Chicago Fed Letter

Recent trends in capital accumulation and implications for investment

by François Gourio, senior economist, and Thomas Klier, senior economist and research advisor

Business investment has been fairly low over the past several years. As a result, the growth in the stock of capital has not kept up with the growth in gross domestic product (GDP) or employment. This *Chicago Fed Letter* studies these recent trends and discusses their implications for future investment.

One manifestation of economic growth has been the increase in the capital–labor ratio—the quantity of equipment and other productive assets available for each worker to produce goods and services. Over the past four decades, we have also observed a significant increase in the capital–output ratio—the quantity of productive assets relative to GDP. The increase in these capital ratios reflects the accumulation of assets thanks to higher productivity—in particular the availability of cheaper, more efficient capital goods, such as computers. In turn, these higher capital ratios allow higher productivity and a higher standard of living per worker.

However, relatively weak business investment over the past few years has led to a slowdown in the growth of the capital stock. Views differ on how to interpret this fact. Some argue that the weak investment is the consequence of excess investment experienced before the recent recessi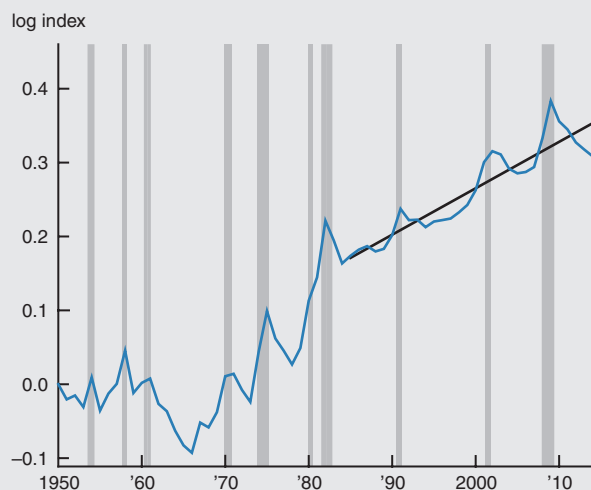on. Others argue that it merely reflects weak output growth, owing perhaps to contemporaneously deficient demand or lower productivity growth. And some believe that the underaccumulation of capital means the U.S. economy is poised for a large increase in investment if the current expansion continues. This leads us to consider two questions. First, where does the U.S. economy currently stand in terms of capital accumulation? And second, what does this tell us about future investment?

Is capital currently on track?

Figures 1 and 2 depict the capital–output and capital–labor ratios for the period from 1950 to 2014. In both figures, the shaded areas represent recessions as classified by the National Bureau of Economic Research (NBER). We use annual real data produced by the U.S. Bureau of Labor Statistics (BLS) multifactor productivity program.[1] Three facts are evident from these figures.

First, both ratios have been on a positive trend. The capital–output ratio was stable until around 1970 before starting a secular rise, which brought it up by around 30% by the beginning of the most recent recession. The capital–labor ratio has grown steadily and significantly since World War II, by 1.5 log points, which translates into growth by a factor of around 4.5. Second, both of these
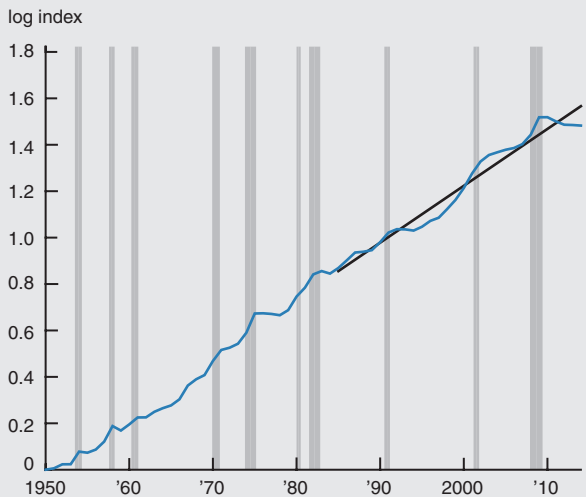

1. Capital–output ratio (*K/Y*)

log index

2. Capital–labor ratio (K/L)

log index

NOTES: The shaded areas represent recessions as classified by the National Bureau of Economic Research.
SOURCE: U.S. Bureau of Labor Statistics.

