The Statistical Behavior of GDP after Financial Crises and Severe Recessions

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Abstract

Do severe recessions associated with financial crises cause permanent reductions in potential GDP, or does the economy return to its trend? If the economy eventually returns to its trend, does the return take longer than the return following recessions not associated with financial crises? We develop a statistical methodology that is appropriate for identifying and analyzing slumps, episodes that combine a contraction and an expansion, and end when the economy returns to its trend growth rate. We analyze the Great Depression of the 1930s for the U.S., severe and milder financial crises for advanced economics, severe financial crises for emerging markets, and postwar recessions for the U.S. and other advanced economies. The preponderance of evidence for episodes comparable with the current U.S. slump is that, while potential GDP is eventually restored, the slumps last an average of nine years. If this historical pattern holds, the Great Recession that started in 2007:4 will not ultimately affect potential GDP, but the Great Slump is not yet half over.

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I. Introduction

The United States is well into the fourth year of the Second Great Contraction, exceeded only by the Great Depression of the 1930s in its length and severity. While the Great Recession of December 2007 – June 2009 ended over two years ago, the recovery has been characterized by very slow growth and persistently high unemployment. [1] When economists have the data to study the long-term effects of this episode, what will they conclude?

This paper uses historical experience to analyze one aspect of this question: Do severe recessions associated with financial crises cause permanent reductions in potential GDP, or does the economy return to its trend? If the economy eventually returns to its trend, does the return take longer than the return following recessions not associated with financial crises?[2]

Economists do not have generally accepted language to describe the type of episode that we analyze. The National Bureau of Economic Research (NBER) defines a recession (or contraction) as the period from peak to trough of a business cycle, and an expansion as the period from trough to peak. Our metric combines a contraction and part of an expansion, which ends when the economy returns to its long-run growth rate, but not necessarily on its long-run trend path. Following Hall (2011), we will call this period of low resource allocation a slump, although Hall defines a slump in terms of unemployment rather than in terms of GDP.[3] Hall calls the contraction that began in late 2007 the Great Slump. We will use the terms Second Great Contraction and Great Slump interchangeably.

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[1] Reinhart and Rogoff (2009) and Rogoff (2011) argue persuasively that the Great Recession, which connotes a downturn similar, although larger, than a typical recession, is a very misleading description of the current situation. They propose Second Great Contraction, where the First Great Contraction was the Great Depression, as an alternative.

[2] Wynne (2011) shows that medium-term U.S. real GDP relative to the trend following the Great Recession is comparable to the average of other countries that have experienced similar banking crises. The focus here is on the long-run effects.

[3] Hall's definition of a slump is the period from the time when employment falls below its normal level during a contraction to the time when it attains its normal level during an expansion.

We develop a statistical methodology that is appropriate for identifying and analyzing slumps. We consider (log) aggregate real GDP, so that the first-difference is the economy's growth rate. Since long-term growth is generally positive, the data will be trending. We search for a pair of structural changes in real GDP. The first break is characterized by a negative change in the intercept and a change in the slope, while the second is characterized by a change in the slope. We estimate three types of models. The less restricted model constrains the slope following the second break to equal the slope preceding the first break, so that long-term growth is unchanged. The more restricted model also constrains the level of GDP following the second break to equal the level that would have been attained if the first break had not occurred, so that the slump does not affect potential GDP. In a few cases where neither type of model appears to be appropriate, we estimate an unrestricted model where long-term growth can change.

By far the most severe example of a slump in U.S. economic history is the Great Depression of the 1930s. Using the more restricted model with annual data from 1870 – 2008, we identify the first break in 1929 and the second break in 1941, a 12 year period that encompassed the contractions of 1929 – 1933 and 1937 – 1938 before potential GDP was restored. Moreover, we cannot reject the more restricted model in favor of the less restricted model at standard significance levels, so even the Great Depression did not affect potential GDP.

The picture is very different after World War II. Using quarterly data from 1950 – 2007, we find evidence of slumps associated with all nine postwar recessions prior to 2007, with the median slump lasting six quarters. Comparing our results with the recessions identified by the NBER Business Cycle Dating Committee, the slumps begin (on average) in the quarter when the contraction starts and end three quarters after the trough signifies the end of the recession. The

more restricted model cannot be rejected in favor of the less restricted model for any of the nine slumps, and so we find no evidence that any of the postwar recessions affected potential GDP.

Neither the Great Depression nor the postwar recessions provide sufficient evidence to answer our questions. The magnitude of the Great Depression, where real GNP fell by 33.6 percent from 1929 to 1933, dwarfs that of the Great Recession, where real GDP fell by 5.3 percent from 2007:4 to 2009:2. While the magnitude and duration of postwar recessions and slumps are negatively correlated, the magnitude of the Great Recession is larger than any postwar recessions and the duration of the Great Slump is already longer than any previous postwar slump.

Since our questions cannot be answered by using solely U.S. data, we turn to international evidence in order to utilize more comparable experiences. Reinhart and Rogoff (2009) identify four severe postwar bank-centered financial crises that caused recessions in advanced economies: Norway (1987), Finland (1991), Sweden (1991), and Japan (1992), with the start of the crisis denoted by the year in parentheses. We find evidence of slumps lasting 4 ¾ years for Norway, 8 ½ years for Finland, 9 ½ years for Sweden, and 10 ¾ years for Japan following the financial crises. The evidence regarding the long-run effects of the crises on potential output is mixed, as the more restricted model for which potential output is eventually restored can be rejected for Finland and Japan, but not for Norway and Sweden. The evidence for Norway and Japan, however, is not useful for understanding the effects of the Second Great Contraction because real GDP fell by less than 0.5 percent following the financial crises, an order of magnitude less than during the Great Recession.

Reinhart and Rogoff (2009) also analyze 13 milder financial crises for advanced economies. We only find evidence of slumps following these crises for two countries: Denmark

(1987) and Australia (1989), with the slump lasting 7 ¼ years for Denmark and 7 ¾ years for Australia. The magnitude of these slumps is larger than for Norway and Japan, but smaller than for Finland, Sweden, and the U.S. following their financial crises. The more restricted model for which potential output is eventually restored cannot be rejected for either country.

We proceed to analyze slumps for six emerging markets: Mexico (1994), Korea, Malaysia, and Thailand (1997), Colombia (1998), and Argentina (2001), for which Reinhart and Rogoff (2009) identify severe postwar financial crises. For each of these countries, the slumps begin in the year of the crisis. While the magnitude of the associated recessions is larger than for advanced economics, the duration of the slumps is much shorter than for advanced economics affected by severe financial crises, lasting from 3 to 19 quarters with a median of 4 quarters. The evidence regarding the long-run effects of the crises on potential output is mixed, as the more restricted model for which potential output is eventually restored can be rejected for Colombia, Malaysia, Mexico, and Thailand, but not for Argentina and Korea. The short duration of these slumps limits their usefulness for understanding the Second Great Contraction.

In a widely quoted speech delivered at the recent Jackson Hole Economic Symposium, Bernanke (2011) expressed his views regarding the long-run effects of the Great Recession. "Notwithstanding the severe difficulties we currently face, I do not expect the long-run growth potential of the U.S. economy to be materially affected by the crisis and the recession if -- and I stress *if* -- our country takes the necessary steps to secure that outcome."

We focus on slumps of sufficiently large duration to be comparable with the Second Great Contraction: the Great Depression and slumps following severe and milder financial crises for advanced economies. The preponderance of evidence is that these slumps end with the economy on its trend growth path, so that long-run potential GDP is not affected, which is

consistent with Bernanke's views. The average length of these slumps is nine years which, assuming that the Great Recession started in 2007:4, would put the end of the Second Great Contraction in 2016:4.

