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Perspectives on the Recent Weakness in Business Investment

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After having been a relatively bright spot early in the recovery, business fixed investment (BFI) has increased at an annual rate of only about 4 percent over the past two years, an unusually slow pace during an expansion. Given the importance of investment both for understanding cyclical variation in the economy and for potential output growth, this memo describes our interpretation of the recent weakness in investment growth and discusses the considerations that inform our baseline projection.

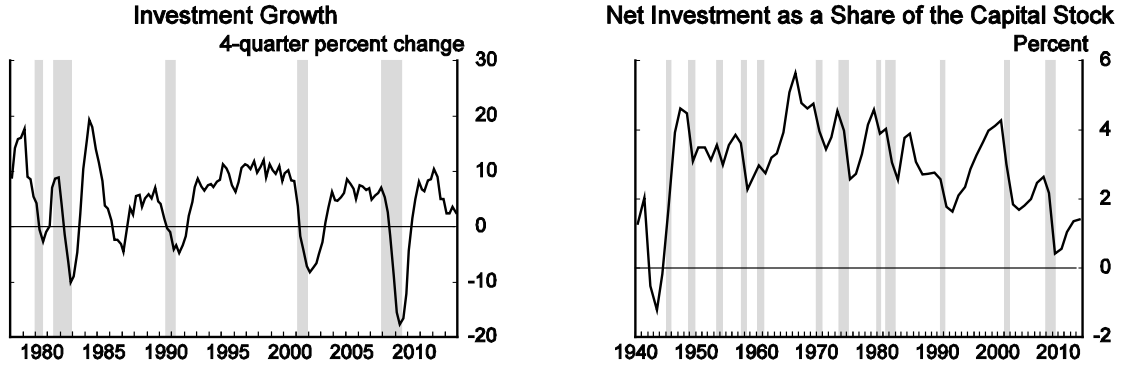
We begin by describing the recent behavior of aggregate investment spending and the analytical framework we employ. Using this framework, we argue that the recent weakness in investment growth is not surprising and note that current observable indicators suggest only a moderate step-up in the pace of investment gains over the projection period. However, we also emphasize that the staff's historical forecast errors for business investment are quite large, which implies some caution regarding our interpretation of the recent past as well as our ability to accurately project this volatile category of spending. In this context, we discuss some key unanswered questions about the behavior of investment.

Recent Behavior of Investment

As was typical in previous business cycles, changes in BFI were an important component of the cyclical swings during the most recent recession and recovery. As shown in the left panel of Figure 1, BFI declined a cumulative 20 percent during 2008 and 2009 and then rose 17 percent over the subsequent two years. These movements were large by historical standards, as would be expected given the depth of the recent recession.

The large decrease in investment in 2009 brought down the level of BFI so substantially that investment was barely sufficient to keep up with the replacement of depreciated capital. As shown in the right panel of Figure 1, *net* investment as a share of the capital

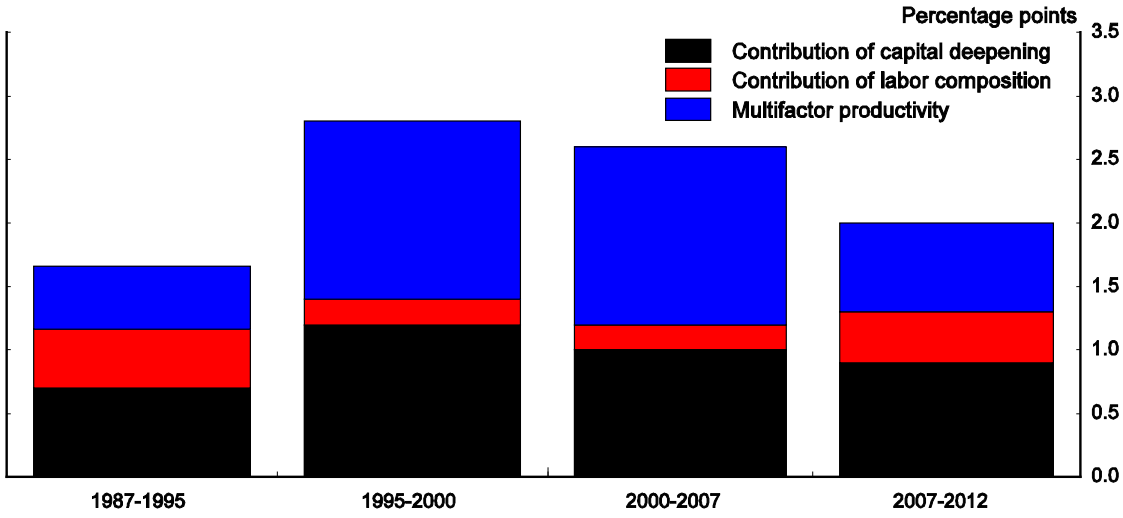
Figure 1: Real Business Fixed Investment



stock (which is equivalent to the growth rate of the real capital stock) fell to its lowest level since World War II.[1] Although net investment has rebounded some in the ensuing years, it remains quite subdued, hovering around 1½ percent per year.

