[The Case of the Missing Productivity Growth, or Does Information Technology Explain Why Productivity Accelerated in the United States but Not in the United Kingdom?]: Comment

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Comment

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1. Introduction

The exceptional productivity performance of the U.S. economy in the period 1995–2000 is well documented (see, for example, Jorgenson 2001): relative to the previous five years, total factor productivity (TFP) growth accelerated by 0.7% (and labor productivity growth by 1%) per year in 1995–2000. What are the sources of this sharp acceleration? Should we expect this higher TFP growth to be a long-term trend for the future, as some argue, or is it just a transitory phenomenon? Basu, Fernald, Oulton, and Srinivasan offer a comparative macroeconomics perspective to these important questions. They bring into the picture the experience of another country, the United Kingdom, which in many dimensions is similar to the United States.

From a long-run perspective, the U.S. and the U.K. economies stand at the same stage of development and share—unlike many other European countries—a similar institutional framework of labor and product markets. From a short-run perspective, the business cycle in the two economies in the 1990s was remarkably akin. I'd like to add that the United States and the United Kingdom were the only two among the developed economies that experienced a substantial rise in earnings inequality in the past 30 years, with analogous characteristics (e.g., both within and between skill groups).

Given these short-run and more structural affinities, one would expect a similar evolution of TFP growth in the 1990s for the U.K. economy. Instead, U.K. TFP growth decelerated by 0.5% (and labor productivity growth by 1%) per year from 1990–1995 to 1995–2000.

How do we explain the missing productivity growth in the United Kingdom (or the exceedingly high productivity growth in the United States)? Basu et al. build a convincing argument on two assumptions. First, because of unmeasured organizational capital that is complementary with information technology (IT) capital in production, TFP growth is mismeasured. Periods of strong investment in IT (and in the complementary organizational capital) are times where mostly output is unmeasured, so true TFP growth is underestimated, whereas periods where the economy has large stocks of IT and complementary capital are times where inputs are grossly undermeasured, and true TFP growth is overestimated. Second, IT investment boomed with a lag of 5 to 10 years in the

U.K. economy, relative to the U.S. economy. Thus, in 1995–2000, TFP growth was underestimated in the United Kingdom and overestimated in the United States, which explains, at least qualitatively, the gap.

This comment is organized into three parts: (1) an exploration of the role of convergence between the United Kingdom and the United States within a Solow-growth model; (2) a deeper look into the retail sector, where the TFP acceleration gap between the two countries is particularly striking; and (3) a quantitative exercise based on the model developed by Basu et al. in Section 4 of their paper.

2. Convergence

If one extends the comparison for the two countries back to the early 1980s (see Basu et al., Table 1), it emerges clearly that labor productivity growth was considerably faster in the United Kingdom until the mid-1990s. Basu et al. put it in plain words: "[T]he Europeans were catching up." The authors somewhat downplay the role of transition in their analysis, so here I try to assess if the fact that the United Kingdom was catching up is relevant in explaining the productivity acceleration gap. Intuitively, the transitional dynamics of the United Kingdom would naturally lead to a reduction in labor productivity growth as the economy approaches its steady state.

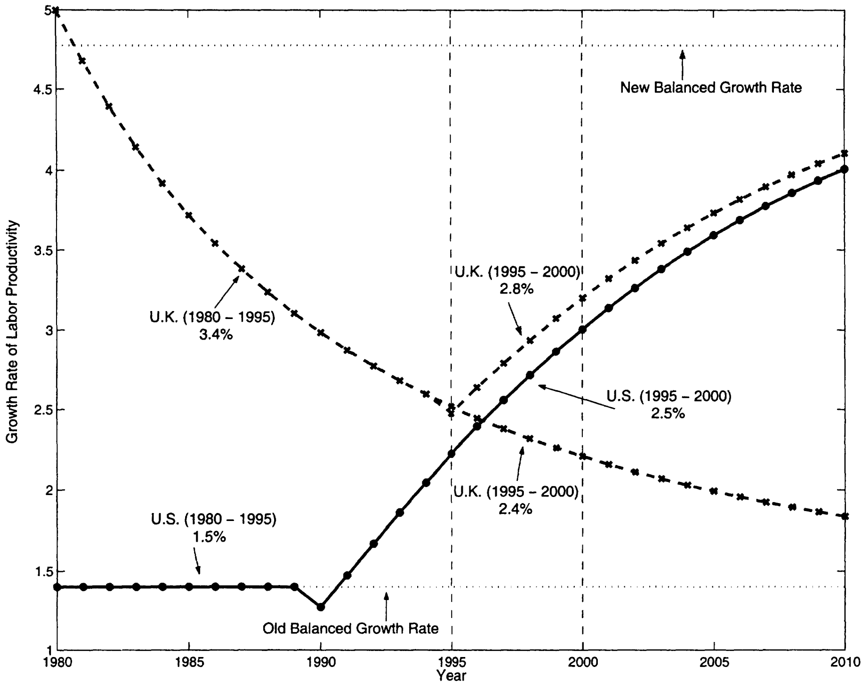
Think of the two countries (indexed by i) in terms of Solow-model economies with capital-embodied technical change: at time t the new investment goods $x_i(t)$ embody a productivity factor $A_i(t) = e^{\gamma_i t}$. The model can be summarized as:

$$x_i(t) = sy_i(t) = sk_i(t)^{\alpha}$$

$$k_i(t) = A_i(t)x_i(t) - (\delta + n)k_i(t)$$

where $k_i(t)$ is capital per worker, s is the savings rate, α is the income share of capital, δ is the depreciation rate, and n is the growth rate of the labor force. The thought experiment is as follows: start the two economies in 1980 with the same parameter vector (s, α, δ, ν, γ) but assume that the United States is already on its balanced-growth path, while the United Kingdom is endowed with lower capital per worker, so it has a faster growth rate of labor productivity and slowly converges toward the U.S. level. In 1990 a technological breakthrough raises permanently capital-embodied productivity growth to γ' in the U.S. economy. From this simple exercise, one can learn the implied labor productivity growth in the United Kingdom in the period 1995–2000 under two scenarios: (1) the acceleration in technological change does not spill over to the United

Figure 1 CONVERGENCE BETWEEN THE UNITED KINGDOM AND THE UNITED STATES IN A SOLOW MODEL ECONOMY



Kingdom and (2) the acceleration occurs with a lag of 5 years in the United Kingdom.[1]

To calibrate the model, I set $\gamma = 1.7\%$ and $\gamma' = 5.7\%$ to match the data on average labor productivity in the United States in the period 1980–1995 and 1995–2000, respectively. I chose the initial level of capital in the United Kingdom so that along the transition in the period 1980–1995, average yearly productivity growth is 3.4%, as documented in Table 1 by the authors.[2]

What can we conclude from this simple exercise on the role of catch-up and transitional dynamics? Figure 1 shows that, under the first scenario, the U.K. rate of labor productivity growth implied by the transitional dynamics in 1995–2000 is 2.4%, which is well below 2.9%, the actual data from Table 1. In the absence of a rapid technological spillover to the

1. The first scenario corresponds to a lag of 10 years or more, assuming that we are interested in the period until 2000.
2. The other parameters are set as follows: $s = 15\%$, $\alpha = 0.45$, $\delta = 5\%$, and $n = 1.5\%$. The somewhat high value of the capital share reflects the presence of human capital.

United Kingdom, pure convergence forces push the implied labor productivity too low compared to the data. Under the second scenario, labor productivity grows at an average yearly rate of 2.8%, thus the combination of the authors' view that the U.K. "implementation lag" is around 5 years together with catch-up forces explains the deceleration in full (in fact, it just overexplains it).[3]

An obvious question arises: Why did the United Kingdom adopt this more productive technology later? A satisfactory answer would require a full investigation. Here, I will limit myself to a brief speculation. In Table 3, Basu et al. document the educational characteristics of the labor force in the two countries. The difference with the United Kingdom does not lie so much in the average numbers of years of schooling, but rather in the fact that the United Kingdom has a much larger fraction of workers with specific skills associated with vocational training. At least since Nelson and Phelps (1966), numerous researchers argued that general education is a key force in technology adoption. In a recent mimeo, Krueger and Kumar (2003) embed the Nelson and Phelps mechanism into an equilibrium model and show that an acceleration in the growth rate of the frontier technology will increase the TFP growth gap between an economy with abundant general skills (like the United States) and an economy mostly endowed with specific skills (like the United Kingdom and most of the other European countries).

