

The Anatomy of Stagnation in a Modern Economy *

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Abstract

In 2008, the worst financial crisis since the Great Depression launched a deep contraction of the US economy. Output fell quickly to a level 10 percent below trend. Unemployment reached 10 percent of the labor force. Seven years after the crisis, unemployment was back to normal, but output was 15 percent below trend. Stagnation had set in. The most important source of the stagnation was a sharp decline in productivity growth. A decline in research and development and other productivity-enhancing investment was at least partially responsible. That decline began before the crisis, but the financial events of 2008 worsened the cutback. A second major source of stagnated output and income was capital depletion. Investment in business equipment fell in half immediately after the crisis. Cumulatively, the effect of below-trend investment accounted for 5 of the 15 percentage points of the shortfall in output. The third major development accounting for stagnation in output was a decline in the labor force that remained after unemployment had returned to normal. This development accounted for more than 3 percentage points of the shortfall in output. As a general matter, the direct decline in labor input and in output associated with the rise in unemployment was not important by 2015, but the follow-on stagnation operating through the effects on the two types of capital formation was substantial.

JEL E22, E23, E32, E44

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In the years following the global financial crisis of 2008, many modern, advanced economies suffered stagnation. Unemployment rose sharply and declined slowly, output fell substantially, and growth remained substandard even eight years later. Investment in plant, equipment, software, and research and development languished. Productivity grew well below its historical rate. Monetary and fiscal measures to offset these developments were aggressive, but were only partially successful. This paper studies these events as they occurred in the single largest advanced economy, that of the USA.

Figure 1 and Figure 2 provide a preview of the findings. Subsequent sections will explain the calculations. In 2010, the second full year following the crisis, real GDP was 10.0 percentage points below its pre-crisis trend. Unused resources in the form of unemployment was the single biggest factor in the shortfall, in the sense that real GDP would have been 3.3 percent higher in 2010 if the excessive unemployment present in 2009 could have been eliminated in 2010 by an increase in demand sufficient to drive the unemployment rate down to its normal level of about five percent. But three other factors also contributed significantly to the output shortfall in 2010: (1) the labor force was below its previous trend by enough to take 1.3 percentage points off the level of real GDP, (2) below-trend productivity growth from 2007 to 2010 accounted for 3.1 percentage points of the shortfall in real GDP, and (3) shortfalls of capital formation in 2008 and 2009 resulted in depleted capital that cut real GDP by 2.3 percent in 2010.

Figure 2 shows how different the US economy was in 2015, seven years after the crisis. The shortfall of GDP was half again greater, at 15.4 percent, than it had been in 2010. A close to full recovery had occurred over the five years, in the sense that unemployment was back almost to normal—excess unemployment only cut 0.5 percentage points from real GDP in 2015. But other negative factors had grown. The shortfall in productivity growth continued from 2010 to 2015, cumulating over the entire period from 2007 to 2015 to 6.6 percentage points of the shortfall in real GDP. The other two negative factors also grew, with the shrinkage in the labor force accounting for 3.3 percentage points of the shortfall in 2015 and the depleted capital stock accounting for 5.1 percentage points.

Figure 2 delivers an important message of the paper: In 2015, the output of the US economy was far behind where it would have been based on earlier trends through 2007, but not because of unemployment. An attempt to solve the problem of low output by stimulating demand would have driven unemployment down to levels that have not been sustainable in

