1910 and 1920, a procedure that yields incorrect measures of per capita output. We used a population series that accords with the more likely demographic changes during this period.]
	[1896-1899]	Missing.	Covered with official GDP figures.
Netherlands	19th-20th C. (WWI & WWII)	Started continuous series in 1820; covered World War years with undisclosed aggregate measures.	A new series was constructed with the purpose of extending the series further back into the past, being explicit about proxies used as measures of GDP, and taking advantage of new revisions to older series. In particular, deflated measures of Gross Domestic Income were used to extend the series to the early years of the 19th Century. In the absence of a GDP aggregate, WWI and WWII years were covered with figures corresponding to Net National Product.
Singapore	Early 20th C.	Continuous series starts in 1950. Benchmark for 1913 is provided, apparently from the assumption that per capita GDP moved proportionately to that of Malaysia.	Used newly generated series of GDP starting in 1900 (but missing the period 1940-1949), based on the estimation of all demand side components of GDP.
South Africa	20th C.	Presents data starting in 1950.	Extended the series to 1911.

Appendix I (end)	Focus Period:	In Maddison (updated version):	Our approach:
South Korea	Early 19th C. and war periods [1941-1953]	Older estimates; mismatches with indicated sources for the war years; undisclosed estimation procedure.	Used results from recent research to cover the first half of the 20th century. Constructed estimates for World War II period based on sectoral output in agriculture, forestry, fishery, mining, manufacturing, and services. Weighted indexes for each of these sub-sectors were constructed mainly from primary Korean statistical abstracts. For the Korean War years, we used statistical data from the United Nations.
Sweden	19th-20th C.	Source from an older study; series starts in 1820.	Extended the series to 1800 using recently published figures compatible with revised official data and covering the two centuries.
Switzerland	WWI-1920's [1914-1929]	Uses a baseline source that proxies output with moving averages of railroad transport volume for 1914-1924 (combined with industrial production for 1925-1929). Adjustments to match movements in another source are not detailed.	Re-estimated GDP figures for this period following an indicators approach using a wider set of variables: private consumption (in turn estimated for 1851-1948 from quantities of consumption items and expenditure shares), expenditures of the confederation, exports, imports, freight traffic on railways, gross consumption of energy, industrial production, number of new residences, number of stock companies and capital at year end of stock companies. Whenever necessary, a CPI (built for purposes of the Private Consumption series) was used as deflator.
	19th-20th C.	Not fully explained adjustments based on a combination of sources.	Preferred to construct a new series accounting for specific details. For example, the use of an actual GDP deflator, which is available for the earlier part of the series starting in 1851, and the use of Net National Product to cover the lack of a GDP measure during 1930-1948.
Taiwan	War periods [1939-1949]	Covered 1939-1945 with older estimates and 1945-1949 by assuming equal percentage growth for each of these years.	Used recently published series based on revised national accounts statistics for the 20th Century. This new source presents constant price series based on different deflating methods, all of which show different patterns compared to older estimates.
U.K.	19th-20th C.	Used various sources; made assumptions related to territorial adjustments to present day boundaries.	Although patterns do not change markedly, we chose a different concatenation of sources. Some of these are themselves "compromise" series of earlier estimates; official sources for post-WWII data.
U.S.	19th-20th C.	Provides five benchmark figures for 1820-1870.	Restricted the series to start in 1869 with the estimates from Balke and Gordon (1989) through 1929; followed by *National Income and Product Accounts* figures from the Bureau of Economic Analysis up to 2006. Although estimates for earlier years are available from a new edition of the Historical Statistics of the U.S., we believe these figures warrant further analysis, especially those corresponding to the Civil War period.
Venezuela	19th C. [1884-1899]	Discarded data from the source for pre-1900 decades.	Started the series in 1884 using GDP estimates based on a wide coverage of sectors, including agriculture, commerce, finances, government, and transports.

Appendix II

Graphs of Long-Term per capita GDP and Consumer Expenditure, C

Note: All graphs use a natural-log scale, ranging from 5.5 ($245 in 2000 U.S. dollars) to 11.0 ($59900 in 2000 U.S. dollars). Samples start in 1869 or later depending on data availability.

