Fiscal Studies (2001) vol. 22, no. 3, pp. 271–306

A Perspective on UK Productivity Performance

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Abstract

The paper reviews recent UK productivity performance using insights from new growth economics and its embodiment in growth accounting techniques. The sources of the UK labour productivity gap are found to differ across countries; broad capital per worker plays a larger part with regard to France and Germany while innovation matters more compared with the USA. The role of incentive structures is examined and the importance of competition as an antidote to agency problems in UK firms is highlighted. Current UK policy is reviewed and the need to address government as well as market failures is stressed.

JEL classification: D24, O47, O52.

I. INTRODUCTION

Better productivity is a key aspiration of the present UK government. As the Pre-Budget Report of 1998 put it, 'Productivity ... is a fundamental yardstick of economic performance.… We are not as productive as our major partners and the extent of our under-performance is very substantial.... tackling it must be a central national priority' (HM Treasury, 1998, p. 28).

A much more comprehensive statement of the present government's view both of the nature of the UK productivity problem and of the policy framework with which it should be addressed is contained in HM Treasury (2000). That document includes a detailed description of both the labour productivity gap and

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The authors would like to thank Stephen Broadberry, Michela Vecchi and participants at a seminar at HM Treasury for helpful comments. Funding for the productivity estimates was provided by both the Economic and Social Research Council (ESRC) and the Leverhulme Trust.

its proximate sources, together with a review of the policy implications derived from an analysis of market failures related to productivity performance, which focuses on five priorities — namely, increasing investment in physical capital, developing human capital, promoting innovation and research and development (R&D), strengthening competition, and encouraging enterprise and entrepreneurship (HM Treasury, 2000, p. 58).

This paper develops a framework for thinking about productivity which is used both to clarify and to appraise the Treasury view of productivity in the UK. This requires an appropriate theoretical structure within which not only to understand the determinants of productivity outcomes but also to interpret the productivity evidence. It is important to consider the microeconomics of firms' decisions that impact on productivity and also to appreciate that productivity comparisons need to be set in a theoretical framework. Recent developments in growth economics are an important ingredient in this endeavour, but so also is an awareness of the empirical evidence.

Traditionally, international comparisons were usually made in terms of labour productivity, which will be positively influenced by the availability of other factors of production such as the amount of physical and human capital per hour worked. More recently, comparisons of total factor productivity (TFP) have also been widely used. Estimates of TFP attempt to identify the component of labour productivity performance that is accounted for not by factor inputs but by the efficiency and technology with which labour is used. The methodology used to attribute labour productivity to these proximate sources is growth accounting. This technique, which can be regarded as a flexible but disciplined way of benchmarking these various contributions to labour productivity and thus of quantifying the apparent strengths and weaknesses of an economy, is central to the analysis of the UK productivity problem in HM Treasury (2000).

Interpretation of the results of growth accounting requires explicit recognition of its growth theoretic foundations. Originally, these lay in the traditional neo-classical (Solow) growth model, but the technique can be adapted to accommodate the new growth economics, although this does make matters more complicated. For example, the effects of technological change, which show up simply in TFP in the Solow model, will partly be attributed to capital within an endogenous innovation growth model. Thus, while growth accounting is potentially a powerful diagnostic tool, inferences of underlying supply-side capabilities are not entirely straightforward.

This methodology is reviewed in Section II. In Section III, we go on to consider detailed estimates from growth accounting exercises. Our objective is to address the following two questions:

1. How should growth accounting comparisons of UK productivity performance be interpreted?

2. What have been the proximate sources of the gap between the productivity performance of the UK and that of its peer group?

The answers that we obtain provide insights into two much discussed issues — namely, the extent to which the radical change in UK supply-side policy after the 1970s has made a difference and the role that the information and communications technology (ICT) revolution has played in recent productivity outcomes.

The impact of incentive structures on investment and innovation has become an important theme in current government thinking about productivity. It is also central to the new growth economics, much of whose genuine novelty lies in its exploration of the microeconomic foundations of economic growth. This literature suggests, on the one hand, that productivity performance should be understood in terms of the profit-maximising decisions of firms, which will be concerned, *inter alia*, about the appropriability of returns. On the other hand, growth economics is also aware of the possible importance of agency problems within firms in the context of the separation of ownership and control, which may overturn some of the apparent policy implications of the early work in endogenous growth.

