

REVISITING AND RETHINKING THE BUSINESS CYCLE[†]

Okun's Law and Productivity Innovations

By ROBERT J. GORDON*

A long tradition in macroeconomics dating back to Arthur Okun (1965) and Walter Oi (1962) regards cyclical productivity fluctuations as an artifact, a residual generated from the incomplete and lagged response of employment and labor hours to demand-driven fluctuations in real output. In Okun's version a one percent decline in output relative to trend is divided up into a reduction of $\frac{1}{3}$ point in productivity and $\frac{2}{3}$ point in aggregate hours. The latter is further subdivided into a reduction of $\frac{1}{3}$ point in the employment rate, with the remaining adjustment taking the form of lower hours per employee and in the labor force participation rate (hereafter LFPR). Yet this tradition of regarding cyclical productivity fluctuations as a byproduct of demand-driven output cycles has been almost forgotten over the past three decades as a result of widespread adoption of the real business cycle (RBC) model in which productivity shocks are treated as exogenous, as unexplained, as unrelated to aggregate demand, and as the sole driver of business cycles. Even in the more enlightened modern macro work on Dynamic Stochastic General Equilibrium Models, aggregate demand and sticky prices have reappeared, but most recent papers still include an autonomous "technology shock" as one of several causes of short-term business cycle fluctuations.

[†]*Discussants:* Marcelle Chauvet, University of California; Jeremy Piger, University of Oregon; Martin Feldstein, Harvard University and NBER; Mark Watson, Princeton University.

*Department of Economics, Northwestern University, Evanston IL 60208-2600 (e-mail rjg@northwestern.edu). This is a drastically shortened version of the full paper that is available at the author's Web site, is forthcoming as a NBER working paper, and that contains all the graphs and tables of results that have been deleted from this version for lack of space.

Neither the older nor newer paradigm has paid attention to an evolving structural shift in the relationship between output, hours, and productivity.¹ The last three recessions (1990–91, 2001, and 2007–09) have been followed by "jobless recoveries" in which a revival of output growth in the initial stages of the recovery is accompanied by a burst of productivity growth and a continuing decline in employment. In contrast cyclical recoveries prior to 1990 were accompanied by prompt recoveries in employment and declines in unemployment. This new divergence of timing between the output and employment cycles has added difficulty to the task of the NBER Business Cycle Dating Committee in choosing the date of the cycle trough.

This paper quantifies the cyclical responses of employment, hours, labor force participation, and productivity to cyclical changes in output.² As a prerequisite to defining cyclical gaps, it provides new estimates of trends in growth rates of output and its components. The core question for this paper is whether the previously recognized tendency of aggregate hours to grow slowly and productivity to grow rapidly in an output recovery has exhibited a significant change in magnitude over successive business cycles.

I. The Breakdown between Trend Growth and Changes in Cyclical Gaps

Output, hours, and productivity (output per hour) are linked together by a simple definition. This can be extended to include hours per employee, the employment rate, and the LFPR in the "output identity" (see Robert J. Gordon

¹ An exception is Galí and Gambetti (2009).

² The exogenous output changes are assumed to be caused by shocks to aggregate demand and their propagation through the economy, as well as by price shocks due to changes in the relative price of oil and of imports.

1993) and is implicit in Okun's original (1965) formulation of his law. We begin with the basic identity that decomposes real GDP (Y) into output per hour (Y/H), aggregate hours per employee (H/E), the employment rate (E/L), the LFPR (L/N), and the working-age population (N).

$$(1) \quad Y \equiv \frac{Y}{H} \frac{H}{E} \frac{E}{L} \frac{L}{N} N$$

We can maintain equation (1) in its simple five-component form by defining "total economy productivity" as real GDP divided by total-economy hours, an unpublished series provided upon request by the Bureau of Labor Statistics (BLS), rather than as the more familiar BLS published series for the nonfarm private business sector (for which the identity is invalid unless extra "bridging terms" are added).

To make the identity operational, we take logs of (1) and use lower-case letters to designate the log of upper-case letters. For instance, y is the log of Y in equation (1) above. Thus the output identity in equation (1) can be restated in logs as follows:

$$(2) \quad y \equiv y - h + h - e + e - l + l - n + n.$$

Because logs are additive, we can express output (y) as the sum of each of the right-hand side components, say x . The trend of the log of real GDP (y^*) is the sum of the same five components x^* as in (2). The log-ratio of actual to trend output ($y' = y - y^*$), or output gap, is equal to the sum of the gaps of the right-hand side components ($x' = x - x^*$). In the same notation, the growth rates of right-hand-side components of (2) are Δx , the growth rate of the trend of the components is Δx^* , and the growth rate of the gap is $\Delta x'$.