How could that outcome be achieved? Real GDP growth has averaged 2.4 percent since the end of the Great Recession in 2009:2 and, according to the average of economists' forecasts reported in the Wall Street Journal (2011), is expected to average 2.5 percent through 2012:4. In order for real GDP to return to trend in 2016:4, growth would have to equal 4.16 percent for the following four years, a rate comparable with the experience of advanced countries that have undergone slumps following financial crises.

History does not always repeat itself, and we do not know the ultimate shape and duration of the Second Great Contraction. The overarching message of Reinhart and Rogoff (2009), however, is that the "this time is different" syndrome leads people to mistakenly believe that the current financial crisis will be different from past financial crises. Taking comparable historical experience as a guide, the Great Recession will not ultimately affect potential GDP, but the Great Slump is not yet half over.

2. Structural Change Tests for Slumps

While structural change tests play an important role in studying long-run macroeconomic time series, existent tests for a single break in Andrews (1993), multiple breaks in Bai and Perron (1998), and multiple breaks with restrictions in Perron and Qu (2006) are not well-suited for identifying slumps.[4] We propose a very specific two-break test for structural change. The first break allows for a change in both the intercept and the slope, with the change in the intercept constrained to be negative to ensure that we are finding the start of a contraction. The second break is just in the slope, and dates the end of the slump. Both the question posed in the paper,

[4] The very large literature on structural change is surveyed in Perron (2006).

does real GDP return to its trend following a slump, and the statistical methods that we use require real GDP to be regime-wise trend stationary.[5]

We utilize a variant of the Bai (1999) likelihood ratio test, which allows for lagged dependent variables and multiple changes in the intercept and the slope of the trend function. The estimated model is presented below,

$$y_t = \mu + \beta t + \gamma_1 DU_{1t} + \theta_1 DT_{1t} + \theta_2 DT_{2t} + \sum_{i=1}^{k} \rho_i y_{t-i} + u_t, \quad (1)$$

where $DU_t = 1$ if $t > Tb_i$ and 0 otherwise, and $DT_t = t - Tb_i = 1$ if $t > Tb_i$ and 0 otherwise. The lag length, k, is chosen by Schwarz Information Criterion (SIC), which involves minimizing the function of the residual sum of squares combined with a penalty for a large number of parameters. The estimated break points are obtained by a global minimization of the sum of squared residuals. The Sup F_t statistic is based on the difference between the minimized SSR associated with zero and two breaks, and is the maximum, over all possible breaks, of the F-statistic for the null hypothesis that $\gamma_1 = \theta_1 = \theta_2 = 0$.[6]

If potential output is restored following the slump, the trend following the second break will be a linear projection of the trend preceding the first break. We call this the more restricted model, which we estimate by adding two constraints to equation (1):

$$\theta_1 + \theta_2 = 0, \quad (2)$$

which imposes the same slope prior to the first break and following the second break, and

$$\gamma_1 + \theta_1 (Tb_2 - Tb_1) = 0, \quad (3)$$

[5] Ben-David, Lumsdaine, and Papell (2003) provide evidence of regime-wise trend stationarity for long-horizon GDP data. Papell and Prodan (2004) and Murray and Nelson (2004) provide an exchange of views regarding whether U.S. real GDP is better described as a trend stationary or integrated process with a large and long-lasting, but temporary, structural change.

[6] We impose 5 percent trimming to avoid finding breaks at the beginning and end of the sample.

which restricts the trend following the second break to be a continuation of the trend prior to the first break. We also estimate a less restricted version of the model that imposes (2) but not (3). In this case, the growth rate is equal before and after the slump, but potential output is not necessarily restored. In occasional cases, we estimate an unrestricted version where neither (2) nor (3) are imposed and the growth rate is allowed to change. The restrictions can be evaluated using standard F tests.[7]

Our test differs from the standard methodology used to calculate output losses from financial crises, as in International Monetary Fund (1998), Bordo et al. (2001), and Jonung and Hagberg (2005), who measure the trend by extrapolating the three or five-year average growth rate prior to the crisis. This tends to overstate the trend because output growth prior to crises is often unsustainably high.[8] By estimating potential GDP using data before and after the slump, we mitigate the effects of the level of GDP at the time of the crisis.

We are usually interested in analyzing the effects of a particular financial crisis, so identifying a single episode is appropriate. In some cases, however, we wish to identify multiple episodes. The first episode is identified as described above. The data is then split into two sub-samples, one before the first break and another following the second break. For each sub-sample, we search for another pair of breaks as described above, and so on. The process stops when the structural changes are no longer significant or when the sub-samples become too short.

Critical values are calculated using parametric bootstrap methods. We assume that the underlying process follows a stationary finite-order autoregression of the form:

$$A(L)\,y_t = e_t\,, \tag{4}$$

[7] Papell and Prodan (2011) estimate these models with long-horizon GDP per capita to conduct tests of constant steady-state growth.

[8] International Monetary Fund (2009) measure the trend by extrapolating from a seven-year period that ends three years before the onset of the crisis. This often produces negative trend growth rates.

$e_t \sim iidN(0,1)$ with $E(e_t) = 0$ and $E(e^2{}_t) < \infty$. $Y = (y_{1,\ldots,} y_T)'$ denotes the observed data. $A(L)$ is an invertible polynomial in the lag operator. The AR(p) model may be bootstrapped as follows: First, using the Schwartz criterion, determine the optimal AR(p) model. Next, estimate the parameters $\hat{A}(L)$ for the optimal model.[9] To determine the finite-sample distribution of the statistics under the null hypothesis of no structural change, use the optimal AR model with $iidN(0, \sigma^2)$ innovations to construct a pseudo sample of size equal to the actual size of the data, where σ^2 is the estimated innovation variance of the AR model. Then calculate the bootstrap parameter estimates: $\hat{A}*(L)$ and compute the statistics of interest. The critical values are taken from the sorted vector of 1000 replicated statistics, and depend on the number of observations, the estimated AR parameters, and the coefficient on the trend. Since the critical values are unique to each estimate, we only report p-values.

3. Identifying and Dating Slumps

We use the statistical methods described above to identify and date slumps associated with the Great Depression in the U.S., postwar U.S. recessions, severe financial crises in advanced economies, mild financial crises in advanced economics, and severe financial crises in emerging markets. We focus on two measures. The magnitude of the recession following the crisis is the percentage decrease in GDP from peak to trough. The duration of the slump is the length of time between the first and second breaks, and will generally be longer than the associated recession.

[9] Diebold and Chen (1996) and Prodan (2008) show that, with highly persistent data, tests for structural change suffer from serious size distortions when tabulated critical values calculated with iid errors are used.

3.1 The Great Depression in the United States

The Great Depression of the 1930s is the most severe combination of a recession and financial crisis in U.S. history. Unemployment rose from 3.2 percent in 1929 to 25.2 percent in 1933, and real GNP fell by 33.6 percent over the same period. During the Great Recession, unemployment rose from 4.8 percent in 2007:4 to 10 percent in 2009:4, and real GDP fell by 5.3 percent from 2007:4 to 2009:2. We start by analyzing the long-term effects of the Great Depression. Given the advances in economic policymaking since the 1930s, this (hopefully) provides an upper bound for the long-term effects of the Great Recession. We use annual real GDP data from Maddison (2003), which starts in 1870 and has been updated through 2008.

Using the more restricted model, for which potential GDP is not affected by the episode, we search for the combination of breaks that provides the most evidence of a slump. The results are reported in Table 1. The first break (intercept and slope) is in 1929, the year that the recession at the commencement of the Great Depression began, and the second break (slope) is in 1941, eight years after the August 1929 – March 1933 recession ended and three years after the May 1937 – June 1938 recession ended. The null hypothesis of no structural change can be rejected against the more restricted two-break alternative at the 1 percent significance level. We also test the more restricted against the less restricted model. The constraint that GDP following the second break lies on the trend line preceding the first break, so that potential GDP in not affected by the slump, cannot be rejected at the 25 percent significance level.[10] Figure 1 depicts a graph that illustrates the more restricted model for the U.S. long-run real GDP data.