Section IV explores these issues and argues that they are fundamental to the general stance of government attempts to stimulate productivity, especially with regard to the balance between competition and industrial policy. In Section V, we go on to evaluate the government's productivity policy framework as set out in HM Treasury (2000). Our objective is to address two further questions:

3. How do incentive structures impact on growth?
4. Is the government's stance on productivity appropriate in the light of recent theory and evidence?

If incentives matter, it is also important to recognise that economic policy is made by politicians who may often dislike the possible electoral consequences of productivity improvement. Section V considers some implications of this, given that excellent productivity performance involves continual entry and exit of firms, restructuring and job losses and that some policy decisions with major productivity impacts are not discussed at all in HM Treasury (2000).

II. MEASUREMENT OF AND ACCOUNTING FOR PRODUCTIVITY PERFORMANCE

The most readily available and hence most commonly cited measure of a country's relative well-being is GDP per capita. This measure has the most direct bearing on average standards of living. From an economist's point of view, however, productivity is more readily defined as output per units of productive inputs; hence economists' use of alternative definitions such as GDP per person engaged, GDP per hour worked or GDP per unit of multiple inputs.

GDP per capita (*GDPC*) is calculated comparing country *J* with the UK using the formula

$$(1) \qquad GDPC^{J,UK} = \frac{\left(Y^J / P^J\right)}{POP^J} \Big/ \frac{\left(Y^{UK} / P^{UK}\right)}{POP^{UK}},$$

where *Y* is the nominal value of output, *P* is an aggregate price index of the goods and services produced and *POP* is population. An analogous formula can be employed to compare GDP per capita growth over time.

Labour productivity measures are calculated by replacing *POP* in equation 1 by employment (*E*) or total hours worked (*L*). Differences between GDP per capita and GDP per person engaged reflect the extent of labour force participation and unemployment rates. GDP per hour worked takes account additionally of deviations from the standard working week due to part-time working, paid holidays, etc.

1. Total Factor Productivity

The above partial productivity measures do not incorporate substitution among factor inputs; this is taken into account by calculating total factor productivity.[1] In considering productivity estimates with multiple inputs, we begin with a production function given by

$$(2) \qquad Q = F(A, \mathbf{X}),$$

where *Q* is real output (*Q* = *Y*/*P*), *A* is the level of TFP and **X** is a vector of *i* aggregate factor inputs including labour, capital and intermediate inputs.

Increases in *A* can be interpreted as costless improvements in productive potential, whereas payment has to be made for additional factor inputs. Genuinely higher *A* can result from technical change viewed as (exogenous) 'manna from heaven', from externalities or from better use of paid factor inputs. Measurement error may lead to apparently higher *A*, in particular where some aspects of factor accumulation are not recorded accurately.

Taking logs, letting the symbol ^ represent proportionate rates of change of a variable and dividing by *Q* gives an equation for technical change, *g*:

$$(3) \qquad g = \hat{Q} - \sum_i \frac{F_{X_i} X_i}{Q} \hat{X}_i ,$$

[1]The terms 'multifactor productivity' (MFP) and 'the Solow residual' are also frequently used to describe this calculation.

where F_{X_i} is the (social) marginal product of input X_i. If the technology is Hicks neutral, so that F(A,**X**) = AF(**X**), and there are no other sources of improvement in TFP, then $g = \hat{A}$. The implementation of equation 3 involves either the use of index numbers, where it is assumed that factor prices measure social marginal products, or econometric estimation of F_{X_i}. TFP growth in period t relative to period $t–s$ is most frequently calculated using the Törnqvist discrete approximation to the Divisia index (for example, Jorgenson, Gollop and Fraumeni (1987)), given by

$$\text{(4)} \qquad \ln\left(\frac{TFP_t}{TFP_{t-s}}\right) = \ln\left(\frac{Y_t}{Y_{t-s}}\right) - \alpha_i(t,t-s)\sum_i \ln\left(\frac{X_{i,t}}{X_{i,t-s}}\right),$$

where $\alpha_i(t,t–s)$ is the share of input i in the value of output averaged over t and $t–s$. The assumptions underlying this result include that the production function exhibits constant returns to scale and that product and factor markets are competitive so that all inputs in the production process are paid their marginal products. Hence the sum of factor shares exhausts all returns from pursuing that activity, implying $\Sigma_i\alpha_i = 1$.