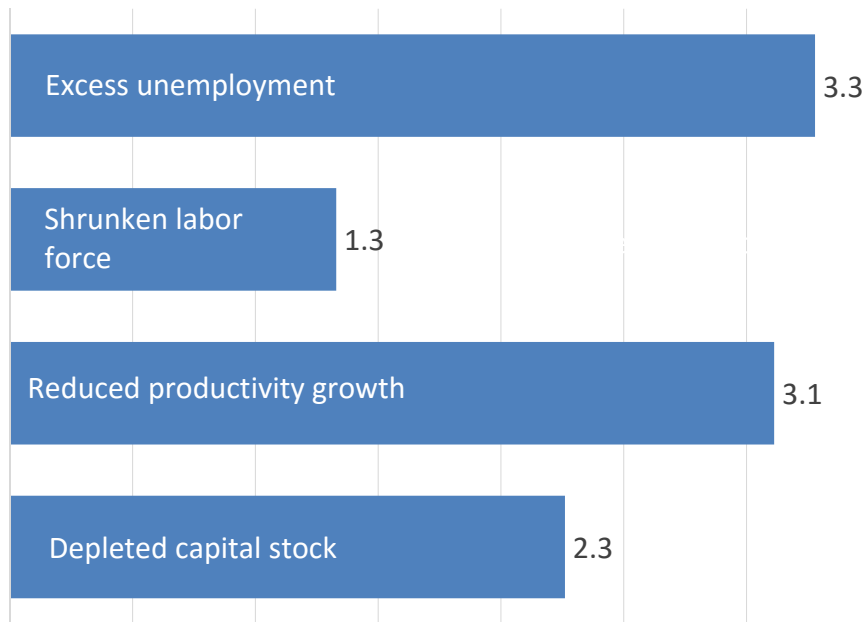


Figure 1: Allocation of 10.0 percentage points of shortfall in real GDP, 2010

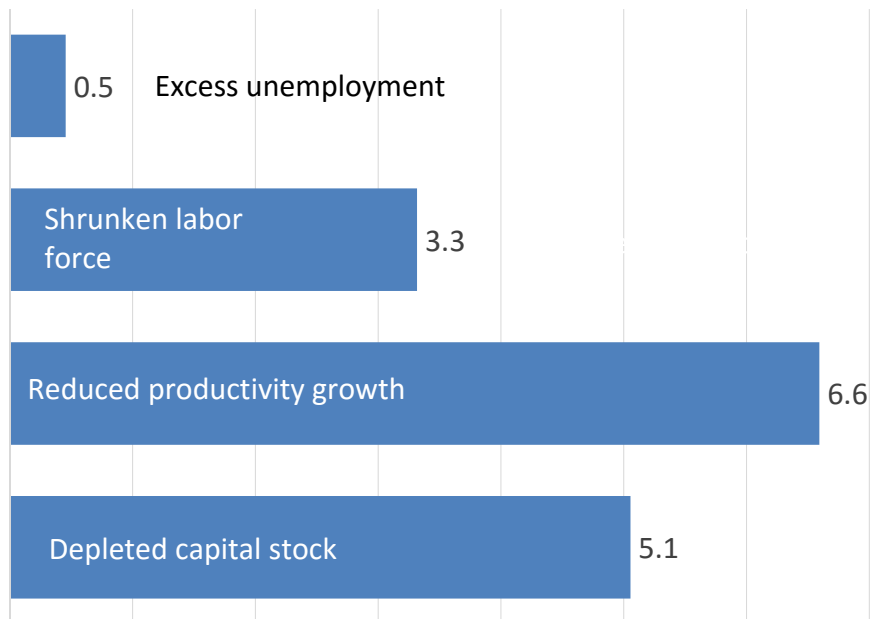


Figure 2: Allocation of 15.4 percentage points of shortfall in real GDP, 2015

the U.S. economy. It would have been completely impossible to close the entire 15-percent shortfall in output through monetary or fiscal policy. The three negative supply factors, lower labor force, lower productivity, and depleted capital stock, would overwhelm demand-oriented policies that attempted to bring output back quickly to its previous growth path.

1 Output

Figure 3 shows US real GDP from 1948 to 2015, with its trend removed. The paper uses a uniform approach to removing trends from time series such as real GDP where the upward historical trend dominates the movements of the series and makes it hard to see the deviations from trend that are the subject of the paper. The approach is to remove a constant growth rate that is chosen so that the beginning and ending values of the detrended series are the same. Starting with a series y_t with t running from 1 to T , I compute the growth rate as

$$g = \left(\frac{y_T}{y_1} \right)^{1/(T-1)} \quad (1)$$

and then form the detrended series as

$$\hat{y}_t = \frac{y_t}{(1+g)^{t-1}}. \quad (2)$$

In the detrended data shown in the figures starting with Figure 3, in periods when the line is flat, normal growth occurred. When the line slopes upward, growth exceeded normal, and when downward, growth was below normal.

The trend or normal rate of growth of real GDP over the full period was 3.1 percent per year. Figure 3 shows that GDP growth was unusually high around 1950, continued at normal levels until the mid-1960s, had another burst of growth until the late 1960s, continued at normal levels until 2007, then plunged at an alarming rate through to 2015. All of the extra real GDP gained in the high growth period from 1948 to 1968 was lost after 2007. Over the time when the US has had reliable measures of output, only the Great Depression saw a larger decline of real GDP from trend (but that decline was much greater than the one after 2007).

2 Unemployment

Figure 4 shows the unemployment rate, the fraction of the labor force who are looking actively for work but are not working. Unemployment has been measured accurately and consistently

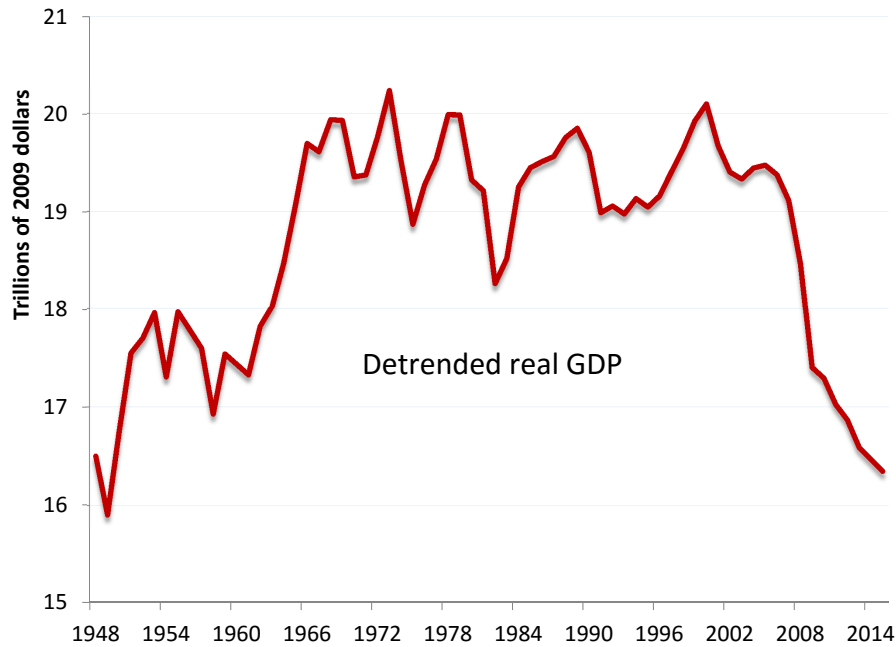


Figure 3: Detrended Real GDP

since 1948. The series has little trend, so no detrending is needed. Unemployment tracks the business cycle closely. It rises sharply when recession strikes, then declines to normal more gradually during the following recovery. Previously, the largest increases occurred from closely spaced recessions in 1970 and 1973-75 and again in 1980 and 1981-82. The first of these double shocks raised unemployment by slightly more than the increase from 2007 to 2010. The second resulted in a smaller increase but a slightly higher maximum value of over 10 percent. The post-crisis unemployment burden was the worst of three major experiences since 1948, but involved neither a higher peak unemployment rate nor a slower recovery to the normal rate.

Figure 5 shows the fairly close relationship between the unemployment rate and the stock market. The latter is stated in inverse form because the relationship is negative—unemployment is low when the stock market is high in real terms. It is also detrended. This relationship is consistent with the unemployment theory of Diamond, Mortensen, and Pissarides, which links unemployment to the incentives for employers to create jobs. When the payoff to hiring a new worker is strong, employers put high levels of resources into recruiting new workers. Job-seekers find it correspondingly easy to find work, so the time spent looking for jobs declines and unemployment is low. The stock market is high when discounts applied to future cash flows are low. All forms of investment, including job-