While the contraction precipitated by the financial crisis of 1929 lasted four years, we estimate that it took 12 years for the Great Depression to end and for potential GDP to be

[10] We do not extend this analysis to other countries because, as documented by Ben-David and Papell (1995), Ben-David, Lumsdaine, and Papell (2003), and Papell and Prodan (2011), analysis of structural change for long-horizon aggregate and per capita GDP is dominated by wars, particularly World War II.

restored. Reinhart and Rogoff (2009) propose a different metric, the number of years that it takes GDP per capita to return to its pre-crisis level, and calculate 10 years for the U.S. during the depression. Hall (2011) identifies slumps as periods when the employed fraction of the labor force aged 25 through 54 is below its normal level of 95.5 percent. While the exact definition is specific to the postwar U.S., we can implement the concept. The unemployment rate for the U.S. averaged 4.7 percent between 1920 and 1929. It rose to 8.9 percent in 1930, peaked at 25.2 percent in 1933, and remained above 14 percent through 1940 before falling to 9.9 percent in 1941 and 4.7 percent in 1942.[11] By this metric, the great Depression lasted for 13 years, putting our estimate of 12 years in between Reinhart and Rogoff's and Hall's measures.

3.2 Postwar Recessions in the United States

Postwar recessions in the U.S. are much less severe than the Great Depression. We use quarterly data from International Financial Statistics that starts in 1950:1 to avoid the aftermath of World War II and ends in 2007:4 to avoid the Great Recession.

Again using the more restricted model, for which potential GDP is not affected by the episode, we first search over the whole sample for the combination of breaks that provides the most evidence of a slump. The results are reported in Table 2. The first break (intercept and slope) is in 1957:3 and the second break (slope) is in 1958:2, with a p-value of 0.07. This is also the slump with the largest magnitude, with a fall in real GDP of 3.8 percent from peak to trough. By repeatedly splitting the sample, 8 more slumps are found, although most are not significant at conventional levels. This should not be surprising considering the small samples. The magnitude of the median slump is 2.07 percent, much lower than the 5.3 percent drop in real GDP during the Great Recession. The duration of the median slump is six quarters.

[11] We start the calculations in 1920 to avoid including the low unemployment rates during World War I. The data is from Gordon (1981).

The slumps closely correspond with NBER recession dates. The start of each slump is one period before, equal, or one period after the peak of the NBER business cycle that signifies the beginning of a recession, with the median first break equal to the date of the peak. The slumps end between zero and six quarters after the end of their corresponding recessions, with the median slump being three quarters longer than its associated recession. Since the median recession lasts 10 months, the slumps are about double the length of the recessions.

We test the more restricted against the less restricted model. The constraint that GDP following the second break lies on the trend line preceding the first break, so that potential GDP in not affected by the slump, cannot be rejected at the 10 percent significance level for any of the nine slumps. Combined with the results on the Great Depression, we do not find any evidence that recessions, whether or not associated with financial crises, have affected potential GDP for the U.S.

The experience of postwar U.S. recessions provides no guidance for the duration of the Second Great Contraction. As shown in Table 2, the magnitude of postwar recessions is negatively correlated with the duration of postwar slumps, as the largest recession is associated with one of the shortest slumps and the two smallest recessions are associated with the two longest slumps. The magnitude of the Great Recession, however, is larger than any postwar recessions and the duration of the Great Slump is already longer than any previous postwar slump. As emphasized by Rogoff (2011), the Second Great Contraction should be diagnosed as a typical deep financial crisis, not a typical deep recession.

3.3 Severe Financial Crises in Advanced Economies

Since the U.S. experience is not sufficient to analyze the potential long-term effects of the Second Great Contraction, we turn to international evidence. Following Reinhart and Rogoff

(2009), we analyze the effects of four severe postwar bank-centered financial crises in advanced economies: Norway (1987), Finland (1991), Sweden (1991), and Japan (1992), with the start of the crisis denoted by the year in parentheses.[12] We use real GDP quarterly data from International Financial Statistics.[13] The magnitude of the recessions following these crises varies greatly country-by-country. Real GDP fell from peak to trough by 9.9 percent for Finland and 3.2 percent for Sweden, but only by 0.23 percent for Japan and 0.18 percent for Norway. The results are reported in Table 3.

We first estimate the more restricted model for each country. For Sweden, the slump starts in 1990:1 and ends in 1999:3, the null hypothesis of no structural change can be rejected in favor of the two restricted break alternative at the 15 percent significance level, and the more restricted model cannot be rejected in favor of the less restricted model at the 25 percent level. For Norway, the slump starts in 1987:2 and ends in 1992:1, but the no structural change null cannot be rejected at virtually any significance level. The more restricted model, however, cannot be rejected in favor of the less restricted model at the 25 percent level. We also tried estimating the other models, but did not find evidence of structural change corresponding to the dates of the financial crisis.

Estimating the more restricted model does not work well for the other countries. For Finland, the second break for the more restricted model is at the end of the sample, indicating that the model is inappropriate. Estimating the less restricted model, the slump starts in 1990:3 and ends in 1999:1, the null hypothesis of no structural change can be rejected in favor of the two restricted break alternative at the 1 percent significance level, and the more restricted model

[12]Reinhart and Rogoff (2009) also include Spain (1977) as a severe financial crisis, but it did not cause a recession and, therefore, cannot cause a slump.

[13] This data source is common for all countries. We use an index where the base year, 2005, equals 100. The quarterly data starts from 1950:1 to 1997:1, depending on the data availability, and ends in 2007:4 for all countries. We seasonally adjust the data when necessary.

can be rejected in favor of the less restricted model at the 1 percent level. For Japan, the second break is at the end of the sample for both the more and less restricted models. Estimating the unrestricted model, the slump starts in 1991:2 and ends in 2002:1, the null hypothesis of no structural change can be rejected in favor of the two break alternative at the 15 percent significance level, and both the more restricted and less restricted models can be rejected in favor of the unrestricted model at the 1 percent level. For all four countries, the first break closely corresponds with the start of the financial crises.

The long-term effects of these financial crises are much different than the long-term effects of U.S. postwar recessions. First, while potential output is eventually restored for Norway and Sweden, it is not restored for Finland and Japan. Second, the slumps following the severe crises are much longer than the slumps associated with U.S. recessions, ranging from 4 ¾ years for Norway, 8 ½ years for Finland, 9 ½ years for Sweden, and 10 ¾ years for Japan, with a median length of 9 years. The length of these slumps is also more than twice Reinhart and Rogoff's measure of the duration of major financial crises, the number of years for per capita GDP to return to its previous level, which ranges from 2 years for Japan, 3 for Norway, 5 for Sweden, and 8 for Finland, with a median length of 4 years.

The experience of Japan is often used as an example of the severe effects of a major financial crisis. For example, Reinhart and Rogoff (2009) write "The worst postwar crisis prior to 2007, of course, was that of Japan in 1992, which set the country off on its "lost decade."" While Japan undoubtedly experienced severe effects following the crisis, they were not the same effects that the U.S. is experiencing during the Second Great Contraction. Real GDP fell from peak to trough by only 0.23 percent, compared with 5.3 percent for the U.S. during the Great Recession. Moreover, long-term growth in Japan decreased after the crisis, as both the more

restricted and the less restricted models are rejected in favor of the unrestricted model. It is the decline in long-term growth that caused the "lost decade," not the aftermath of a severe recession caused by a financial crisis.

Reinhart and Rogoff (2009) argue that the U.S. subprime crisis has more in common with severe financial crises than with U.S. postwar recessions. We would further argue that, since only Finland and Sweden experienced large falls in GDP following their financial crises, they form a better basis for comparison with the U.S. than the others.[14] This can be seen in Figure 2, which depicts the data and the appropriate model for Finland, Sweden, Japan, and Norway. While GDP falls for Finland and Sweden following the crises, Japan experienced a substantial decline in its growth rate and no evidence of structural change can be seen for Norway.

