

# RBC Reassessed

*When official data better account for intangible capital, labor productivity figures are likely to cycle up and down with the broad economy, consistent with real business cycle theory*

**Douglas Clement**

Editor

The source of business cycles—ups and downs in economic activity commonly referred to as booms and recessions—has long been disputed by economists. Some theorists argue that monetary shocks—an unexpected surge in money supply, for example—are the cause. Others suggest structural frictions (a tax, tariff or union) that impede labor markets, for instance, result in reduced production, lower spending and higher unemployment.

But real business cycle (RBC) theory, an influential school of thought pioneered in two papers published in the early 1980s, first by Edward Prescott and Finn Kydland (1982) and a year later by John Long and Charles Plosser (1983), holds that technology shocks provide the major explanation for busts and bursts of economic activity. If an engineer designs a wing modification that enables airplanes to fly more efficiently, ticket prices might fall and tourism increase. If government regulations restrict use of that modification, the positive shock will be reversed.

The recession of 2008-09 presented a strong challenge to RBC theory. The theory implies that labor productivity drops when output drops, as in a recession (and rises when output does, in a boom); in other words, labor productivity is “procyclical.” But government data from the Great Recession showed that productivity rose some-

what—*greater* output per worker, not less—even though output fell dramatically.

This suggested at a minimum that the Recession was an anomaly, not a typical business cycle that technology shocks could explain. At worst (for RBC adherents), the data indicated fundamental weakness in the theory itself: If one of its key predictions wasn’t borne out by the largest recession in decades, perhaps the theory itself was flawed. Regardless, economists soon looked elsewhere for the recession’s source—most notably at disordered financial markets. See, for example, Cristina Arellano, Yan Bai and Patrick J. Kehoe (2012).

In a recent paper, however, Minneapolis Fed economists Ellen McGrattan and Edward Prescott argue that it’s far too soon to abandon RBC theory. Official calculations underestimated the actual drop in economic output, the economists contend, because they neglected a large component of national economic activity: business expenditure on *intangibles* investment. In fact, according to McGrattan and Prescott, theory and (other) data suggest that spending on intangibles dropped significantly during the recession, meaning that economic output—which includes expenditure on intangibles investment—fell far further in reality than indicated by government statistics. Labor productivity—the ratio of total output to hours worked—therefore likely fell from 2008 to 2009, in accord with RBC prediction.

---

Eulogies for RBC theories are  
**premature.**

---

As predicted by  
Real Business Cycle theory,  
U.S. labor productivity likely fell during the Great Recession.

---

Why do government statistics say otherwise?

---

Theory and relevant data suggest they dramatically underestimate the actual drop in total economic output because they neglect much actual spending on

**intangible  
capital.**

---

## Review, extend, evaluate

Their paper, “A Reassessment of Real Business Cycle Theory” (McGrattan and Prescott 2014), consists of three key sections. The first reviews the basics of an RBC model and addresses two critiques, which they label “naïve” and “sophisticated.” The second section extends the basic model to include intangible capital and finds that the model thus extended supports the idea that “wedges” in labor markets account for observed fluctuations in labor productivity and demonstrates that “*measured* productivities are misleading statistics for judging the theory.” The paper’s final section reviews empirical evidence showing, among other things, that the intangible investments for which direct measures are available are large and correlated with tangible investments.

A key point made by the paper: The very premise of the argument—that economic output declined only modestly, resulting in higher measured productivity (output per worker)—is flawed if calculations haven’t measured investment levels (a part of total output) properly.

How could the calculations be improved, at least theoretically? By accounting fully for investment in corporate assets like research and development, patents, trademarks, skills training, advertising and investments in organization-building: very real, indisputably valuable, but usually hard to measure.

Once investment in this intangible capital is incorporated into measures of total investment, suggest the economists, the drop in total output during the recession will likely seem larger, and measured labor productivity will probably not increase. McGrattan cautions that “we don’t observe all intangible investments so, at this point, we can’t make this a definitive statement. Only if we could observe and measure all intangible expenditure could we be certain.”

## Start with the basics

The basic theory is just that: a very bare-bones version of the original models set forth in the Kydland-Prescott (1982) and Long-Plosser (1983) papers. It includes a household (representative of all households) that supplies labor to firms and that, in addition to receiving wages for work supplied, receives dividends from those firms (as part-owners); the firms that produce final goods

for households and the government, as well as intermediate goods for other firms; and a government that has spending obligations financed through taxes on households and firms.

The crucial variables in this mathematical model are those that affect labor in the same way that a tax on labor income does. The variables can change over time and have a strong impact on how many hours of labor households provide to firms. By decreasing take-home pay, labor taxes encourage workers to supply fewer hours in the workplace.