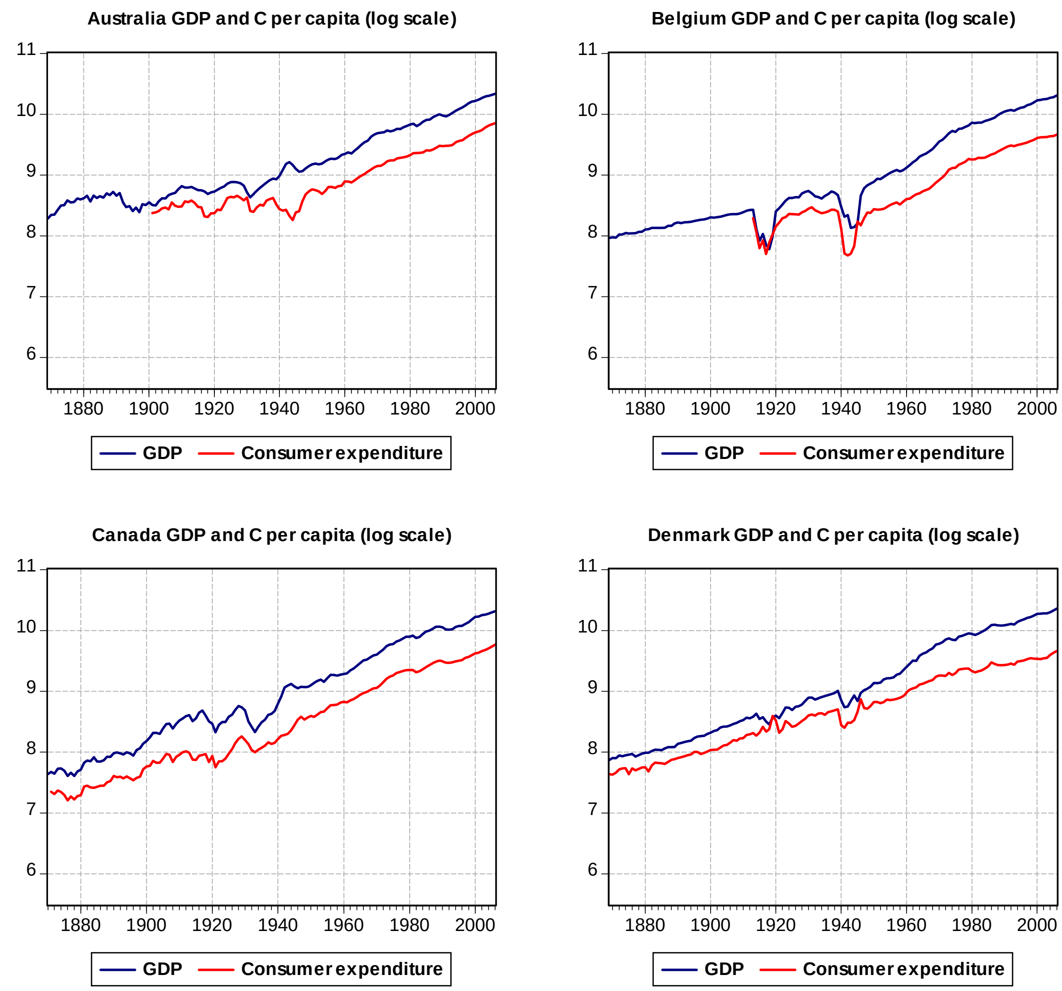


Figure A1

GDP and Consumer Expenditure for Australia, Belgium, Canada, Denmark

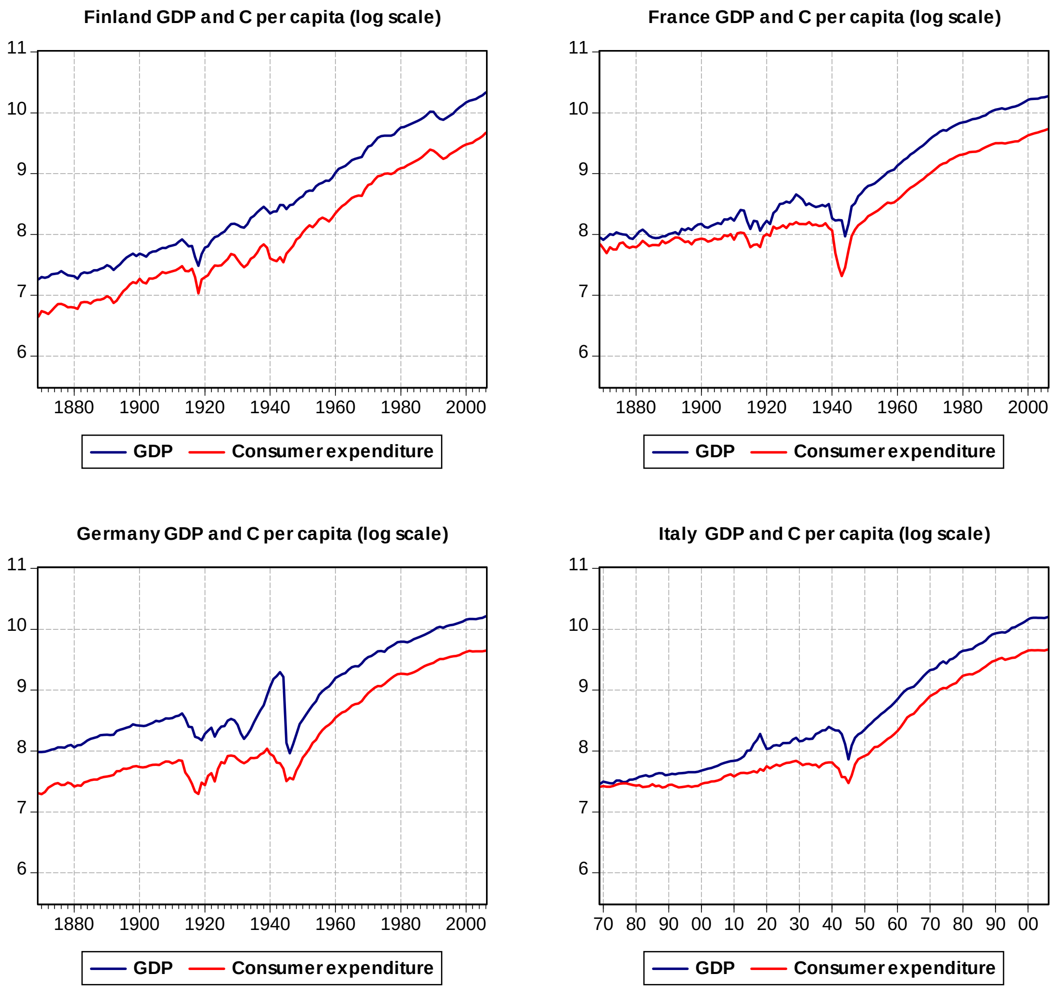


Figure A2

GDP and Consumer Expenditure for Finland, France, Germany, Italy