Analogously, we can define TFP levels in country J relative to the UK by the following Törnqvist index:

$$\text{(5)} \qquad \ln(TFP^{J,UK}) = \ln(Y^{J,UK}) - \alpha_i^{J,UK}\sum_i \ln(X_i^{J,UK}),$$

where $Y^{J,UK}$ denotes relative output, $X_i^{J,UK}$ is the relative quantity of input X_i and $\alpha_i^{J,UK}$ is the share of factor input i in the value of output averaged over the two countries.

2. Interpreting Growth Accounting

Although the growth accounting equations are based on somewhat restrictive assumptions, they are capable of taking into account a range of factors that influence output. The most commonly employed refinement of the method is to incorporate variations in the quality as well as the quantity of factor inputs using the method developed by Jorgenson and Griliches (1967), which weights types of inputs by their shares in total income. This method has been employed in various contexts to take account of changes in the quality of labour input, in particular educational attainment (Jorgenson and Fraumeni, 1989). Thus, for example, with l distinct types of labour, aggregate labour input, L, in equation 5 is replaced by $\alpha_L^{J,UK} \sum_l \alpha_{L_l}^{J,UK} \ln(L_l^{J,UK})$. If one country employs more skilled labour, which commands higher wage premiums, then some part of the differential productivity in the two countries will be assigned to greater use of the higher-quality labour input. Without this adjustment, the differences in labour quality are subsumed under differences in TFP. Similarly, changes in the quality of capital input — for example, greater investment in ICT equipment — can be incorporated within the same framework.

The model underlying the calculations in equations 4 and 5 is the neo-classical growth model, originating in Solow (1956), or, where human capital is included as an additional factor input, is the Augmented-Solow model of Mankiw, Romer and Weil (1992). But the theory of economic growth has moved in new directions with the publication of many papers on endogenous growth in the 1980s and 1990s. This poses the question of to what extent the growth accounting calculations need to be modified or even replaced in the light of these new theoretical developments.

Whereas the Solow and Augmented-Solow models embodied diminishing returns to capital accumulation, the first generation of endogenous growth models emphasised increasing returns models, whereby productivity rises with cumulative knowledge or experience, thus creating spillovers from investment in capital, broadly defined to include physical capital, human capital or research activities; see, for example, Barro and Sala-i-Martin (1995).

Suppose the aggregate production function is Cobb-Douglas, relating output, Q, to k types of broad capital, $K_1,\ldots,K_k$, labour input, L, and exogenous technical change, A:

(6) $$Q = A\sum_k K^{\beta_k} L^{\alpha}.$$

With no spillovers, $\alpha+\Sigma_k\beta_k = 1$. Taking logs, letting the symbol ^ represent proportionate rates of change of a variable and subtracting L from both sides gives an expression for the change in labour productivity:

(7) $$\hat{Q} - \hat{L} = \sum_k \beta_k(\hat{K}_k - \hat{L}) + \hat{A}.$$

Thus changes in capital deepening and TFP will have an impact on labour productivity, but TFP growth in this framework is unaffected by changes in the use of various forms of capital. Suppose, however, that each form of capital has spillover effects so that the β coefficients have two components — γ, which captures the private benefits of capital accumulation, and η, which captures external benefits. Suppose also that $\alpha+\Sigma_k\gamma_k = 1$, so that there are no internal increasing returns. Then technical progress is given by

(8) $$\hat{A} = (\hat{Q} - \hat{L}) - \sum_k \gamma_k (\hat{K}_k - \hat{L}) - \sum_k \eta_k (\hat{K}_k - \hat{L}) .$$

The growth accounting calculation measures the rate of change of underlying technical change by $\hat{A}*$, given by

(9) $$\hat{A}* = \hat{A} + \sum_k \eta_k (\hat{K}_k - \hat{L}) ,$$

which includes both exogenous and endogenous (spillover) components. In this case, measured TFP is affected both by capital deepening and by differences in the extent of spillovers across types of capital. Econometric estimation is required to separate external effects of investment in all forms of capital from exogenous technical progress.

