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. (A separation of consumer expenditure into durables and non-durables is feasible for only a minority of cases.) We have essentially full annual data on C for 22 countries and GDP for 35 countries, and we plan to complete the long-term time series for a few more 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 87 crises for C and 148 for GDP, implying disaster probabilities around 3.6% per year. The disaster size has a mean of 21-22% and an average duration of 3.5 years. The cumulative density function for disaster size accords with a power-law form with an exponent of two. 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. Our first pass constrains the fractional decline in real stock prices (for unlevered equity) during a crisis to equal the measured fractional fall in C or GDP. 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. Another simulation, which uses actual changes in real stock prices during crises, also fits with observed average returns on levered equity. We plan a statistical analysis that uses all the time-series data and includes estimation of long-run effects of crises on levels and growth rates of C and GDP. We will also study the bond-bill premium (empirically around 1%) and allow for time-varying disaster probabilities.

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An earlier study (Barro [2006]) applied 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 in the long-term data. (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 is most common for 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 in other cases, 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 22 countries on C and 35 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. We estimate a power-law frequency distribution for disaster size that turns out to be an inverse-square law. 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. In this simulation, the proportional fall in the real value of unlevered equity during a crisis is constrained to equal the observed fractional decline in C or GDP. The simulated model with a reasonable coefficient of relative risk aversion turns out to accord with observed equity premia. Section IX modifies the simulation to use observed real stock-price changes to gauge crisis returns on stocks. This model successfully replicates observed average rates of return on equity for overall samples and for normal times. We also discuss how the model can be consistent with the low average of 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 (22 countries), and real per capita GDP (35 countries).[1] 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—only 5 of these are in our C sample, and 14 are in our GDP sample. The three countries that we are studying that are omitted from Table 1 are Egypt, Ireland, and Russia. We start our analysis of growth rates in 1870, although earlier data are available in some cases.

Most of our analysis uses growth rates of C and GDP and does not involve comparisons of levels across countries. Therefore, for most purposes, 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

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[1] GDP data are missing for Greece in 1944 and the Philippines in 1941-45, but we are able to include these countries in our GDP analysis.

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 an example, Mexico has GDP data since 1895 but is missing reliable information between 1910 and 1919, the period that includes the Revolution and Civil War. Inclusion of the incomplete Mexican time series since 1895 in our analysis would bias downward estimated disaster probabilities. That is, the missing period almost surely contains a crisis.[2] Even the United States is a concern because of missing data during the U.S. Civil War, likely a crisis event, though prior to our starting date of 1870. 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. At present, we take the approach of excluding cases with (selected) gaps in data. For example, our analysis of consumer expenditure and GDP omits Mexico, as well as Malaysia and Singapore, which are missing data around World War II. Similarly, our analysis of consumer expenditure omits South Korea because of missing data during World War II and the Korean War.

The construction of estimates of real personal consumer expenditure relied on various procedures. In many cases, we used existing long-term national-accounts studies.

[2] We believe that we will eventually be able to fill in the missing Mexican data.

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 estimated C from quantities of specific consumption items, using estimates of expenditure shares to calculate changes in aggregate C. The details of our procedures will appear in a report to be posted on the Internet.

One recurring 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,[3] but we do not want to apply this approach to border changes in general (where the implication would be that the initially richer part would inevitably regard 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,[4] assumes that we can apply a

[3] As an analogy, some South Koreans view a reunification with North Korea as a pending disaster.
[4] 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.

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 main analysis but do matter for our planned effort to construct 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 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 used are as long as possible going back to 1870 (that is, the first observation is for the growth rate from 1869 to 1870).

For C, the average growth rate for 22 countries is 0.020, with an average standard deviation of 0.060. The average for the 17 OECD countries is 0.019 (s.d.=0.056) and that for the 5 non-OECD countries is 0.024 (s.d.=0.077). For GDP, the average growth rate for 34 countries is 0.021 (average s.d.=0.056). The average for the 21 OECD countries is 0.020 (s.d.=0.054) and that for the 13 non-OECD countries is 0.021 (s.d.=0.059).

In comparison with the more familiar post-World War II data, the main difference is that the long samples have substantially higher standard deviations and somewhat lower means. The main reason for the difference is that—especially for the OECD group, which is comparatively tranquil after World War II—the long samples include realizations of disasters, notably during the two world wars and the Great Depression of the early 1930s. (Another reason for the differences in standard deviations, stressed by Romer (1986) for the United States, is that the long samples likely include data with more measurement error.) For the 17 OECD countries, the growth rate of C for 1954-2006 has a mean of 0.026 (average s.d.=0.024), compared to 0.019 (s.d.=0.057) for the full sample. For the 21 OECD countries, the growth rate of GDP for 1954-2006 has a mean of 0.027 (s.d.=0.025), compared to 0.020 (s.d.=0.054) for the full sample.

Particularly because of the fat tails indicated by excess kurtosis, normality for growth rates of consumer expenditure or GDP is rejected at low p-values in most cases for the long time series.[5] For long-term C growth, the only cases in which normality is accepted (by a Jarque-Bera test) at the 5% level are Portugal (p-value=0.18) and the United States (p-value=0.23). For long-term GDP growth, normality is accepted only for Iceland (p-value=0.07) and Switzerland (p-value=0.15). In contrast, in the tranquil post-1954 period for the OECD countries, normality is accepted in the majority of cases. The exceptions for C growth are Canada (p-value=0.04), Japan (p-value=0.00), and Portugal (p-value=0.03). For GDP growth, the exceptions are Australia (p-value=0.01), Austria (p-value=0.00), Finland (p-value=0.01), Germany (p-value=0.02), and Switzerland

[5] The tendency for negative skewness—disasters rather than bonanzas—is less pronounced than we anticipated. For C growth, 12 of the 22 countries exhibit negative skewness, and for GDP growth, 26 of the 34 exhibit negative skewness.

(p-value=0.01). Departures from normality in the post-1954 period are more common for the non-OECD countries.

Appendix II has long-term graphs of real per capita GDP and consumer expenditure, C, for the 22 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 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 the other cases (even including Canada, which comes close), the fixed-trend hypothesis is rejected by the GDP data.

We plan to examine thoroughly the statistical properties of the full time series of GDP and C for our universe of countries in future research with Emi Nakamura and Jon Steinsson. The 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 kinds of 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 3 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. Therefore, rates of return are averages during each year.

Table 3 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 expect eventually to be able to use 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 4 shows means and standard deviations of rates of return for countries with nearly continuous annual time series back at least to the 1920s.[6] 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—though we plan in the future to analyze the premium of bonds over bills.

For 17 countries, the mean real rates of return over long-term samples were 0.0829 for stocks and 0.0072 for bills. (For each country, we used a common sample for stock and bill returns.) Thus, the average equity premium was 0.0757. 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.

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 0.0757/1.5 = 0.050. 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

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[6] 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 clearly 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.

average level of the real bill rate (taken as a rough estimate of a risk-free rate, although bills are not literally 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 reasonable. 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 model considered later will not explain the bond-bill premium, but extensions of this model may work (see Gabaix [2008]).

Table 4 shows the familiar high annual standard deviation of stock returns—an average of 0.248 for the 17 countries with matched bill data (0.235 for the 15 OECD countries). The corresponding average standard deviation for bill returns was 0.089 (0.082 for the 15 OECD countries). Thus, bill returns had substantial volatility but not nearly as great as stocks. As discussed later, the occurrences of low real bill returns tend to be associated with high inflation rates.

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 turns out to have 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 our ongoing research with Nakamura and Steinsson, we are taking a formal statistical approach that considers transitional probabilities for movements between normal and crisis regimes and that 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 Tables 5 and 6. The coverage is 21 OECD countries—17 with enough data for our subsequent analysis—and 14 non-OECD—5 in our later analysis. For GDP, shown in Tables 7 and 8, the coverage is 21 OECD countries—all used in our subsequent analysis—and 18 non-OECD—14 in our later analysis. For the samples used later, the mean size of C contraction (87 events for 22 countries) was 21.8%, and the mean size of GDP contraction (148 events for 35 countries) was 20.8%.

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 (which featured banking panics[7]), 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.

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

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 54% 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, Chatterjee and Corbae [2007] and Cogley and Sargent [2008]). One reason for the U.S. 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. Our ongoing research with Emmanuel Farhi and Xavier Gabaix seeks to check this perspective by using prices of U.S. stock-index options since the early 1980s to gauge directly the time-varying disaster probability as perceived by U.S. investors.

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—which had similar overall consequences.

For the broad group of 35 countries included for consumer expenditure in Table 5, World War II had 22 crises with an average size of 34% (see Table 6). World War I had 19 crises with an average size of 24%, and the Great Depression had 18 with an average size of 21%. The 1920s had another 10 events—8 with troughs in 1920-21—with an average size of 19%. As already suggested for the United States, the contractions at the start of the 1920s may reflect the influenza epidemic of 1918-20 (Ursua [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 28 non-OECD consumption events with an average size of 18%. 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.

Tables 7 and 8 provide a roughly similar picture for crises gauged by per capita GDP. For the broad group of 38 countries included in Table 7, World War II had 25 events with an average size of 36% (see Table 8). World War I had 26 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 46 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 (which we subsequently refer 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 9 shows the 28 cases among the C-disasters from Table 5 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, 18 are in our main sample of 87 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 selected 28 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 9.[8] 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 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.

Our measured durables adjustment of 3 percentage points likely overstates the overall effects. The reason is that we are systematically missing data for the larger crises on the durables/non-durables division—the mean contraction in C for the 28 cases in Table 9 was 18.3%, compared to a mean of 21.8% for the 87 C contractions that we use in our subsequent analysis. The largest C contractions in Table 9 are 46% for Spain in 1937, 36% for Finland in 1918, 33% for Chile in 1985, and 32% for Venezuela in 1989.

[8] 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.

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:

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

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 (in percentage points) would tend to be less important 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 9—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 9. Therefore, we apply the rest of our analysis to crises gauged by personal consumer expenditure, C, in Table 5, as well as to crises measured by GDP in Table 7.

V. Consumer Expenditure and GDP Disasters Compared

Table 10 matches disasters for personal consumer expenditure, C, and GDP for countries with full data (17 OECD and 5 non-OECD). We match the C and GDP contractions in Tables 5 and 7, 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 5 or 7). In those cases, we enter in Table 10 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 5 and 7 verify this view: 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-World War II 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.[9] 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 idea), 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.