3.4 Mild Financial Crises in Advanced Economies

In addition to the severe crises, Reinhart and Rogoff (2009) identify 13 milder crises for advanced economies: United Kingdom (1974, 1991, and 1995), Germany (1977), Canada (1983), United States savings and loan (1984), Iceland (1985), Denmark (1987), New Zealand (1987), Australia (1989), Italy (1990), Greece (1991), and France (1994), with the start of the crisis denoted by the year in parentheses. The results for these countries are reported in Table 4.[15]

We do not find much evidence that mild financial crises are followed by slumps. Estimating the more restricted model, the most significant breaks only correspond with the financial crises for Denmark. This accords with earlier results for the U.S., where the 1984 savings and loan crisis is not one of the nine slumps. The duration of most of the slumps is similar to that of U.S. postwar recessions, with the slumps not associated with financial crises lasting between 2 and 15 quarters. Most of the slumps do not affect potential GDP, as the more

[14] Jonung and Hagberg (2005), Haugh, Ollivaud, and Turner (2009), and European Commission (2009) analyze the impact of financial crises in various subsets of Finland, Japan, Norway, and Sweden.
[15] We do not report results for Iceland because our data does not include the financial crisis.

restricted model can only be rejected in favor of the less restricted model at the 5 percent level for United Kingdom and at the 10 percent level for Germany.

For Denmark, the breaks are chosen by estimating the more restricted model, the slump starts in 1989:1 and ends in 1996:2, and the null hypothesis of no structural change cannot be rejected in favor of two structural breaks at the 25 percent significance level. After splitting the sample, we also find evidence of slumps associated with mild financial crises for Australia. With the more restricted model, the slump starts in 1990:4 and ends in 1998:3, and the null hypothesis of no structural change can be rejected in favor of the two restricted break alternative at the 1 percent significance level. For both countries, the more restricted model cannot be rejected in favor of the less restricted model at virtually any significance level. The graphs for Australia and Denmark using the appropriate models are depicted in Figure 3.

The magnitude of the recessions following the two milder financial crises is 1.8 percent for Denmark and 1.6 percent for Australia, smaller than for either the U.S. during the Great Recession or for the two countries, Finland and Sweden, which experienced severe recessions following major financial crises. The duration of the slumps is 7 ¼ years for Denmark and 7 ¾ years for Australia, shorter than for Finland and Sweden but much longer than for slumps not associated with financial crises.

3.5 Severe Financial Crises in Emerging Markets

Financial crises are not, of course, restricted to advanced economies. Following Reinhart and Rogoff (2009), we analyze the effects of six severe financial crises in emerging markets: Mexico (1994), Korea, Malaysia, and Thailand (1997), Colombia (1998), and Argentina (2001), with the start of the crisis denoted by the year in parentheses. The magnitude of the recessions following these crises is very large. Real GDP fell from peak to trough by 5.1 percent for

Mexico, 7.1 percent for Colombia, 7.6 percent for Korea, 11.7 percent for Malaysia, 17.3 percent for Argentina, and 17.5 percent for Thailand. The results are reported in Table 5.[16]

We again first estimate the more restricted model for each country. For Argentina, the slump starts in 2001:2 and ends in 2003:2, the null hypothesis of no structural change can be rejected in favor of the two restricted break alternative at the 1 percent significance level, and the more restricted model cannot be rejected in favor of the less restricted model at the 25 percent level. For Korea, the slump starts in 1997:4 and ends in1998:4, the no structural change null can be rejected at the 1 percent significance level, and the more restricted model cannot be rejected in favor of the less restricted model at the 25 percent level. For Mexico, the slump starts in 1995:1 and ends in 1995:4, the no structural change null can be rejected at the 1 percent significance level, and the more restricted model can be rejected in favor of the less restricted model at the 5 percent level. For Malaysia, the slump starts in 1997:4 and ends in 1999:1, but the no structural change null cannot be rejected at the 25 percent significance level. The more restricted model can be rejected in favor of the less restricted model at the 5 percent level.

Estimation of the more restricted model does not produce sensible results for the other countries. For Thailand, the second break for the more restricted model is at the end of the sample. Estimating the less restricted model, the slump starts in 1997:2 and ends in 1998:2 for Thailand. The null hypothesis of no structural change can be rejected in favor of the two restricted breaks alternative at the 1 percent significance level and the more restricted model can be rejected in favor of the less restricted model at the 1 percent level. For Colombia, the second break is at the end of the sample for both the more and less restricted models. Estimating the unrestricted model, the slump starts in 1998:2 and ends in 2003:1, the null hypothesis of no

[16] Reinhart and Rogoff (2009) analyze three additional financial crises. We do not have quarterly data for Hong Kong, the data for Indonesia does not go far enough back to establish a pre-crisis trend, and we do not find evidence of a slump around the crisis for the Philippines.

structural change can be rejected in favor of the two breaks alternative at the 1 percent significance level, and both the more restricted and less restricted models can be rejected in favor of the unrestricted model at the 1 percent level. For all six countries, the first break closely corresponds with the start of the financial crises.

The duration of the slumps for emerging markets is much shorter than for the advanced economics affected by severe financial crises, lasting from 3 quarters for Mexico, 4 quarters for Korea and Thailand, 5 quarters for Malaysia, 8 quarters for Argentina, and 19 quarters for Colombia, with a median of 4 ½ quarters. In contrast with the results for advanced economies, the duration of the slumps is much shorter than the measure, return to per capita GDP, used by Reinhart and Rogoff (2009), which has a median of 6 years for these countries, and is even shorter than the length of the slumps associated with postwar U.S. recessions. These results do not appear to provide any guidance regarding the length of the Second Great Contraction. The magnitude of the recessions is much larger and the duration of the slumps is much shorter than the experience of advanced countries following either severe or mild financial crises.

4. Implications for the Second Great Contraction

We have analyzed a number of slumps precipitated by financial crises. We now become more speculative and ask whether our results can help answer two questions: (1) Will real GDP for the U.S. return to its trend line following the end of the Second Great Contraction? (2) When will the Second Great Contraction end?

The preponderance of evidence we have presented indicates that the Great Slump will not affect long-term potential GDP. Focusing on the episodes for which the parallels with the Second Great Contraction are closest, the more restricted model where potential GDP is not affected by the slump cannot be rejected for the Great Depression of the 1930s in the U.S. and 3 of the 4

postwar slumps for advanced economies. In addition, none of the nine postwar recessions for the U.S. affected potential GDP.

How long will the Great Slump last? Again restricting attention to the Great Depression and the postwar slumps for advanced economies, the slumps lasted from 7 ¼ years for Denmark, 7 ¾ years for Australia, 8 ½ years for Finland, 9 ½ years for Sweden, and 12 years for the U.S. Whether you consider all five slumps or just consider the two slumps following severe postwar financial crises in advanced economies (Finland and Sweden), the average duration is 9 years.[17] While this is not an estimate, it can be taken as a guide to the duration of the Great Slump.

We now ask whether our results can help answer two additional questions: (1) Are the implied growth rates between now and the predicted end of the Second Great Contraction consistent with historical experience? (2) How do our results compare with the results obtained by using other measures?