The stepdown in the level of net investment since the recession also has led to a decline in the contribution of capital deepening (capital services per trend employee hour) to the growth rate of trend labor productivity and thus to potential output growth. The bars in Figure 2 decompose changes in labor productivity for the nonfarm business sector over various periods as reported by the BLS earlier this month. The areas in black show the portion of productivity growth attributable to increases in the quality and quantity of the stock of fixed capital relative to trend hours. Over the 1995-2000 period, when businesses were accumulating new capital very rapidly, this contribution was large. Since then, however, the pace of capital deepening has slowed.

Figure 2: Contributions to Growth in Output per Hour



Staff Framework[2]

In forecasting business fixed investment, we employ slightly different modeling strategies for nonresidential structures investment and for equipment and intangibles (E&I) investment. In the description below, we focus on our framework for modeling E&I because this category is much larger and it plays a more important role in capital deepening.

[1] The capital stock data are the BEA's published figures, which use published data on gross investment along with assumptions about depreciation rates on highly disaggregated types of structures, equipment, and intangibles. Because the BEA assumes most depreciation rates do not change over time, comparisons of capital stock measures across time, especially at a business-cycle frequency, can be problematic.

[2] The description here is our framework for forecasting investment in the judgmental medium-term projection presented in DEDO. The investment equations used in the alternative simulations and the long-term outlook (which come from the FRB/US model) are similar in some ways, but a full accounting of the differences is beyond the scope of this memo.

The staff's approach begins with a basic neoclassical investment model in which a representative firm chooses capital spending to maximize expected future profits. Under this framework (and, for ease of exposition, assuming a Cobb-Douglas production function), the optimal choice for the log of the capital stock in the absence of frictions will be:

$$k_t^* = \alpha + y_t - c_t$$

where α is a constant, y is the log of business output, and c is the log of the user cost of capital.[3] Note that taking the difference of this equation twice yields the familiar result that the change in net investment is related to the acceleration in output—a relationship that gives its name to the "accelerator" mechanism described in Samuelson (1939).[4]

In our implementation, we use a more general form of the production function, and we allow for additional elements like capital depreciation and adjustment costs (which we assume are quadratic). We also assume that firms form expectations of future output and the user cost rationally, and we use methods proposed by Hansen and Sargent (1980) to solve for k. Taking differences yields our basic estimating equation.[5]

$$\Delta k_t = \alpha + \rho \Delta k_{t-1} + \sum_{i=0}^{N} \beta_i \Delta y_{t-i} - \sum_{i=0}^{N} \gamma_i \Delta c_{t-i} + u_t$$

Impulse response functions based on our estimates of this equation are shown in Figure 3. As is typical for these types of regressions, a 1 percent level shock to business output leads to a much larger change in business investment than a 1 percent level shock to the user cost of capital does.[6] Of course, in this regression, the right-hand side variables are unlikely to be exogenous and so interpreting the magnitude of the estimated coefficients should be done with great caution.[7]

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[3] We define the user cost of capital according to the standard Hall-Jorgenson rental-rate formula,

$$c_t = p_t \left(r_t + \delta_t - \frac{\dot{p_t}}{p_t} \right) \left(\frac{1 - itc - \tau \cdot dep}{1 - \tau} \right)$$

where p is the relative price of capital, r is the real corporate bond rate, δ is the depreciation rate, τ is the marginal corporate tax rate, *itc* is the investment tax credit, and *dep* is the value of tax depreciation allowances.

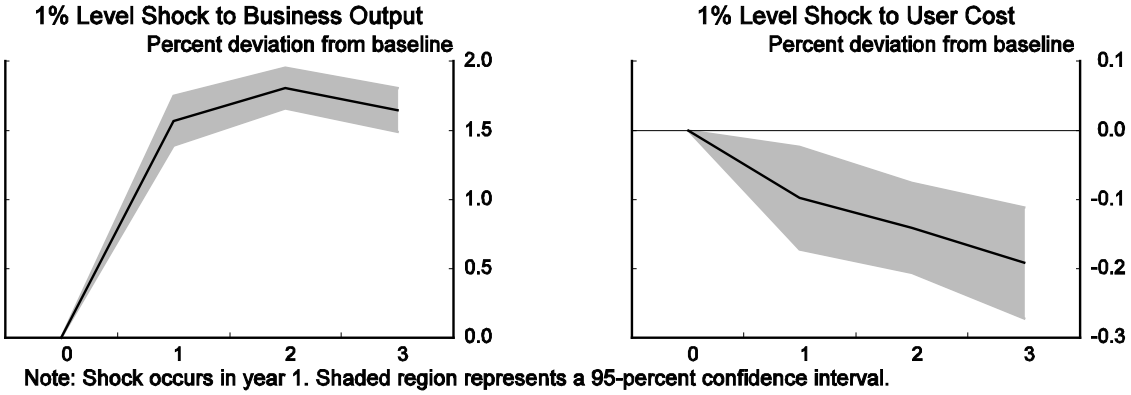
[4] Our approach to projecting nonresidential structures is only a little different. The structures model also relies heavily on an accelerator mechanism, but it incorporates interest rates in the form of a bond spread rather than as the user cost of capital. Beyond the basic model, we also look at vacancy rates and credit conditions in commercial real estate markets to help us project nonresidential structures.