The first task of this paper is to identify trends, and we reject the frequently used Hodrick-Prescott (H-P) filter, as well as the more recently developed band-pass filter. These techniques deliver a trend that is much too sensitive to the business cycle. For instance in 2009 we would expect the trend growth rate of aggregate hours to resemble the ongoing growth in the working-age population of 1.2 percent, with small adjustments for the slowly evolving trends in the components $h - e$, $e - l$, and $l - n$ in equation (2). However the H-P technique is so overly responsive to the business cycle that it registers a trend growth rate for aggregate hours in 2009:III

of *minus* 1.5 percent! Instead we use the Kalman trend technique that (unlike the H-P filter) allows the use of outside information on the size and timing of the business cycle. To obtain this outside information we use the long-tested "triangle" relationship between the inflation rate and the unemployment gap (Gordon 1997) to "back out" the unemployment gap conditional on the behavior of inflation, the specification of lags, and the behavior of explicit supply shock variables. This unemployment gap is then entered into the Kalman filter routine to deliver trends for all the variables in equation (2) above that are insensitive to cyclical fluctuations. To avoid unusual aspects of the 2007–09 recession contaminating the trend estimates, the growth trends for all variables are determined from data extending from 1962 to the end of 2006 and are then held constant during 2007–09.

Now that we have separated trend and cycle, we can examine the behavior of cyclical gaps in real GDP and the components of the output identity. Has the 2008–09 recession experienced a larger gap than the 1981–82 recession? The signature feature of the more recent episode is weakness in the labor market. Even though the 2007–09 recession had a maximum negative output gap (–7.4 percent) that was less than the larger maximum output gap in 1982 (–10.4 percent), the recent maximum hours gap (–8.9 percent) was substantially larger than in 1982 (–6.3 percent). The earlier experience adhered roughly to the Okun's Law prediction of a less-than-unitary response of the hours gap, but in 2008–09 that response has been substantially larger than unity.

II. Uncovering Structural Change: Coefficient Shifts since 1986

To quantify changes in behavior, we carry out a regression analysis of the response of each component to changes in the output gap in which coefficients are allowed to change between an "early" (1962–86) and a "late" (1986–2009) sample period. Each of these dependent variables is expressed as the change in the gap ($\Delta x'_i$). This is regressed on a series of lagged dependent variable terms and on the change in the output gap ($\Delta y'_i$), which for the labor market variables (h , $h - e$, $e - l$, and $l - n$) are entered as the current value and four lags. Because productivity growth leads output, the output gap is

TABLE 1—LONG-RUN RESPONSES TO CHANGES IN THE OUTPUT GAP

Dependent variable	Okun's 1965 prediction	1963:I–1986:I	1986:I–2009:III
Output per hour	0.33	0.22	0.03
Aggregate hours of which:	0.67	0.74	1.27
Hours/employee	0.17	0.28	0.34
Employment rate	0.33	0.40	0.64
LFPR	0.17	0.03	0.15

entered into the productivity gap equation as the current value and four leading values.

Two additional explanatory variables are included. The first is an error-correction term consisting of the lagged log ratio of actual to trend of the variable in question. The second is a set of “end-of-expansion” (EOE) dummy variables, which reflect my observation (Gordon 1979, 1993, 2003) that optimistic overhiring causes productivity growth to slow in the final stages of a business expansion and to rebound in the subsequent post-recession economic recovery. These are not 0, 1 dummies; rather, they are in the form $1/M$, $-1/N$, where M is the length in quarters of the period of the initial interval of excessive labor input growth, and N is the length of the subsequent correction. By forcing the sum of coefficients on each variable to equal zero, the regression is forced to recognize that any overhiring in the initial phase is subsequently corrected. Combining these explanatory variables, the basic equation to be estimated for the components of the output identity is:

$$(3) \quad \Delta x'_t = \sum_{i=1}^4 \alpha_i \Delta x'_{t-i} + \sum_{j=0}^4 \beta_j \Delta y_{t-j} + \phi x'_{t-1} + \sum_{k=1}^6 \gamma_k D_k + \varepsilon_t$$

where $D_k = 0$ in all quarters except the EOE and subsequent correction period. Here the α_i are the coefficients on the lagged dependent variable; the β_j are the current and lagged coefficients on the change in the real GDP deviation from trend; ϕ is the coefficient on the error-correction term; and the γ_k are the coefficients on the EOE dummies.