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.[10] 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, it is not surprising that C would decline proportionately by more than GDP.

Table 10 covers 102 contractions overall, 70 for OECD countries and 32 for non-OECD. Of the 102 contractions, 26 featured participation as a war combatant and 76 were non-war (where the label "non-war" includes non-combatants during major wars).

[9] 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.
[10] The declines in consumption and investment could be moderated by a fall in the current-account balance; however, the option of borrowing from abroad tends to be severely limited during a global conflict.

In the 76 non-war cases, the average proportionate decrease in C was slightly greater than that in GDP—14.5% versus 13.1% (12.7% versus 12.3% for the OECD countries). In the 26 war cases, the margin was greater—33.3% versus 28.8% (32.9% versus 28.4% for the OECD countries).

In terms of timing patterns, Table 10 shows for the full sample of 102 crises that 59 have the same trough years for C and GDP. The trough year for C comes later in 23 cases and earlier in 20 cases. Thus, at least in the annual data, there is no clear timing pattern as to whether C or GDP declines first during non-war crises. For wartime cases, 13 of the 26 have the same year, whereas C moves later in 4 and earlier in 9. Thus, there is a slight suggestion that the declines in C during wartime crises tend to precede those in GDP. This pattern makes sense since the rise in government purchases early in a war could reduce C before any physical destruction caused a fall in GDP.

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 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 used a conventional smoothing parameter for annual data of 100. Unlike the standard setup, we used 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 calculated the proportionate peak-to-trough decreases in the HP-trend values. This procedure downplays short-lived contractions and tends to count, instead, 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 number of disasters—from 87 to 38 for C and from 148 to 68 for GDP. The full results are in Tables A1 and A2 in Appendix III. We matched the C and GDP crises, as before. There are 28 non-war pairs, 17 OECD and 11 non-OECD. There are 21 wartime pairs, 19 OECD and 2 non-OECD. In the non-war sample, the average size of C decline was 11.6%, compared to 13.8% for GDP (8.8% versus 13.4% for the OECD countries). In the war sample, the mean size of C decline was 29.1%, compared to 23.3% for GDP (27.4% versus 21.7% for the OECD countries). Thus, the HP-filtered data generate patterns for war samples that are similar to those found before—the average magnitude of C declines was notably larger than that of GDP declines. However, the findings for non-war samples are reversed—the average size of C declines was smaller than that of GDP declines. Thus, overall, the main robust finding is that C tends to fall by more than GDP during wartime crises. The relative magnitude of decline during non-war crises is less clear and may be roughly similar for C and GDP.

VI. Disaster Probability and the Frequency Distribution of Disaster Sizes

In this section, we study the sample of countries with essentially complete annual time series since before 1914. We use 22 countries (17 OECD) on per capita consumer expenditure, C, and 35 countries (21 OECD) on per capita GDP.[11] For the C-sample of 22 countries, we isolated 87 disasters (Table 5). 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 35 countries, we found 148 disasters (Table 7). 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.

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 87 disasters for C and 148 for GDP. Also as noted before, we measured

[11] 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.

disaster-years by the interval between peak and trough for each event. This calculation yields 312 disaster-years for C and 516 for GDP. The total number of annual observations is 2762 for C and 4511 for GDP. Therefore, the number of normalcy years is 2450 for C and 3995 for GDP. We estimate p as the ratio of the number of disasters to the number of normalcy years. This calculation yields p=0.0355 for C and 0.0370 for GDP.[12] 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=0.279 for C and 0.287 for GDP. Therefore, whether we gauge disasters by declines in consumption 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.

Our present theoretical model, summarized below, does not deal explicitly with the duration of disaster states. In the theory, a disaster is a jump that takes place in one period, which amounts to an instant of time. The model that we are constructing with Nakamura and Steinsson will deal explicitly with the time evolution of economic contraction 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 by the numbers shown for C and GDP, respectively, in Tables 5 and 7. 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 of time or is, more realistically, spread out over a few years.[13]

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[12]The main reason that these disaster probabilities are higher than 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=0.0213 for C and 0.0198 for GDP.

[13]Barro (2006, section V) studied the effect on the equity premium from varying the length of the period, T, in the model—this extension was feasible within the context of 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 a large impact on the implied equity premium.

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 forms. That is, the cumulative density satisfies

(2) $$\Pr(b>x) = Ax^{-\alpha},$$

where A>0 and α>0. We use the method of Gabaix and Ibragimov (2007) to estimate the exponent α. We ordered the observations on disaster sizes for C or GDP with the largest having rank 1, the next largest rank 2, and so on. Gabaix-Ibragimov show that α can be estimated consistently by running an OLS regression with log(rank – 1/2) as the dependent variable and log(disaster size) as the independent variable.

An OLS regression for the 87 observations for C-disasters is

(3) $$\log(\text{rank} - 1/2) = \underset{(0.095)}{0.264} - \underset{(0.055)}{1.934}*\log(\text{C-size}),\ R^2 = 0.94,$$

where OLS standard errors are in parentheses. Thus, the consistent point estimate of α is 1.934. However, the OLS standard error, 0.055, for this coefficient estimate is strongly biased downward because the rank-variable construction creates serially correlated errors. Gabaix-Ibragimov derive a formula for the correct standard error, given by $\hat{\alpha} \cdot \sqrt{(2/N)}$, where $\hat{\alpha}$ is the estimated value of α, and N is the number of observations (87). In the present case, this formula gives the value 0.29. Therefore, the estimated α is 1.93 with a valid standard error of 0.29.

The parallel OLS regression for the 148 observations for GDP-disasters is

(4) $$\log(\text{rank} - 1/2) = \underset{(0.071)}{0.690} - \underset{(0.040)}{1.940}*\log(\text{GDP-size}),\ R^2 = 0.94.$$

In this case, the correct standard error for the estimated coefficient $\hat{\alpha}$ =1.940 is 0.23. Therefore, the estimated α based on GDP crises is 1.94 with a standard error of 0.23.

The upshot of these results is that the cumulative density functions for disaster sizes for C and GDP follow Pareto formulas with exponents that are estimated with high precision and are both insignificantly different from 2. We have not derived an underlying theory that suggests that these cumulative densities should obey inverse-square laws. However, we hope that the world's expert on these power representations, Xavier Gabaix, will provide such a theory.

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:

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

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

The disaster size, b, follows some probability distribution, which we gauge by the empirical densities shown in Figures 1 and 2. (An alternative, not pursued here, would be to specify that the distribution of b accords with the Pareto densities that we estimated.)

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.[14] 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

$$(6) \qquad g^* = g + (1/2)\sigma^2 - p \cdot Eb,$$

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

A key simplification in this model—which allows for closed-form solutions—is that the shocks u_{t+1} and v_{t+1} in Eq. (5) 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

[14] 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 part of the existing Lucas trees. We can also 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.

extension, needed to match observations on rate-of-return volatility, 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:

$$(7) \qquad C_t^{-\gamma} = (\frac{1}{1+\rho^*}) \cdot E_t(R_t \cdot C_{t+1}^{-\gamma}),$$

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

$$(8) \qquad \rho^* = \rho - (\gamma - \theta) \cdot \left\{ g^* - (1/2) \cdot \gamma\sigma^2 - (\frac{p}{\gamma - 1}) \cdot [E(1-b)^{1-\gamma} - 1 - (\gamma - 1) \cdot Eb] \right\},$$

where *E* is the expectations operator and *g** is the expected growth rate given in Eq. (6).

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. (7), given the process that generates Y_t and C_t in Eq. (5). If we assume zero chance of default on either asset, the results are

$$(9) \qquad r^e = \rho^* + \gamma g^* - (1/2)\cdot\gamma\cdot(\gamma-1)\cdot\sigma^2 - p\cdot[E(1-b)^{1-\gamma} - 1 - (\gamma-1)\cdot Eb],$$

$$(10) \qquad r^f = \rho^* + \gamma g^* - (1/2)\cdot\gamma\cdot(\gamma+1)\cdot\sigma^2 - p\cdot[E(1-b)^{-\gamma} - 1 - \gamma\cdot Eb].$$

Hence, the equity premium is

$$(11) \qquad r^e - r^f = \gamma\sigma^2 + p\cdot[E(1-b)^{-\gamma} - E(1-b)^{1-\gamma} - Eb],$$

which depends only on γ and the uncertainty parameters (σ, p, and the distribution of b). In practice, the term $\gamma\sigma^2$ is negligible (as in the equity-premium puzzle found by Mehra and Prescott [1985]). The disaster term is proportional to p and tends to be large.

The key moments of the disaster-size distribution are $E(1\text{-}b)^{-\gamma}$ and $E(1\text{-}b)^{1-\gamma}$. The first term relates to the expected marginal utility of consumption, conditional on a fractional decline in C by the amount b. The second term comes from the crisis-contingent expectation of the product of R, the gross return on unlevered equity, and the marginal utility of consumption, which involves $(1\text{-}b)^{-\gamma}$. Given that, in a crisis, real stock prices (for unlevered equity) fall by the same fraction, b, as C and GDP, the relevant expectation becomes $E(1\text{-}b)^{1-\gamma}$. Note that the two key moments depend on the form of the b-distribution and on γ.

VIII. Simulating the Lucas-Tree Model

We now use the historical information on disaster probability and sizes to simulate the Lucas-tree model. Our present approach views the Euler condition in Eq. (7) as applying at each point in time 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 so that Eq. (7) applies 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. (7) to the determination of each country's asset returns, we neglect any implications from international trade in goods and assets; that is, we assume that each country is a closed economy. Moreover, we assume that the underlying parameters are fixed over time and across countries. Given all these assumptions, we can reasonably 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 element in the determination of crises—most obviously from wars but also from some financial crises and, perhaps, from epidemics of disease and natural-resource shocks.

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. These choices 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. [9] and [10]). Given the lack of useful outside information on ρ, we set ρ* in Eq. (10) to generate r^f=0.01—roughly the long-run average across countries of real rates of return on bills from Table 4.[15] Then ρ takes on the value needed to satisfy Eq. (8).