[5] To follow all the steps of this derivation, see Tevlin and Whelan (2003).

[6] If we scale the impulses so that both are shocks of one standard deviation, shocks to output still explain more of the variation in investment than shocks to the user cost do. The larger responsiveness to output is what we would expect in a CES production function if the elasticity of substitution between capital and labor is less than 1 and returns to scale are decreasing. Additional issues related to the small magnitude of the user cost elasticity are taken up in the final section of this memo.

[7] For example, if shocks to the economy originated mainly in the investment sector (as in Justiniano *et al* (2009), Fisher (2005), or Greenwood *et al* (2004)), both investment and output would rise and the estimated βs would be overstated and positive, even if investment were completely unresponsive to movements in output.

Figure 3: Impulse Responses of Real E&I Investment



Note: Shock occurs in year 1. Shaded region represents a 95-percent confidence interval.

In putting together the staff projection, we also consider economic determinants that are excluded from our baseline model.[8] First, increased uncertainty about future outcomes can be a drag on investment when adjustment costs are not convex or investment is irreversible. Second, firms' expectations of future profits may not be well captured by our right-hand side variables. And third, a lack of access to financing may hinder investment, particularly for small or young firms during financial crises or recessions.

To assess the importance of these additional factors, we monitor a variety of indicators and run auxiliary estimating equations to gauge their effects on investment. These additional indicators are included in Table 1 along with the variables used in our basic model. We note that there is not always a one-to-one mapping from observable indicator to the economic determinant we are trying to capture. For instance, corporate bond spreads may be correlated with information about expected profits (through changes in default risk), uncertainty (which may correspond to greater riskiness), and credit rationing (which likely increases during times of financial market distress). While we cannot disentangle these various channels empirically, we nonetheless find it is important to consider bond spreads in our judgmental projections.

Explaining the Recent Weak Investment Growth and the Current Projection

In this section, we use the framework just described to present our baseline interpretation of the recent weakness in business investment, describe our March Tealbook projection, and discuss our confidence in the accuracy of that projection based on the staff's historical forecast errors. The left panel of Figure 4 shows the latest data along with an out-of-sample prediction for growth in real E&I investment from the neoclassical model described above. The model estimation uses data through the end of 2007, while the model simulation incorporates data on the right-hand side variables (business output and the user cost) through the end of 2013 and the staff projection of those variables through

[8] In most cases, the variables are excluded because they do not have a reliable linear relationship with investment once output data are included in the regression. For our near-term forecast, which is not otherwise addressed in this memo, we use data on orders, shipments, prices, and net exports of capital goods along with survey and company data on intangibles spending to anticipate the BEA's published estimates of E&I investment.

Table 1: Investment Determinants and Observable Indicators

Variables Affecting Investment	Observable Indicators
Current and expected future sales	Changes in Business Output*; Bond spreads; Analysts' earnings expectations; Business sentiment.
Cost of capital	BBB corporate bond rates*; Tax variables*; Depreciation*; Relative capital goods prices*.
Uncertainty	Dispersion of analysts' earnings expectations; Bond spreads; VIX; Baker, Bloom, Davis (2013) index; Business sentiment.
Credit supply constraints and financing frictions	SLOOS; bond spreads; cash flow.

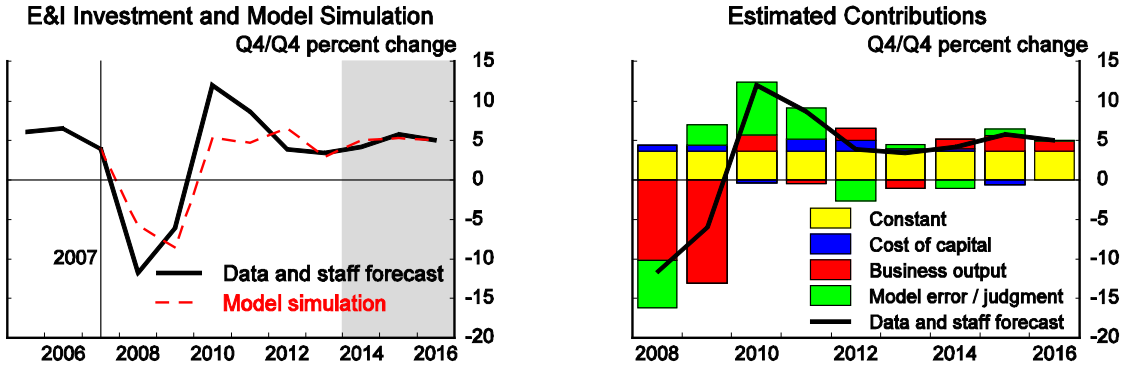
*Variables included in our basic empirical model.