The results exhibit highly significant responses to changes in the output gap. The error-correction terms have the expected negative sign,

indicating a mean-reversion mechanism. Two of the six EOE coefficients have the expected positive sign in the equation for aggregate hours, while four of the six EOE coefficients have the expected negative sign in the equation for total-economy productivity. The most important result of this regression analysis is the change in the long-run responses, defined as the sum of coefficients on the output gap lags divided by unity minus the sum of coefficients on the lagged dependent variable. Table 1 illustrates the sharp changes in these long-run responses in contrast to the original 1965 Okun predictions. These results imply that (1) the Okun's Law responses suggested in 1965 correspond remarkably well to the actual responses over the early sample period, 1962–86, (2) Okun's Law is obsolete for the 1986–2009 interval, since aggregate hours now respond to changes in the output gap with an elasticity substantially greater than unity instead of Okun's $2/3$, and (3) since there is no longer any procyclical responsiveness of output per hour, the procyclical productivity shocks that motivate the RBC model are obsolete as well.

III. Interpretations of Structural Shifts and of the Jobless Recoveries

What broader aspects of macroeconomic behavior might have caused this change in cyclical responsiveness? A leading hypothesis links this shift in cyclical behavior with the much-discussed increase in income inequality, which in turn has been attributed to a combination of causes that combine to weaken labor's bargaining power, including an increase in immigration, imports, and the cost burden of medical care, together with a decline in the real minimum wage and in the penetration of labor unions. All of these factors may interact to embolden firms to respond to cyclical fluctuations by reducing

hours of work more than in proportion to the decline in output.

One problem with this linkage of growing inequality and a greater responsiveness of aggregate hours to cyclical output gaps is that job qualifications have generally shifted toward greater skills, more white-collar work, and less reliance on brute-force manual labor. Yet as David Autor and his co-authors (2008) have pointed out with their “polarization” hypothesis, the middle tier of the white-collar office workforce is uniquely vulnerable to replacement by computers or outsourcing. Middle-level white collar employees have been turned into mere commodities by the ubiquity of substitution between people and computers. A second complementary hypothesis is that the increased responsiveness of labor hours to the output gap could reflect greater flexibility in American labor markets, taking the form in the 2008–09 recession of a disproportionate rise of involuntary part-time unemployment. Another possible cause of increased labor market flexibility is the development of internet-based job matching. Firms can reduce employment and hours with impunity if they no longer value the human capital embodied in their experienced workers and have confidence that via the internet they can find replacement employees with equivalent skills.

A primary motivation for this research is to understand the causes of the jobless recovery of 2001–03, when aggregate hours for the total economy reached their trough in 2003:II, fully six quarters after the 2001:IV trough in real GDP. Will hours continue to decline for as long as six quarters following the 2009 output trough, which appears to have occurred in 2009:II? The econometric analysis decomposes the hours decline during those six quarters of 2002–03 into four components: (1) a decline in the trend growth rate of hours, (2) unusually slow growth in output, (3) the shift in coefficients noted above toward a larger hours response to the recession, and (4) the role of the EOE dummy as an explanation of slow hiring during the first four quarters of the recovery through 2002:IV. The equation “misses” by overpredicting the growth of hours and underpredicting the growth of productivity at an annual rate of about 0.5 percent between mid-2002 and mid-2004.

What explanations can be proposed to explain the particularly sharp decline in hours relative to output in 2001–04? I have previously (2003)

proposed two complementary explanations. The first centers on three interrelated facts, that the share of executive compensation taking the form of stock options rose from about 45 percent in the early 1990s to about 70 percent in 2000–01, that the Standard & Poor’s measure of corporate profits fell by 50 percent in 2000–01, and that the stock market fell by half in 2000–02. Corporate managers, seeing their compensation collapse with profits and the stock market, cut costs relentlessly, and this cost-cutting continued for several years after the post-2001 recovery began. This hypothesis was validated by Steven Oliner, Daniel Sichel, and Kevin Stiroh (2007), who showed in cross-section data that industries experiencing the steepest declines in profits in 2000–02 had the largest declines in employment and largest increases in productivity.

The second part of the explanation asks how firms could have produced so much output with so little labor input. The answer lies in the intangible capital hypothesis proposed by Susanto Basu et al. (2003) and by Erik Brynjolfsson et al. (2002). Their work suggests that the surge of information and communication technology (ICT) investment in the late 1990s not only boosted productivity in the late 1990s but also had lagged “spillover” benefits for productivity that lingered well into the post-2000 period. As a result conventional growth accounting overstates the contribution of ICT capital in 1997–2000 and understates it in 2001–04.

The 2008–09 recession period was very different from the previous cyclical episodes in 1990–92 and 2001–03. The decline in the output gap was much greater in 2008–09, and employment responded much more to the output gap than in 1991–92 or 2001–03. Productivity growth was actually above trend during most of the recession, especially at the end. What hypotheses can be offered to explain these unique aspects of behavior in 2008–09?