What is the empirical evidence on spillover effects? The empirical evidence hitherto suggests small or insignificant spillovers from physical capital (Oulton and Young, 1996), although it has been conjectured that there are likely to be spillovers from ICT capital, such as network externalities, that benefit economic agents other than those who own the technology (Schreyer, 2000). To date, there is no consensus on the extent of external benefits from human capital. Most authors claim that there are likely to be positive spillovers, but this remains a matter of some dispute.[2]

There is, however, ample evidence of large effects on output growth from R&D expenditures (for example, Griliches (1998), Griffith, Redding and Van Reenen (2000) and O'Mahony and Vecchi (2000)) and that these are greater than the coefficients that would be derived in a growth accounting exercise treating R&D as a form of capital. Thus there is consensus that spillovers from R&D activity are significant.

The impact on output from innovative activities has been implemented differently in more recent, endogenous innovation, variants of endogenous growth models. Barro (1999) sets out the implications for growth accounting of the endogenous innovation literature, including both the product-varieties models of Romer (1990) and Grossman and Helpman (1991) and the quality-ladders models of Aghion and Howitt (1992) and Grossman and Helpman (1991). In the product-varieties model, the production function is given by

(10) $$Q = AL^{1-\alpha} N^{1-\alpha} K^{\alpha} ,$$

where N is the number of varieties of capital goods, k_j is the service flow from the jth type of capital good and $K = Nk$ is the flow of service from the aggregate

[2] Compare, for example, Krueger and Lindahl (2000) with Rudd (2000).

capital stock. Innovation raises N over time. The growth accounting equation becomes

$$(11) \qquad g = \hat{Q} - (1-\alpha)\hat{L} - \alpha\hat{K} = \hat{A} + (1-\alpha)\hat{N},$$

where $\alpha\hat{K} = \alpha(\hat{N} + \hat{k})$. If N depends on the flow of new R&D expenditures, then the latter would appear in the residual but with a different interpretation from that in the spillover model.

As with the spillover model, the Solow residual measure of TFP growth captures contributions both from exogenous technological change and from the endogenous expansion of varieties of capital goods. However, the expansion of the number of varieties also makes a remunerated contribution to growth, which shows up through the embodiment of technological advance in new capital goods. Thus a fraction $1-\alpha$ of the endogenous component of technological change is in TFP but a fraction α is in the capital contribution to growth. The alternative, quality-ladders formulation, in which technological change is experienced as an improvement in the quality rather than the number of capital goods, yields exactly analogous results.

If there is endogenous innovation with embodiment in new capital goods, the residual tends to understate the contribution of technological change to growth, and this undermeasurement tends to be larger the greater is the endogenous component in technology. But, in principle, this could be taken into account using the input quality adjustment of Jorgenson and Griliches (1967) outlined above. An approach to growth accounting along these lines has been implemented by several authors in the context of trying to pinpoint the contribution of ICT to recent US economic growth (for example, Jorgenson and Stiroh (2000) and Oliner and Sichel (2000)). In this work, the US ICT experience appears to be a case where important technological changes raise the growth rate primarily through the remunerated contribution of new varieties of capital and through faster TFP growth in ICT production itself, rather than through a general economy-wide impact on TFP.

It should be noted that, in the short term, capacity may not be optimally adjusted. This may be because there are fixed factors of production such that the economy is not on the long-run cost curve and/or because forecasting errors lead to incorrect investment and labour hiring decisions. This would imply both that TFP growth as conventionally measured would not correspond to technical change even in the traditional Solow model and that more sophisticated estimation methods are required to distinguish these different impacts (Morrison-Paul, 1999). It seems highly likely that it is important to take this into account when considering TFP growth in the UK, especially in the context of the turbulent conditions of the 1970s and 1980s. For example, Lynde and Richmond (2000) estimate that a substantial part of the improvement in manufacturing TFP growth in the 1980s relative to the 1970s resulted from reduced cost inefficiency rather than faster technical change.