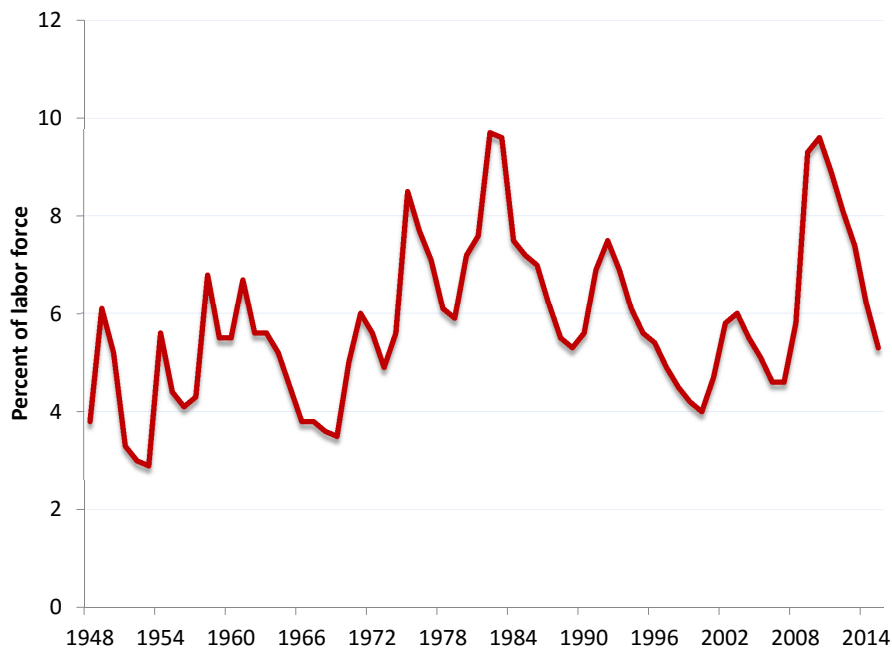


Figure 4: Unemployment Rate

creation, are at high levels when discounts are low. The financial crisis resulted in a major decline in the stock market thanks to higher discounts, so investment in job-creation fell and unemployment rose. A similar process operated in most previous recessions over the period from 1948 to 2015.

Higher unemployment means lower employment for a given level of the labor force, and lower employment implies less output according to the production function. Thus higher unemployment has a *direct effect* on output. I distinguish this direct effect from other channels by which forces that raise unemployment also lower output—these other channels are the subject of later sections in this paper. The direct effect of unemployment on employment is

$$N = (1 - u)L, \tag{3}$$

where N is employment, u is the unemployment rate (as a decimal), and L is the labor force. The elasticity of output with respect to employment is generally accepted to be about 0.65, so the direct effect of unemployment on output is that elasticity applied to the change in N induced by the change in u , according to equation (3). For example, if u rises from 0.05 to 0.10, output falls by 3.5 percent. An interesting use of this relationship is to calculate a counterfactual level of output by backing out the direct effect of unemployment. In the

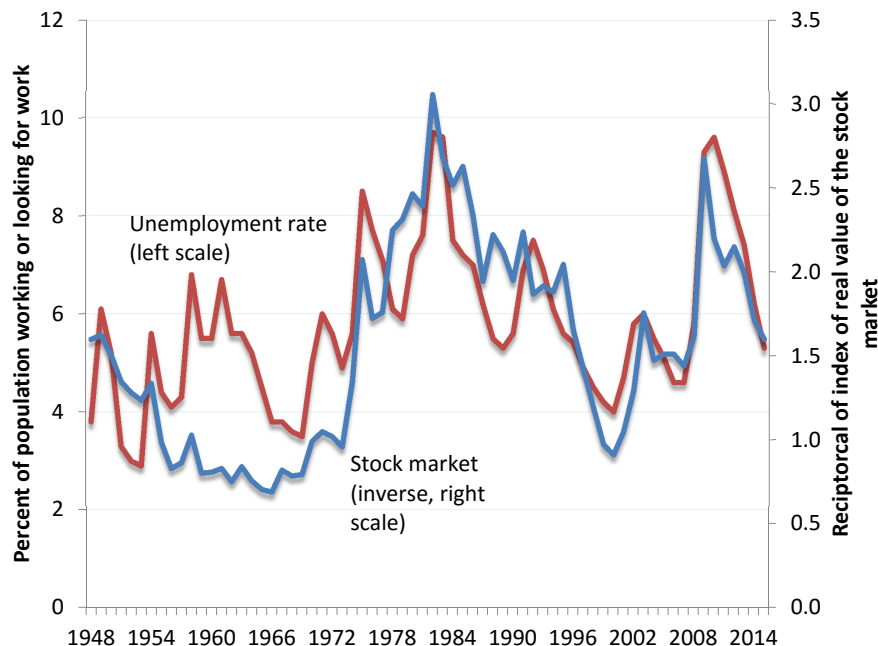


Figure 5: Unemployment and the stock market

example, the counterfactual level of output is higher by a factor of $1/(1 - .035) - 1 = 3.6$ percent higher.

The allocations to unemployment shown in Figure 1 and Figure 2 are calculated as follows: In 2010, the unemployment rate was 9.6 percent and in 2015, 5.3 percent. The benchmark unemployment rate, that of 2007, was 4.6 percent. Applying the formulas above shows that output would have been 3.3 percent higher if the 9.6 percent had been 4.6 percent instead, and 0.5 percent higher if the 5.3 percent had been 4.6 percent instead.

Figure 6 shows real GDP adjusted for the direct effect of unemployment, using a counterfactual unemployment rate of 5.8 percent, the average rate over the years from 1948 through 2015. The thick line is actual detrended real GDP and the thin line is the counterfactual level of real GDP with the direct effect of unemployment removed. In times of high unemployment, such as 1982 and 2010, the counterfactual level is noticeably higher than the actual level, reflecting the loss of the productive value of people who would have been working but for the high unemployment. But the general impression from the figure is how closely the two measures move together. Apart from the serious recessions, the direct effect of unemployment is small—most of the movement of real GDP comes from other sources. I hasten to emphasize that some of the other sources are indirect effects of unemployment, in the sense that a force that raises unemployment, such as a financial crisis that raises discounts, also