2016. Investment growth was considerably above the model in 2010-11, but fell short of the model's prediction in 2012 (an error of about 3 percentage points). In 2013, the model appears to explain E&I growth fairly well.

The right panel of Figure 4 shows a decomposition of E&I growth into its various model determinants. The yellow portions of the bars roughly represent the constant term in the model. Usually, investment growth, the black line, would be far above this constant level during a recovery because of robust business output growth. However, in 2012 and 2013, the contribution to investment growth from business output (the red portions of the bars) was only marginally positive, on net, an important reason for the sluggish pace of investment over the past two years.

The green portions of the bars represent the part of investment growth not explained by the factors in the model. As noted, these model errors swing from a sizable positive in

Figure 4: Real E&I Investment, Model Simulation, and Contributions

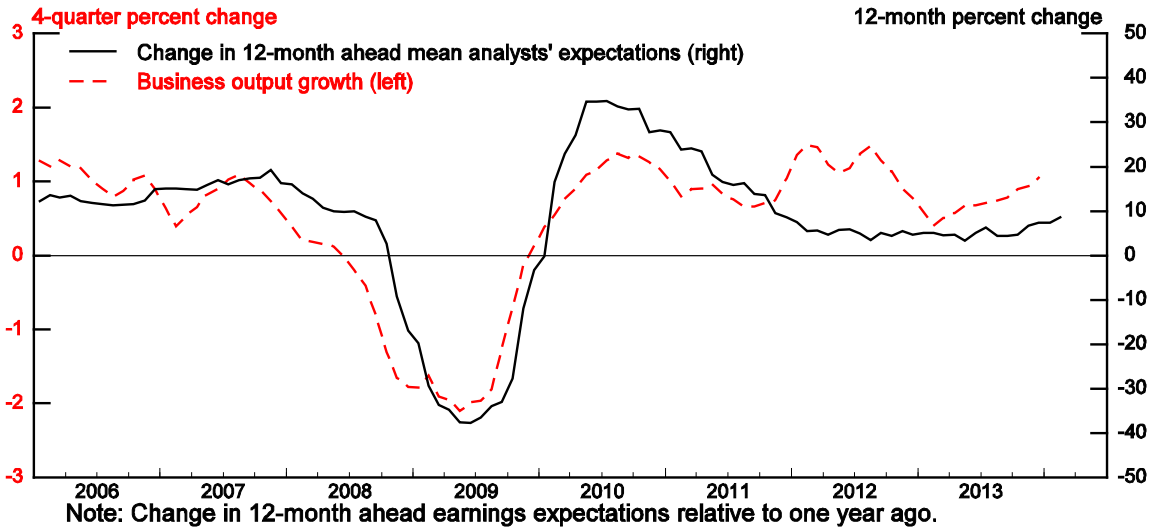


2010-11 to a small net negative in 2012-13. To understand these errors better, we turn to our supplemental indicators. Early in the recovery it seems likely that some investment projects that were delayed during the recession due to tight financing conditions and elevated uncertainty were resumed, boosting investment growth above the model for a year or two. In addition, as shown by the black line in Figure 5, profit expectations, measured here by analyst's earnings expectations 12-months ahead, moved up quite rapidly in 2010 but the increases slowed through 2012 and remained fairly low thereafter, a pattern that was not fully captured by business output growth (the red line), the proxy variable we use in our basic model.

Although with the benefit of hindsight we may have pieced together a plausible story for the recent behavior of investment, in real time we were less successful. In particular, the left panel of Figure 6 shows that the staff's year-earlier projection for E&I spending growth in 2012—that is, the projection that was made in the March 2011 Tealbook, indicated by the second red bar—was about 4 percentage points too optimistic compared with the BEA's current estimate (the second black bar). Current estimates for 2013 are also weaker than we had projected a year earlier (in March 2012).[9] To be sure, these misses partly just reflect the inaccuracy of the staff's projections for business output growth (about which we were also too optimistic).

