MACROECONOMIC ADVISERS®
Macro Focus

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Accounting for Productivity Growth

Since mid-2010, annualized growth of labor productivity in the nonfarm business sector, adjusted by Macroeconomic Advisers for cyclical variation, averaged 0.7%, less than half the 2% averaged over the previous half century (Chart 1). The duration of the recent slowdown has no precedent since 1967. It can be traced back to: the direct and—via capital deepening—indirect effects of a deceleration of total factor productivity (TFP); and, also via capital deepening, a halted decline in the cost of capital. Without a sharp acceleration of TFP, trend productivity growth will remain historically slow over the horizon of our short-term forecast.[1]

Productivity Accounting Looking Backwards

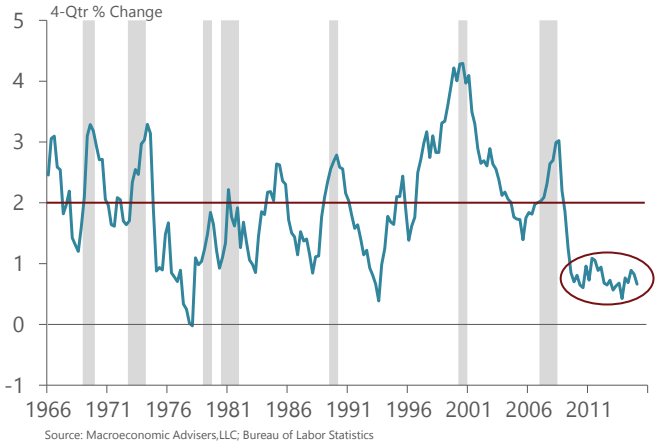
To facilitate our analytical exposition, consider a Cobb-Douglas production function with output, *Q*, as a function of total factor productivity, *A*, capital, *K*, and labor, *L*:

(1) $$Q = AK^{\alpha}L^{1-\alpha}$$

The parameter α is a technical coefficient but, if product and factor markets are competitive, is interpreted as capital's share of gross income. From (1), labor productivity can be written as:

(2) $$\frac{Q}{L} = A\left(\frac{K}{L}\right)^{\alpha}$$

Chart 1. Full Employment Labor Productivity



Source: Macroeconomic Advisers,LLC; Bureau of Labor Statistics

From (2), and using a "dot" over a variable to denote its growth rate, productivity growth can be expressed as:

(3) $$\dot{Q} - \dot{L} = \dot{A} + \alpha\left(\dot{K} - \dot{L}\right)$$

From (3) it follows that productivity growth has two components: growth in TFP; and, the weighted (by capital's share) growth in the capital-labor ratio. The latter is referred to as the contribution to productivity growth from capital deepening.

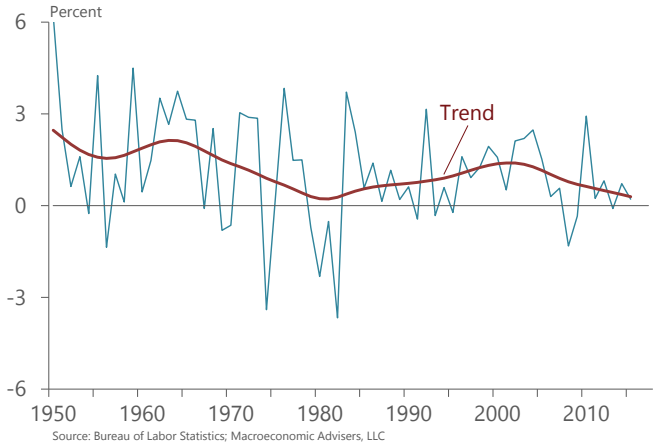
TFP Growth

By 2015, the trend value of TFP growth slipped to just 0.3%, well below the historical average of 1.2% (Chart 2) and, apart from the years 1980-81, the slowest since 1950.[2] Obviously, then, the recent deceleration of TFP has contributed directly and significantly to the recent deceleration of productivity.

[1] For data underlying the charts, contact Prakken@macroadvisers.com.