Assume that the Second Great Contraction started in 2007:4, when real GDP peaked and the Great Recession started, and will end after 9 years in 2016:4 with unchanged potential GDP. What growth rate of real GDP will be required? According to our results in Section 3.2, the last slump for the U.S. before the Great Recession ended in 2003:3. Since we do not have data after 2016, we cannot exactly replicate our methodology for calculating potential GDP. We use the Congressional Budget Office (CBO) (2011) measure of actual and forecasted potential GDP growth, which is 2.3 percent per year from 2003 to 2016.[18] Real GDP growth averaged 2.4 percent from 2009:2 to 2011:2. [19]

[17] The median duration is 8 ½ years for all five countries and 9 years for Finland and Sweden.
[18] The average real GDP growth rate from 2003:3 to 2007:4 was 2.6 percent per year. Since this was clearly unsustainably high, the use of this measure would overstate potential GDP at the end of the slump.
[19] Although real GDP data for 2011:3 is not yet available, it is clear that growth has not increased. We use the nowcast of real GDP growth from the Wall Street Journal (2011), 2.1 percent, as our 2011:3 data.

One scenario is depicted in Panel A of Figure 4.[20] Assume that real GDP growth follows the mean forecasts reported in the Wall Street Journal (2011), which average 2.5 percent from 2011:4 to 2012:4, and growth increases starting in 2013:1. In that case, it would require a 4.16 percent annual growth rate over the following 4 years for real GDP to equal potential GDP in 2016:4.

Is this scenario plausible? The annual growth rate of real GDP over the last four years of the slumps that are most relevant for comparison with the Second Great Contraction is 6.94 percent for the U.S., 5.12 percent for Finland, 4.16 percent for Australia, 3.04 percent for Sweden, and 2.75 percent for Denmark. The average of these growth rates is 4.40 percent. If we eliminate the U.S. during the Great Depression because the magnitude of the contraction was so much larger than the others, the average growth rate is 3.77 percent. The 4.16 percent annual growth starting in 2013:1 that will restore potential GDP by 2016:4 is consistent with the historical experience of countries recovering from severe recessions caused by financial crises.

Other scenarios are, of course, possible. An alternative is depicted in Panel B of Figure 4. Suppose that real GDP growth increases starting in 2011:4. In that case, it would require a 3.78 percent annual growth rate over the next 5 years for real GDP to equal potential GDP in 2016:4. The average growth rate of real GDP over the last five years of the slumps for Australia, Denmark, Finland, Sweden, and the U.S. is 4.19 percent, falling to 3.64 percent if we eliminate the U.S., so this path is also consistent with historical experience.

We conclude this section by comparing our result that the Great Slump will last for 9 years and end in 2016:4 with results from other measures. Reinhart and Rogoff (2009) measure the duration of financial crises by the number of years that it takes for GDP per capita to return to its pre-crisis level. Population growth in the U.S. is about 0.96 percent per year. Assuming that

[20] Through 2012:4, this figure replicates Figure 6 in Chinn (2011).

this continues, GDP per capita will return to its 2007:4 level in 2013:2 under our first scenario, where growth averages 2.5 percent through 2012 and 4.16 thereafter, and in 2012:4 under our second scenario, where growth averages 3.78 percent starting in 2011:4. Our measure of duration is considerably longer than Reinhart and Rogoff's measure under both scenarios, a result consistent with our findings for slumps associated with the Great Depression and financial crises for advanced countries.

According to Hall's (2011) measure, the Great Slump will end when the employed fraction of the labor force aged 25 through 54 returns to its normal level. While we are not aware of forecasts for this measure, we can conduct an analysis in the spirit of Hall's metric. The CBO (2011) projects that the unemployment rate will remain elevated at 8.7 percent in 2012 and 2113, fall to 5.4 percent by 2016, and achieve its long-term level of 5.2 percent in 2017. The CBO projections assume federal tax and spending policies under current law, including the expiration of the 2001 and 2003 tax cuts at the end of 2012, which will impose substantial restraint on the economy in 2013. Assuming that at least some of these tax cuts will continue past 2012, Hall's return to normal employment level measure is consistent with our return to potential GDP measure.

The final alternative that we consider is to calculate, using the CBO's (2011) real GDP growth projections, how long it will take for real GDP to equal potential GDP. According to these projections, which are conditional on current law, the Great Slump will not end until 2017:4. The only substantive difference between the CBO projections and our first scenario is that, after averaging 2.5 percent in 2011 and 2012, the CBO projects that growth will fall to 1.7 percent in 2013 before rising to 4.2 percent in 2014 through 2016. Although the CBO is required to make projections under current law, it seems extremely unlikely that none of the tax cuts will

be extended. If the CBO's projections are correct except that growth increases to 4.2 percent in 2012 instead of 2013, the Great Slump will end in 2016:4.

5. Conclusions

This paper posed two questions: (1) Do severe recessions associated with financial crises cause permanent reductions in potential GDP, and (2) If the economy does eventually return to its trend, does the return take longer than the return following recessions not associated with financial crises?

In order to answer these questions, we need to measure episodes whose duration lasts longer than the peak to trough that defines a recession. We define a slump as a contraction and part of an expansion which ends when the economy returns to its long-run growth rate, but not necessarily on its long-run trend path where potential GDP in unchanged by the episode.

The answer to both questions differs between advanced countries and emerging markets. Most severe recessions associated with financial crises in advanced countries do not cause permanent reductions in potential GDP. Potential GDP is restored following the financial crises of 1929 for the U.S., 1987 for Denmark, 1989 for Australia, and 1991 for Sweden. The only exception is Finland, where long-run growth was restored with a reduction of potential GDP following the crisis of 1991. Among emerging markets, in contrast, potential GDP is restored following the recessions associated with financial crises for only two of the six countries.

Among advanced countries, the return to potential GDP following recessions associated with financial crises is much longer than the return following other recessions. It takes an average of 9 years to return to trend following a financial crisis, compared with an average of 1 ½ years for postwar recessions prior to 2007. Among emerging markets, while the magnitude of

the recessions following financial crises is larger than for advanced economies, the duration is comparable with recessions not associated with financial crises in advanced economies.

Which of these episodes are most relevant for predicting the long-run effects of the Great Recession? Eliminating the episodes whose duration is already exceeded by the Second Great Contraction, we are left with five: The Great Depression of the 1930s for the U.S. and the slumps following the financial crises of the late 1980s and early 1990s for Australia, Denmark, Finland, and Sweden. If the Second Great Contraction which started in 2007:4 follows the pattern of these slumps, it will end in 2016:4 with no effect on potential GDP. In order for that to occur if slow growth continues for another year, real GDP growth will have to average 4.16 percent per year for the following four years, a rate consistent with other countries that have experienced recessions following financial crises.

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Figure 1. The Great Depression in the United States