The forecast misses for investment growth over the past two years are not particularly large by historical standards. The right panel of Figure 6 shows the 70 percent confidence interval around the data and staff forecast for the four-quarter percent change of real spending on E&I in the March Tealbook. The 70 percent confidence bands are very wide, about 3½ percentage points above and below the forecast at the 4-quarter

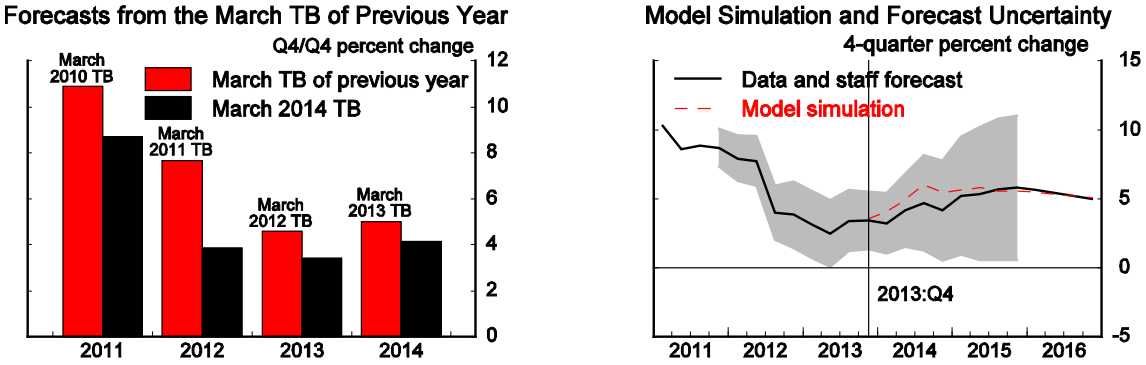
Figure 5: Business Output and Expectations of Future Earnings for Capital Goods Producers



Note: Change in 12-month ahead earnings expectations relative to one year ago.

[9] Our forecast errors for 2012 and 2013 were similar to those from the consensus Blue Chip forecasts as of April 2011 and April 2012, respectively.

Figure 6: Real E&I Investment Forecasts and Uncertainty



ahead horizon and about 5¼ percentage points above and below the forecast at the 8-quarter ahead horizon.[10]

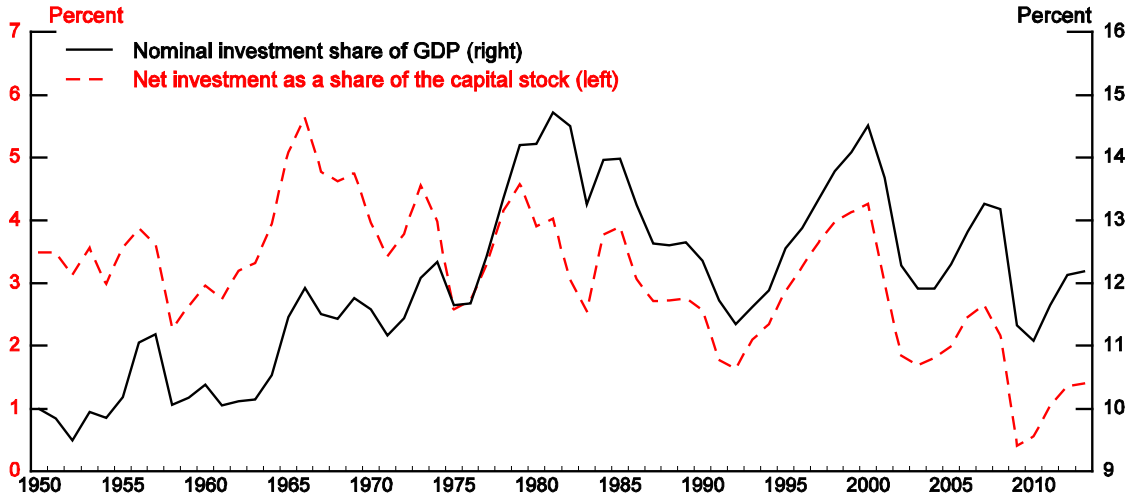
As shown by the black line, after continuing to rise at a subdued pace this year, real E&I spending in our March Tealbook projection was expected to increase at an average pace of about 5 percent through 2016, only somewhat above the modest gains seen over the past two years.[11] This projection is roughly in line with the prediction of the baseline model (the red line) because we do not anticipate the influence of other factors such as uncertainty or credit constraints to be a major source of restraint over the medium term. Given the wide confidence bands around our current projection, we next discuss some key questions that help assess whether the risks to our projection are balanced.

Is the Level of Investment Currently "Too Low"?

In the previous section, we focused on explaining the low growth rates of investment over the past two years. However, many high-profile analyses in recent years have focused instead on the *level* of investment and have reached the conclusion that it is disappointingly low.[12] While these analyses often focus on total private fixed investment (that is, they include housing construction in the calculations), some focus on business investment, as we do here.