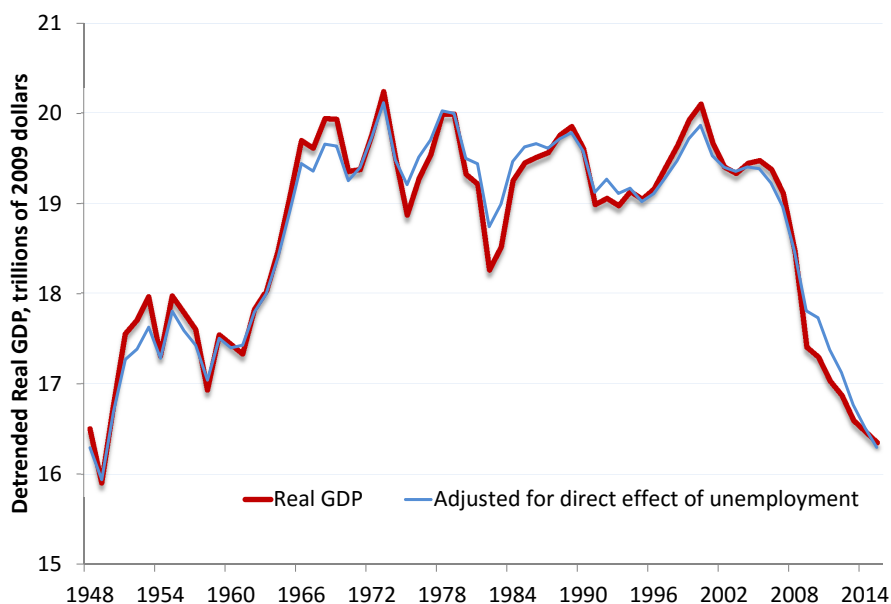


Figure 6: Real GDP: Actual and Counterfactual without Direct Effect of Unemployment

affects state variables such as the capital stock and the level of productivity. Later sections consider these channels.

Figure 6 shows that the limited role of the direct effect of unemployment in the aftermath of the crises was not a new phenomenon. At the lowest frequencies, it has never been thought that important movements—such as the high level of real GDP relative to trend from the late 1960s to the mid-2010s—were accompanied by exceptionally low levels of unemployment. But the figure reveals that even at frequencies thought to capture mainly the business cycle, most of the movement of real GDP does not operate through the channel of the direct effect of unemployment. For example, in the great expansion of the 1990s, though unemployment fell dramatically, most of the growth of real GDP came from higher productivity growth and the indirect, cumulative effect of the capital accumulation that occurred in the strong economy. To the extent that unemployment is a good indicator of demand relative to the economy’s capacity to produce output, the figure demonstrates the unimportance of current demand fluctuations compared to fluctuations in productivity growth, capital accumulation, labor-force participation, and other influences.

Some macroeconomists try to capture the contemporaneous indirect effects of unemployment through a relationship called *Okun’s Law*, proposed by Arthur Okun in 1962. Data available in 1962 suggested that productivity growth declined when unemployment rose and

that labor-force participation also declined, so the full contemporaneous relation between real GDP and unemployment was more negative than the direct effect considered here. Subsequent experience has shown that the indirect effects are unstable. Most fluctuations in productivity growth and participation are unrelated to the forces that cause fluctuations in unemployment. More important, the focus on only the contemporaneous relationships fails to account for the cumulative effects—if a bulge of unemployment results from a force that also discourages innovation and capital formation, the effects will linger well past the time when unemployment is back to normal, as the experience following the financial crisis of 2008 shows. So Okun’s shortcut is not a good idea. Rather, full analyses of each of the determinants of real GDP is the appropriate framework.

3 Shrinkage of the Labor Force

The labor force comprises people who are working or are actively looking for work. In US data, only those aged 16 and above are included. Trends in participation have been quite different for men and women, so it is a good idea to consider them separately. Figure 7 shows the percentages of the populations who are in the labor force. There is no detrending in the figure. Prior to the financial crisis in 2008, recessions only slightly depressed participation—unemployment rose by almost the same amount that employment fell. With higher unemployment, participation was discouraged by the added time needed to find a job. But wealth and income fall in recessions. The loss induces more people to seek and take jobs, and so is a force that raises participation. In previous recessions, the two forces approximately offset each other.

Figure 7 shows that participation by both men and women fell noticeably—by about three percentage points—after 2008. Discerning the counterfactual, what would have happened to participation had the trauma of 2008 and the long slump following not occurred, is a challenge. But it seems likely that some force specific to the post-crisis years depressed participation.

The calculations for 2010 and 2015 in Figure 1 and Figure 2 run as follows: The benchmark participation rate in 2007 was 66.3 percent, while the rate in 2010 was 64.9 percent and in 2015 62.9 percent. Lowering employment by the ratio $64.9/66.3$ and applying the labor elasticity of 0.65 yields a decrease in output of 1.3 percent in 2010 and similarly in 2015 a decrease of 3.3 percent.

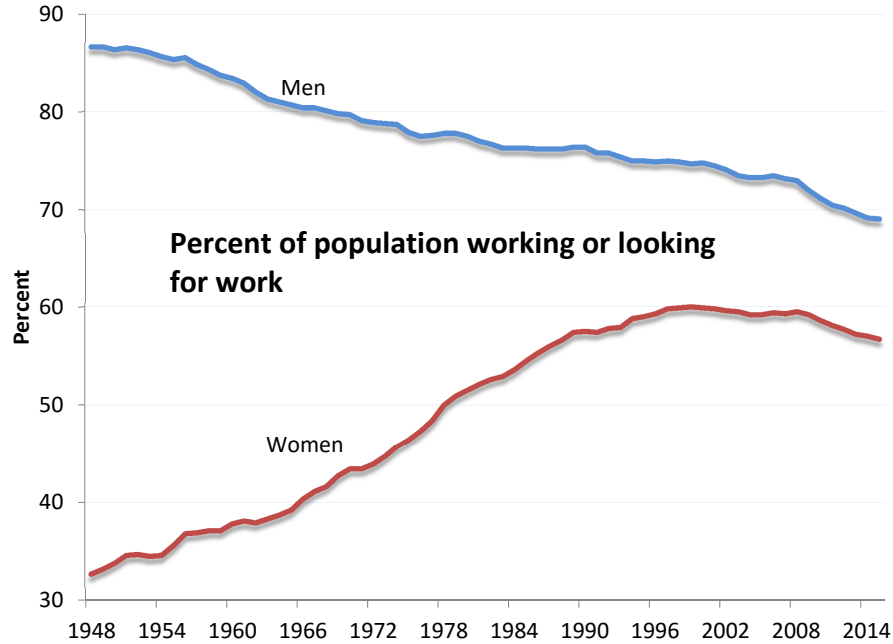


Figure 7: Labor-Force Participation Rates

Table 1 provides some information useful in trying to understand the decline in participation. It shows participation rates for people aged 25 through 54, broken down by family income. Between 2004 and 2007, years when the labor market was unaffected by the crisis, small declines in participation, averaging 0.8 percentage points, occurred in all four categories of family income. Between 2007 and 2013, participation *rose* among members of the poorest quarter of families, fell just a bit in families in the second quartile, and fell by 2.5 percentage points in the upper half, the third and fourth quartiles. Essentially all of the decline in participation occurred in families with higher incomes. This finding points away from the hypothesis that the decline in participation represented marginalization of poorer families from the labor market.

