Comment on “The Case of the Missing Productivity Growth: Or, Does information technology explain why productivity accelerated in the Unites States and not in the United Kingdom?”

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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 .5% (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 it is 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 U.K., that in many dimensions is similar to the U.S. economy.

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 U.S. and the U.K. were virtually the only two, among the developed economies, who 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 0.9% (and labor productivity growth by 1%) per year from 1990-1995 to 1995-2000.

How do we explain the missing productivity growth in the U.K. (or the exceedingly high productivity growth in the U.S.)? 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 overestimated. Second, IT investment boomed with a lag of 5 to 10 years in the U.K., relative to the U.S. economy. Thus, in 1995-2000 TFP growth was underestimated in the U.K. and overestimated in the U.S. which explains, at least qualitatively, the gap.

This Comment is organized in three parts: 1) an exploration of the role of convergence between U.K. and U.S. within a Solow growth model, 2) a deeper look into the Retail sector where the TFP acceleration gap between two countries is particularly striking, 3) a quantitative exercise based on the model developed by the authors in Section 4 of their article.

Convergence

If one extends the comparison for the two countries back until the early 1980s (see Table 1), it emerges clearly that labor productivity growth was considerably faster in the U.K. until the mid 1990s. Basu et al. put it in plain words: “the Europeans were catching up” (page 7). The authors somewhat downplay the role of transition in their analysis, so here I try to assess to what extent the fact that the U.K. was catching-up is relevant in explaining the productivity acceleration gap. Intuitively, the transitional dynamics of the U.K. 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 $A_i(t) = e^{\gamma t}$. The model can be summarized as

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

$$\dot{k}_i(t) = A_i(t) x_i(t) - (\delta + n) k_i(t),$$

where $k_i(t)$ is capital per worker, $s$ is the saving rate, $\alpha$ is the income share of capital, $\delta$ 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 $(s, \alpha, \delta, n, \gamma)$ but assume that the U.S. are already on their balanced-growth path while the U.K. are endowed with lower capital per worker, so they have a faster growth rate of labor productivity and slowly converge towards the U.S. level. In 1990 a technological breakthrough takes place that raises permanently capital-embodied productivity growth to $\gamma'$ in the U.S. economy. From this simple exercise one can learn what is the implied labor productivity growth in the UK in the period 1995-2000 under two scenarios 1) the acceleration in technological change does not spill over to the UK and 2) the acceleration occurs with a lag of 5 years in the U.K.\(^1\)

To calibrate the model, I set $\gamma = 1.7\%$ and $\gamma' = 5.7\%$ to match the data on average labor productivity in the U.S. in the period 1980-1995 and 1995-2000 respectively. I chose the initial level of capital in the U.K. 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 absence of a rapid technological spillover to the U.K., 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).\(^3\)

\(^1\)The first scenario corresponds to a lag of 10 years or more, given that we are interested in the period until 2000.

\(^2\)The other parameters are set as follows: $s = 15\%, \alpha = .45, \delta = 5\%, n = 1.5\%$. The somewhat high value of the capital share reflects the presence of human capital.

\(^3\)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.
An obvious question arises: why did the U.K. adopt later this more productive technology? A satisfactory answer would require a full investigation. Here, I will limit myself to a brief speculation. In Table 3, the authors document the educational characteristics of the labor force of the two countries: the difference with the U.K. does not lie so much in the average numbers of years of schooling, but rather in the fact that the U.K. has a much larger fraction of workers with specific skills associated to vocational training. At least since Nelson and Phelps (1966), a vast literature argued that general education is a key force in technology adoption. In a recent paper Krueger and Kumar (2001) embed the Nelson-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 U.S.) and an economy mostly endowed with specific skills (like the U.K. 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 U.S. of 1.5% and an acceleration in TFP growth for the U.K. of .3% under the first scenario and of .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 U.K.), it predicts a gap of roughly 1% between the two countries, in line with the data of Table 1.

**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 show a relatively similar sectoral
performance with one important exception: in the Retail Trade sector, TFP growth accelerated by 4.5% per year in the U.S., whereas it decelerated by 1.9% per year in the U.K. economy. The authors note this puzzling divergence, but they do not search for its specific causes. It is clear though that an argument based on the dynamics of unmeasurable organizational capital is unlikely to be able 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 towards the periphery, 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 U.S. put no significant restrictions on retailers’ location decision.

As a result of these stringent planning guidelines, a large fraction of retail stores in the U.K. have sub-optimal size and are not located optimally on the territory. McKinsey estimates the productivity loss associated to 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 around 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

**Complementary capital**

The equilibrium model of Section 4 allows the authors to obtain the structural equation in (4.9) that relates the bias in TFP growth to the 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

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4 Regulatory restrictions that have 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.
rewrite equation (4.9) as
\[ \Delta TFP_t^* - \Delta TFP_t = \frac{C}{Y_{NT}} (1 - r - \delta_c) [\Delta C_t - \Delta C_{t-1}], \] (1)
where \( \Delta TFP_t^* \) 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, \( \delta_c \) 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
\[ \Delta C_t = \Delta K_{IT}^T + \Delta p_t, \] (2)
where \( \Delta K_{IT}^T \) is the growth rate of IT capital and \( \Delta p_t \) 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 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 in order to set 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 \( (\delta_c, r) \), one can then compute the true TFP growth \( \Delta TFP^* \) in the two countries for different values of the complementary capital output ratio, which is unobservable. Finally, one can ask: assuming that U.K. and U.S. 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) what is the specific value of \( C/Y_{NT} \) 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 engaging in the art of “reverse engineering”. Ex-post I will express a subjective judgment on
the plausibility of the number obtained.

In the exercise, I will also make use of 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 \(\Delta C_t\) in the U.S. measured through both IT-based and Hall’s
methods, and \(\Delta C_t\) in the U.K. 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 IT-based measure
of C-capital growth for the U.S. 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 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 into equation (1) the three series for
\(\Delta C_t\) just constructed.\(^6\) Note that when this ratio is zero, we obtain the measured \(\Delta TFP\) 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 U.S. in the
1990s, this value is .26 corresponding to a true TFP deceleration of .1% per year in both coun-
tries. However, if the U.S. stockmarket were overvalued in the 1990s, this source of information
on intangibles can be imprecise. The alternative IT-based measure of C-capital for the U.S.
proposed by the authors tells us that the long-run \(C/Y^{NT}\) ratio that solves the puzzle is around
.5, corresponding to a true acceleration of .7% per year in both economies.

How reasonable are these two numbers? I argue that they are quite plausible. To under-
stand, 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 U.S.). Take the mean of these two estimates for \(C/Y\),

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\(^5\) 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.

\(^6\) I have assumed that, in both countries, the depreciation rate for C-capital \(\delta_c\) is the same as the depreciation
rate for IT used by the authors (16%), and that \(r = 4\%\).
which is .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%. Moreover, a $C/Y$ ratio of .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 U.S. to be around .65 of aggregate GDP and, after reviewing the literature, conclude that a reasonable range for this ratio is between .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.

**References**


Convergence between U.K. and U.S. in a Solow Model Economy

Growth Rate of Labor Productivity

New balanced growth rate
Old balanced growth rate

US (80–95) 1.5%
UK (80–95) 3.4%
UK (95–00) 2.8%
UK (95–00) 2.4%
US (95–00) 2.5%
Growth Rate of Complementary Capital

"True" TFP Acceleration

Complementary Capital / Non–IT GDP ratio

US Hall "C"
US IT–based "C"
UK IT–based "C"