The careful reader will have noticed that the predictions of this exercise are relevant to explain the *labor productivity* acceleration gap between the two countries, but not the TFP growth differential. However, this is true only if all inputs are correctly measured. Suppose that the productivity improvements in investment goods captured by the factor $A(t)$ are completely missed by statisticians. In this case, measured total factor productivity $z(t)$ is obtained residually from the production relationship $y(t) = z(t)\hat{k}(t)^{\alpha}$, with $\hat{k}(t) = x(t) - (\delta + n)\hat{k}(t)$. In other words, $z(t)$ is an average of all past values of $A(t)$ weighted by the investment flow in each year.

What are the predictions of our simple calibrated model for TFP? Simulations under the same exact parametrization show that the model generates an acceleration in TFP growth for the United States of 1.5% and an acceleration in TFP growth for the United Kingdom of 0.3% under the first scenario and of 0.7% under the second scenario. Although the model produces larger accelerations in absolute value in the two economies (in particular, it does not generate a TFP deceleration for the United

3. Obviously, if all inputs are correctly measured, the predictions of this exercise are relevant only to explain the labor productivity acceleration gap between the two countries. TFP is constant over time.

Kingdom), it predicts a gap of roughly 1% between the two countries, in line with the data of Table 1.

3. Institutions in the Retail Sector

A comparison between Table 4 and Table 5 documenting the size of the TFP acceleration from 1990–1995 to 1995–2000 by industry in the two countries shows a relatively similar sectoral performance with one important exception: in the retail trade sector, TFP growth accelerated by 4.5% per year in the United States, whereas it decelerated by 1.9% per year in the United Kingdom. The authors note this puzzling divergence, but they do not search for its specific causes. It is clear, however, that an argument based on the dynamics of unmeasurable organizational capital is unlikely to account for the TFP acceleration gap in the retail industry. Tables 6 and 7 show that the share of IT investments in value added did not change much between 1990 and 2000 in either country in this sector.

A report of the McKinsey Global Institute (1998) sheds some light on the puzzle: between 1993 and 1996, fearing a massive "high-street flight" of retail stores toward the periphery of towns and cities, the U.K. government voted a series of planning restrictions establishing that local planning authorities should promote the development of small retail stores in town centers and restrict the concession of planning permissions for new stores or for the extension of existing stores outside town centers. By contrast, land regulations in the United States put no significant restrictions on retailers' location decisions.

As a result of these stringent planning guidelines, a large fraction of retail stores in the United Kingdom have suboptimal size and are not located optimally on the territory. McKinsey estimates the productivity loss associated with these strict regulations to be roughly 10% at the sectoral level, so the entire TFP deceleration in the U.K. retail sector (– 1.9% per year compounded over 5 years) could be explained through this channel. Retail trade is a large industry, accounting for about 12% of aggregate value added in both economies, thus these institutional restrictions alone can potentially explain over 60% of the differential TFP acceleration between the two countries.[4]

4. Complementary Capital

The equilibrium model of Section 4 allows Basu et al. to obtain the structural equation in equation (9) that relates the bias in TFP growth to the

4. Regulatory restrictions that have a significant impact on store size and productivity are not uncommon in other parts of the world. For example, in Japan, until 2000, the large-scale retail law limited greatly the entry of stores larger than 1,000 square meters.

change in the stock of complementary capital. Consider a special case of the model where $g = r$ (the growth rate of the economy equals the interest rate) and $\sigma = 1$ (a unitary elasticity between IT capital and the complementary organizational capital is necessary to have a balanced growth path in the model), then one can rewrite equation (9) as:

$$\Delta TFP_t^* - \Delta TFP_t = \frac{C}{Y^{NT}} \left(1 - r - \delta_c\right) \left[\Delta C_t - \Delta C_{t-1}\right] \quad (1)$$

where ΔTFP_t^* is true TFP growth in year t, C/Y^{NT} is the long-run (or steady-state) ratio of the stock of complementary capital to output produced in the non-IT industries, and δ_c is the depreciation rate of complementary capital. Given the assumptions made on the substitutability between IT capital and *C* capital in production, the growth rate of complementary capital at time *t* can be written also as:

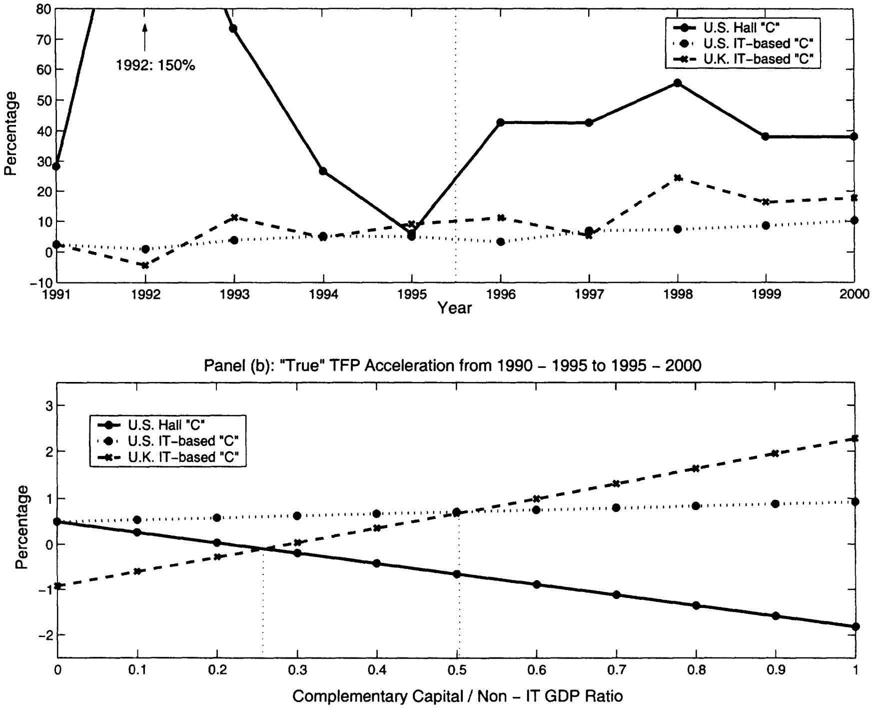
$$\Delta C_t = \Delta K_t^{IT} + \Delta p_t \quad (2)$$

where ΔK_t^{IT} is the growth rate of IT capital, and Δp_t is the change in the price of new IT investment relative to non-IT output.

The authors use equations (1) and (2) as their statistical model in a series of cross-sectional regressions where different rates of IT investment across industries provide a source of variation to estimate the size of the bias in TFP growth due to the missing *C* capital. The results are encouraging, but not as sharp as one would hope. The main reason of the weak statistical significance, in my view, lies in the very same point the authors are trying to prove: if IT is truly a general-purpose technology, then we should expect similar investment rates across all industries, which makes the cross-sectional data not very informative. Indeed, Tables 6 and 7 show that, with the exclusion of a few outliers (like mining, real estate, and communications), the variability of investment rates in IT among industries is rather small.

I take a different approach for setting the complementary capital model in action. The spirit of the exercise will be as follows. From the data on IT capital and prices and from equation (2), one can construct growth rates of *C* capital for the whole decade 1990–2000 for both countries. Together with a common parametrization for the pair (δ_c, r), one can then compute the true TFP growth ΔTFP^* in the two countries for different values of the complementary capital output ratio, which is unobservable. Finally, assuming that the United Kingdom and the United States have the same long-run C/Y^{NT} ratio along their balanced growth (and this will be the case if the two economies differ only in the *timing* of the productivity shock, as in the convergence exercise), one can ask, What is the specific value of

Figure 2 GROWTH RATE OF COMPLEMENTARY CAPITAL



C/Y^{NT} that rationalizes the TFP acceleration differential? In other words, given the scarcity of information contained in the industry-level data, and the fact that C capital is not directly measurable, the best we can do is engage in the art of "reverse engineering." I will express later a subjective judgment on the plausibility of the number obtained.

In the exercise, I will also use another indirect source of measurement of C capital growth constructed from Hall's (2001): the difference between the stock-market valuation of firms and the book value of their physical assets provides an implicit measure of the stock of intangibles in the U.S. economy.[5]

The top panel of Figure 2 plots ΔC_t in the United States measured through both IT-based and Hall's methods, and ΔC_t in the United Kingdom measured with the IT-based approach. The U.K. IT-based estimate of C capital growth is higher in the second half of the sample. The

5. Hall's data are available from http://www.stanford.edu/~rehall/. To my knowledge, there is no similar attempt to obtain an estimate of intangible capital for the U.K. economy.

IT-based measure of C capital growth for the United States is slightly increasing over time, albeit at a slower pace than the U.K. measure; instead Hall's U.S. C capital growth is much higher in the first half of the sample. Taken together, these numbers mean that the correction of the bias in TFP growth will go in the right direction.