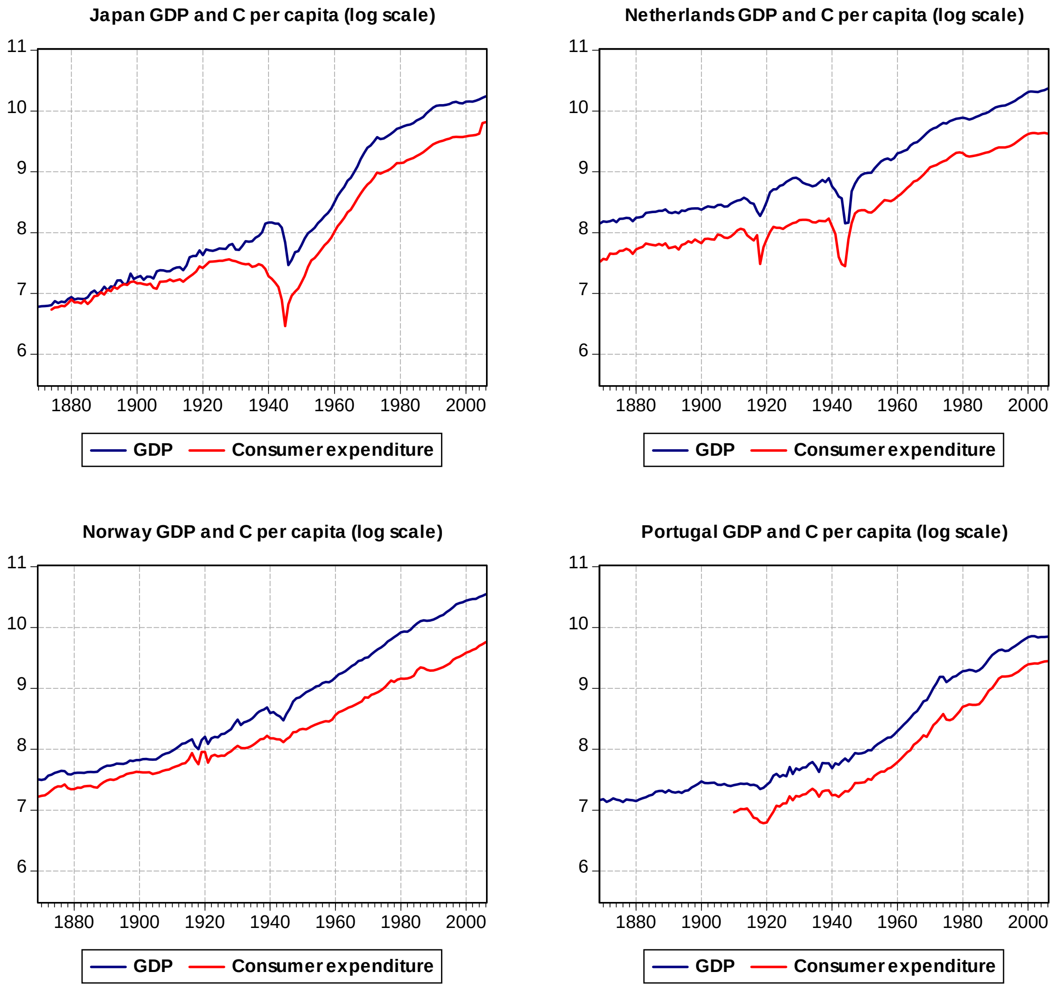


Figure A3

GDP and Consumer Expenditure for Japan, Netherlands, Norway, Portugal

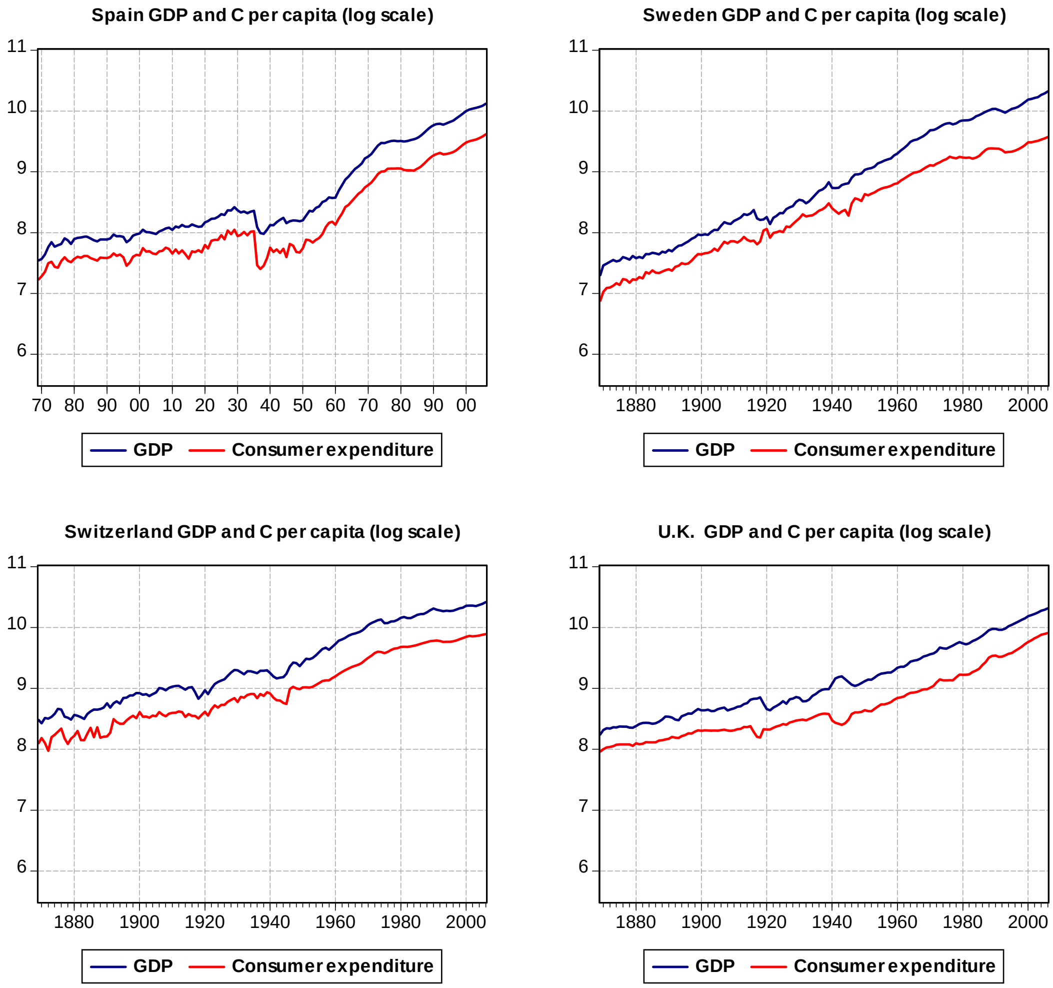


Figure A4

GDP and Consumer Expenditure for Spain, Sweden, Switzerland, U.K.