3. Deviations (in log points) from linear trend as of 2014

Sample used for trend:						
Start date	1995	1995	1985	1985	1979	1979
End date	2007	2014	2007	2014	2007	2014
Deviations from trend of:						
Capital–output ratio	−0.058	−0.046	−0.042	−0.045	−0.063	−0.055
Capital–labor ratio	−0.200	−0.096	−0.100	−0.084	−0.078	−0.077

SOURCE: Authors' calculations based on data from the U.S. Bureau of Labor Statistics.

4. Source of the deviation from trend

All entries in percent	K/Y	K/L
Deviation from trend in 2007	−1.3	−0.2
+ Numerator (K) growth 2007–14	10.8	10.8
− Denominator (Y or L) growth 2007–14	9.2	2.3
− Required trend growth 2007–14	4.5	19.4
= Deviation from trend in 2014	−4.2	−9.5

SOURCE: Authors' calculations based on data from the U.S. Bureau of Labor Statistics.

ratios exhibit a pronounced cyclical pattern: They increase during recessions and subsequently fall during recoveries. The ratios then flatten out before starting to grow again. This pattern simply reflects the fact that the stock of capital (the numerator in both ratios) changes more slowly than either production or employment. Third, the recent Great Recession is no outlier—it has followed the historical pattern but has been more pronounced owing to the historically large fluctuation experienced at the time.

In terms of current conditions, both the capital–output and the capital–labor ratios are shown to currently lie below their respective trend lines. To measure the extent of this gap, we estimate a linear trend for both the log capital–output and log capital–labor ratio. Figure 3 presents the estimated deviation from trend for both measures as of 2014. Because trend lines can be sensitive to the specific window of time used to estimate the trend, we construct a variety of estimates, corresponding to different starting and ending dates (figures 1 and 2 show the trend from 1985 to 2014). Regardless of which dates we use, figure 3 shows that the capital–output ratio is currently 4% to 6% below its trend, while the capital–labor ratio is 7% to 10% below its trend (excluding the most extreme estimate of 20%). Overall, this exercise shows that relative to output or labor, capital formation in the United States is currently growing well below trend.

Where does this imbalance come from?

Before turning to our second question it is perhaps worthwhile to ask how the U.S. economy has fallen so far below trend. Figure 4 provides a simple decomposition of the deviation from trend for both ratios. It starts in 2007, the most recent year in which the capital–output and capital–labor ratios were not far from trend. As a matter of accounting, the current deviation from trend (at the end of 2014) is the sum of the starting deviation in 2007 and capital growth accumulated since 2007, less the growth in output (or labor) since 2007 and the required growth to keep up with the trend line.[2] Overall, we see that capital growth since 2007 has been too weak, even relative to the disappointing growth in output or labor, to sustain the trend.[3]

Of course, such an accounting exercise does not imply causality. Capital growth may well have been slow, in part, because output growth was slow. That is, there need not have been a specific factor that impeded investment.[4]

Looking ahead

We can now turn to our second question: What does the current situation tell us about future business investment? If capital–output (or capital–labor) is to return to its trend line, the current deviation from trend must be corrected. This can happen either through an increase in the numerator—an increase in capital, i.e., a significant increase in investment—or through a decrease in the denominator—i.e., a contraction in output or labor. Figure 5 presents some simple linear regressions to shed light on this question. In this exercise the dependent variable is the growth rate of capital; the right-hand side variables are the lagged growth rate of capital, a constant and a linear trend, the lagged capital–output ratio (or capital–labor ratio) and lagged output growth (or labor growth).[5] We first present (in the first two columns) the results of this model for the aggregate capital stock. However, because the three major subcomponents of investment spending (spending on equipment, structures, and intellectual property) have exhibited very different trends over the past 30 years, we also estimate a separate model for each of these subcomponents. We show the results of this exercise in the remaining columns of figure 5. For simplicity, we

5. Dynamics of adjustment of capital

	Aggregate capital		Equipment		Structures		Intellectual property	
Lagged capital–output ratio	−0.07		−0.15**		−0.01		−0.09**	
Standard error	(0.06)		(0.05)		(0.01)		(0.04)	
Lagged capital–labor ratio		−0.06*		−0.08*		−0.02**		−0.08**
Standard error		(0.04)		(0.04)		(0.01)		(0.03)
R^2	0.92	0.90	0.93	0.90	0.95	0.98	0.94	0.94
Start date	1985	1985	1987	1987	1987	1987	1987	1987
End date	2014	2014	2013	2013	2013	2013	2013	2013

NOTES: Asterisks indicate statistical significance at 1% (***), 5% (**), or 10% (***) level, measured using ordinary least squares standard errors. See text for variables and specification.
SOURCE: Authors' calculations based on data from the U.S. Bureau of Labor Statistics.

only report the coefficient on the lagged capital–output or capital–labor ratio.