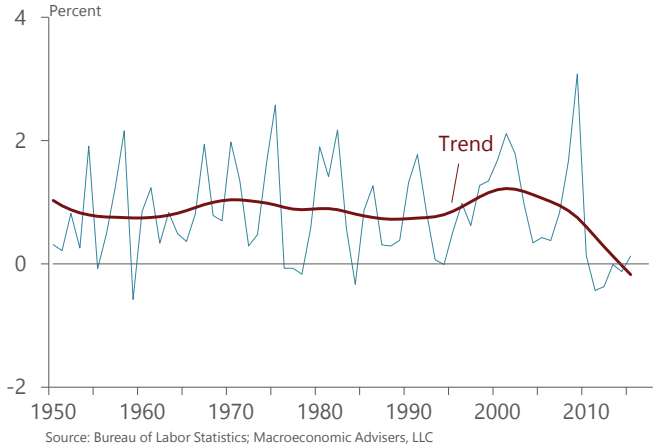
[2] Annual data for TFP growth from 1950 through 2015 are from the BLS report on multifactor productivity, not the measure of TFP growth used in our macro model. The BLS measure is based on a finer disaggregation of both capital and labor inputs. In addition, the BLS adjusts labor inputs for educational attainment. Trend TFP growth is represented as a Hodrick-Prescott (HP) filter through the annual data on TFP growth; the filter's smoothing parameter is set to 100.

Chart 2. Sources of Productivity Growth: TFP



Source: Bureau of Labor Statistics; Macroeconomic Advisers, LLC

Chart 3. Sources of Productivity Growth: Capital Deepening



Source: Bureau of Labor Statistics; Macroeconomic Advisers, LLC

Capital Deepening

What about capital deepening? Its contribution to productivity growth has been near zero—indeed, slightly negative—over the last five years (Chart 3). [3] What's behind that slowdown? To see, note that expression (1) can be re-written in terms of the capital-labor ratio as:

$$(4) \qquad \frac{K}{L} = \left(A \frac{K}{Q} \right)^{\frac{1}{1-\alpha}}$$

An equilibrium condition is that that the capital-output ratio is inversely related to the user cost of capital, q:

$$(5) \qquad \frac{K}{Q} = \frac{\alpha}{q}$$

Substituting (5) into (4):

$$(6) \qquad \frac{K}{L} = \left(\alpha \frac{A}{q} \right)^{\frac{1}{1-\alpha}}$$

Expression (6) can be re-stated in terms of the contribution to productivity growth from capital deepening as:

$$(7) \qquad \alpha\left(\dot{K} - \dot{L}\right) = \frac{\alpha}{1-\alpha}\left(\dot{A} - \dot{q}\right)$$

Capital Deepening and TFP Growth

In expression (7), the contribution to productivity growth from capital deepening depends positively on TFP growth. Hence the deceleration of TFP is also, through its impact on capital deepening, *indirectly* a major factor in the recent deceleration of productivity. This impact, which often goes unappreciated, is significant. For example, using (7) and assuming α=0.4,[4] the slowdown in trend TFP growth from 1.4% in the early 2000s to 0.3% in 2015 shaved 0.6 percentage point from productivity growth via slower capital deepening, accounting for roughly a third of the overall recent slowdown in productivity growth.

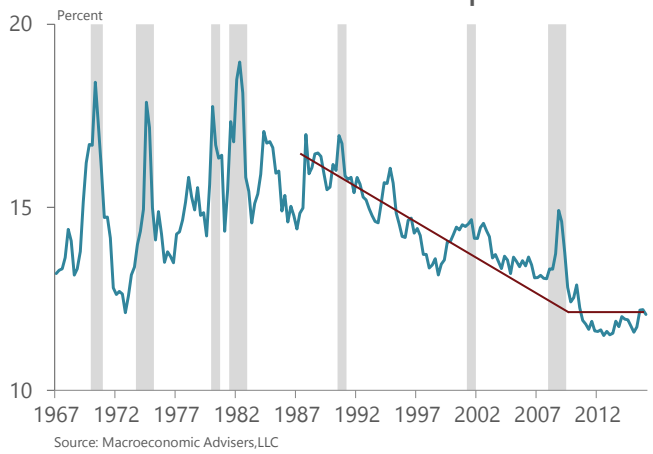
Capital Deepening and the Cost of Capital

In addition, in (7) capital deepening depends inversely on changes in the cost of capital. We compute q as a weighted average of user costs across the four different types of business capital in our macro model. This cost of capital declined steadily from around 17% in the late 1980s to about 12% by 2010, but has been practically

[3] Annual data on the contribution to productivity growth from capital deepening from 1950 through 2015 are from the BLS report on multi-factor productivity. The trend is represented by an HP filter with the smoothing parameter set to 100.