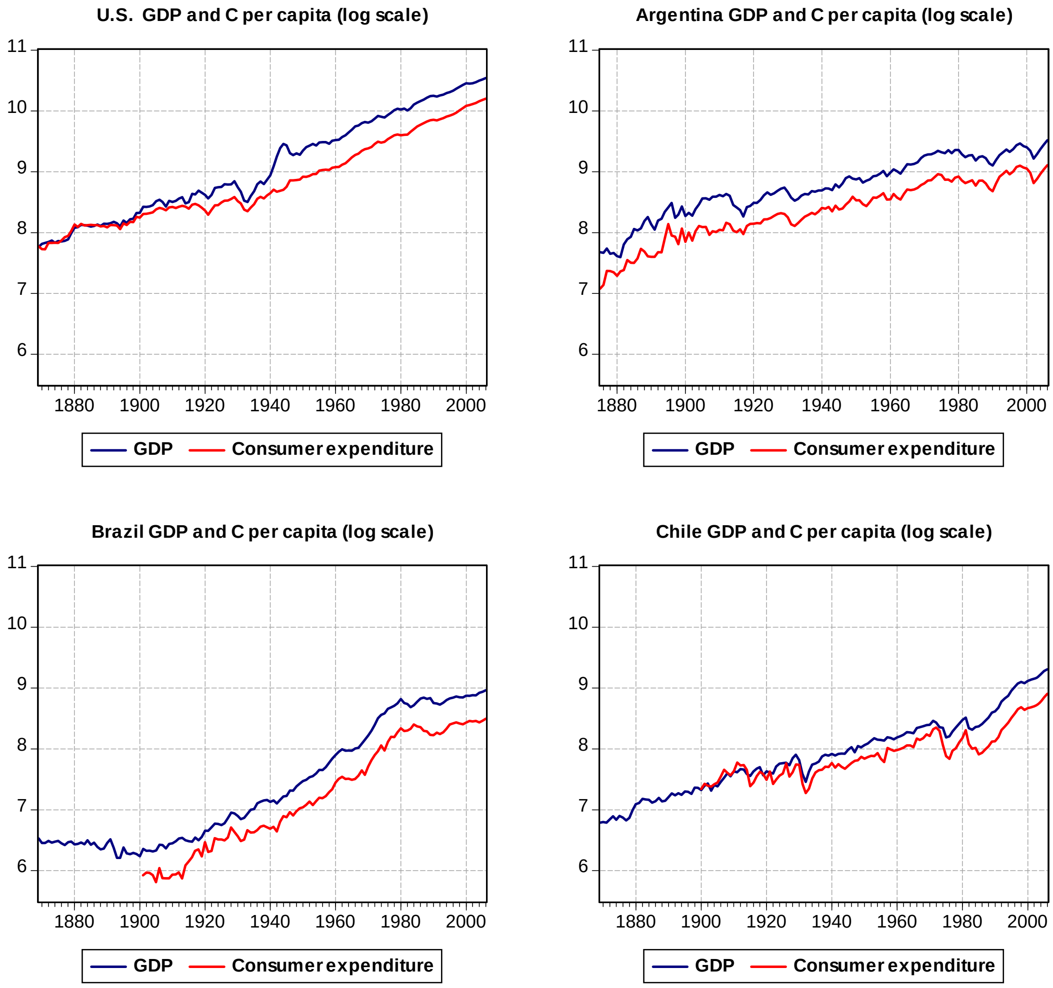


Figure A5

GDP and Consumer Expenditure for U.S., Argentina, Brazil, Chile

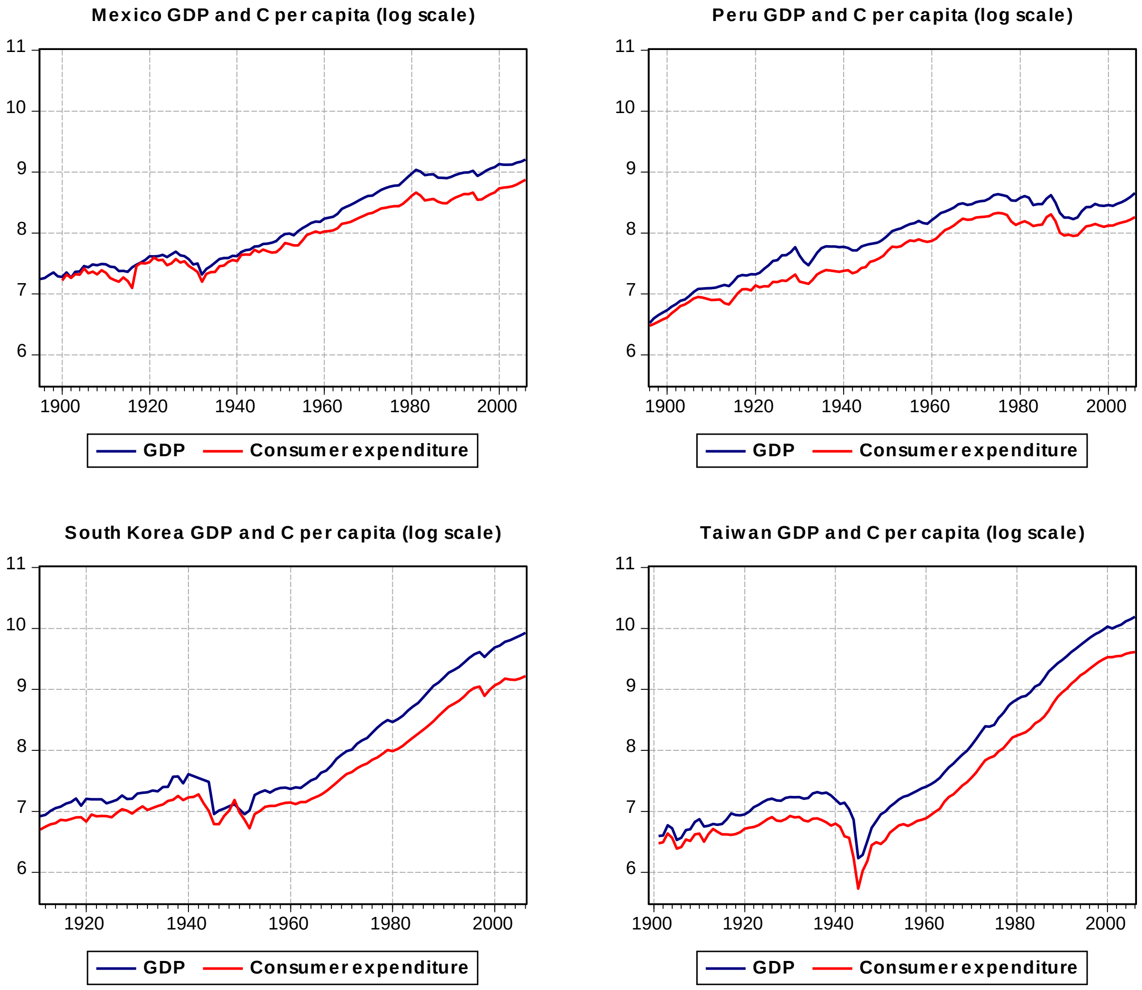


Figure A6

GDP and Consumer Expenditure for Mexico, Peru, South Korea, Taiwan

Appendix III
Measures of Consumption and GDP Disasters

Table A1 Consumption Disasters						
Part 1: OECD countries						
Country	**Trough**	**Peak**	**C decline (fraction)**	**Stock-price decline (fraction)**	**Bills rate of return**	**Inflation rate**
Australia	**1918**	1913	0.238	0.144	-0.008	0.036
	1932	1927	0.234	0.069	0.086	-0.032
	1944	1938	0.301	0.225	-0.024	0.041
Austria (X)	**1918**	1913	0.451	--	0.034	0.019
	1933	1929	0.217	0.533	0.071	-0.004
	1947?	1938	0.438?	--	--	--
Belgium	**1917**	1913	0.445	--	-0.160	0.353
	1942	1937	0.530		-0.024	0.034
Canada	1876	1873	0.152	--	--	-0.023
	1908	1906	0.113	--	0.014	-0.046
	1915	1912	0.130	--	0.022†	0.034
	1921	1918	0.196	0.210	--	0.104
	1933	1929	0.230	0.650	--	-0.054
Denmark	1921	1919	0.241	0.502	-0.113	0.201
	1941	1939	0.261	0.336	-0.120	0.193
	1948	1946	0.144	0.040	0.005	0.025
Finland	1892	1890	0.102	--	--	--
	1918	1913	0.360	--	-0.194††	0.389††
	1932	1928	0.199	0.207	0.115	-0.041
	1944	1938	0.254	0.168	-0.067	0.122
	1993	1989	0.140	0.620	0.092	0.045
France	**1871**	1864	0.158	0.212	0.027	0.007
	1915	1912	0.215	0.171	0.031	0.006
	1943	1938	0.580	--	-0.121	0.162
Germany	**1918**	1912	0.425	0.539	-0.101	0.186
	1923	1922	0.127	0.654	-0.970	34.5
	1932	1928	0.121	0.562	0.109	-0.035
	1945	1939	0.412	-0.366	0.000	0.020
Greece (X)	**1944**	1938	0.636	0.442*	-0.442	4.65
	1946	1945	0.113	--	--	--
Iceland (X)	1952	1947	0.250	--	--	0.202
	1969	1967	0.118	--	--	0.108
	1975	1974	0.107	--	--	0.515
	1993	1987	0.176	--	0.060^	0.144
Italy	**1945**	1939	0.286	0.429	-0.236	1.02
Japan	**1945**	1937	0.639	0.457	-0.066	0.101

Netherlands	1893	1889	0.098	--	-0.013	0.038
	1918	1912	0.440	--	-0.013	0.060
	1944	1939	0.545	-0.506	-0.050	0.069
New Zealand (X)	**1944**	1939	0.224	0.089	-0.009	0.031
Norway	**1918**	1916	0.169	-0.035	-0.212	0.326
	1921	1919	0.161	0.536	-0.032	0.094
	1944	1939	0.100	-0.222	-0.062	0.090
Portugal	1919	1913	0.215	--	--	--
	1936	1934	0.121	-0.434	0.044	0.010
	1942	1939	0.104	0.084	-0.058	0.110
	1976	1974	0.098	--	-0.136	0.242
Spain	1896	1892	0.182	-0.088	0.079	-0.024
	1915	1913	0.128	0.065	0.021	0.026
	1930	1929	0.101	0.090	0.027	0.028
	1937	1935	0.461	0.238**	-0.051	0.058
	1945	1940	0.145	-0.079	-0.021	0.107
	1949	1946	0.131	0.014	-0.029	0.075
Sweden	1917	1913	0.115	0.095	-0.014	0.074
	1921	1920	0.132	0.251	0.052	0.019
	1945	1939	0.182	0.173	-0.030	0.059
Switzerland	1872	1870	0.190	--	--	--
	1878	1876	0.225	--	--	--
	1883	1881	0.142	--	--	-0.018
	1886	1885	0.141	--	--	-0.059
	1888	1887	0.157	--	--	0.010
	1918	1912	0.108	0.475	-0.031	0.088
	1945	1939	0.173	0.382	-0.052	0.074
U.K.	**1918**	1915	0.167	0.490	-0.117	0.188
	1943	1938	0.169	0.123	-0.032	0.047
U.S.	1921	1917	0.164	0.584	-0.071	0.139
	1933	1929	0.208	0.631	0.093	-0.064

*1937-40, **1934-35, †1913-14, ††1915-17, ^1988-92
X: Not in analysis for C sample.