Abramovitz (1956) famously describes the TFP residual 'as a measure of our ignorance'; in practice, many influences on output growth remain hidden in the residual term. This continues to be a drawback of the growth accounting method. In theory, regression methods have an advantage in that they can identify the variables that influence the residual, although including general variables such as R&D expenditures in a regression would not help to identify the underlying model (spillovers versus endogenous innovation). Also, over the past few decades, increasing awareness of statistical problems such as endogeneity and the development of sophisticated econometric techniques have resulted in a myriad of estimates of factors that affect output growth. These estimates are often sensitive to the techniques chosen and the specification of the production function. For example, the literature is far from reaching a consensus on the impact of R&D expenditures (Mairesse and Sassenou, 1991; Griliches, 1998).

Moreover, while it is correct that growth accounting cannot fully explain why growth rates differ whereas potentially a well-designed cross-country regression analysis might shed light on this (Temple, 1999, p. 121), it is also true that growth accounting is an important corrective to misleading impressions from growth regressions. Thus growth accounting shows that the apparently miraculous growth performance of the Asian Tigers suggested by growth regressions (World Bank, 1993) actually stems very largely from a demographic transition that has substantially raised labour inputs per person through age structure effects and from high capital stock growth relative to investment shares of GDP stemming from initially very low capital/output ratios. Very rapid growth in these countries has resulted mainly from growth of factor inputs (both labour and capital) rather than from TFP growth, which has been mediocre rather than outstanding (Crafts, 1999).

Despite its limitations, the growth accounting framework, with its grounding in economic theory and its independence from statistical problems, is a useful method of describing and benchmarking performance. Labour productivity outcomes are seen as depending upon the availability of complementary factors of production, such as physical capital, together with the state of technology and the efficiency with which productive resources are utilised. TFP, as measured in practice, is an important diagnostic in international comparisons but, in general, contrary to common belief, is not to be interpreted as an index of technological progress.

III. THE UK'S RELATIVE PRODUCTIVITY PERFORMANCE

This section considers the empirical evidence on the UK's productivity performance relative to some of its major competitors. There are a number of problems involved in the measurement of productivity and its components, including which price deflators to use to compare output across countries and how to measure physical and human capital in an internationally consistent manner, as well as a host of data measurement issues. These issues are covered in detail in O'Mahony (1999) and so are not replicated here. But this is not to say that data measurement considerations are unimportant; our estimates are only as good as the underlying data, and the reader should be aware that there are serious limitations in official statistics, not least of which is poor measurement of output in service sectors. Nevertheless, it is likely that these problems beset official statistics in all countries, so international comparisons may be less sensitive to these criticisms.

1. GDP Per Capita and Labour Productivity

Table 1 shows levels of GDP per capita and labour productivity for 1995 and 1999, comparing the UK with some of its major competitors. Currently, GDP per capita is much higher in the USA than in the three European countries shown or Japan. When productivity is measured per hour worked, a significant gap emerges between the UK on the one hand and the USA, France and Germany on the other, with Japan showing the lowest productivity level of the five countries.

Differences between GDP per capita and GDP per hour worked reflect differences in unemployment rates, labour force participation and annual hours worked per employee. The US lead in per capita output reflects the traditionally much lower unemployment rates in the USA than in Europe and the greater willingness of its citizens to participate in productive activities. Also, employees generally work longer hours in the USA than in the UK and considerably so relative to workers in France and Germany. In the latter two countries, rising living standards were reflected in a greater preference for increased leisure in the form of more paid holidays. Workers in Japan are employed for the longest numbers of hours annually of the five countries considered.

In the second half of the 1990s, the US lead in terms of GDP per capita has increased, and the USA has also gained ground in terms of labour productivity. Within Europe, there has not been much change in the relative position of the three countries. Japan's position has deteriorated relatively in recent years, reflecting both the end of catch-up growth in that country and well-reported regional problems in Asia.

Table 1 also shows relative output per hour worked in the market sectors, i.e. excluding activities such as health, education and government services where output is both difficult to measure and difficult to compare across countries. Using market output as the numerator puts the USA well above the three European countries by 1999 but does not alter the UK's poor relative standing.