The disaster probability, p, and the frequency distribution of disaster sizes, b, come from our multi-country study of disaster events. We can then determine the value of γ needed in Eq. (11) to replicate an unlevered equity premium of around 0.05—the long-run average across countries implied by the data in Table 4. 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 11 applies to crises gauged by consumer expenditure, and Table 12 uses the crises gauged by GDP. For baseline cases, which encompass 87 observations of C crises and 148 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; that is, r^e=0.061 in the C case and 0.069 in the GDP case. The respective rates of time preference, ρ, are 0.046 and 0.054, and the corresponding effective rates of time preference, ρ*, are 0.030 and 0.039.

The results are sensitive to the choice of γ. For example, the second lines of Tables 11 and 12 show that, if γ=3.0, the values for r^e fall to 0.043 in the C case and 0.046 in the GDP case.

[15]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 (as discussed in Section IX). Thus, r^f is likely to be somewhat 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 not very different if the sample encompasses only the OECD countries, in which case the number of C disasters falls from 87 to 57, and the number of GDP disasters falls from 148 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 also do not change greatly if we truncate the b-distribution to eliminate smaller crises. Tables 11 and 12 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 0.049 in the case of C and 0.055 in the case of GDP. Thus, it is clear that the larger crises are crucial for getting the equity premium into the right ballpark for "reasonable" risk aversion, such as γ=3.5.

This reasoning also applies when we examine non-war samples, a selection that effectively eliminates the biggest crises from the sample. (We define war here as applying only to active combatants.) For C crises, the consideration of a non-war sample (which retains 62 of the original 87 disasters) yields r^e=0.017. For GDP crises, with 111 of the original 148 disasters retained, the result is again 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 11 and 12 show that γ=9 yields r^e=0.053 for C and 0.059 for GDP.

As discussed before, we also redid the analysis using the 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. In our planned formal statistical modeling, we will take a more rigorous approach to dealing with transitory versus permanent shifts in C and GDP.

Tables 11 and 12 show that the HP-filtering procedure substantially reduces the number of disasters—from 87 to 38 for C and from 148 to 68 for GDP—and, thereby, lowers the estimated disaster probabilities—to 0.0157 for C and 0.0179 for GDP. However, the size distributions of the crises are not so different from those in the original procedure. For C crises, the mean of b is 0.236, versus 0.218 in the original case, and for GDP, the mean of b is 0.226, rather than 0.208.

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 0.038 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=0.051, whereas for GDP, γ=4 yields r^e=0.052.

In terms of general patterns, the results based on consumer expenditure, C, in Table 11 deliver results for the equity premium that are similar to those based on GDP in Table 12. On the one hand, this finding suggests a kind of robustness in that the results are not sensitive to measurement differences in these main macro aggregates. On the other hand, this conclusion also 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 11 and 12 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 simple model from 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. In our empirical analysis, we approximated the crisis declines in C and GDP by cumulated fractional amounts over peak-to-trough intervals, as shown in Tables 5 and 7 and Figures 1 and 2. Now we extend the analysis to consider observed returns on stocks and bills during crises.

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 sharply each time a negative piece of news hit the financial markets. Since we are conditioning on crises that cumulate to at least a 10% fall in C or GDP, the crises that we isolated 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 declines in stock prices by cumulative fractional amounts. Specifically, the real stock-price falls shown in Tables 5 and 7 are the total fractional declines from the end of the year before the peak to the end of the year before the trough. This procedure omits changes in stock prices during the trough year—where the financial markets would likely be influenced by news that the crisis had ended.

Data on real stock prices are available only for a sub-sample of the C and GDP crises—51 of the 87 C crises (Table 5) and 71 of the 148 GDP crises (Table 7). Most of these crises show declines in real stock prices—39 of 51 (76%) of the C events and 55 of

71 (77%) of the GDP events. Figure 3 shows the size distribution of real stock-price declines during crises. The left-hand panels are the full distributions, and the right-hand panels eliminate the cases of stock-price increases. The left-hand panels show that a couple outliers feature large stock-price increases—these are for Argentina in the late 1980s and Chile in the mid 1970s. In these situations, periods of economic contraction were accompanied by major actual or prospective reforms that were viewed as highly favorable by the stock markets.[16] The overall mean and median of fractional stock-price declines were 0.080 and 0.173, respectively, for C crises and 0.169 and 0.296, respectively, for GDP crises. Conditioning on cases of stock-price decrease in the right-hand panels of Figure 3 shows roughly uniform shapes for the frequency distributions in the range of sizes between 0 and 0.7.[17] In this range, the mean and median of stock-price declines were 0.334 and 0.325, respectively, for C crises and 0.375 and 0.374, respectively, for GDP crises. An important property for the subsequent analysis is that the right-end tails for large stock-price declines are fat.

In Tables 11 and 12, we simulated the underlying asset-pricing model using the observed distributions of C and GDP crises. A critical 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 actual stock-price changes during the crises. That is, we use the data shown in Tables 5 and 7 and plotted in the left-hand panels of Figure 13. Table 13 shows the results from this alternative simulation.

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[16]An analogous case is Venezuela in the late 1980s—a C crisis in Table 5 that is not included in the sample currently being considered.

[17]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.

We mentioned before that a key moment for determining expected stock returns is $E[R_t \cdot (1-b)^{-\gamma}]$, conditioned on the economy being in a crisis. The term R_t is the gross return on stocks during a crisis, and b is the fractional decrease in C (or GDP) during a crisis. Given the assumption that R_t during a crisis equaled 1-b, this moment became $E[(1-b)^{1-\gamma}]$. Table 13 shows that the crisis mean of this object equaled 2.282 for the C crises and 2.255 for the GDP crises. If we instead set R_t to one minus the observed fractional stock-price decline (including negative values for stock-price increases), we get the values 1.808 for the C crises and 1.544 for the GDP crises. These values are smaller than those in the original simulation because, although the stock-price decreases are not perfectly correlated with the declines in C or GDP, the tails of the distribution of stock-price declines are fatter. For this reason, the implied expected rates of return on stocks (levered equity) somewhat overshoot the observed values. Table 13 shows that the model gets an overall expected stock return of 0.086 based on C crises and 0.107 based on GDP crises, compared with the long-run mean of stock returns of 0.083 from Table 4. The main point is that the observed pattern of stock-price changes during crises delivers reasonable results for expected stock returns (in overall samples and also in non-crisis samples).

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 4—if we introduce a constant probability of default or, for nominal claims, a time-invariant process for inflation.

Observed returns on short-term bills do not conform to these predictions. Table 14 shows means and medians for real bill returns during the C and GDP crises shown in Tables 5 and 7. (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 (87 C crises and 148 GDP crises) when data are also available on bill returns (53 for C and 69 for GDP). The average real bill return during crises was between -3% and -6% 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 well below the long-term average of around 1% shown in Table 4.

There are two main issues to consider. The first is whether a substantially negative number, such as -3% to -6% 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 real bill return during crises is that the disaster probability, p, is unusually high. In this case, 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 level of the equilibrium bill return during crises (caused by a high p 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 capital 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, the real capital losses at the onsets of crises could 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 4. However, the measurement of crisis-induced real capital losses on these bonds 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—the median inflation rates were 5.9% for C crises and 6.9% for GDP crises, compared to 4.5% for long samples for all countries taken together. (The inflation rate for each crisis is the mean value from the peak year to one year prior to the trough year.) 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).

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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 stock-market crashes associated with crises.

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.[19] 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 22-country sample for consumer expenditure and the 35-country sample for GDP. Promising candidates are Mexico, with gaps from 1911 to 1920, and Malaysia and South Korea, 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 separate Irish macroeconomic variables 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 9 shows the data that we have been able to compile, thus far, for crisis periods. These data cover 28 of the C crises contained in Table 5—18 of the 28 are in our main sample of 87 events. We

[19]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 nominal returns.

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—such as 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.

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 real rates of return on bonds in normal times and during crises.

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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.	1834	1790	1860-68	1860-68?

Part 2: Non-OECD Countries				
Country	**Starting Dates**		**Missing Values**	
	C	**GDP**	**C**	**GDP**
Argentina	1875	1875		
Brazil	1901	1850		
Chile	1900	1900		
Colombia	1925*	1905		
India	1919*	1872		
Indonesia	1960*	1880		
Malaysia	1900*	1900†	1940-46	1943-46
Mexico	1920*	1895†		1910-19?
Peru	1896	1896		
Philippines	1950*	1902††		1941-45
Singapore	1900*	1900†	1940-47	1940-49
South Africa	1946*	1911		
South Korea	1911*	1911	1941-52	
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 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.
††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 (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	0.0209	0.0620
Colombia	--	--	0.0236	0.0229
India	--	--	0.0140	0.0487
Indonesia	--	--	0.0160	0.0556
Peru	0.0174	0.0463	0.0207	0.0482
South Africa	--	--	0.0130	0.0485
South Korea	--	--	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.

Table 3 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	1925	--
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 a few 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 4 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	1925	0.1689 (0.4590)	-0.0302 (0.1918)	--	--	--
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†††	--	0.0829 (0.248)	0.0072 (0.089)	--	0.0266 (0.131)	0.0147 (0.081)

*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 3. 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 5 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 5, 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	-0.021	--	0.030
	1922	1918	0.181	0.154	--	0.085
	1932	1929	0.374	0.538	0.063	0.007
	1956	1954	0.136	-0.315	-0.410	0.774
	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 (X)	1932	1926	0.317	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 (X)	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
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 6

Consumption Disasters Grouped by Events/Periods

Pre-1914 (21)

OECD (11). 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). 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) (19)

OECD (14). 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 (5). Argentina (0.17), Brazil (0.11), Chile (0.32), Malaysia (0.10), Singapore (0.14).

1920s (10)

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

Non-OECD (4). Brazil (0.15), Chile (0.18), Malaysia (0.42), Singapore (0.13).

Great Depression (early 1930s) (18)

OECD (7). 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). Argentina (0.19), Brazil (0.20), Chile (0.37), Colombia (0.18), India (0.22), Malaysia (0.26), Mexico (0.32), Peru (0.14), Singapore (0.10), Turkey (0.12), Venezuela (0.31).

Spanish Civil War (includes non-combatant) (2)

OECD (2). Portugal (0.12), Spain (0.46).