Table A1, Part 2: Non-OECD countries						
Country	**Trough**	**Peak**	**C decline (fraction)**	**Stock-price decline (fraction)**	**Bills rate of return**	**Inflation rate**
Argentina	1891	1887	0.123	--	--	0.080
	1898	1895	0.283	--	--	0.030
	1900	1899	0.195	--	--	-0.096
	1902	1901	0.127	--	--	0.059
	1907	1906	0.123	--	--	0.025
	1917	1912	0.172	--	--	0.047
	1932	1928	0.189	--	--	-0.028
	1959	1958	0.101	--	--	0.507
	1982	1980	0.104	0.575	0.516	1.09
	1990	1987	0.160	-3.264	-0.249	18.3
	2002	1998	0.249	0.401	0.090	-0.009
Brazil	1905	1902	0.148	--	--	-0.029
	1909	1906	0.157	--	--	0.023
	1919	1918	0.109	--	--	0.123
	1921	1920	0.147	--	--	0.099
	1931	1928	0.201	--	--	-0.037
	1990	1984	0.163	-0.271	--	6.42
Chile	1915	1911	0.322	0.125	0.021	0.069
	1922	1918	0.181	0.154	0.011	0.085
	1932	1929	0.374	0.538	0.063	0.007
	1956	1954	0.136	-0.315	-0.410	0.775
	1976	1972	0.401	-2.470	-0.516	3.47
	1985	1981	0.327	0.684	0.165	0.191
Colombia (X)	1932	1929	0.181	0.263	--	-0.090
	1943	1939	0.228	-0.053	--	0.041
	1999	1997	0.099	0.043	0.095	0.172
India (X)	**1942**	1932	0.217	-0.814	0.003	0.016
	1946	1943	0.130	-0.305	-0.053	0.086
	1950	1947	0.177	0.504	-0.025	0.038
Malaysia (X)	1916	1914	0.096	--	--	--
	1920	1917	0.425	--	--	--
	1932	1929	0.258	--	--	--
	1947?	1938	0.336?	--	--	--
	1952	1951	0.118	--	--	0.164
	1986	1984	0.145	0.434	0.036	0.014
	1998	1997	0.124	0.533	0.036	0.029
Mexico	**1916**	1909	0.252	--	--	0.031**
	1924	1921	0.118	--	--	-0.074
	1932	1926	0.311	0.406*	--	-0.025

	1988	1981	0.161	-0.148	0.024	0.852
	1995	1994	0.113	0.147	0.075	0.071
Peru	1914	1907	0.118	--	--	--
	1932	1929	0.140	0.105	--	-0.043
	1979	1975	0.179	0.325	--	0.437
	1992	1987	0.300	0.519	-0.522	24.8
Singapore (X)	1916	1910	0.145	--	--	--
	1920	1918	0.127	--	--	--
	1931	1928	0.104	--	--	--
	1951	1949	0.159	--	--	0.098
	1959	1956	0.117	--	--	0.013
South Korea	**1945**	1942	0.387	--	--	--
	1952	1949	0.371	--	--	1.68
	1998	1997	0.143	0.458	0.072	0.066
Taiwan	**1905**	1903	0.219	--	--	0.076
	1911	1910	0.127	--	--	0.082
	1945	1936	0.684	--	--	0.148
Turkey (X)	1932	1929	0.120	--	--	-0.031
	1946	1938	0.298	--	--	0.215
	2001	2000	0.108	0.565	-0.078	0.390
Uruguay (X)	1965	1960	0.099	--	--	0.274
	1984	1981	0.267	--	--	0.338
	2002	1998	0.219	--	--	0.054
Venezuela (X)	1933	1930	0.311	0.074	--	-0.060
	1936	1935	0.107	-0.069	--	-0.058
	1952	1948	0.203	0.103	-0.025	0.048
	1964	1957	0.223	0.329	0.020	0.016
	1989	1982	0.320	-3.493	-0.048	0.183
	2003	1993	0.147	0.690	-0.043	0.421

*1929-31, **1909-13
X: Not in analysis for C sample.

Note: Declines of real per capita personal consumer expenditure, C, by 0.1 or greater are cumulative fractions from peak year to trough year. Declines of real stock prices are cumulative fractions from the end of the year prior to the peak to the end of the year prior to the trough (unless the timing is indicated otherwise because of missing data). A negative number means that real stock prices increased. Real rates of return on bills and inflation rates are mean values from the peak year to one year prior to the trough year (unless the timing is indicated otherwise because of missing data). Bold for trough year indicates current participant in external or internal war.

Table A2 GDP Disasters						
Part 1: OECD countries						
Country	**Trough**	**Peak**	**GDP decline (fraction)**	**Stock-price decline (fraction)**	**Bills rate of return**	**Inflation rate**
Australia	1895	1889	0.271	0.067	0.085	-0.050
	1918	1910	0.118	0.188	-0.020	0.045
	1931	1926	0.221	0.179	0.061	-0.013
	1946	1943	0.145	-0.167	0.007	0.005
Austria	**1918**	1912	0.381	--	0.031	0.022
	1933	1929	0.235	0.533	0.071	-0.004
	1945	1941	0.587	--	--	--
Belgium	**1918**	1913	0.477	--	-0.225	0.492
	1934	1930	0.117	0.451	0.070	-0.052
	1943	1937	0.453	-0.764	-0.033	0.045
Canada	1878	1874	0.117	--	--	-0.020
	1921	1917	0.301	0.393	--	0.115
	1933	1928	0.348	0.558	--	-0.041
Denmark	**1918**	1914	0.160	0.132*	-0.045	0.128
	1941	1939	0.239	0.336	-0.120	0.193
Finland	1881	1876	0.120	--	--	--
	1918	1913	0.353	--	-0.194††	0.389††
	1940	1938	0.103	0.142	0.017	0.024
	1993	1989	0.124	0.620	0.092	0.045
France	**1870**	1868	0.095	--	--	-0.011
	1879	1874	0.102	--	--	-0.002
	1886	1882	0.133	0.296	0.028	0.000
	1918	1912	0.289	0.395	-0.055	0.117
	1935	1929	0.187	0.535	0.068	-0.039
	1944	1939	0.414	--	-0.147	0.197
Germany	**1919**	1913	0.357	0.736	-0.125	0.214
	1923	1922	0.135	0.654	-0.970	34.5
	1932	1928	0.280	0.562	0.109	-0.035
	1946	1943	0.736	0.068	-0.009	0.028
Greece	1872	1868	0.106	--	--	--
	1877	1873	0.152	--	--	--
	1891	1888	0.233	--	--	--
	1897	1896	0.151	--	--	--
	1901	1899	0.144	--	--	--
	1913	1911	0.419	--	--	--
	1919	1918	0.177	--	-0.553	1.38
	1923	1921	0.238	--	-0.203	0.369
	1942	1939	0.660	0.448**	-0.331	4.31

Iceland	1883	1881	0.125	--	--	--
	1918	1913	0.221	--	--	0.206
	1920	1919	0.157	--	--	0.114
	1952	1948	0.139	--	--	0.235
Italy	1920	1918	0.221	0.374	-0.101	0.195
	1945	1939	0.413	0.429	-0.236	1.02
Japan	**1944**	1940	0.503	0.239	-0.026	0.054
Netherlands	**1918**	1913	0.258	--	-0.021	0.070
	1934	1929	0.129	0.582	0.057	-0.032
	1944	1939	0.525	-0.506	-0.050	0.069
New Zealand	1879	1878	0.174	--	--	--
	1909	1907	0.110	--	--	--
	1918	1911	0.107	--	--	0.040
	1927	1925	0.117	--	0.057	0.009
	1948	1947	0.119	0.003	-0.061	0.081
	1951	1950	0.097	-0.049	-0.068	0.089
Norway	**1918**	1916	0.148	-0.035	-0.212	0.326
	1921	1920	0.110	0.447	-0.117	0.194
	1944	1939	0.193	-0.222	-0.062	0.090
Portugal	1928	1927	0.109	--	--	--
	1936	1934	0.148	-0.434	0.044	0.010
Spain	1896	1892	0.119	-0.088	0.079	-0.024
	1933	1929	0.096	0.464	0.061	-0.009
	1938	1935	0.313	0.238†	-0.035	0.098
Sweden	1918	1916	0.150	0.169	-0.185	0.323
	1921	1920	0.108	0.251	0.052	0.019
	1941	1939	0.095	0.349	-0.071	0.104
Switzerland	1879	1875	0.161	--	--	--
	1918	1912	0.191	0.475	-0.031	0.088
	1942	1939	0.126	0.308	-0.080	0.105
U.K.	1921	1918	0.192	0.321	-0.069	0.130
	1947	1943	0.148	-0.269	0.003	0.006
U.S.	1908	1906	0.105	0.365	0.019	0.041
	1914	1913	0.095	0.160	0.034	0.020
	1921	1918	0.118	0.293	-0.057	0.125
	1933	1929	0.290	0.631	0.093	-0.064
	1947	1944	0.165	-0.061	-0.062	0.076