[10] These confidence bands were computed from the distribution of historical forecast errors, relative to the latest data, in the second Tealbook of each quarter over the past 20 years. Note that because BEA's initial estimates tend to be revised substantially, the confidence band on the eight-quarter *behind* projection is still about 1½ percentage points above and below the latest data.
[11] At this point, we do not anticipate significant revisions to the investment outlook in the April Tealbook.
[12] For example, see "Quantifying the Lasting Harm to the US Economy from the Financial Crisis," draft for the *NBER Macro Annual*, April 2014, Robert Hall; "The American Investment Drought" *WSJ* (January 13, 2014); Goldman-Sachs *US Economic Analyst* (August 2013); "On Secular Stagnation" *Reuters*, Lawrence Summers (December 16, 2013); "The Slow Growth of Investment," *Econbrowser*; Menzie Chin (December 2012); "How to Make Businesses want to Invest Again," *New York Times* editorial, Greg Mankiw (September 10, 2011).

Figure 7: Measures of BFI Levels



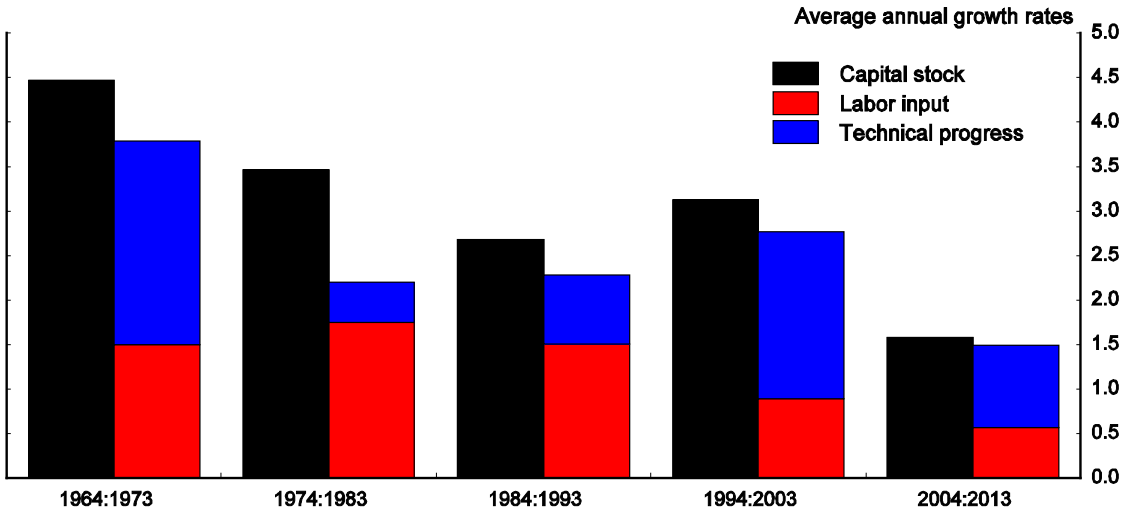
Investment levels are low by historical standards

To illustrate this issue we start with two measures that are frequently cited as evidence of the low level of investment. First, the nominal share of gross investment in GDP is shown by the black line in Figure 7. At 12 percent, it is currently in the middle of the 9 - 15 percent range that has prevailed for the past sixty years. However, because the rate of depreciation has been rising over time (as high-tech capital has become increasingly important), the ratio of gross investment to GDP should have an upward trend, suggesting this ratio is pretty low. The red line shows the level of the net investment rate (the growth rate of the capital stock). As noted earlier, this measure is also quite low by historical standards.

In the previous section, we analyzed the recent weakness of investment from the point of view of a partial equilibrium model that is helpful in understanding movements in investment growth at a business cycle frequency. And that analysis showed that an important reason for sluggish investment growth is the sub-par pace of the overall recovery. However, Figure 7 makes clear that there is also a long-standing downtrend in the level of the net investment rate. Lower frequency movements of this type can be better explained by looking at the steady-state growth rate in a general equilibrium model—that is, the growth rate of capital that holds when prices have moved to clear the markets for output, labor, and capital, and when the capital stock has completed its transition due to any past shocks. In the Solow growth model, for example, the steady-state net investment rate (the growth rate of the capital stock) is determined by the sum of the growth rate of labor input and the growth rate of technical progress.[13] Figure 8 shows

[13] Solow's (1956) derivation requires constant returns to scale, a constant labor income share, a constant saving rate, and a one-sector model, among other assumptions. Although these restrictions are unlikely to hold (for instance, the labor income share appears to have declined, Elsby *et al* (2013), and a two-sector growth model may be more realistic, Whelan (2003) and Basu and Fernald (2009)), the Solow model helps set the intuition and we think it is a helpful benchmark.

Figure 8: Net Investment, Labor Input, and Technical Progress



some suggestive evidence of this simple relationship.[14] Both the rate of net investment and the sum of these two growth rates display a similar slowdown since the 1960s.