Late 1930s (1)

Non-OECD (1). Venezuela (0.11).

World War II (includes non-combatants) (22)

OECD (17). 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 (5). Colombia (0.23), India (0.13), Malaysia (0.34), Taiwan (0.68), Turkey (0.30).

post-WWII (37)

OECD (9). 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 (28). 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 (0.14), Turkey (0.11), Uruguay 3 (0.10, 0.27, 0.22), Venezuela 4 (0.20, 0.22, 0.32, 0.15).

Note: Numbers in parentheses show fractional declines in C during each crisis.

Table 7 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
X: Not in analysis for GDP sample.

Table 7, 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	0.115	--	0.175
	1915	1912	0.105	0.018	--	0.026
	1919	1918	0.126	-0.018	--	-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 (X)	**1914?**	1909?	0.141?	--	--	0.031
	1932	1926	0.320	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	--	--	--
	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
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 8

GDP Disasters Grouped by Events/Periods

Pre-1914 (46)

OECD (19). 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 (27). 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), Mexico (0.14), 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) (26)

OECD (14). 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 (12). Argentina (0.29), Chile 2 (0.10, 0.13), India (0.15), 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)

OECD (11). 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). Singapore (0.39), South Africa (0.24), Turkey (0.13), Uruguay (0.14).

Great Depression (early 1930s) (22)

OECD (9). 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). Argentina (0.20), Brazil (0.20), Chile (0.36), Indonesia (0.11), Malaysia (0.19), Mexico (0.32), 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)

OECD (2). Portugal (0.15), Spain (0.31).

Late 1930s (2)

Non-OECD (2). Malaysia (0.12), Singapore (0.15).

World War II (includes non-combatants) (25)

OECD (14). 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). 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)

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

Non-OECD (24). 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: Numbers in parentheses show fractional declines in GDP during each crisis.

Table 9 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 9: This table shows the universe of consumption crises considered in Table 5 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 27 C crises (18 of which in our main sample of 87 C crises) from Table 5. 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 5), 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 5 measures to the decline in per capita consumption.

Table 10 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 10, 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 (22) mean	0.329		0.284	
OECD non-war (48) mean	0.127		0.123	
OECD timing breakdown for trough years				
Total 70: 35 same year, 16 C later, 19 GDP later				
War 22: 10 same year, 3 C later, 9 GDP later				
Non-war 48: 25 same year, 13 C later, 10 GDP later				

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
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
Taiwan	**1905**	0.219	**1905**	0.214
	1911	0.127	1911	0.114
	1945	0.684	**1945**	0.662
non-OECD total (32) mean	0.199		0.164	
non-OECD war (4) mean	0.352		0.307	
non-OECD non-war(28) mean	0.177		0.144	
non-OECD timing breakdown for trough years				
Total 32: 24 same year, 7 C later, 1 GDP later				
War 4: 3 same year, 1 C later, 0 GDP later				
Non-war 28: 21 same year, 6 C later, 1 GDP later				

Table 10, continued		
	C contraction	**GDP contraction**
	size	**size**
Full sample total (102) mean	0.193	0.171
Full sample war (26) mean	0.333	0.288
Full sample non-war (76) mean	0.145	0.131
full sample timing breakdown for trough years		
Total 102: 59 same year, 23 C later, 20 GDP later		
War 26: 13 same year, 4 C later, 9 GDP later		
Non-war 76: 46 same year, 19 C later, 11 GDP later		

Note: We consider here only 17 OECD and 5 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 5 and 7 (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 11 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**	**$E(1-b)^{-\gamma}$**	**$E(1-b)^{1-\gamma}$**	**ρ**	**ρ***	**r^e**
baseline (b≥0.10, γ=3.5)	87	312	0.0355	0.279	0.218	3.97	2.36	0.046	0.030	0.061
γ=3.0	87	312	0.0355	0.279	0.218	3.01	1.91	0.029	0.008	0.043
OECD	57	214	0.0286	0.266	0.223	3.87	2.37	0.034	0.007	0.048
non-OECD	30	98	0.0654	0.306	0.219	4.14	2.34	0.099	0.130	0.116
b≥0.15	54	226	0.0213	0.239	0.276	5.42	2.95	0.043	0.019	0.058
b≥0.20	32	144	0.0122	0.222	0.349	7.80	3.87	0.040	0.008	0.055
b≥0.30	17	87	0.0064	0.195	0.444	12.39	5.54	0.036	-0.003	0.052
b≥0.40	11	60	0.0041	0.183	0.506	16.90	7.07	0.034	-0.010	0.049
non-war	62	195	0.0242	0.318	0.170	2.02	1.64	0.005	-0.050	0.017
non-war, γ=9	62	195	0.0242	0.318	0.170	7.69	5.89	0.037	-0.037	0.053
HP-filtered	38	242	0.0157	0.157	0.236	3.85	2.42	0.016	-0.030	0.030
HP-filtered, γ=4.5	38	242	0.0157	0.157	0.236	6.58	3.85	0.035	-0.011	0.051

Note: The baseline simulation uses the 87 consumption disasters of size b≥0.10 for the 22 included countries from Table 5. 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. $E(1-b)^{-\gamma}$ and $E(1-b)^{1-\gamma}$ in columns 7 and 8, respectively, are the mean values of these key determinants of the equity premium (from Eq. [11]). 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. (8). The values of ρ and ρ* are chosen to generate r^f=0.01 in Eq. (10). r^e in column 11 is the overall expected rate of return on unlevered equity (from Eq. [9]).

Table 12 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)	148	516	0.0370	0.287	0.208	4.09	2.33	0.054	0.039	0.069
γ=3.0	148	516	0.0370	0.287	0.208	3.02	1.88	0.033	0.012	0.046
OECD	75	263	0.0287	0.285	0.221	4.96	2.60	0.057	0.039	0.073
non-OECD	73	253	0.0527	0.289	0.196	3.19	2.06	0.046	0.040	0.060
b≥0.15	83	317	0.0198	0.262	0.277	6.06	3.08	0.049	0.025	0.065
b≥0.20	54	228	0.0126	0.237	0.336	8.29	3.89	0.047	0.017	0.063
b≥0.30	23	109	0.0052	0.211	0.459	15.82	6.39	0.042	0.002	0.058
b≥0.40	14	69	0.0032	0.203	0.532	23.13	8.63	0.039	-0.005	0.055
non-war	111	371	0.0268	0.299	0.168	2.02	1.63	0.005	-0.048	0.017
non-war, γ=9	111	371	0.0268	0.299	0.168	7.76	5.92	0.041	-0.017	0.059
HP-filtered	68	433	0.0179	0.157	0.226	4.14	2.44	0.024	-0.019	0.038
HP-filtered, γ=4.0	68	433	0.0179	0.157	0.226	5.64	3.13	0.037	-0.004	0.052

Note: The baseline simulation uses the 148 GDP disasters of size b≥0.10 for the 35 included countries from Table 7. See the notes to Table 11 for discussion and definitions.

Table 13 Simulated Model Using Observed Stock-Price Changes during Crises		
Variable/parameter	**C-crises**	**GDP-crises**
γ: coefficient of relative risk aversion	3.5	3.5
ρ^*: effective rate of time preference (see Eq. [8])	0.030	0.039
g: expected normal growth rate	0.025	0.025
$(1+g)^{-\gamma}$	0.917	0.917
p: disaster probability	0.0355	0.0368
N: crisis samples with stock-price data	51	71
Eb: mean contraction size in crisis sample	0.224	0.201
$E[(1-b)^{-\gamma}]$: mean in crisis sample	3.610	4.029
$E[(1-b)^{1-\gamma}]$: mean in crisis sample	2.282	2.255
Stock-returns:		
$E(R_t-1)$: overall mean (Table 4)	0.0829	0.0829
$E(R_t-1)$: mean in crisis sample	-0.0798	-0.1689
$E(R_t-1)$: implied non-crisis mean*	0.0888	0.0925
$E[R_t \cdot (1-b)^{-\gamma}]$: mean in crisis sample	1.808	1.544
Model simulation:		
$E(R_t-1)$: non-crisis**	0.092	0.118
$E(R_t-1)$: implied overall mean*	0.086	0.107

*Based on the formula:

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

**Based on approximate formula derived from Eq. (7):

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

Note: The parameters γ, ρ^*, g, and p come from Tables 11 and 12. N is the number of crises in the C and GDP samples with data on stock-price changes (from Tables 5 and 7). For these samples, Eb is the mean contraction size for C or GDP, $E[(1-b)^{-\gamma}]$ is the mean of $(1-b)^{-\gamma}$, and $E[(1-b)^{1-\gamma}]$ is the mean of $(1-b)^{1-\gamma}$. "$E(R_t-1)$: mean in crisis sample" is the mean fractional change in real stock prices (algebraic value) during the C and GDP crises in Tables 5 and 7. "$E[R_t \cdot (1-b)^{-\gamma}]$: mean in crisis sample" is the mean of the interaction between (1+fractional change in real stock prices) and $(1-b)^{-\gamma}$, where b is the contraction size for C or GDP.

Table 14 Bill Returns and Inflation Rates during Crises		
C crises		
	mean	**median**
Real rate of return on bills (N=53)	-0.060	-0.029
Inflation rate (N=81)	1.18	0.059
GDP crises		
Real rate of return on bills (N=69)	-0.057	-0.031
Inflation rate (N=121)	0.970	0.069

Note: The results apply to the crisis samples used in the main analysis: 87 C crises from Table 5 and 148 GDP crises from Table 7. 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 5 and 7. The cells show means and medians of real rates of return on bills and inflation rates for these sub-samples.