*1914-17, **1938-40, †1934-35, ††1915-17

Table A2, Part 2: Non-OECD countries						
Country	**Trough**	**Peak**	**GDP decline (fraction)**	**Stock-price decline (fraction)**	**Bills rate of return**	**Inflation rate**
Argentina	1891	1889	0.189	--	--	0.284
	1897	1896	0.219	--	--	0.069
	1900	1899	0.147	--	--	-0.096
	1917	1912	0.289	--	--	0.047
	1932	1929	0.195	--	--	-0.002
	1959	1958	0.101	--	--	0.507
	1982	1980	0.111	0.575	0.516	1.09
	1990	1988	0.141	-3.430	-0.355	26.6
	2002	1998	0.220	0.401	0.090	-0.009
Brazil	1887	1884	0.105	--	--	-0.020
	1893	1891	0.262	--	--	0.248
	1900	1895	0.135	--	--	0.033
	1931	1928	0.201	--	--	-0.037
	1992	1987	0.110	0.358	--	10.8
Chile	1903	1902	0.111	0.015	0.022	0.055
	1915	1912	0.105	0.185	0.000	0.090
	1919	1918	0.126	-0.018	0.103	-0.014
	1932	1929	0.361	0.538	0.063	0.007
	1975	1971	0.240	-2.081	-0.479	2.67
	1983	1981	0.180	0.499	0.296	0.151
Colombia	none					
India	1877	1875	0.154	--	--	-0.065
	1896	1894	0.100	--	0.120	-0.060
	1918	1916	0.146	--	0.004	-0.061
	1948	1943	0.117	0.073	-0.058	0.082
Indonesia	1933	1930	0.114	0.406	--	-0.186
	1945	1940	0.545	--	--	0.044
	1999	1997	0.158	0.681	-0.066	0.440
Malaysia (X)	1904	1902	0.100	--	--	--
	1935	1929	0.193	--	--	--
	1937	1936	0.117	--	--	--
	1941	1939	0.235	--	--	--
	1947?	1942	0.361	--	--	--
Mexico	**1915**	1909	0.119	--	--	0.031†
	1932	1926	0.314	0.406*	--	-0.025
	1988	1981	0.128	-0.148	0.024	0.852
Peru	1932	1929	0.258	0.105	--	-0.043
	1979	1975	0.104	0.325	--	0.437
	1983	1981	0.136	0.879	--	0.728
	1992	1987	0.325	0.519	-0.522	24.8

Philippines	1904	1903	0.158	--	--	0.234
	1915	1913	0.116	--	--	-0.109
	1935	1929	0.134	--	--	-0.038
	1946	1939	0.572	--	--	--
	1985	1982	0.187	0.736	-0.050	0.285
Singapore (X)	1904	1902	0.214	--	--	--
	1913	1910	0.337	--	--	--
	1916	1915	0.174	--	--	--
	1920	1917	0.235	--	--	--
	1927	1925	0.389	--	--	--
	1932	1929	0.412	--	--	--
	1938	1937	0.151	--	--	--
	1952	1950?	0.345	--	--	0.192
	1957	1956	0.113	--	--	0.033
South Africa	1917	1912	0.229	0.139	--	0.031
	1920	1919	0.239	-0.200	--	0.009
	1987	1981	0.113	-0.156	0.006	0.147
	1993	1989	0.102	0.028	0.032	0.140
South Korea	1919	1918	0.111	--	--	--
	1939	1938	0.104	--	--	--
	1945	1940	0.480	--	--	--
	1951	1949	0.151	--	--	0.492
Sri Lanka	1878	1870	0.158	--	--	--
	1886	1883	0.141	--	--	--
	1923	1913	0.138	--	--	--
	1932	1929	0.147	--	--	--
	1946	1942	0.211	--	--	0.147
Taiwan	**1905**	1903	0.214	--	--	0.076
	1911	1910	0.114	--	--	0.082
	1945	1936	0.662	--	--	0.148
Turkey (X)	1927	1926	0.134	--	--	0.033
	1932	1931	0.122	--	--	-0.025
	1945	1939	0.395	--	--	0.283
Uruguay	1875	1872	0.269	--	--	--
	1881	1878	0.153	--	--	--
	1887	1886	0.140	--	--	-0.054
	1890	1888	0.202	--	--	0.181
	1901	1896	0.156	--	--	0.045
	1905	1904	0.122	--	--	-0.081
	1915	1912	0.280	--	--	0.057
	1920	1919	0.142	--	--	0.099
	1933	1930	0.367	--	--	-0.005
	1943	1939	0.139	--	--	0.033
	1959	1957	0.118	--	--	0.190
	1984	1981	0.236	--	--	0.338

	2002	1998	0.186	--	--	0.054
Venezuela	1892	1890	0.235	--	--	--
	1897	1893	0.225	--	--	--
	1907	1903	0.134	--	--	--
	1916	1913	0.167	--	--	0.025**
	1933	1930	0.162	0.074	--	-0.060
	1942	1939	0.155	-0.134	--	-0.003
	1961	1957	0.152	0.270	0.007	0.020
	1985	1977	0.295	0.616	-0.005	0.121
	2003	1993	0.259	0.690	-0.043	0.421

*1929-31, ** 1914-15, †1909-13
X: Not in analysis for GDP sample.

Note: Declines of real per capita GDP by 0.1 or greater are cumulative fractions from peak year to trough year. Declines of real stock prices are cumulative fractions from the end of the year prior to the peak to the end of the year prior to the trough (unless the timing is indicated otherwise because of missing data). A negative number means that real stock prices increased. Real rates of return on bills and inflation rates are mean values from the peak year to one year prior to the trough year (unless the timing is indicated otherwise because of missing data). Bold for trough year indicates current participant in external or internal war.