Table 2 investigates how people spent the time freed up by reduced work and job search. It compares time allocations in 2014 to 2007. Market work, including job search, fell by 1.6 hours per week for men and by 1.4 hours for women. The two categories with increases were personal care and leisure, which includes a large amount of TV and other video-based entertainment, especially for men. The decline in hours devoted to other activities included a decline in housework for women. Basically, time use shifted toward enjoyment and away for work-type and investment activities. There was no substitution from market work to either non-market work or investment in human and household capital.

**Labor force participation among prime-age workers
across household income distributions**

	2004	2007	2013
Total	83.8%	83.0%	81.2%
1 st quartile (lowest income)	62.3%	61.2%	61.5%
2 nd quartile	80.0%	78.0%	77.6%
3 rd quartile	88.0%	87.3%	84.8%
4 th quartile (highest income)	91.9%	91.4%	89.9%

Table 1: Role of Family Income

	<i>Personal care, including sleep</i>	<i>Market work</i>	<i>Education</i>	<i>Leisure</i>	<i>Other</i>
Men	1.3	-1.6	-0.1	1.6	-1.2
Women	2.2	-1.4	0.0	1.2	-2.0

Table 2: Changes in Weekly Hours of Time Use, 2007 to 2014, People 15 and Older

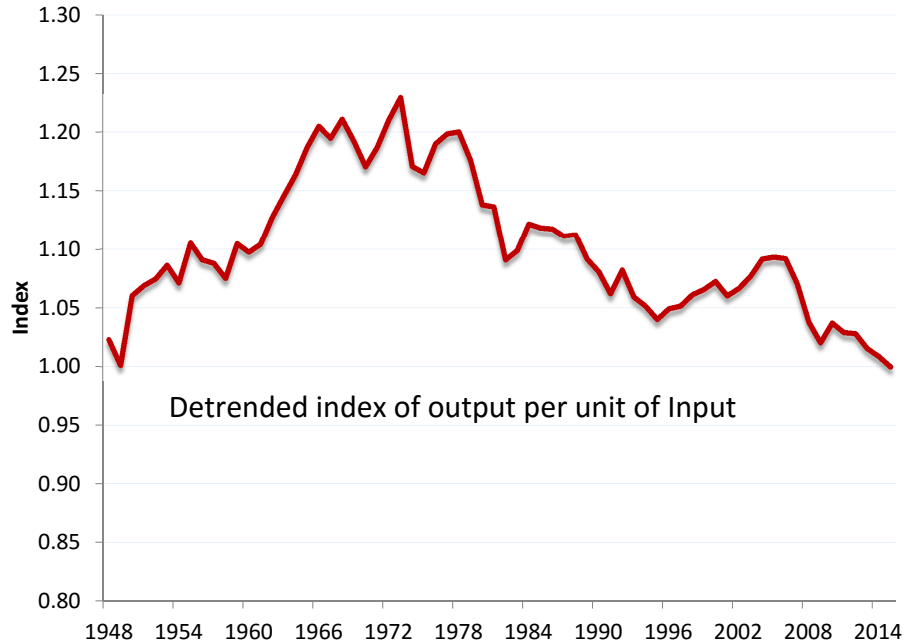


Figure 8: Total Factor Productivity

4 Productivity Growth

For most purposes, the best measure of productivity is total factor productivity or TFP, the ratio of output to an index of all factor inputs. An alternative measure, output per worker, is useful for some purposes, but it scores capital accumulation as a source of productivity growth. In this paper, capital accumulation is a contributor to growth that receives its own treatment. Figure 8 shows an index of TFP in the same detrended form used earlier for real GDP. As with GDP, times when the index is rising are times when productivity is growing faster than its average growth rate of 1.3 percent per year from 1948 to 2015.

From 1948 to 1972, TFP grew faster than normal and was a major contributor to the unusually fast growth of real GDP shown in Figure 3. Between 1972 and 1995, productivity growth was substandard. A burst of fast TFP growth started in 1996 and ended in 2005. TFP actually declined in 2007 and has had growth well below normal ever since. Because poor TFP growth began before the financial crisis, there is a real question about how much of the poor growth can be attributed to the crisis.

The calculations in Figure 1 are based on the principle that output moves in proportion to TFP, holding factor inputs constant. The index of TFP was 2.31 in 2007, 2.33 in 2010, and 2.40 in 2015. The ratio of the 2010 value to the 2007 value was 1.007 and the ratio of