Post-war growth rates for the aggregate economy for selected periods are also shown in Table 1. Since the UK started the post-war period with labour

TABLE 1

The UK's Relative Labour Productivity Position

	UK	*USA*	*France*	*Germany*	*Japan*
1995 (UK = 100)					
GDP per capita	100	142	104	105	116
GDP per hour worked	100	122	126	112	93
Market output per hour	100	124	120	115	79
1999 (UK = 100)					
GDP per capita	100	148	105	104	112
GDP per hour worked	100	126	124	111	91
Market output per hour	100	133	121	114	n.a.
Growth rates (% p.a.)					
GDP per hour worked:					
1950–99	2.53	1.67	3.53	3.65	4.23
1950–73	2.99	2.34	4.62	5.18	6.11
1973–99	2.13	1.08	2.56	2.29	2.78
1989–99	1.92	1.47	1.32	1.87	2.70
1995–99	1.30	2.08	1.16	1.15	1.22

Notes: German growth rates prior to 1993 refer to area of the Federal German Republic. Market sectors exclude non-market services (education, health and government services). Value added and employment (including self-employed) are taken from each country's National Accounts, incorporating recent revisions. The calculation of average annual hours worked considers the extent of the average working week and allows for part-time working and time lost per year due to paid or unpaid holidays, sickness, maternity and work stoppages such as strikes, short-time working, etc. Output is converted to a common currency using the ratio of price levels across countries for 1996, known as purchasing power parities (PPPs). For additional detail on methodology, see O'Mahony (1999). The estimates in this and subsequent tables differ in many respects from those in O'Mahony (1999) and earlier drafts of this paper. These changes are driven largely by substantial revisions to National Accounts and the use of 1996 rather than 1993 PPPs. In addition, estimates are now shown for unified Germany rather than for the former West Germany as in earlier drafts, which generally leads to a worsening of Germany's relative position. Based on an attempt to update O'Mahony (1999), a reasonable guess is that, in 1999, the former West Germany would have real GDP per hour worked of about 128 (UK = 100).

productivity levels equal to about 55 per cent of US levels, compared with 40 per cent in France and Germany and 20 per cent in Japan (O'Mahony, 1999), we would expect catch-up growth to US levels to be less rapid in the UK than in these three countries. Over the entire post-war period, productivity growth in the UK was about 1 percentage point per annum greater than that in the USA but fell considerably short of the growth rates experienced in the remaining three countries. By 1999, labour productivity levels in Germany and France had overtaken UK levels by a considerable extent. Thus the UK experience cannot be entirely explained within a catch-up model.

If the time period is split into the years from 1950 to 1973 and post-1973, growth rates of aggregate labour productivity are lower in the latter period in all countries, although the decline is less for the UK than for the other four countries. The beginning of the period is also affected by post-war reconstruction, but starting the analysis in 1960 does not radically alter the picture. From 1979, since when the stance of supply-side policy has been markedly different, the UK has maintained its position against France and West Germany while continuing to close the gap with the USA. A similar picture emerges if attention is confined to the market economy, as discussed in O'Mahony (1999), although in all countries labour productivity tends to be higher using this measure than for total economy GDP. The upsurge in US labour productivity is a recent phenomenon — since 1995, annual growth rates have more than doubled over the average value achieved in the previous two decades.

The results for the aggregate economy mask some differences at the sector level. Thus O'Mahony (1999), who presents trends and levels of output per hour by sector, shows the continuing lead in the USA in manufacturing, with only Japan catching up in recent years. In contrast, by 1996, both France and Germany had significant labour productivity leads over the UK in market service sectors. Historical evidence in Broadberry (1998) shows that, over the past 120 years, the deterioration in the UK's labour productivity performance relative to the USA has been heavily concentrated in services. Thus the focus on manufacturing as providing the driving force behind convergence of productivity needs to be switched to a greater focus on developments within services.