Table A3 Declines in Consumer Durables during Consumption Crises							
Country	**Share of Durables in C (nominal values)**				**Proportionate decline in real per capita:**		
	Trough		**Peak**		**Consumer expenditure**	**Durables**	**Non-durables**
OECD countries							
Canada	1933	0.054	1929	0.085	0.230	0.507	0.201
Finland	1892	0.029	1890	0.042	0.102	0.132	0.101
Finland	1918	0.010	1913	0.017	0.360	0.655	0.353
Finland	1932	0.013	1928	0.030	0.199	0.636	0.182
Finland	1944	0.019	1938	0.038	0.254	0.634	0.237
Finland	1993	0.072	1989	0.138	0.140	0.512	0.062
Iceland	1969	0.101	1967	0.133	0.118	0.321	0.087
Iceland	1975	0.134	1974	0.181	0.107	0.340	0.043
Iceland	1993	0.102	1987	0.183	0.176	0.529	0.053
Portugal	1976	0.092	1974	0.101	0.098	0.195	0.091
Spain	1896	0.020	1892	0.018	0.182	0.063	0.185
Spain	1915	0.020	1913	0.034	0.128	0.405	0.109
Spain	1930	0.045	1929	0.057	0.101	0.238	0.090
Spain	1937	0.022	1935	0.034	0.461	0.642	0.450
Spain	1945	0.023	1940	0.019	0.145	-0.206	0.153
Spain	1949	0.025	1946	0.027	0.131	0.170	0.127
U.K.	1918	0.040	1915	0.037	0.167	0.198	0.166
U.K.	1943	0.023	1938	0.049	0.169	0.649	0.144
U.S.	1921	0.094	1917	0.094	0.164	0.227	0.158
U.S.	1933	0.076	1929	0.119	0.208	0.501	0.169
non-OECD countries							
Chile	1985	0.060	1981	0.098	0.327	0.695	0.179
Colombia	1999	0.088	1997	0.110	0.099	0.314	0.060
Mexico	1995	0.070	1994	0.082	0.113	0.340	0.077
South Korea	1998	0.063	1997	0.089	0.143	0.363	0.096
Turkey	2001	0.150	2000	0.195	0.108	0.315	0.056
Venezuela	1964	0.042	1957	0.079	0.223	0.581	0.184
Venezuela	1989	0.047	1982	0.073	0.320	0.643	0.299
Venezuela	2003	0.076	1993	0.081	0.147	0.478	0.105
Overall means		0.058		0.080	0.183	0.396	0.151

Note to Table A3: This table shows the universe of consumption crises considered in Table A1 for which we have been able to break down the decline in real per capita personal consumer expenditure, C, into durables versus non-durables and services. The latter category should be closer than C to "consumption." We have the necessary data for 28 C crises (20 of which in our main sample of 95 C crises) from Table A1. The first four columns show the share of nominal durables expenditure in nominal C at the trough and peak years of each crisis. The last three columns show the proportionate fall in real per capita consumer expenditure (the number contained in Table A1), the fall in real per capita durables spending, and the fall in real per capita spending on non-durables and services. The last measure would be closer than our Table A1 measures to the decline in per capita consumption.

Table A4 Consumption Disasters Gauged by One-Sided HP Filters			
Part 1: OECD Countries			
Country	**Trough**	**Peak**	**C decline**
Australia	**1920**	1913	0.202
	1935	1928	0.167
	1945	1938	0.215
Belgium	**1944**	1938	0.505
Canada	1923	1913	0.166
	1935	1930	0.136
Denmark	**1943**	1939	0.202
Finland	**1919**	1913	0.201
	1933	1929	0.105
	1944	1939	0.181
France	1874	1864	0.104
	1918	1913	0.185
	1944	1934	0.530
Germany	**1920**	1913	0.384
	1947	1940	0.356
Iceland (X)	1995	1988	0.096
Italy	**1946**	1940	0.221
Japan	**1936**	1928	0.123
	1946	1937	0.515
Netherlands	**1919**	1913	0.264
	1944	1934	0.487
Norway	none		
Portugal	none		
Spain	**1939**	1929	0.416
Sweden	1945	1940	0.106
Switzerland	1945	1940	0.142
U.K.	**1918**	1915	0.109
	1944	1939	0.160
U.S.	1934	1929	0.136

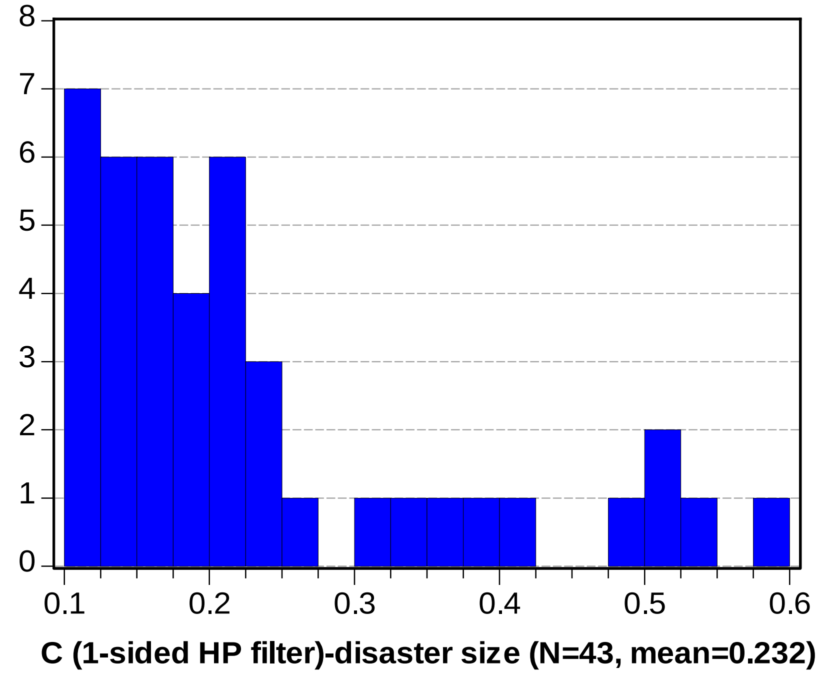
Table A4, Part 2: Non-OECD Countries			
Country	**Trough**	**Peak**	**C decline**
Argentina	1933	1929	0.141
	1990	1980	0.168
	2004	2000	0.149
Brazil	1992	1985	0.158
Chile	1917	1913	0.198
	1933	1930	0.247
	1978	1973	0.320
	1987	1981	0.157
Colombia (X)	1945	1941	0.095
India (X)	**1942**	1933	0.184
Malaysia (X)	1922	1917	0.297
	1934	1930	0.141
Mexico	**1916**	1909	0.194
	1934	1926	0.240
	1988	1982	0.115
Peru	1914	1909	0.095
	1985	1976	0.205
	1993	1988	0.229
Singapore (X)	1916	1910	0.103
South Korea	**1947**	1942	0.325
	1952	1949	0.127
Taiwan	**1947**	1937	0.578
Turkey (X)	1946	1940	0.222
Uruguay (X)	1985	1981	0.189
	2004	2000	0.134
Venezuela (X)	1933	1930	0.499
	1971	1961	0.148
	1990	1982	0.331

Note: This analysis is based on one-sided HP filters for log(C) (where C is real per capita consumer expenditure) with a conventional smoothing parameter of 100. Declines in this filtered C by 0.1 or greater are cumulative fractions from peak year to trough year. Bold indicates current participant in external or internal war. X denotes not in C sample.