[4] This is computed for 2015 as one minus the share of nominal compensation in nominal valued added by the private nonfarm business sector, all taken from the BLS report on productivity and costs. However, a simple regression of (6) also yields a value of α= 0.4. See Appendix.

Chart 4: User Cost of Capital



Source: Macroeconomic Advisers,LLC

unchanged since (Chart 4). The main reason for this is that the long secular decline in the relative price of investment goods that began in the early 1980s tapered off before the Great Recession. Another factor is that a gradual decline in nominal interest rates, combined with a series of changes (and extensions) to write-off schedules, have left little room for further increases in the present value of tax depreciation allowed on tangible investments.

In any event, expression (7) suggests that the decline from 1987 to 2010 raised productivity growth via capital deepening, but that after 2010 this source of productivity growth stalled. While not fully accounting for lagged investment dynamics, a calculation based on a simple regression of (7) implies that the decline in user cost added roughly 0.9 percentage point to productivity growth via capital deepening between 1987 and 2010, but that this contribution has since abated—re-enforcing the slowing of capital deepening attributable to the deceleration of TFP.[5]

Productivity Accounting Looking Forward

For an unchanged cost of capital, the sum of expressions (3) and (7) reveal, for a given cost of capital, that trend productivity growth is simply TFP growth grossed up by the inverse of labor's share of income:

(8) $$\dot{Q} - \dot{L} = \frac{\dot{A}}{1-\alpha}$$

[5] See Appendix.

Given recent TFP growth, the fundamentals for underlying productivity growth are discouraging. For example, as mentioned above, the current trend growth of TFP is 0.3%. With the cost of capital unchanged, expression (8) implies an underlying productivity growth of just 0.3/(1-0.4) = 0.5% of which 0.2% is the contribution from capital deepening. For this to improve soon, either: (1) TFP growth must recover; (2) the cost of capital must resume its previous decline, spurring investment; or (3) the capital-labor ratio must rebound independent of either TFP growth or the cost of capital, perhaps because capital stocks have fallen below desired levels and might begin catching up.

We do assume that TFP growth, the version of which in our macro model is currently near zero, gradually recovers towards its historical average. Our forecast also shows some capital deepening in excess of that implied indirectly by our assumptions for TFP growth. This reflects the "correction" of currently depressed capital stocks towards higher equilibrium levels. However, the cost of capital is projected to rise from 11.9% in 2015 to 13.5% by 2021, a factor that mitigates investment and hence capital deepening. The net result of these forces is a projection that productivity growth will average only 0.7% through 2017 before finally moving above 1% by mid-2018.

Appendix:

The long-run relationship between the capital-labor ratio, the level of TFP and the level of the user cost of capital is given by expression (6). In logs:

(A1) $$\log(KL) = \alpha + \left(\frac{1}{1-\alpha}\right)\log\left(\frac{A}{q}\right)$$

We estimated this relationship using annual data 1966 through 2015. *KL* is an index of the ratio of capital services to labor input from the BLS report on multi-factor productivity; *A* is an index of the level of TFP form the same report; *q* is the aggregate user cost of capital computed as described in the text. The variables log (*KL*) and log(A/q) tested as I(1) and co-integrated. The long-run relationship between them was estimated by dynamic OLS over the years 1966-2015 with a Newey-West correction to the standard errors. The co-integrating relationship was (Newey-West t-statistics in parentheses).

(A2) $$\log(KL) = 1.043 + 1.662\ \log(A/q)$$
$$(2.9) \quad (9.1)$$

The coefficient of 1.662 implies an estimate of α=0.4.