In other words, an important reason why businesses are accumulating capital goods at a slower pace than two or three decades ago is likely that the *effective* labor force that will use that capital (i.e. the labor force adjusted for technical progress that enhances productive efficiency) is also expanding less rapidly.

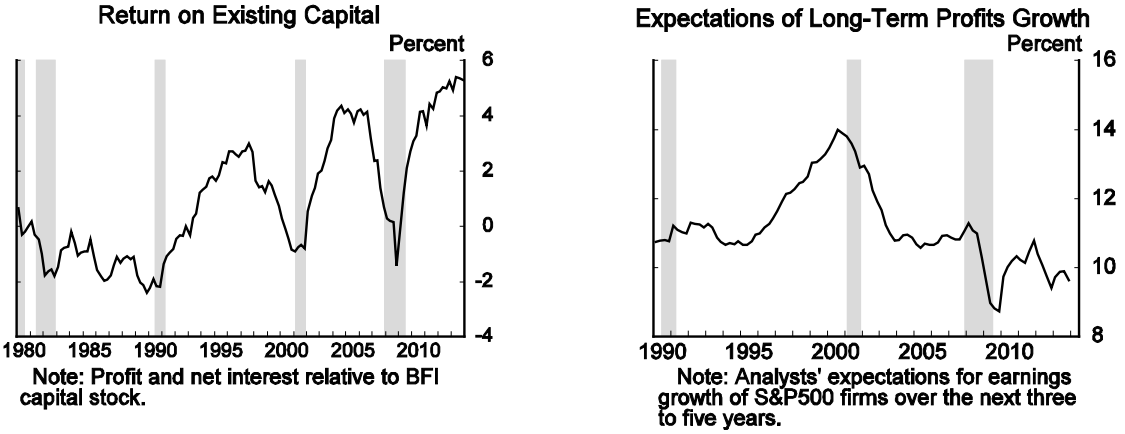
It is worth noting that because we think we can explain reasonably well both the long-run decline in the level of net investment and the recent cyclical behavior, we also do not consider the current level of the capital *stock* surprisingly low. Thus, our projection does not include any additional investment spending as firms try to rebuild depleted stocks of capital. This interpretation is supported by the pattern of model errors shown earlier in Figure 4, which show that investment growth has not been noticeably above the model since 2011. However, our ability to measure the level of the capital stock that firms would ideally like to hold is poor, and so there may be some upside risk that businesses will want to boost investment to address a possible capital stock shortfall as the economy improves further.

Investment levels are low relative to profits

Another factor that is also often cited as a sign that investment is currently too low is the high level of profits. As shown in the left panel of Figure 9, the return on capital—measured here as profits plus net interest divided by the nominal capital stock—was high

[14] The growth rate of the labor input is based on the staff's judgmental estimates of population, the trend employment rate (1 minus the natural rate of unemployment), trend labor force participation, the trend workweek, and a few other assumed pieces. The growth rate of technical progress is derived from the BLS data on multifactor productivity assuming a Cobb-Douglas production function and a labor share of 2/3. Although Figure 8 shows capital stocks, a series that is perhaps more comparable to labor input is capital services, which weights capital stocks by their productive value, rather than by their market prices. Using this measure does not change the basic message of Figure 8.

Figure 9: Profits Measures and Expectations



in the early years of the recovery (as it was in the years before the recession) and has recently moved higher.[15]

This measure suggests that firms are making ample profits on their existing capital and raises the question of why the profitability of investment doesn't spur them to expand. Unfortunately, we do not have a fully satisfying answer to this question. Uncertainty is often cited as a reason for businesses' apparent reluctance to invest, but most measures of uncertainty do not seem to be particularly elevated. Another possibility is that the return on capital is overstated as firms are increasingly shifting toward heavier use of intangible capital (which is likely not as completely measured), but in that case we would expect to see rising rather than slowing multifactor productivity growth. It is also plausible that the combination of high profits along with low investment and hiring reflects an increase in market concentration; we would expect to see this combination if there were unusually high barriers to entry. Indeed, during the financial crisis, many startups reportedly had difficulty acquiring financing. However, the high profit rate was present before the crisis, and we are not aware of evidence that shows barriers to entry have been high for nearly a decade.

Our preferred explanation is that current profits are not a particularly good indicator of future expected profits. Indeed, the return on capital (and other similar measures) does not have a very good track record at predicting investment. Moreover, one available measure of longer-run profit growth expectations (shown in the right panel of Figure 9) has stepped down over the past two years even as current profits have remained high.[16] At this point, while we don't entirely understand the mismatch between current

[15] Gruber and Kamin (2014) show that the combination of rising profits and sluggish investment is also present in other G7 countries, a pattern that they attribute mainly to an endogenous response to the global financial crisis.