The lower panel of Figure 2 plots—for a range of values of the C/Y^{NT} ratio—the true acceleration in TFP between 1990–1995 and 1995–2000 calculated using in equation (1) the three series for ΔC_t just constructed.[6] Note that when this ratio is zero, we obtain the measured ΔTFP of Table 1. The point where the U.S. and the U.K. lines cross corresponds to the value of the long-run C/Y^{NT} ratio that reconciles the measured U.S./U.K. differential in *TFP* acceleration with equal true *TFP* growth.

Using Hall's estimates for the growth in the stock of intangible capital in the United States in the 1990s, this value is 0.26, which corresponds to a true TFP deceleration of 0.1% per year in both countries. However, if the U.S. stock market were overvalued in the 1990s, this source of information on intangibles can be imprecise. The alternative IT-based measure of C capital for the United States proposed by the authors tells us that the long-run C/Y^{NT} ratio that solves the puzzle is around 0.5, which corresponds to a true acceleration of 0.7% per year in both economies.

How reasonable are these two numbers? I argue that they are quite plausible. To understand, it is useful to express them in terms of aggregate output Y (non-IT value-added Y^{NT} accounts for 95% of total output in the United States). Take the mean of these two estimates for C/Y, which is 0.35. Given the assumed depreciation rate, this number would imply that steady-state investment in C capital is less than 6% of output, very close to the current share of IT investment in U.S. data, which is around 7%. A C/Y ratio of 0.35 is a conservative estimate in light of the recent work by McGrattan and Prescott (2002, Table 2), who estimate the stock of intangible capital in the United States to be around 0.65 of aggregate gross domestic product (GDP) and, after reviewing the literature, conclude that a reasonable range for this ratio is between 0.5 and 1.

To conclude, this calculation provides support, from a different angle, to the authors' main argument: theory is *still* ahead of measurement. We have rich models suggesting that organizational capital plays an important role in macroeconomics, especially in phases of technological transformation, but we are lacking reliable direct measurements. However, I have also argued that one should not neglect more traditional explanations of productivity differentials, like convergence forces and institutions.

6. I have assumed that, in both countries, the depreciation rate for C capital δ_c is the same as the depreciation rate for IT used by the authors (16%), and that $r = 4\%$.

REFERENCES

Hall, Robert. (2001). The stock market and capital accumulation. *American Economic Review* 91(5, December)1185–1202.

Jorgenson, Dale W. (2001). Information technology and the U.S. economy. *American Economic Review* 91(1, March)1–32.

Krueger, Dirk, and Krishna B. Kumar. (2003). Skill-specific rather than general education: A reason for U.S.-Europe growth differences? Mimeo, Stanford University.

McGrattan, Ellen, and Ed Prescott. (2002). Taxes, regulations, and the value of U.S. corporations: A general equilibrium analysis. Research Department Staff Report 309, Federal Reserve Bank of Minneapolis.

McKinsey Global Institute. (1998). Driving productivity and growth in the UK economy. Available from http://www.mckinsey.com/knowledge/mgi/ (accessed April 3, 2003).

Nelson, Richard R., and Edmund S. Phelps. (1966). Investment in humans, technological diffusion and economic growth. *American Economic Review* 56(2):69–75.

Discussion

Several participants remarked on the role of the wholesale and retail trade in the authors' story. Mark Gertler suggested that the TFP slowdown in the United States appears to be partly associated with a slowdown in these sectors, which in turn implies that there is something important about these particular sectors that economists should try to understand. John Fernald remarked that the wholesale and retail trade contributed to three-fourths of the difference in TFP growth between the two countries. He also remarked that net entry alone—the entry of Wal-Mart and the exit of Kmart—explains the productivity performance of the retail sector. Robert Shimer counseled caution in the use of Wal-Mart as an example of the retail trade. He pointed out that by joining together successes such as Wal-Mart and failures such as Kmart, one would get a more realistic picture of the U.S. retail trade in the 1990s. In response to Olivier Blanchard's discussion, Nick Oulton noted that though planning regulations in the United Kingdom could lower the level of TFP, they should not affect the growth rate of TFP. He contended that the small size of individual stores should not affect the incentives for retail chains to invest in IT.

The theme of the choice of sample countries was raised by several participants. Mark Gertler questioned the authors' identification assumption that there are many macroeconomic similarities between the United Kingdom and the United States. He pointed out that according to the authors' Table 1, there was moderate growth in output and strong growth in investment in the United States between 1990 and 1995, but there was low output growth and no net investment in IT in the United Kingdom.