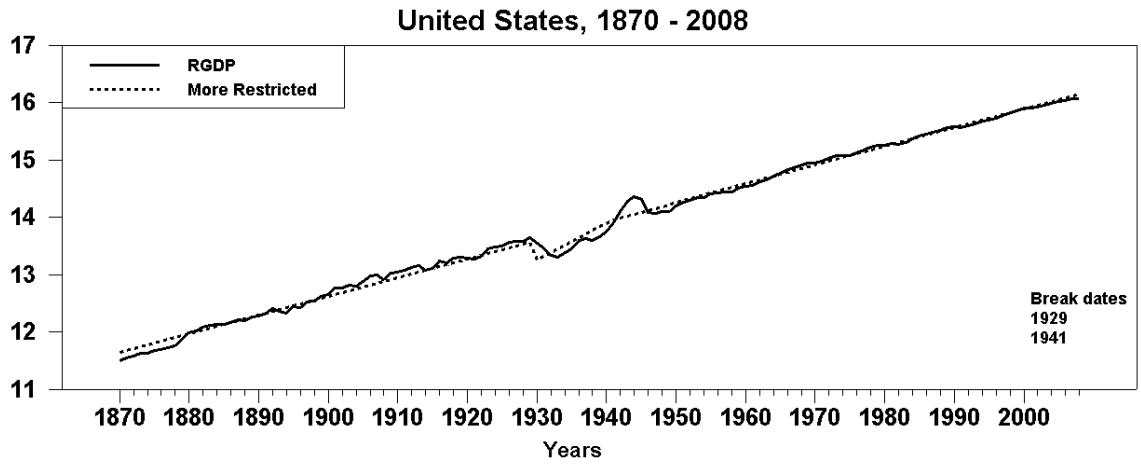
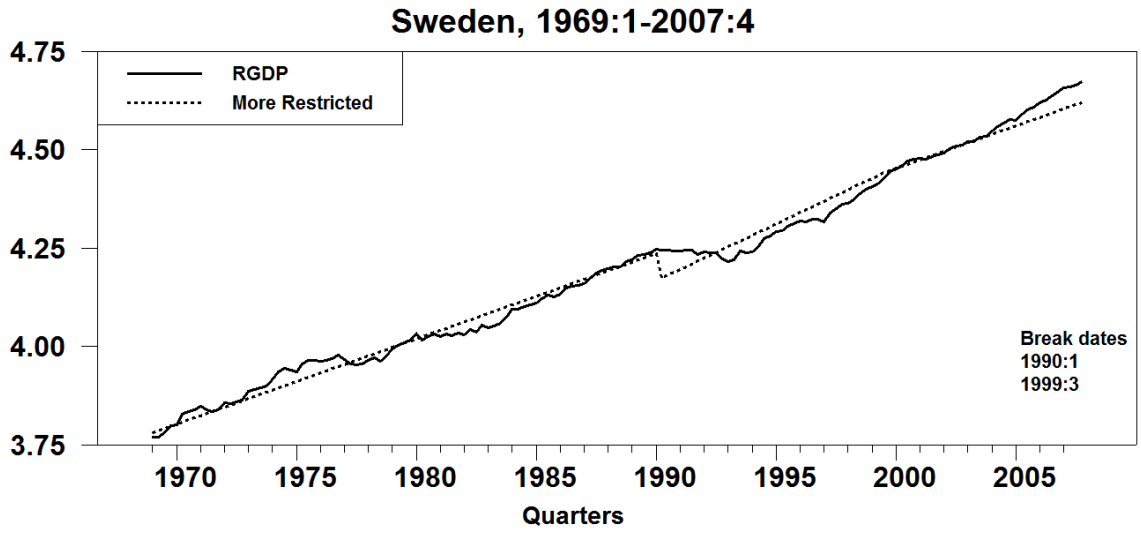
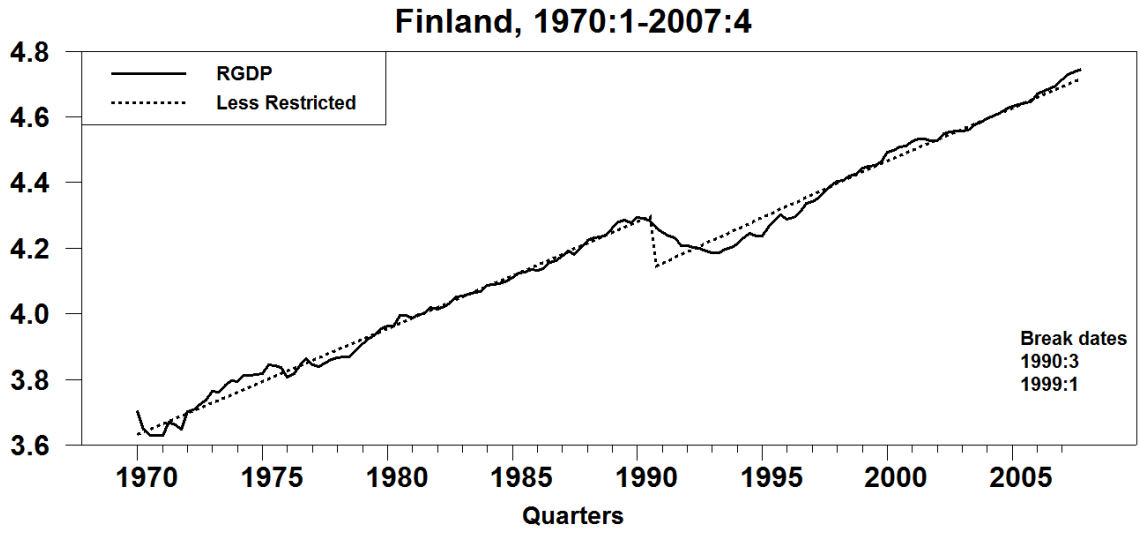
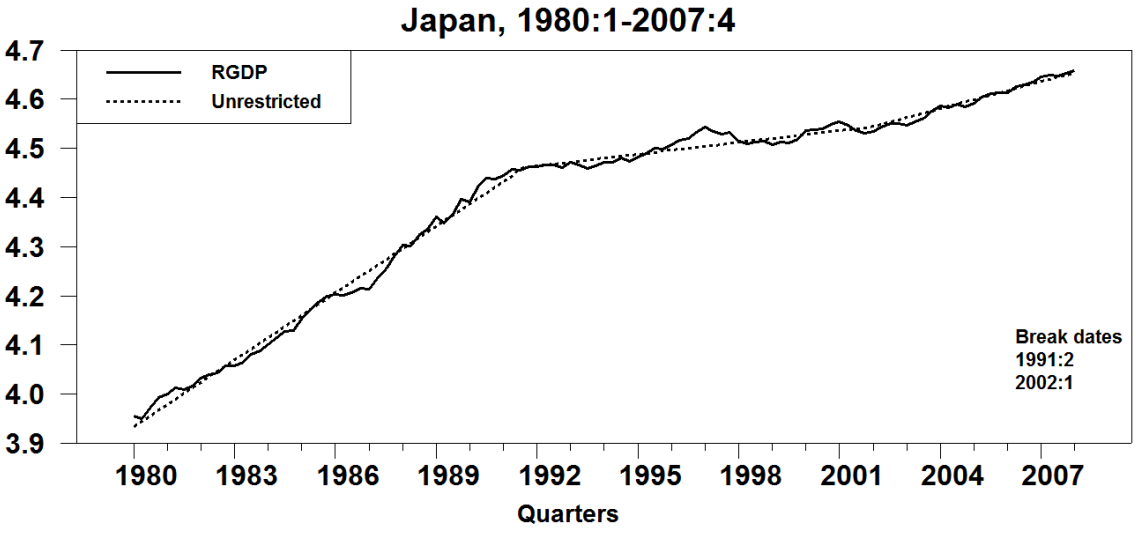


Figure 2. Severe Financial Crises in Advanced Economies






Japan, 1980:1-2007:4
RGDP
Unrestricted
Break dates
1991:2
2002:1
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
3.9
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
Quarters