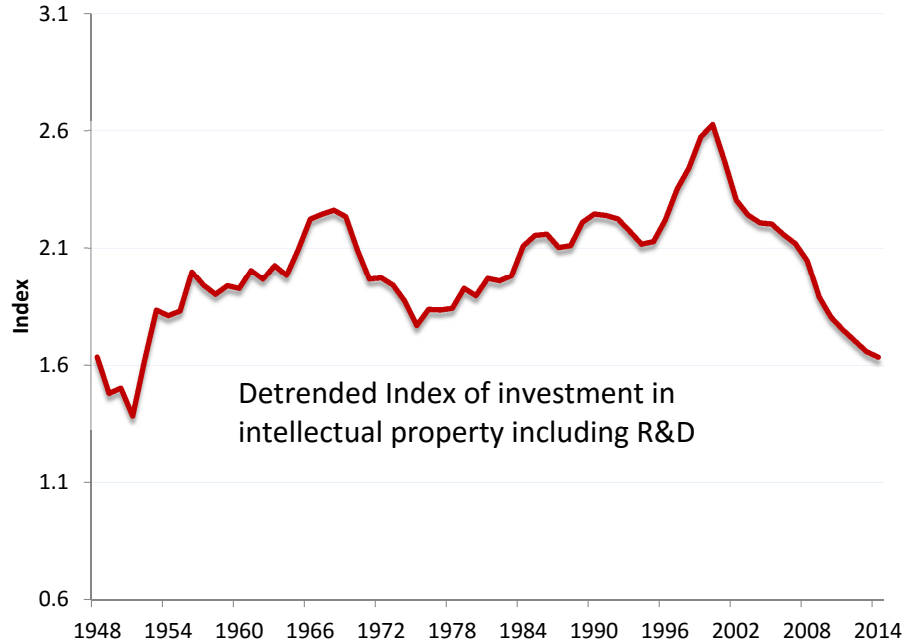


Figure 9: Investment in Productivity Improvements

the 2015 value was 1.035. With normal growth at 1.29 percent per year, the ratios would have been 1.039 and 1.108. The shortfall percents are $1 - 1.007 / 1.039 = 3.1$ percent and $1 - 1.035 / 1.108 = 6.6$ percent.

TFP grows as the economy accumulates better ways to produce output. Some of the flows into the process of innovation and improvement are measured in the national income and product accounts. Figure 9 shows a detrended index of intellectual property investment from the accounts. It includes computer software, research and development spending in businesses, research at universities and nonprofits, and the production of books, movies, TV shows, and music. It is worth noting that the real growth rate of this category is 6.5 percent per year, far above the growth rate of any of the other series detrended in this paper.

Figure 9 shows that IP investment grew faster than normal during the period of high TFP growth, grew more slowly than normal until the mid-1970s, and then entered a long period of high growth that came to an abrupt end in 2000 when the stock-market values of tech companies collapsed. Since 2000, IP investment has grown much more slowly than normal. The financial crisis in 2008 only slightly worsened the rate of contraction of IP investment relative to trend. The recovery that began in the economy as a whole in 2010 has so far done nothing to halt the low growth of investment in improved productivity.

TFP is one of the state variables that connects conditions in a given year to output in future years. On the hypothesis that useful knowledge is rarely forgotten, innovations cumulate over time and each one raises output for many future years. A corollary is that a damaging event, such as a financial crisis, may cut investment in productivity in the year that it occurs, and thus reduce future output because of the cumulative nature of TFP. The evidence on IP investment and on the stock of TFP suggests that this process was already important before the crisis in 2008, but leaves room for the possibility that some of the shortfall in investment and TFP was the result of the crisis. In particular, because monetary and fiscal policy was unable to offset the reduction in demand that followed the crisis, and IP investment was cut as a result, output lost as a result of shortfalls in demand extend well into the future.

5 Capital Depletion

Figure 10 shows real business investment in equipment, detrended as for other indexes. The most prominent feature of this series is its rapid growth in the 1990s. The tech collapse in 2000 resulted in a relatively small contraction followed by expansion in the mid-2000s. Equipment investment was well above trend in 2007 and even a bit above trend in 2008. It fell in half in 2009, a much larger percentage drop than in any previous recession in the years since 1948. In the recovery, it has returned to trend, well below its level in the previous two decades (detrended).

The capital stock is the cumulation of past investment, with allowance for the deterioration that physical capital experiences. Figure 11 shows the business capital stock, stated as a detrended index. It includes business plant and equipment and the IP investment discussed in the previous section. The history of business capital is simple—from the early 1960s, it grew faster than the overall trend of 3.6 percent per year up to the tech crash in 2000. Since then, especially after the crisis, capital has grown much more slowly than the overall trend. Substantial depletion of capital has occurred. As Figure 2 shows, capital depletion has had a big role in the slow growth of output since 2007. And it had an important role in limiting output growth during the years 2001 to 2007, though favorable forces tended to offset that influence.

The calculations in Figure 1 are based on an elasticity of output with respect to capital of 0.35, holding TFP and non-capital factors inputs constant. The index of capital was