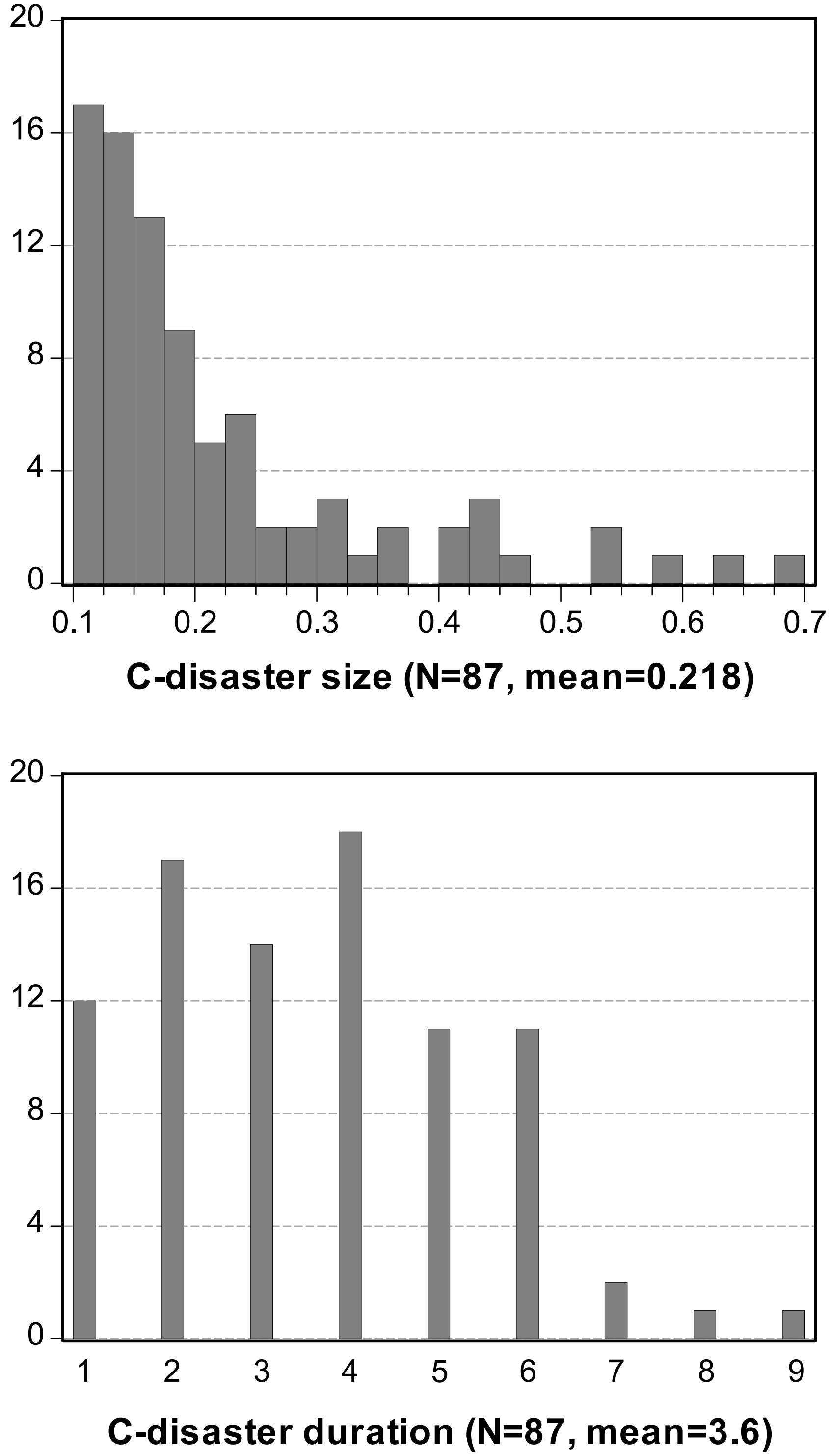


Figure 1 C-Disaster Sizes and Durations (Years)

Note: Histograms show distributions of consumption disaster sizes (fractional declines) and durations (years between trough and peak) for 87 cases from Table 5.

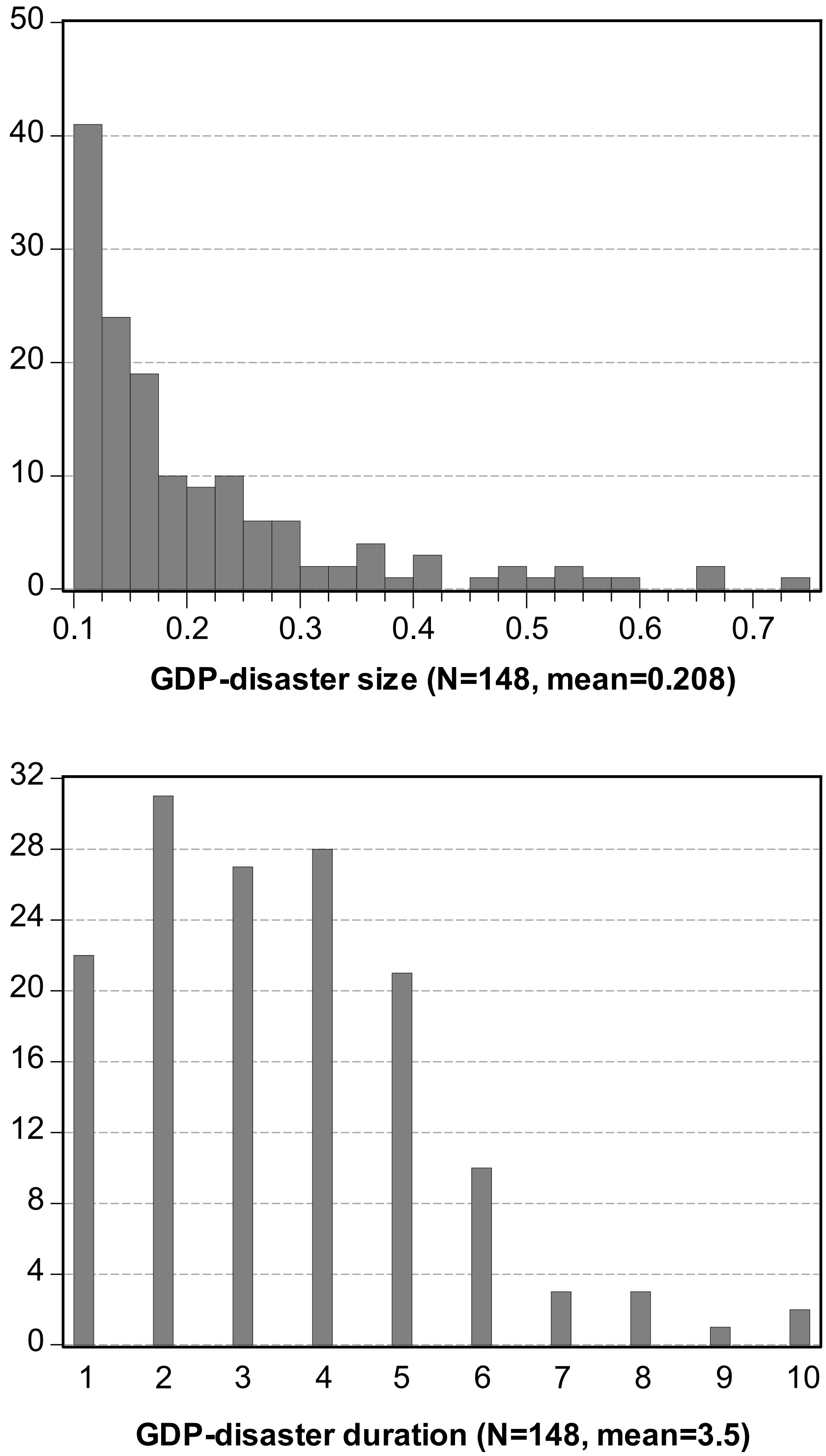


Figure 2 GDP-Disaster Sizes and Durations (Years)

Note: The histograms show distributions of GDP disaster sizes (fractional declines) and durations (years between trough and peak) for 148 cases from Table 7.

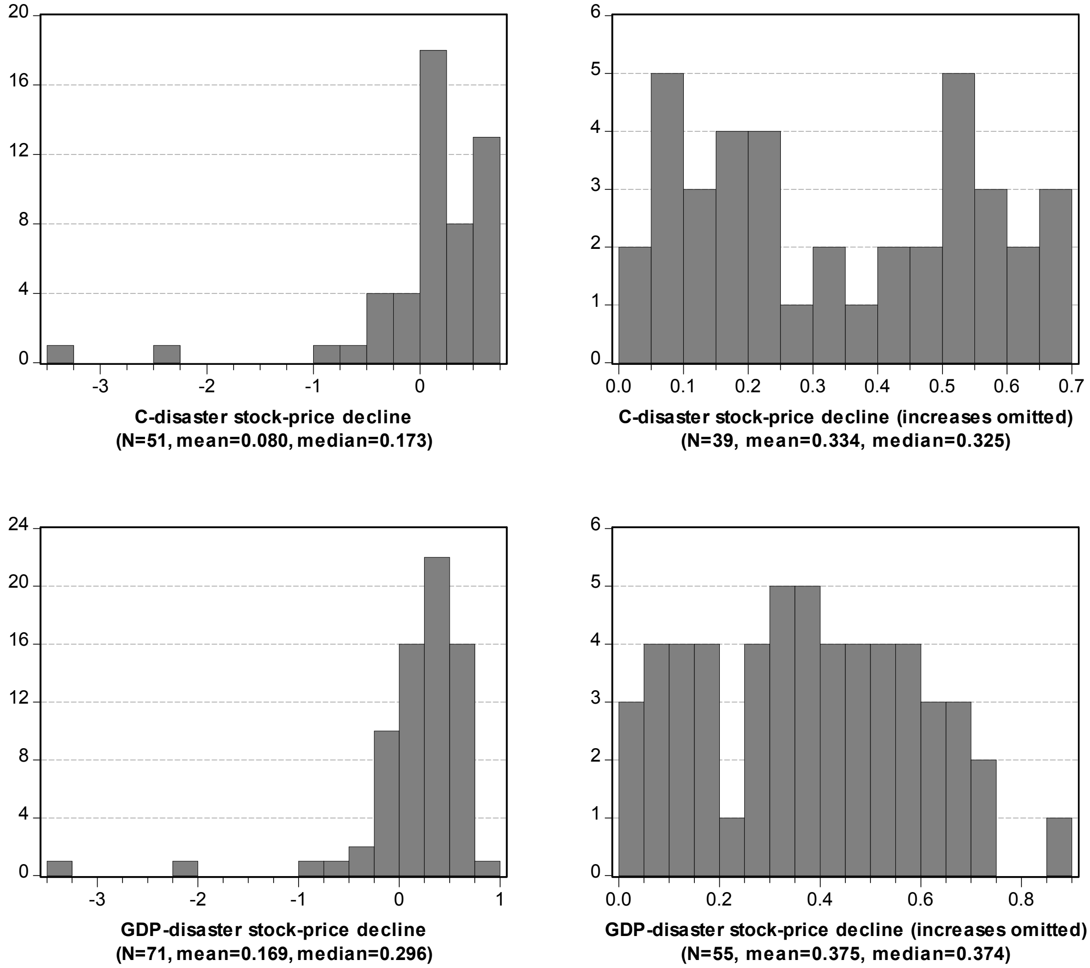


Figure 3

Stock-Price Decreases during Disasters

(horizontal axes show fractional declines in real value)