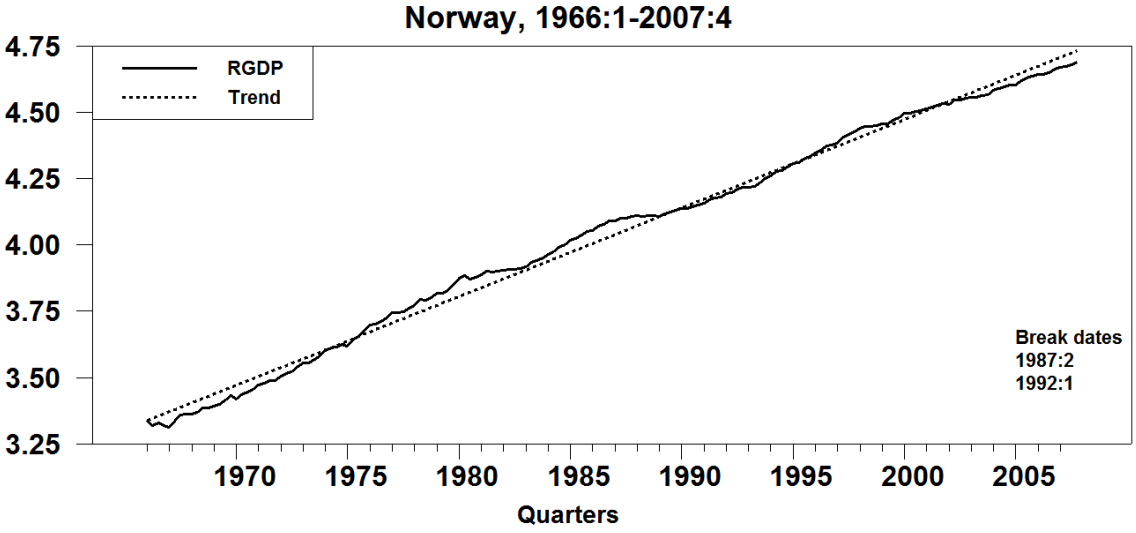
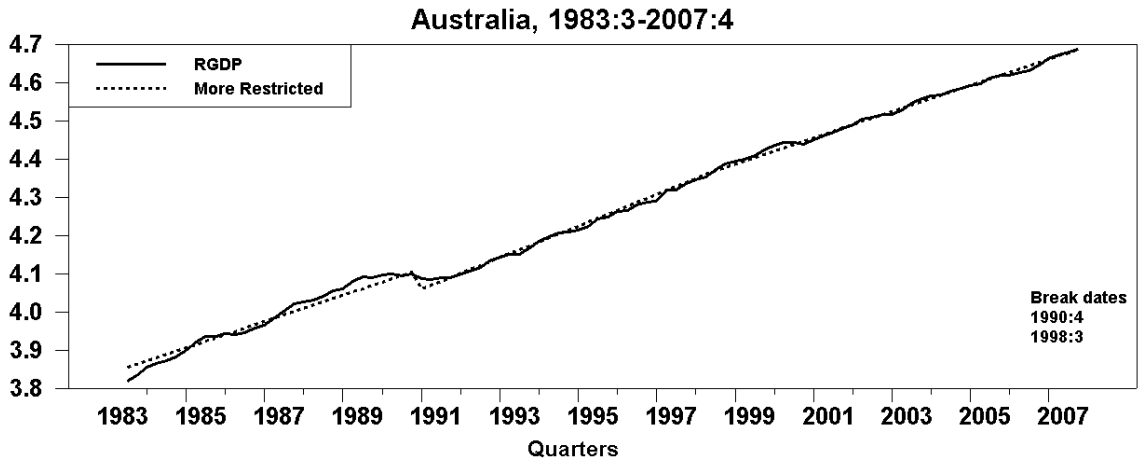

Norway, 1966:1-2007:4
RGDP
Trend
Break dates
1987:2
1992:1
4.75
4.50
4.25
4.00
3.75
3.50
3.25
1970
1975
1980
1985
1990
1995
2000
2005
Quarters

Figure 3. Mild Financial Crises in Advanced Economies: Australia and Denmark



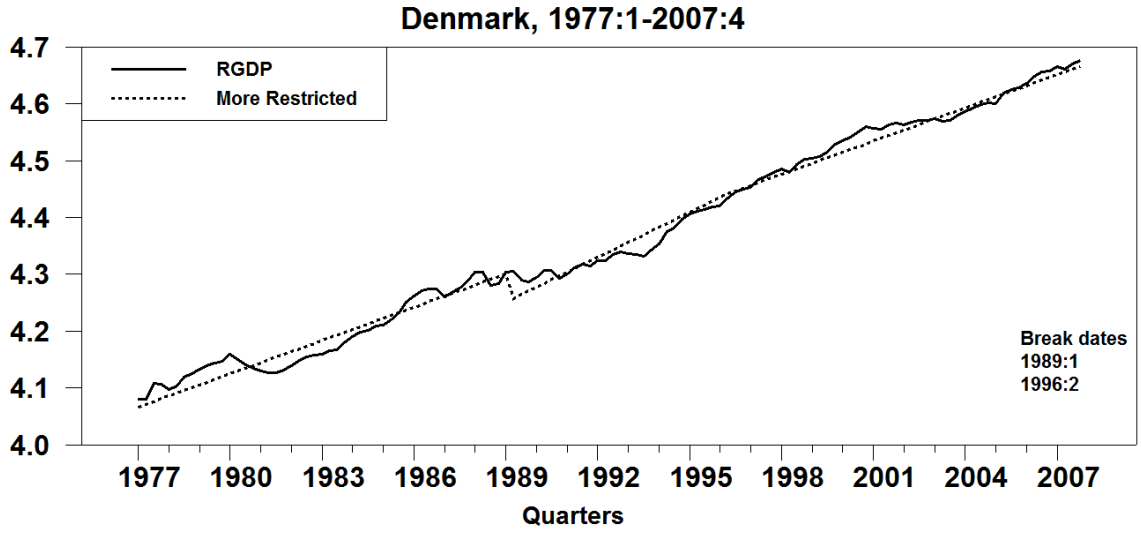
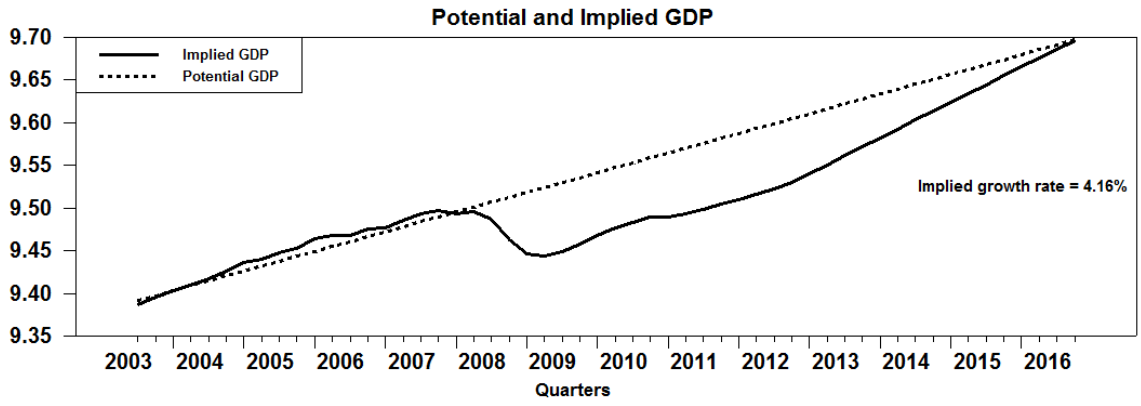
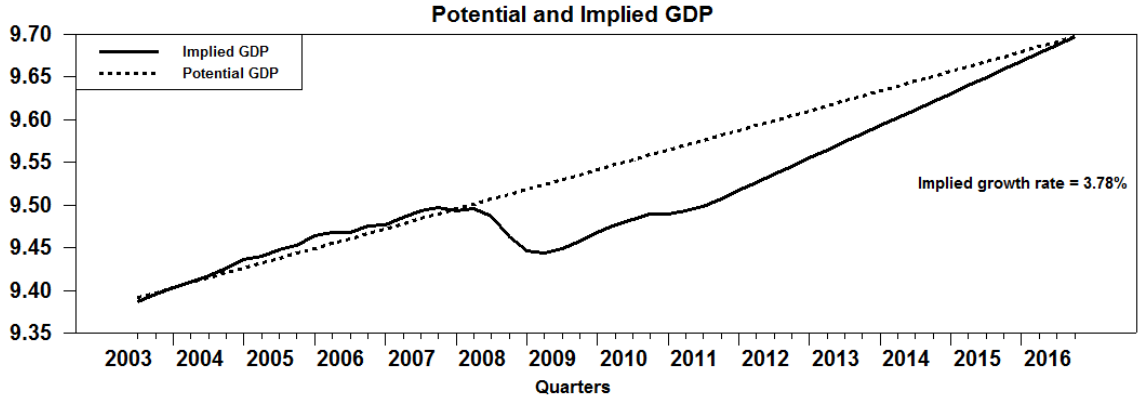


Figure 4. The Implied Growth Rate for the United States

A. Implied Real GDP Growth Increases Starting in 2013:1



B. Implied Real GDP Growth Increases Starting in 2011:4



Note: The source for the actual and forecasted potential GDP growth is the Congressional Budget Office (CBO) (2011). In Panel A the growth rate of real GDP between 2011:3 and 2012:4 follows the mean forecasts reported in the Wall Street Journal (2011) and the implied growth rate is computed between 2013:1 and 2016:4. In Panel B the implied growth rate of real GDP is computed between 2011:4 and 2016:4.