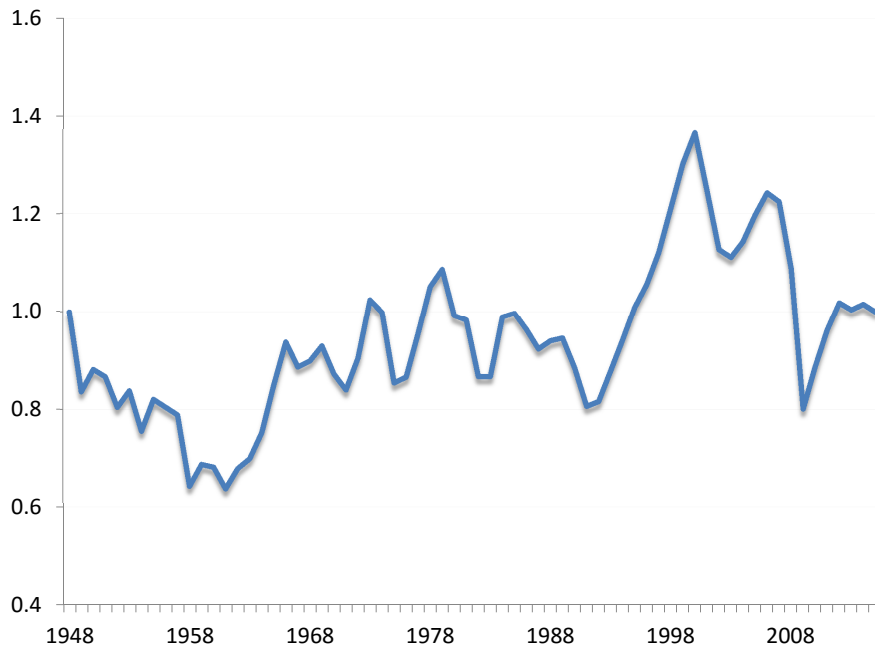


Figure 10: Equipment Investment

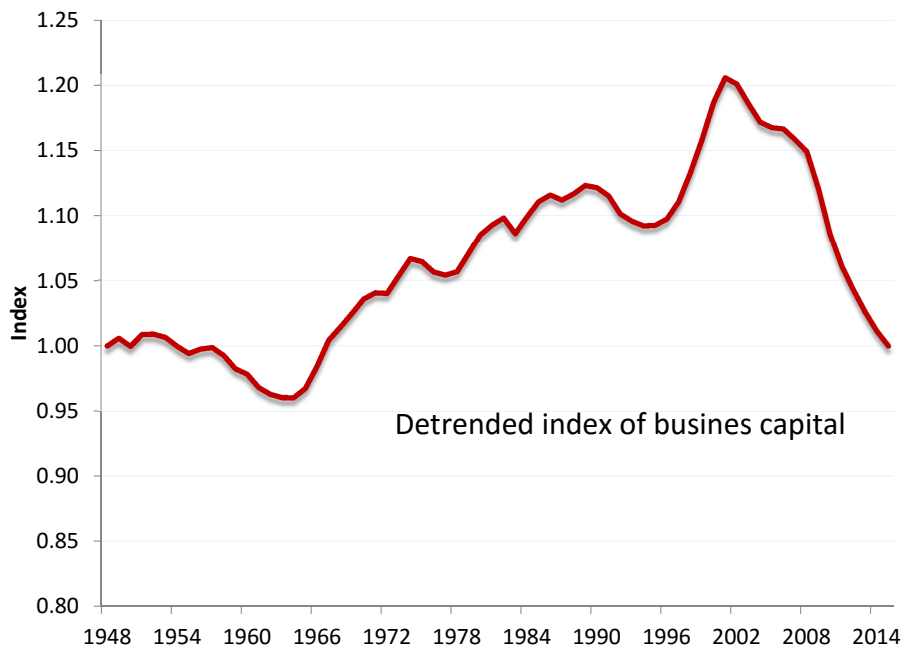


Figure 11: Capital Depletion

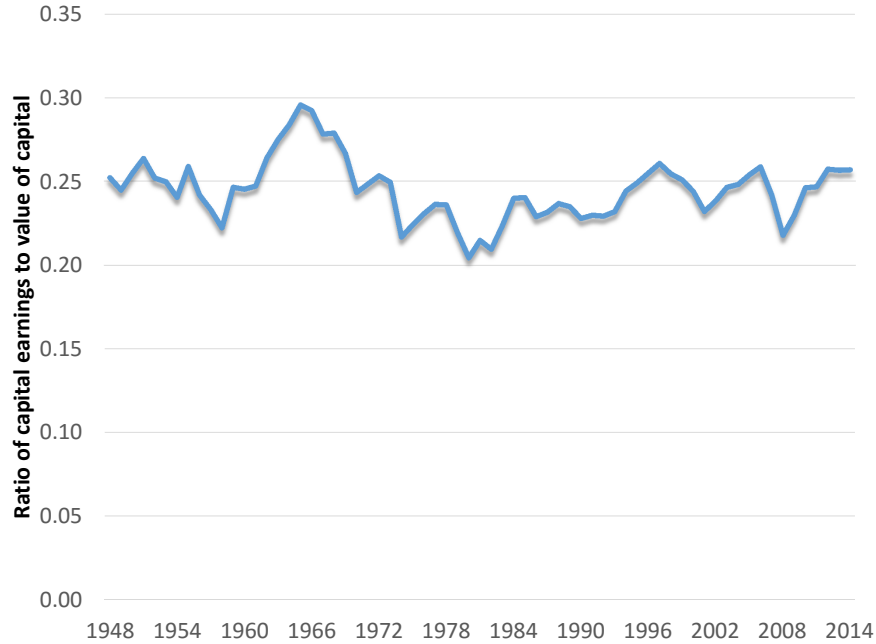


Figure 12: Business Earnings as a Ratio to the Value of Capital

9.94 in 2007, 10.36 in 2010, and 11.41 in 2015. The ratio of the 2010 value to the 2007 value was 1.043 and the ratio of the 2015 value was 1.148. With normal growth at 3.58 percent per year, the ratios would have been 1.113 and 1.332. The shortfall percents are $1 - (1.043/1.113)^{0.35} = 2.3$ percent and $1 - (1.148/1.332)^{0.35} = 5.1$ percent.

An important determinant of business investment is the payoff to holding capital. A potential explanation for the extraordinary weakness of investment following the financial crisis would be a finding that capital was not earning as much as in normal times. But, as Figure 12 shows, the earnings of capital, measured as the sum of business profits, interest paid, and depreciation, have been remarkably steady since the crisis. Earnings per dollar of capital fell in 2009, but rebounded to normal in 2010 and remained normal in the succeeding years.

Investment in plant, equipment, and IP has remained weak at the same time that investment in job creation has returned to normal. The puzzle of low investment has yet to be solved.

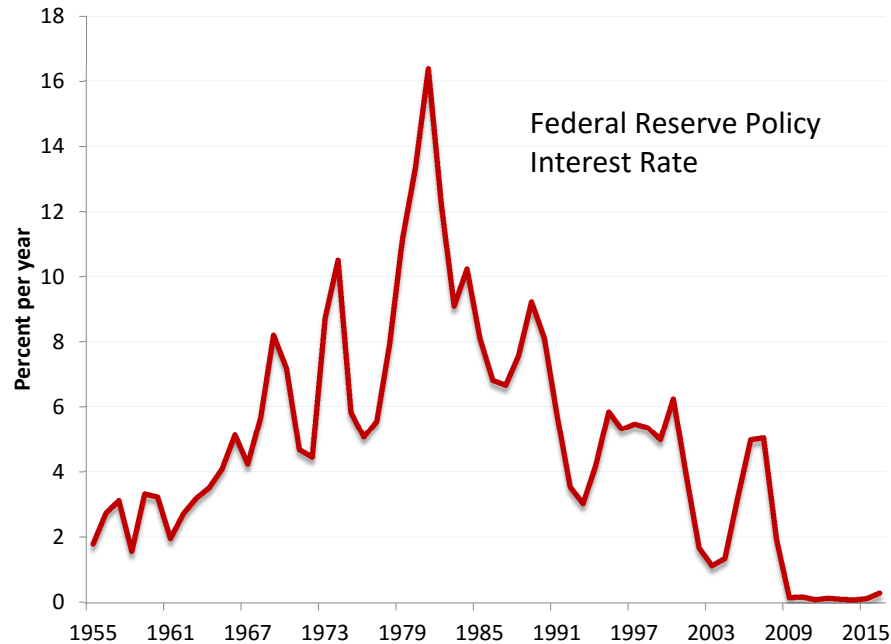


Figure 13: History of the Federal Reserve's Policy Interest Rate

6 The Lower Bound on the Nominal Interest Rate

The operating principles of modern central banks involve immediate, aggressive cuts in the interest rate when some force cuts demand, threatening higher unemployment and lower inflation. Both conditions call for expansion to offset the cut in demand. In the US, the Federal Reserve's remit requires maintenance of full employment along with price stability. Thus a shortfall in demand should be reversed by monetary policy. Figure 13 shows that, in the two recessions that preceded the financial crisis—in 1990-91 and 2001—the Fed cut the interest rate quickly and limited the harm from shocks to investment demand.