Note: The sample for consumption, C, disasters is the 51 of 87 cases from Table 5 with data on stock-price declines. The sample for GDP disasters is the 71 of 148 cases from Table 7 with data on stock-price declines. 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 [1911-1920]	Used linear interpolation as done in another source.	[Forthcoming] Estimated based on sectoral shares and output from oil, mining , sugar, breweries, steel, textiles, sisal, transports, electricity, other manufacturing, various harvests, and trade data. (Maddison's population series is also a linear interpolation between 1910 and 1920, which yields incorrect measures of per capita output; a separate population series was built from historical records.)
	[1896-1899]	Missing.	Covered with official figures of GDP.
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	War periods [1941-1953]	Mismatch with indicated sources, undisclosed estimation procedure.	Estimated real growth rates for most of the period by weighting movements in agricultural production, commodities production, and provision of services. In some cases, explicit assumptions were made due to lack of continuous data points. An aggregate measure of GDP was built for the last four years with information reported by international organizations during the Korean War.
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 C.	Provides five benchmark figures for 1820-1870.	Continuous series starting in 1790 taken from a new edition of the Historical Statistics of the U.S. This series is modified to incorporate our preferred estimates for certain periods and to exclude the Civil War years, which warrant further analysis.
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 and 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).

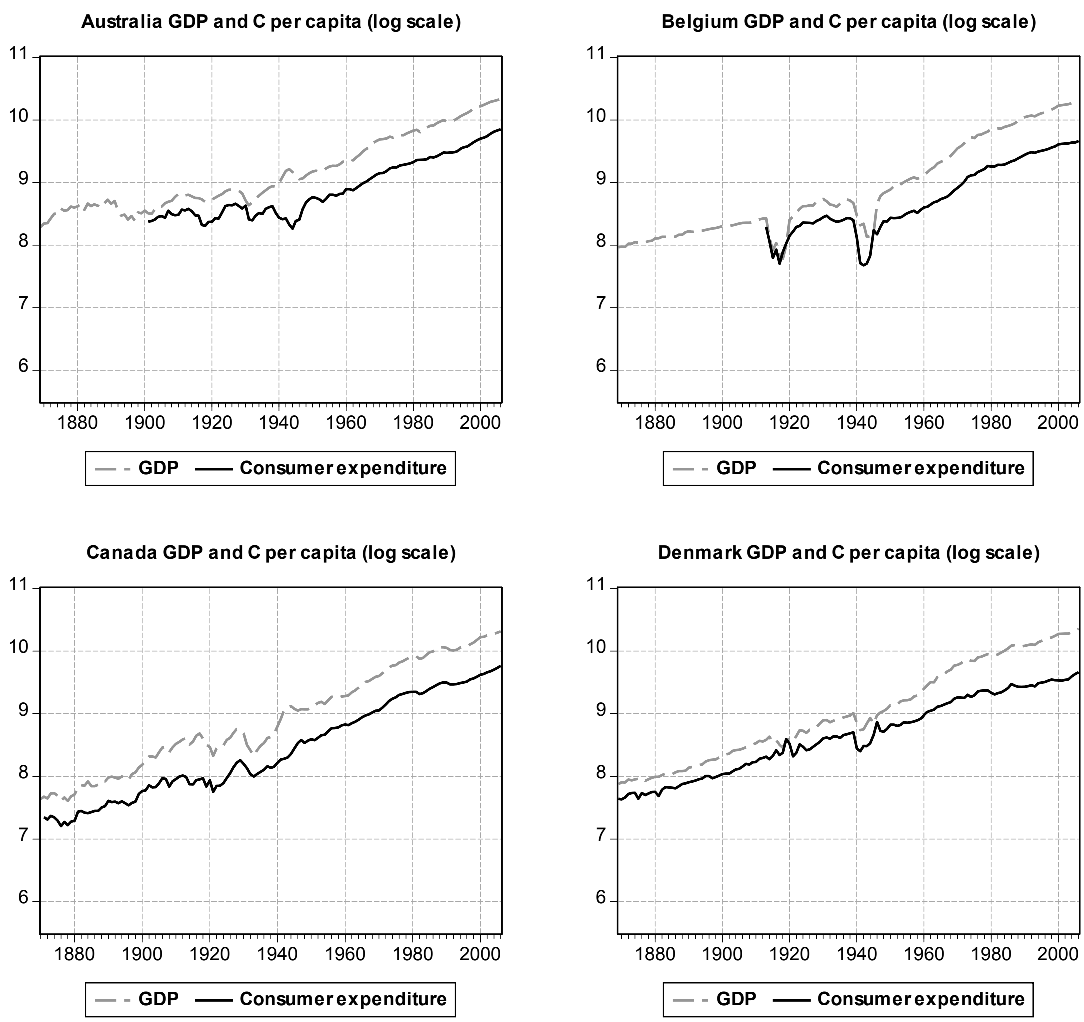


Figure A1

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

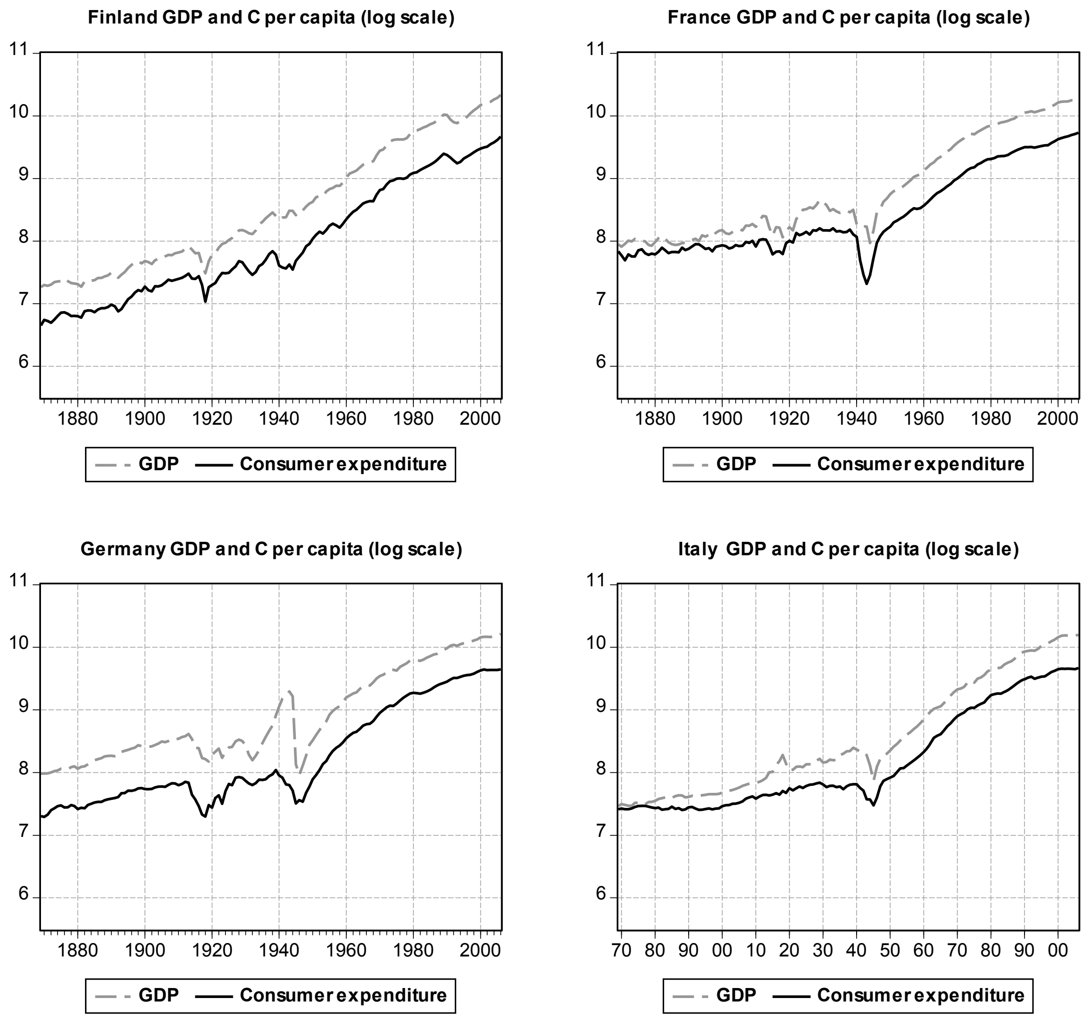


Figure A2

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

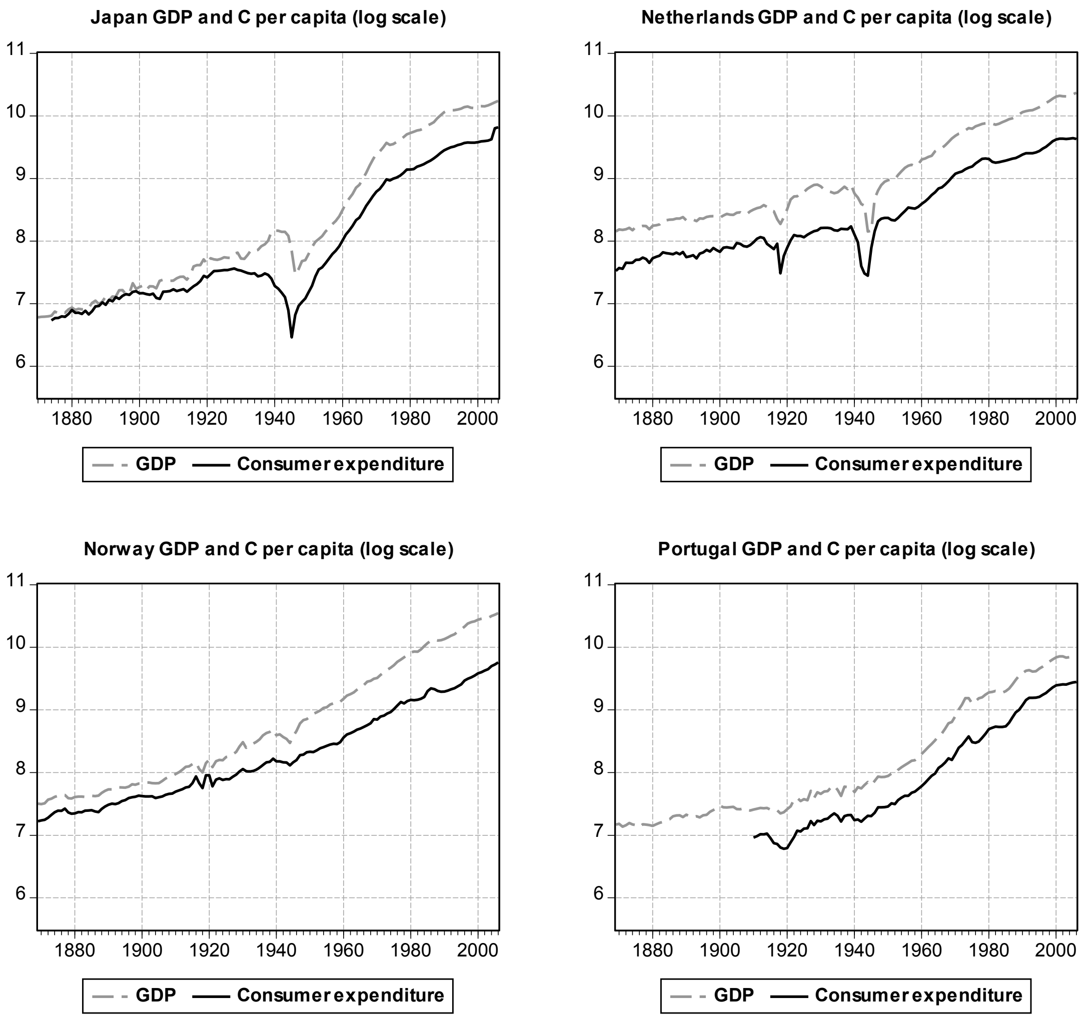


Figure A3

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

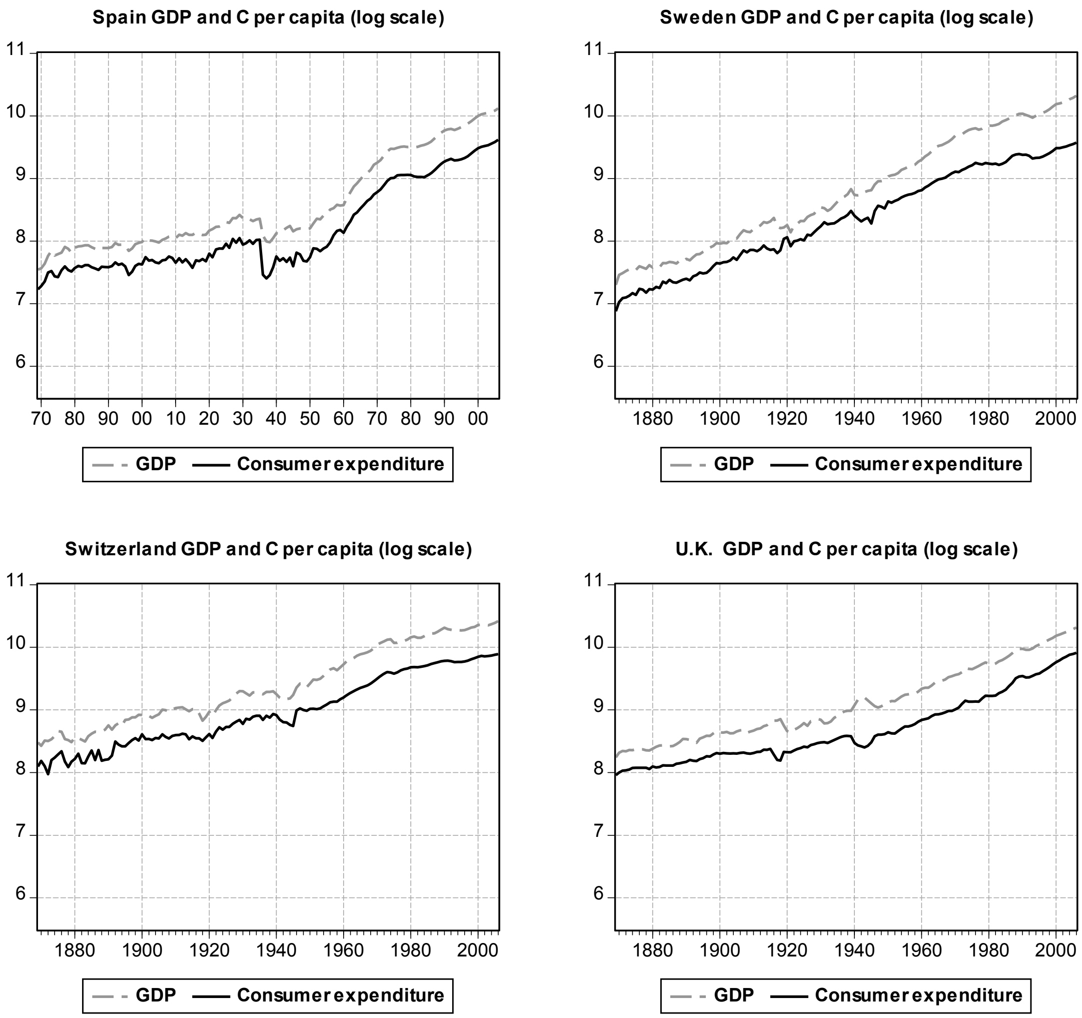


Figure A4

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

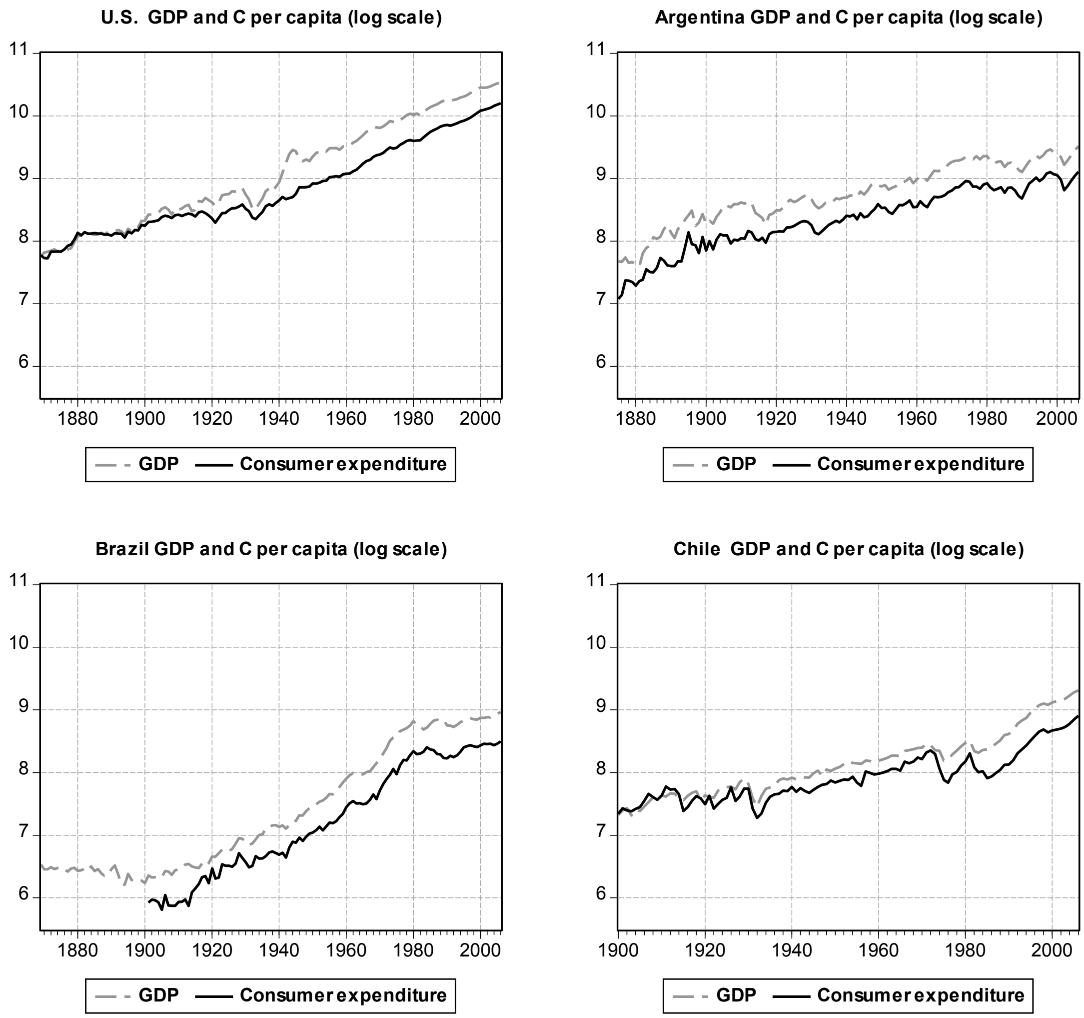


Figure A5

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

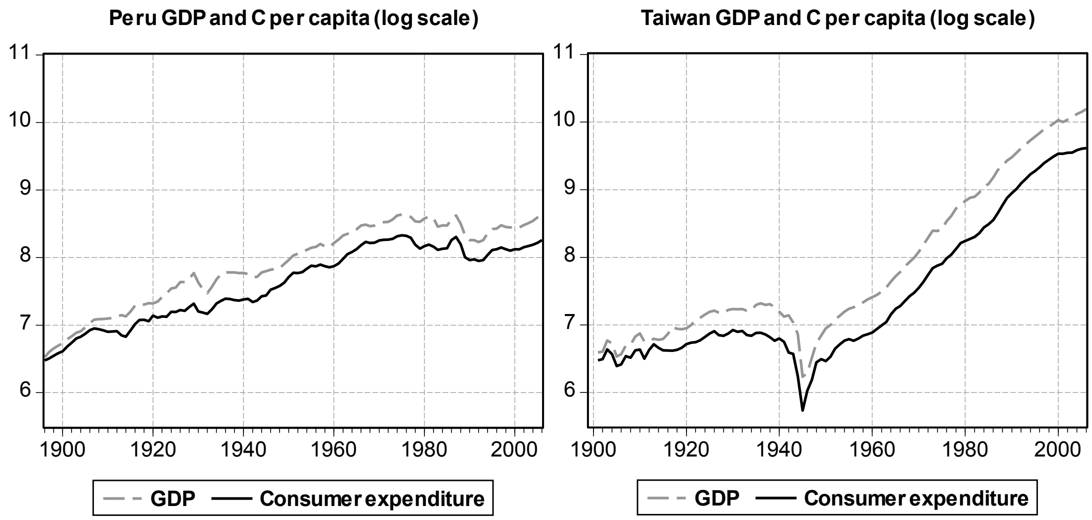


Figure A6

GDP and Consumer Expenditure for Peru, Taiwan

Appendix III

Disasters Gauged by (one-sided) HP-Filtered C and GDP

Table A1 Consumption Disasters (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