[16] Another measure that should, in theory, capture the expected future return on today's capital is Tobin's Q. Unfortunately, in aggregate models, Q has not been empirically successful (Caballero (1999)). One implementation that works better is in Cummins *et al* (2006), which uses analysts' earnings expectations as an instrument for Q.

profitability and investment, subdued expectations of future profit growth are consistent with our projection for only a moderate step-up in the net investment rate through 2016.

How Sensitive is Business Investment Likely to Be to Rising Interest Rates?

As already shown in Figure 3, our basic empirical model suggests that a 1 percent increase in the level of the user cost (which is comparable to about 20 basis points on the BBB corporate bond rate at its current level) reduces the real level of investment only 0.2 percent after two years. Because the canonical model (with a Cobb-Douglas production function) suggests that, in the long-run, this effect should be closer to 1 percent, results of this magnitude are often described as "surprisingly small."[17,18]

The most frequently cited reason for the small measured elasticity of investment with respect to interest rates (and the user cost more generally) is that the user cost is endogenous. For example, if interest rates fall in response to a negative investment demand shock, then interest rates and investment will both decline. This positive correlation will tend to mask the causal effect of low interest rates in boosting investment. Researchers have devised a number of ways to circumvent this problem. Some have identified unique circumstances when movements in the user cost were largely driven by exogenous variation.[19] Others have used detailed micro data to purge endogeneity from firm-level financial variables, and still other researchers have focused on the low-frequency relationship between the user cost and investment.[20] Each of these approaches has some drawbacks, but taken together we view the evidence as suggesting that endogeneity does indeed damp the econometric estimates of the role of the user cost on investment.

Still, there are good reasons to suspect that even if we could perfectly identify exogenous interest rate shifts, the resulting estimates of the responsiveness of investment might not be as large as the simplest model suggests. When convex adjustment costs are non-trivial, rational firms will consider the entire future path of the user cost when making decisions, leading to a muted response to shocks that are perceived to be transitory.[21] And when adjustment costs are not convex, the situation is even more complicated because these can lead to nonlinearities (such as zones of inaction) that make interpreting

[17] See Eisner (1969) and Chirinko (1993). However, as noted earlier, under a more general CES production function, the coefficient on the user cost term should be related to the elasticity of substitution between capital and labor. When this elasticity is less than one, which seems likely (Antràs (2004) and Chirinko (2008)), the interest rate effect would be expected to be smaller than 1 percent.
[18] In the FRB/US model, the user cost elasticity is assumed to be 1 in the long run. However, a considerable fraction of this total effect is estimated to occur more than two years after the original shock.
[19] For instance, Coulibaly and Millar (2011) use the economic embargo in South Africa to identify periods when interest rates and prices are less endogenous to show that estimates of the user cost elasticity are held down significantly by endogeneity. Cummins *et al* (1995) use large tax reforms to identify shocks to the user cost.
[20] See Gilchrist and Zakrajsek (2007) and Caballero (1994).
[21] Kiyotaki and West (1996) and Tevlin and Whelan (2003) make this point.

aggregate results more difficult.[22] Or perhaps some firms are less able to time their purchases in response to interest rate changes or they are rationally inattentive to small rate changes. Indeed, over the past couple of decades, surveys of CFOs suggest that the "hurdle rates [of return]" they apply to investment decisions are quite insensitive to prevailing interest rates.[23] In general, we think that the direct effect of interest rate movements on business investment is one of the channels of monetary policy transmission, though it may not be the largest one.

As discussed in a recent memo to the Committee, firms' capital spending plans might be especially insensitive to movements in interest rates right now.[24] This could be the case if uncertainty about the economic outlook were currently unusually high, if some firms—such as small businesses or construction enterprises—were unable to obtain credit at any price, if firms were less sensitive to LSAP-induced shifts in the term premium than to other interest rate shocks, or a number of other reasons. The empirical evidence on these issues is limited, and while we have not built such effects into our baseline projection, we also cannot entirely rule them out.

Conclusion

The March Tealbook projects that investment growth, which has been sub-par over the past two years, will step up only gradually over the next few years. This projection reflects the staff's view that the recent weakness is fairly well explained by the steady, modest rate of business output growth so far in the recovery, which we expect to pick up only somewhat in the next couple of years. However, this projection is highly uncertain and there is much we don't understand about the recent behavior of investment. Areas that pose considerable risk include the puzzling relationship between the current high level of profits and low level of investment, whether firms will attempt to resume capital spending that was postponed during and since the recession, and how sensitive business investment has been and will be to rising interest rates.

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[22] While some research (e.g. Thomas (2002), Khan and Thomas (2008)) suggest that the nonlinearities from nonconvex adjustment costs wash out in the aggregate data, more recent work by Bachmann *et al* (2013) and Fiori (2012) point to some role in the aggregate data as well.
[23] See Sharpe and Suarez (2014).
[24] "Evaluating the Efficacy of the Federal Reserve's Large-Scale Asset Purchases." Memo to the FOMC. March 8, 2013. Durdu *et al*.

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