The Federal Reserve lowered its policy rate to just over zero soon after the financial crisis hit. Fiscal policy, almost entirely in the form of augmented transfers, provided additional stimulus. The combined stimulus was not nearly enough to prevent unemployment from rising to 10 percent. The zero lower bound blocked further cuts in the short-term interest rate. The Fed also experimented with policies to lower longer-term interest rates by purchasing long-term bonds. Only at the end of 2015, with the unemployment rate back to normal, did the Fed escape the lower bound and resume normal stabilization policy based on adjusting the short-term rate.

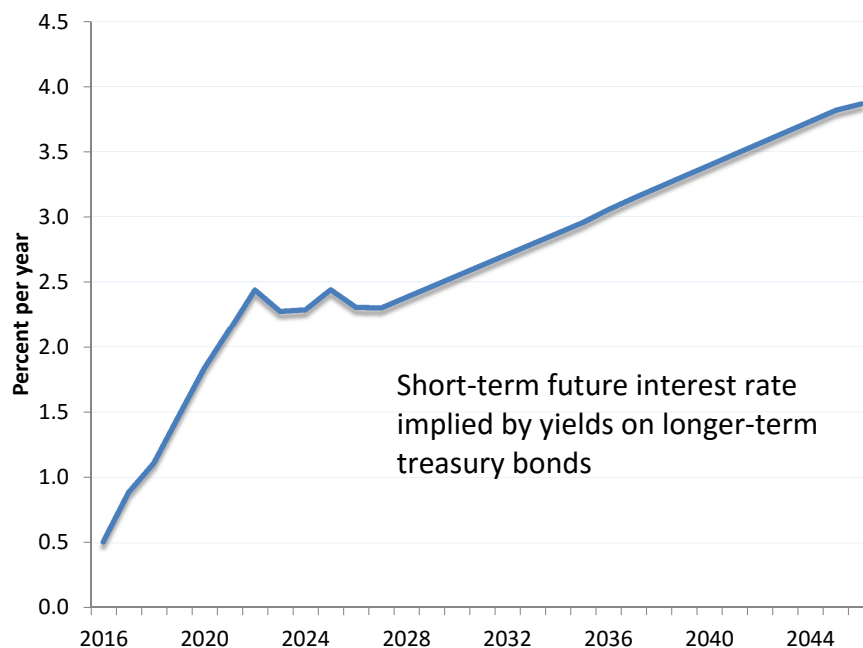


Figure 14: The Future Short-Term Nominal Interest Rate Implicit in the Treasury Debt Market

Figure 13 shows the Fed’s policy rate since 1955. During the period when the Fed tolerated growing inflation, and real interest rates were stable or rising, the nominal rate rose on an upward trend, interrupted by recessions. The switchover to what eventually became strict inflation stabilization at two percent resulted initially in a record-high rate of 16 percent, followed by a consistent downward trend, again with a superimposed countercyclical component. Until the crisis, the policy rate remained above the zero bound, though after the 2001 recession, concern began to develop that the zero bound had become a meaningful potential limitation on monetary policy.

Real interest rates are declining around the world. With the adoption of a low target inflation rate and downward-trending real rates, nominal interest rates are likely to be low in normal times in the future. Figure 14 shows the future short-term nominal rate implicit in the US Treasury debt market as of April 2016. According to the consensus expressed in the debt market, it will take four years for the short rate to hit two percent and 30 years to hit 3.5 percent. Figure 13 shows that the typical expansionary move involves a four percentage point cut in the policy rate. According to the Treasury debt market, it is unlikely that the Fed would have that much operating room even 30 years from now.

7 Concluding Remarks

The initial effect of the financial crisis was a large decline in employment output as unemployment shot up from below 5 percent in 2007 to almost 10 percent in 2010. But the other influences that took over in later years, when unemployment had returned to normal, contributed to the shortfall in real GDP in 2010. Shortfalls in productivity growth and in the capital stock—at least partly attributable to unfavorable conditions in financial markets attributable to the crisis—exceeded the direct effect of the cut in employment even in 2010. By 2015, the direct effect of employment losses had essentially ended, but shortfalls in productivity and in capital formation cumulated further. In both years, surprising shrinkages in the labor force also contributed to diminished output, though the connection to the financial crisis and recession remains imperfectly understood.

An important conclusion of this study is that stagnation involves much more than employment cutbacks from inadequate demand. Diminished demand has a major role through the unemployment channel in the first years after an adverse shock. Diminished demand has large effects long after unemployment is back to normal, because it depresses state variables—productivity and capital stocks—that do not recover anywhere nearly as fast as unemployment.

Modern economies have come to rely mainly on monetary policy to offset demand shocks. Macroeconomists thought this reliance made good sense, prior to the discovery that low inflation expectations and declining real interest rates handcuffed monetary policy by keeping the nominal interest rate close to zero even in normal times. Practical solutions to this development—overcoming the zero lower bound or harnessing countercyclical fiscal policy—have yet to replace traditional monetary policy.

8 Related Literature and Sources

I will not attempt to review systematically the large and growing literature on the macroeconomics of the financial crisis and ensuing slump and stagnation. Many references appear in my chapter, Hall (2016a), for the forthcoming Volume 2 of the *Handbook of Macroeconomics*, and many of the other chapters in the volume treat the subject.

See Hall (2015) for more on the relation between financial discounts and unemployment and Hall (2016b) for a discussion, with references, of the decline in the worldwide real interest rate.

Table 1 is taken from Hall and Petrosky-Nadeau (2016).

See the spreadsheet available at Stanford.edu/~rehall for complete sources and calculations for the tables and figures in this paper.

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