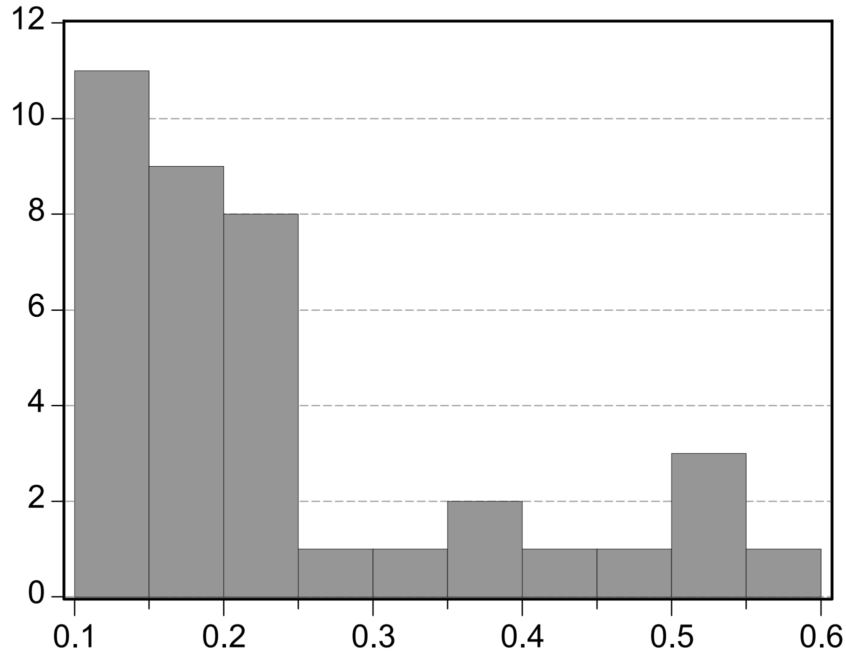
Part 2: Non-OECD Countries			
Country	**Trough**	**Peak**	**C decline**
Argentina	1933	1929	0.141
	1990	1980	0.168
	2004	2000	0.149
Brazil	1992	1985	0.158
Chile	1917	1913	0.198
	1933	1930	0.247
	1978	1973	0.320
	1987	1981	0.157
Colombia (X)	1945	1941	0.095
India (X)	**1942**	1933	0.184
Malaysia (X)	1922	1917	0.297
	1934	1930	0.141
Mexico (X)	1933	1929	0.188
	1988	1982	0.115
Peru	1914	1909	0.095
	1985	1976	0.205
	1993	1988	0.229
Singapore (X)	1916	1910	0.103
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: C declines (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.

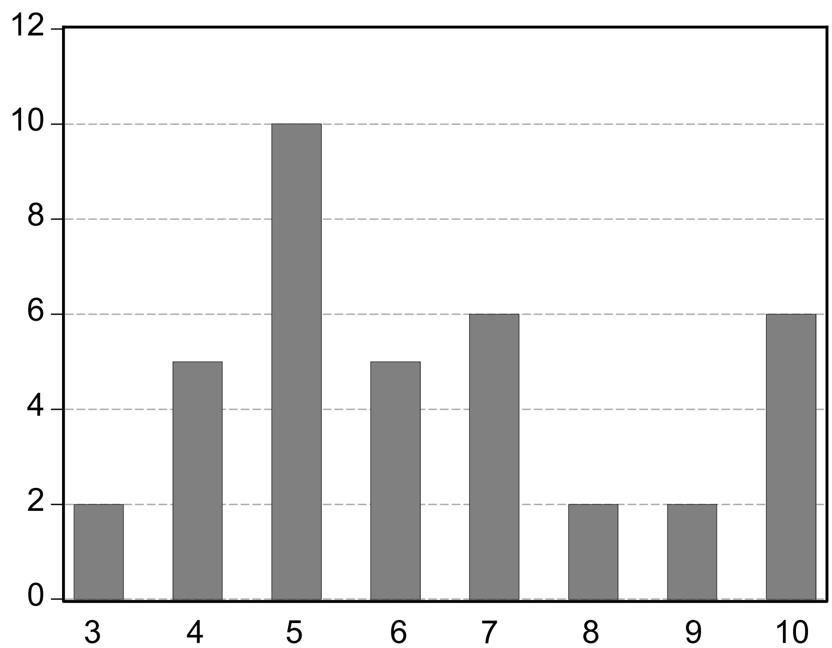
Table A2 GDP Disasters (one-sided HP filters)			
Part 1: OECD Countries			
Country	**Trough**	**Peak**	**GDP decline**
Australia	1897	1891	0.255
	1920	1913	0.109
	1933	1928	0.163
Austria	**1920**	1913	0.346
	1936	1930	0.226
	1947	1943	0.455
Belgium	**1919**	1913	0.436
	1935	1930	0.108
	1945	1938	0.426
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

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 (X)	**1915?**	1910	0.106?
	1934	1926	0.252
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: GDP declines (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.

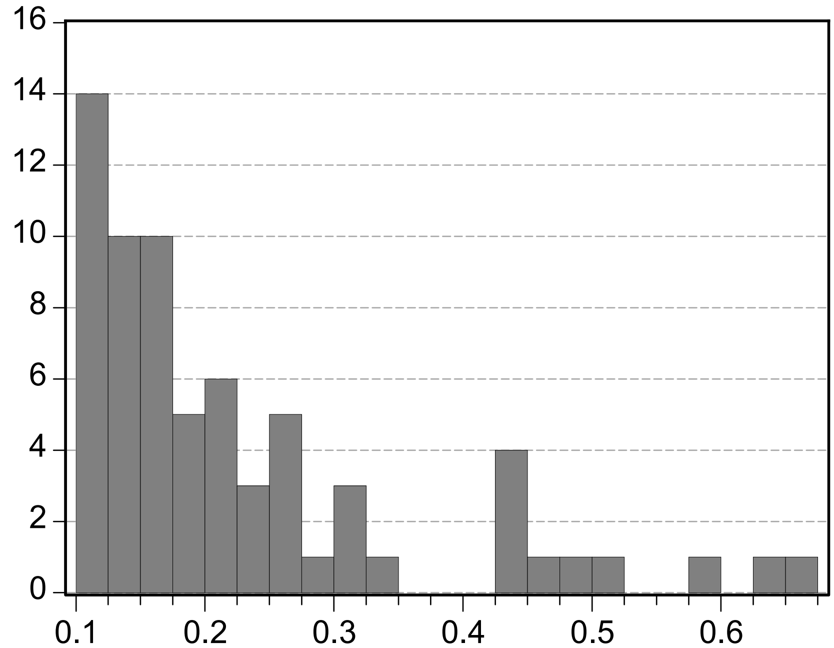


C (one-sided HP filter)-disaster size (N=38, mean=0.236)

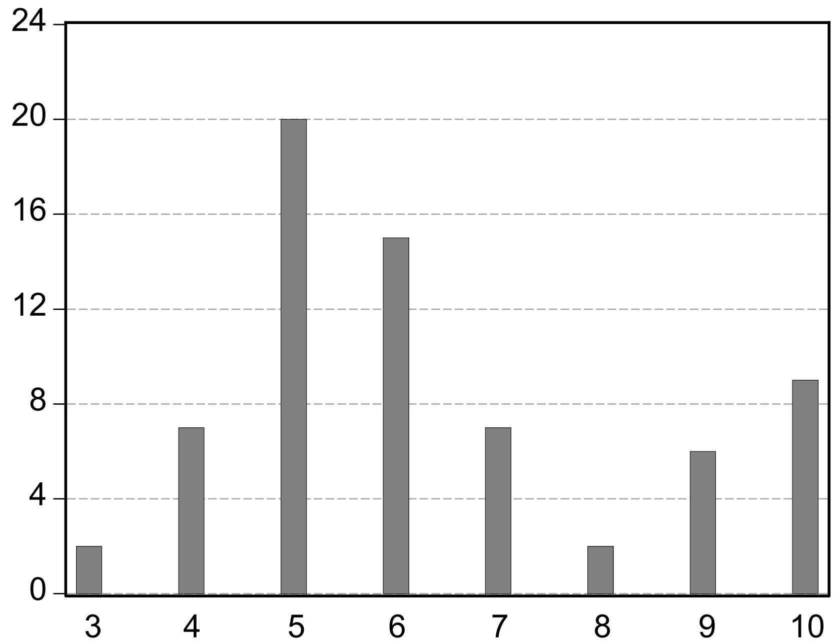


C (one-side HP filter)-disaster duration (N=38, mean=6.4)

Figure A4 C-Disaster Sizes and Durations (Years), HP-filtered



GDP (one-sided HP filter)-disaster size (N=68, mean=0.226)



GDP (one-sided HP filter)-disaster duration (N=68, mean=6.4

Figure A5 GDP-Disaster Sizes and Durations (Years), HP-Filtered