Table A5 GDP Disasters Gauged by One-Sided HP Filters			
Part 1: OECD Countries			
Country	**Trough**	**Peak**	**GDP decline**
Australia	1897	1891	0.255
	1920	1913	0.109
	1933	1928	0.163
Austria	**1920**	1913	0.346
	1936	1930	0.226
	1947	1943	0.455
Belgium	**1919**	1913	0.436
	1935	1930	0.108
	1945	1938	0.426
Canada	1922	1917	0.191
	1935	1930	0.250
Denmark	**1943**	1939	0.165
Finland	**1919**	1914	0.225
France	**1919**	1913	0.208
	1938	1930	0.180
	1945	1939	0.310
Germany	**1920**	1913	0.321
	1933	1929	0.172
	1949	1944	0.663
Greece	1872	1862	0.200
	1898	1888	0.174
	1917	1912	0.260
	1945	1939	0.626
Iceland	1921	1915	0.189
Italy	**1946**	1940	0.267
Japan	**1949**	1943	0.439
Netherlands	**1919**	1914	0.174
	1935	1930	0.128
	1945	1939	0.426
New Zealand	1888	1879	0.116
	1933	1925	0.125
Norway	**1945**	1939	0.115
Portugal	none		
Spain	**1939**	1930	0.316
Sweden	1921	1916	0.131
Switzerland	1883	1876	0.110
	1919	1912	0.132
	1944	1934	0.127
U.K.	1923	1918	0.143
	1949	1944	0.109
U.S.	1934	1929	0.221

Table A5, Part 2: Non-OECD Countries			
Country	**Trough**	**Peak**	**GDP decline**
Argentina	1918	1912	0.248
	1934	1929	0.135
	1990	1980	0.201
	2003	1999	0.113
Brazil	1900	1891	0.175
Chile	1933	1930	0.201
	1977	1972	0.170
India	**1950**	1943	0.103
Indonesia	**1947**	1941	0.517
Malaysia (X)	1941	1931	0.184
Mexico	**1915**	1910	0.105
	1934	1926	0.243
Peru	1933	1929	0.137
	1985	1976	0.142
	1993	1987	0.269
Philippines	1988	1983	0.171
Singapore (X)	1916	1911	0.212
	1928	1925	0.153
	1932	1930	0.178
South Africa	1994	1984	0.156
South Korea	**1952**	1942	0.486
Sri Lanka	1923	1914	0.107
Taiwan	**1947**	1938	0.594
Turkey (X)	1945	1940	0.276
Uruguay	1901	1896	0.112
	1917	1913	0.176
	1935	1930	0.210
	1967	1957	0.169
	1986	1981	0.171
	2003	2000	0.105
Venezuela	1901	1895	0.109
	1963	1958	0.101
	1989	1979	0.298
	2003	1993	0.157

Note: This analysis is based on one-sided HP filters for log(GDP) (where GDP is real per capita GDP) with a conventional smoothing parameter of 100. Declines in this filtered GDP by 0.1 or greater are cumulative fractions from peak year to trough year. Bold indicates current participant in external or internal war. X denotes not in GDP sample.



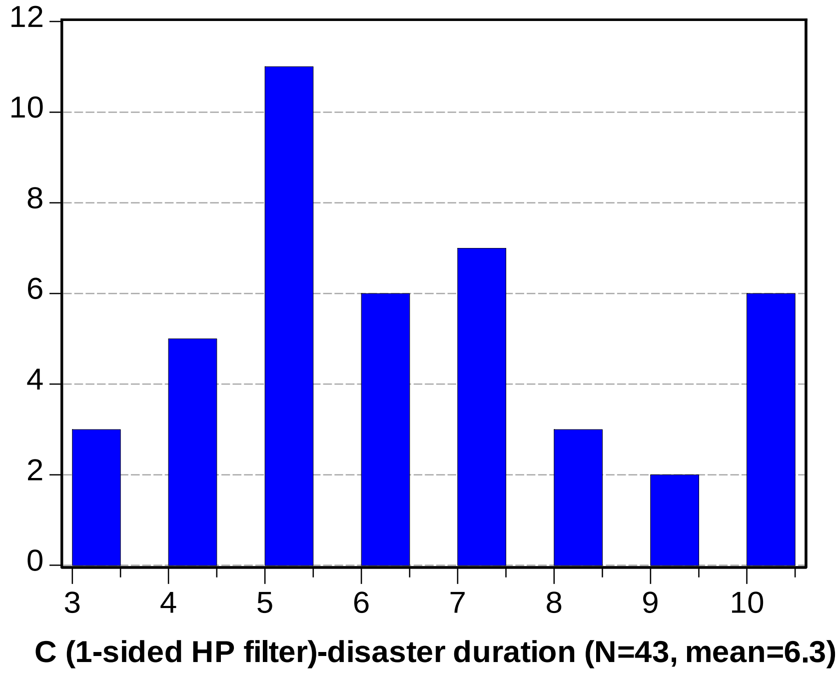
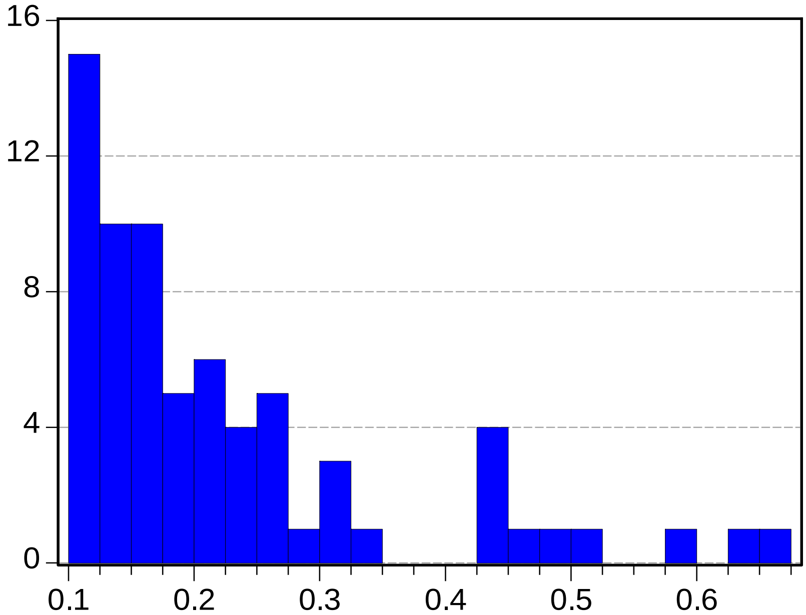
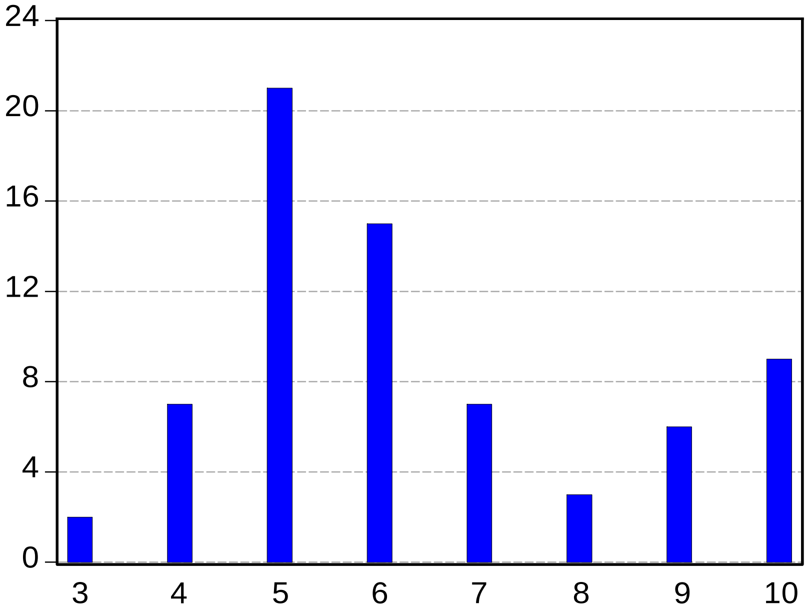


Figure A7 C-Disaster Sizes and Durations (Years), HP-filtered

(data are from Table A4)



GDP (1-sided HP filter)-disaster size (N=70, mean=0.224



GDP (1-sided HP filter)-disaster duration (N=70, mean=6.4)

Figure A8 GDP-Disaster Sizes and Durations (Years), HP-Filtered
(data are from Table A5)