The key message from the figure is that future capital growth tends to be high, when the current capital–output (or capital–labor) ratio is low. Most of these results are statistically significant at conventional levels, especially when we estimate the model separately for each component of capital. (On the other hand, in results not shown here, we find no statistically significant effect of lagged capital–output or capital–labor ratio on future output or labor growth; even the sign of the slope coefficient is not uniform across regressions.) Overall, we expect that the deviation from trend of the capital ratios will be corrected mostly through adjustment in capital.

Most economists, however, focus on investment rather than capital growth. This leads us to conduct a final simple exercise to quantify how much the current value of the capital–output or capital–labor ratio affects the outlook for investment. We compare two simple forecasts for the investment–capital ratio: The first comes from a model that uses only the lagged investment–capital ratio, lagged output growth, and a deterministic trend. The second comes from a model that has the same variables, plus the capital–output (or capital–labor) ratio. This second model turns out to predict growth in investment spending of an additional 1.3% to 1.6%. Breaking it down into its major components suggests that most of the additional expected growth comes from equipment and intellectual property, while structures lead to lower expected growth because the current capital stock remains above the estimated trend. This last finding is consistent with the idea of an "overhang" (i.e., a residual of past overinvestment) in commercial real estate.

Conclusion

Overall we find that capital currently is below its longer-term trend in relation to both output and labor. If historical patterns hold, this suggests some additional growth of investment going forward, of perhaps a little over 1 percentage point per year while the current imbalance lasts. However, this relationship is statistically fragile, owing in part to the relative sparsity of data. There are two additional concerns. First, the trend of capital accumulation may be unstable. In particular, a persistent decline in productivity growth could lead to lower desired capital accumulation and could make the current level of capital sufficient. Second, recent investment may have been underestimated.[6] In that case, the current capital ratios would be underestimated and our analysis would overestimate the extent of their deviation from trend.

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[1] The capital index produced by the BLS differs from the one produced by the U.S. Bureau of Economic Analysis (BEA) in the fixed-assets tables. The BLS index is a better measure of aggregate capital as an input in production because it aggregates capital stocks using estimated rental prices. The BEA aggregates using resale prices instead, resulting in a better measure of wealth.

There are also some differences in the depreciation rates used. The two measures have been diverging since 1980, likely reflecting that high-tech equipment has high depreciation, and hence high rental rates, but quickly declining resale values. As a measure of output, we use nonfarm business sector output; for labor, we use a quality-adjusted index produced by the BLS.

[2] For this calculation, we use the trend estimated from 1985 to 2014.

[3] By comparison, over the previous seven years, 2000 through 2007, capital growth was 25.4%, output growth 21.5%, and labor growth 3.8%.

4 Indeed, when we simulate a simple model for capital growth (a regression of capital growth on lagged capital growth, lagged output growth, the lagged capital–output ratio, a constant, and a linear trend), we find that the low output growth "explains" a significant fraction of capital growth. Consequently, when we simulate the capital–output ratio given data on output growth with this simple model, we find that the capital–output ratio is only about 1% lower than the model implies. Similar results hold for the capital–labor ratio.

5 Technically, these regressions are well specified if capital and output (or labor) are, in logs, cointegrated around a linear trend. A Dickey–Fuller test can reject the null that the log capital–output has a unit root since 1980, but cannot reject it for the log capital–labor.

6 This possibility was discussed recently by economists at the Board of Governors of the Federal Reserve System. See http://www.federalreserve.gov/econresdata/notes/feds-notes/2015/recent-slowdown-in-high-tech-equipment-price-declines-some-implications-for-business-investment-labor-productivity-20150326.html.