Table 1. The Great Depression in the United States

Period (yearly data)	Break Dates	NBER recession dates	Duration (years)	Sup F test (p-value)	F test (p-value)	Trough	Magnitude
1870 - 2008	1929 1941	1929-1933	12	0.01 (MR)	0.39 (MR vs. LR)	1933	33.6%

Note: The yearly real GDP data starts in 1870 and ends in 2008(source: Maddison). The Sup F test p-values are reported for the more restricted model (MR).We test the more restricted (MR) versus the less restricted (LR) model using an F-test.

Table 2. Postwar Slumps in the United States

Period (quarterly data)	Break Dates	NBER recession dates	Duration (quarters)	Sup F test (p-value)	F test (p-value)	Trough	Magnitude
1950:1-1957:2	1953:3 1955:1	1953:2 1954:2	6	0.48 (MR)	0.99 (MR vs. LR)	1954:1	2.07%
1950:1-2007:4	1957:3 1958:2	1957:3 1958:2	3	0.07 (MR)	0.31 (MR vs. LR)	1958:1	3.80%
1958:3-1973:3	1960:1 1961:4	1960:2 1961:1	7	0.16 (MR)	0.88 (MR vs. LR)	1960:4	1.60%
1962:1-1973:3	1969:3 1972:2	1969:4 1970:4	11	0.32 (MR)	0.33 (MR vs. LR)	1970:4	0.62%
1958:3-1981:2	1973:4 1975:3	1973:4 1975:1	7	0.86 (MR)	0.25 (MR vs. LR)	1975:1	3.24%
1975:4-1981:2	1980:1 1980:4	1980:1 1980:3	3	0.24 (MR)	0.27 (MR vs. LR)	1980:3	2.25%
1958:3-2007:4	1981:3 1983:1	1981:3 1982:4	6	0.26 (MR)	0.77 (MR vs. LR)	1982:3	2.75%
1983:2-2007:4	1990:3 1991:2	1990:3 1991:1	3	0.11 (MR)	0.97 (MR vs. LR)	1991:1	1.36%
1991:3-2007:4	2000:2 2003:3	2001:1 2001:4	13	0.08 (MR)	0.14 (MR vs. LR)	-	0.00%

Note: The real GDP quarterly data starts in 1950:1 and ends in 2007:4 (source: International Finance Statistics). We first search over the whole sample (1950:1-2007:4), then repeatedly split the sample and search over sub-samples. The Sup F test p-values are reported for the more restricted model (MR).We test the more restricted(MR) versus the less restricted(LR) model using an F test.

Table 3. Severe Financial Crises in Advanced Economies

Country	Period	Break Dates	Duration (quarters)	Sup F test (p-value)	F test (p-value)	Trough	Magnitude
Sweden	1969:1-2007:4	1990:1 1999:3	38	0.11 (MR)	0.29 (MR vs. LR)	1993:1	3.2%
Norway	1966:1-2007:4	1987:2 1992:1	19	0.97 (MR)	0.26 (MR vs. LR)	1987:3	0.18%
Finland	1970:1-2007:4	1990:3 1999:1	34	0.00 (LR)	0.00 (MR vs. LR)	1993:1	9.9%
Japan	1980:1-2007:4	1991:2 2002:1	43	0.14 (UR)	0.00 (MR, LR vs. UR)	1991:3	0.23%

Note: The quarterly data starts from 1966:1 to 1980:1, depending on the data availability, and ends in 2007:4 (source: International Finance Statistics). For each country we report the Sup F test p-value using the appropriate model: more restricted (MR), less restricted (LR) or the unrestricted (UR) model. Using an F test, the MR is tested versus the LR model for all countries except Japan, where the MR and LR models are tested versus the UR model.

Table 4

a) Postwar Slumps in Advanced Economies

Country	Period	Break Dates	Duration (quarters)	Sup F test (p-value)	F test (p-value)	Trough	Magnitude
UK	1955:1-2007:4	1979:2 1983:1	15	0.04 (MR)	0.04 (MR vs LR)	1981:1	6.19%
Germany	1960:1-2007:4	1962:4 1963:2	2	0.10 (MR)	0.09 (MR vs LR)	1963:1	3.56%
Canada	1950:1-2007:4	1953:4 1954:2	2	0.00 (MR)	0.54 (MR vs LR)	1954:1	4.36%
Australia	1959:3-2007:4	1982:3 1983:3	3	0.46 (MR)	0.93 (MR vs LR)	1983:2	2.79%
Italy	1980:1-2007:4	1992:1 1994:1	8	0.53 (MR)	0.68 (MR vs LR)	1993:3	2.26%
France	1970:1-2007:4	1974:3 1975:2	3	0.00 (MR)	0.16 (MR vs LR)	1975:1	2.06%
New Zealand	1982:2-2007:4	1990:4 1994:1	13	0.09 (MR)	0.14 (MR vs LR)	1991:2	3.55%

b) Mild Financial Crises in Advanced Economies

Country	Period	Break Dates	Duration (quarters)	Sup F test (p-value)	F test (p-value)	Trough	Magnitude
Denmark	1977:1-2007:4	1989:1 1996:2	29	0.31 (MR)	0.85 (MR vs LR)	1989:4	1.78%
Australia	1983:1-2007:4	1990:4 1998:3	31	0.00 (MR)	0.99 (MR vs. LR)	1991:2	1.60%

Note: The real GDP quarterly data starts from 1950:1 to 1983:1, depending on the data availability, and ends in 2007:4 (source: International Finance Statistics). For each country we report the Sup F test p-value using the appropriate model: more restricted (MR), less restricted (LR) or the unrestricted (UR) model. Using an F test, the MR is tested versus the LR model

Table 5. Severe Financial Crises in Emerging Markets

Country	Period	Break Dates	Duration (quarters)	Sup F test (p-value)	F- test (p-value)	Trough	Magnitude
Argentina	1990:1-2007:4	2001:2 2003:2	8	0.01 (MR)	0.43 (MR vs. LR)	2002:1	17.3%
Korea	1980:1-2007:4	1997:4 1998:4	4	0.00 (MR)	0.90 (MR vs. LR)	1998:2	7.6%
Mexico	1980:1-2007:4	1995:1 1995:4	3	0.00 (MR)	0.05 (MR vs. LR)	1995:3	5.1%
Malaysia	1988:1-2007:4	1997:4 1999:1	5	0.27 (MR)	0.05 (MR vs. LR)	1998:4	11.7%
Thailand	1993:1-2007:4	1997:2 1998:2	4	0.01(LR)	0.00 (MR vs. LR)	1998:3	17.5%
Colombia	1994:1-2007:4	1998:2 2003:1	19	0.00 (UR)	0.00 (MR,LR vs. UR)	1999:2	7.1%

Note: The quarterly data starts from 1980:1 to 1994:1, depending on the data availability, and ends in 2007:4 (source: International Finance Statistics). For each country we report the Sup F test p-value using the appropriate model: more restricted (MR), less restricted (LR) or the unrestricted (UR) model. Using an F test, the MR is tested versus the LR model for all countries except Colombia, where the MR and LR models are tested versus the UR model.