Another important variable is the level of new investment made by firms, and in this basic model, new investments are made only in *tangible* capital: machinery, tools, buildings and the like.

McGrattan and Prescott quickly address two critiques of this basic model insofar as it’s capable (or not) of accounting for data patterns of the Great Recession. The first—the “naïve”—is that it doesn’t include complex financial markets or disruptions therein that some argue were central to the recent crisis; therefore, it can hardly be considered relevant to the recession that followed. True, it doesn’t, admit McGrattan and Prescott, but the lack of myriad sophisticated financial instruments doesn’t discredit the model itself. “At issue is whether the theory is a good abstraction for making reliable predictions,” they write. However, the inclusion of firms that raise funds and make new investments with those funds is a key part of the model; therefore, “it may well be a fine approximation.”

The more “sophisticated” critique is that the model’s predictions for output, investment and employment patterns in the recessionary period may strongly deviate from reality. Indeed, that is the motivation for the paper: RBC theory predicts that labor productivity (that is, output/labor hours) should decline during a recession, but the data show the opposite. *This* critique needs serious consideration.

So, is something fundamentally at fault with the theory? Is it now obsolete, unable to aid economists or policymakers? Or is the theory essentially valid and simply missing an element that would align model predictions and reported data? McGrattan and Prescott have dealt with this doubt before in closely related research and, as they write in a 2012 paper, “we find that eulogies for RBC theories are premature.”



Niedorf Visuals

Ed Prescott



Stan Waidhauser

Ellen McGrattan

Using a technique developed previously to analyze specific components of business cycle fluctuations (V. V. Chari, Patrick J. Kehoe and McGrattan's 2007 business cycle accounting method), McGrattan and Prescott determine that the theory requires “time-varying *labor wedges*, that is, something affecting the [effective tax on labor hours supplied by households] in addition to government tax policy.”<sup>1</sup>

In the next section of their paper, McGrattan and Prescott track down the source of that “wedge,” modify the model accordingly and find that fault lies not in RBC theory itself, but in the data as measured. They find that the bare-bones model lacks an important feature. The missing element? The easily overlooked, but absolutely essential *intangible* capital. Like RBC theory itself, intangible capital can't be seen or touched, but it's crucial.

### The basic model plus intangibles

The economists extend the model with a fuller description of the “technology.” That is, they incorporate *two* types of capital inputs, tangible *and* intangible. Again, tangible capital is structures, equipment, machinery—stuff you really can see and touch. Intangible capital includes research and de-

velopment, software, artistic originals, brand equity and organizational capital.

The U.S. government taxes these two things differently, and that's part of why including intangibles makes a difference to model results. Intangible capital is usually treated as an immediate annual expense—like wages paid—when computing taxable income. Counted as an annual expense, it isn't included in business value added and thus not in gross domestic product (GDP).

Also, they can be used differently: Intangible capital—ideas or information—can be used by many people at the same time. Economists say it's “nonrivalrous.” Tangible capital, on the other hand, is rival. A wrench or a factory can be used for only one purpose, by one party, at any given time.

Firms in this extended model have the same goal as in the basic model: maximizing the expected stream of after-tax dividends. But with two kinds of capital, dividends must be defined differently. (Each has different depreciation and tax rates, for instance, and intangible capital can be used nonrivalrously.)

“These minor adaptations of the basic theory,” write McGrattan and Prescott, “can have a significant effect on the key predictions.” Because official calculations of total output (GDP) haven't hereto-

fore included intangible capital investment, total output hasn't been fully measured; therefore, labor productivity (that is, output/labor) couldn't be estimated accurately.

In 2008, the Bureau of Economic Analysis' measure of GDP included only software, a small part of all intangible investment. The BEA expanded its coverage of intangible capital in 2013, including investment in research and development, and artistic originals. Nonetheless, a significant amount of spending on intangible capital remains unaccounted for, including investment in brands and organizational capital. As McGrattan and Prescott write elsewhere, "in other words, it is possible to observe high measured labor productivity while output is low if some output is not included in the statistic but all hours of work are included" (Minneapolis Fed Working Paper 694, p. 3).

In the typical calculation, labor productivity is the ratio of the nation's real value added (that is, inflation-adjusted GDP) to the number of labor hours provided.<sup>2</sup> If, to the numerator, you add total national investment in intangible capital (times the relative price of that investment to consumption), you'll come up with a far more realistic sense of actual labor productivity. *That* is the missing labor wedge: the seemingly invisible expenditure on intangibles.