Some of our previous analysis of 2001–03 applies as well to 2007–09, including the collapse in the stock market and in corporate profits which were even larger. However, mere comparisons of stock market and profit data do not take into account the psychological trauma of the fall of 2008 and winter of 2009, when respected economists were predicting that an economic calamity was occurring that could bring about a replay of at least some aspects of the Great Depression. Fear was evident in risk spreads on junk bonds,

and when the market for many types of securities dried up. Business firms naturally feared for their own survival and tossed every deck chair overboard, slashing both employment and fixed investment. In the three quarters ending in 2009:II, gross private domestic investment declined at an unprecedented annual rate of 32.8 percent.

Will the recovery, which apparently began in 2009:III, exhibit a continuing decline in aggregate hours over six quarters as in 2001–03? There are two good reasons to be optimistic. First, the panic and fear during late 2008 and early 2009 were overdone, and the decline in hours was taken too far, making a bounce-back in hours more likely. Second, the role of a spillover delay from ICT investment that made productivity growth so strong in 2001–04 is unlikely to be as strong this time, because ICT did not experience an investment boom in 2004–07 analogous to 1997–2000, and innovations in the later period were less fundamental than the investment of the Web. However, a V-shaped recovery of aggregate hours does not guarantee a rapid decline in unemployment, as much of the initial recovery of hours will likely take the form of shifting those on forced part-time work back to full-time status.

IV. Conclusion

This paper has shown that the cyclical responses of aggregate hours and of productivity have changed sharply in the past two decades from those predicted by Okun's Law. Aggregate hours before 1986 responded to cyclical deviations in output by about three-quarters as much, whereas now the response is close to 1.25. Productivity no longer exhibits procyclical fluctuations at all, rendering obsolete the modern RBC literature with its unexplained exogenous procyclical productivity shocks. What explains this structural shift? First, the rise of immigration, imports, and medical care costs, together with the decline in the real minimum wage and of labor union power, have contributed both to a rise of inequality and an increasing tendency of firms to treat workers as disposable commodities. The ICT revolution has both increased the flexibility of labor markets and provided firms with new tools to boost productivity during economic recoveries as they continue to cut labor costs. The paper ends with a glimmer of opti-

mism that the decline in aggregate labor hours in the first two years of the post-2009 recovery will not persist for nearly as long as in 2001–03.

REFERENCES

- Autor, David H., Lawrence F. Katz, and Melissa S. Kearney.** 2008. "Trends in U.S. Wage Inequality: Revising the Revisionists." *Review of Economics and Statistics*, 90(2): 300–23.
- Basu, Susanto, John G. Fernald, Nicholas Oulton, and Sylaja Srinivasan.** 2003. "The Case of the Missing Productivity Growth: Or, Does Information Technology Explain Why Productivity Accelerated in the United States but Not the United Kingdom?" *NBER Macroeconomics Annual 2003*, eds. M. Gertler and K. Rogoff, 9–63. Cambridge, MA: MIT Press.
- Brynjolfsson, Erik, Lorin M. Hitt, and Shinkyu Yang.** 2002. "Intangible Assets: Computers and Organizational Capital." *Brookings Papers on Economic Activity*(1): 137–81.
- Galí, Jordi, and Luca Gambetti.** 2009. "On the Sources of the Great Moderation." *American Economic Journal: Macroeconomics*, 1(1): 26–57.
- Gordon, Robert J.** 1979. "The 'End-of-Expansion' Phenomenon in Short-Run Productivity Behavior." *Brookings Papers on Economic Activity* (2): 447–61.
- Gordon, Robert J.** 1993. "The Jobless Recovery: Does It Signal a New Era of Productivity-Led Growth?" *Brookings Papers on Economic Activity* (1): 271–306.
- Gordon, Robert J.** 1997. "The Time-Varying Nairu and Its Implications for Economic Policy." *Journal of Economic Perspectives*, 11(1): 11–32.
- Gordon, Robert J.** 2003. "Exploding Productivity Growth: Context, Causes, and Implications." *Brookings Papers on Economic Activity* (2): 207–79.
- Oi, Walter Y.** 1962. "Labor as a Quasi-Fixed Factor." *Journal of Political Economy* 70(6): 538–55.
- Okun, Arthur M.** 1965. "The Gap between Actual and Potential Output." In *Problems of the Modern Economy*, ed. Edmund S. Phelps, 287–96. New York: Norton.
- Oliner, Stephen D., Daniel E. Sichel, and Kevin J. Stiroh.** 2007. "Explaining a Productive Decade." *Brookings Papers on Economic Activity* (1): 81–137.

This article has been cited by:

1. Michael Frenkel, Eliza M. Lis, Jan-Christoph Rülke. 2011. Has the economic crisis of 2007-2009 changed the expectation formation process in the Euro area?. *Economic Modelling* . [[CrossRef](#)]
2. T. J. Hatton, M. Thomas. 2010. Labour markets in the interwar period and economic recovery in the UK and the USA. *Oxford Review of Economic Policy* **26**:3, 463-485. [[CrossRef](#)]