Significantly, this missing element—the price of intangible investment relative to consumption, times the amount of intangible investment—"is time varying," write the economists. And "it fluctuates in just the right way," as they found in earlier research (2012). Which is to say, its inclusion in the RBC model delivers predictions consistent with the notion that labor productivity is "procyclical"—drops during recessions and rises with booms. With this extension of the RBC model, the economists find that, indeed, labor productivity will rise and fall in concert with the economy as a whole. "Thus," they conclude, "there is no *logical* inconsistency between theory and aggregate data."

## Microdata

So, their argument is sound insofar as it concerns national-level data, but does it hold up to closer scrutiny, at the level of actual firm expenditures on tangible and intangible capital? Is investment in

intangibles *quantitatively significant* for individual industries?

McGrattan and Prescott examine data gathered by the Bureau of Economic Analysis, which in 2013 created an "intellectual property products" category as part of its general intangibles group. This new category includes research and development, and artistic originals. (Previously, BEA data on intangibles included only software expenditure.) McGrattan and Prescott point out that it's a huge, previously ignored, investment category: As a fraction of all private, fixed nonresidential investment in 2012, a full third was devoted to IP, a portion consistent since the early 1990s. About 45 percent went to equipment and the remaining fifth to structures.

In some industries, IP investment is even more significant. In the BEA's computer and electronic products category, IP investments are currently "about *four times* larger than investment in both equipment and structures," they observe. Moreover, IP investment and equipment investment (and to a lesser extent, investment in structures) are correlated. IP spending surged during the late 1990s, reached a peak in 2000, fell, then rose and fell again during 2008-09. Equipment spending followed some same cyclical pattern. McGrattan and Prescott suggest that if the BEA were to broaden its coverage to include other forms of intangible investment (advertising, marketing and organizational capital), data series on these cyclical trends would look even more dramatic.

McGrattan and Prescott also look at 2008-09 data from annual 10-K reports of the largest 500 U.S. advertisers, and research and development spenders. They find that both groups (top advertisers and top R&D spenders) had significant capital expenditures, sales and employment in 2008, and that both faced large declines in all such categories—tangible and intangible—the following year, a tight correlation further suggesting that during the Great Recession, real GDP—and labor productivity—fell further than indicated in BEA data that didn't include all intangibles.

Thus, conclude the economists, "the microevidence suggests that our basic macrotheory—extended to incorporate intangible investments—is worthy of further investigation before declaring it useless," as some have deemed RBC theory. Or to echo their 2012 paper, eulogies are premature. ■

## Endnotes

<sup>1</sup> A “labor wedge” is something that prevents households from providing the number of hours of labor they ordinarily would, given prevailing wage rates (what they receive for an hour’s work and the consumption that provides them) and the value they place on another hour of leisure instead of additional consumption. More technically and accurately, it’s the difference between the marginal rate of substitution of consumption for leisure and the marginal product of labor. Wedges account for whatever difference may exist.

<sup>2</sup> Labor productivity for the business sector (probably the most cited statistic) is real value added for the business sector divided by business hours.

## References

- Arellano, Cristina, Yan Bai and Patrick J. Kehoe. 2012. “Financial Frictions and Fluctuations in Volatility.” Research Department Staff Report 466. Federal Reserve Bank of Minneapolis.
- Chari, V. V., Patrick J. Kehoe and Ellen R. McGrattan. 2007. “Business Cycle Accounting.” *Econometrica* 75 (3): 781-836.
- Kydland, Finn E., and Edward C. Prescott. 1982. “Time to Build and Aggregate Fluctuations.” *Econometrica* 50 (6): 1345-70.
- Long, John B. Jr., and Charles I. Plosser. 1983. “Real Business Cycles.” *Journal of Political Economy* 91 (1): 39-69.
- McGrattan, Ellen R., and Edward C. Prescott. 2012. “The Labor Productivity Puzzle.” In *Government Policies and the Delayed Economic Recovery*, edited by Lee E. Ohanian, John B. Taylor and Ian J. Wright. Stanford, Calif.: Hoover Institution Press, pp. 115-54. See also Minneapolis Fed Working Paper 694, May 2012.
- McGrattan, Ellen R., and Edward C. Prescott. 2014. “A Reassessment of Real Business Cycle Theory.” Research Department Staff Report 494. Federal Reserve Bank of Minneapolis.

### For further background:

McGrattan and Prescott have been researching the economic significance of intangible capital for over a decade. Some of their earlier work is reviewed in “The Untouchables” in the December 2005 issue of *The Region*.  
[minneapolisfed.org/publications\\_papers/pub\\_display.cfm?id=3256](http://minneapolisfed.org/publications_papers/pub_display.cfm?id=3256)