2. Physical Capital and Total Factor Productivity

We now turn to a consideration of the most readily measurable proximate source of growth — physical capital. As can be seen from Table 2, in 1999, for the total economy, levels of capital intensity (capital per hour worked) were highest in Japan, with the UK falling considerably behind all countries, even Germany (which inherited relatively little capital from the Eastern Länder). The UK's poor relative position in 1995 was not as bad for the market economy as for the total. The estimates suggest that both the UK and the USA concentrate investment relatively less in non-market activities than the other three countries. Nevertheless, the UK's capital intensity position remains inferior even in the market economy.

Table 2 also shows growth rates for selected periods in the aggregate economy. In many respects, capital intensity growth rates over the long term mirror those for labour productivity. In general, the USA shows the lowest growth rates and Japan the highest. Capital deepening has occurred at a slower pace since 1973 in all countries. Also, capital intensity growth was higher in the market sectors than in the aggregate economy (O'Mahony, 1999). There are signs of improvement in the UK's position in the past decade relative at least to the European countries, but it is too soon to say if this reversal of previous trends will persist.

TABLE 2

Relative Capital Intensity and Total Factor Productivity

	UK	*USA*	*France*	*Germany*	*Japan*[a]
1995 (UK = 100)					
Capital per hour (total economy)	100	136	160	139	160
Capital per hour (market sectors)	100	126	127	130	113
TFP (total economy)	100	111	109	101	77
TFP (market sectors)	100	115	110	105	76
1999 (UK = 100)					
Capital per hour (total economy)	100	142	146	132	165
TFP (total economy)	100	113	109	100	77
Total economy growth rates (% p.a.)					
Capital per hour					
1950–99	3.74	2.20	3.59	3.84	5.70
1950–73	4.61	2.24	4.18	5.50	6.88
1973–99	2.97	2.17	3.07	2.37	4.79
1989–99	2.54	2.22	1.94	1.17	3.89
1995–99	1.00	2.48	0.88	0.49	1.20
TFP					
1950–99	1.23	1.01	2.29	2.74	2.14
1950–73	1.30	1.66	3.13	3.98	3.39
1973–99	1.17	0.43	1.55	1.64	1.18
1989–99	1.13	0.86	0.61	1.44	0.66
1995–99	0.88	1.42	0.84	0.97	0.80

[a]The comparisons with Japan only distinguish two asset types — equipment and structures.

Notes: The perpetual inventory method was employed to measure net capital stocks. This is based on cumulating investments over periods of time and allowing for depreciation of assets, where it was assumed that depreciation rates followed a pattern of geometric decay. The depreciation rates were assumed to be common across countries, equal to those currently used in the US National Accounts. Five asset types were distinguished — computers, software, communications equipment, other equipment and structures. Data on real investment in ICT equipment including software for the UK were taken from Oulton (2001) and so incorporate the US hedonic price deflator for equipment. Similarly, the German estimates of ICT investment were based on US deflators, adjusted for exchange rate movements. An estimate of the capital stock for the former East Germany at unification was derived using the ratio of capital stocks for total Germany to former West Germany from the National Accounts. Data for the USA and France were obtained from the Bureau of Economic Analysis (BEA) and the Institut National de la Statistique et des Etudes Economiques (INSEE), respectively. Capital services were then calculated by weighting each asset type by its user costs. Purchasing power parities for investment goods for 1996 were used in constructing international levels of tangible capital.

Table 2 also shows relative levels and trends in one measure of TFP where labour productivity is adjusted for differences in physical capital intensity. Both the cross-country rankings and time pattern of the growth rates show similarities to those found for labour productivity. Over the long term, there is evidence of post-war convergence of TFP levels to those in the USA, with again the convergence rate being lower in the UK than in France, Germany or Japan. Also, the UK does not experience the same decline in TFP growth rates post-1973 as is apparent for other countries. On this measure, Japan now looks no better than the continental European countries, confirming the often cited result that a large part of Japan's advantage in labour productivity growth is due to considerably higher growth in capital intensity. The residual productivity gap between the UK and other countries in 1999 is about half that found for labour productivity but remains significant relative to the USA and France. By the end of the 1990s, TFP levels in Japan fall considerably below those achieved by other countries, despite its much higher growth in capital intensity. This raises the possibility that Japan has 'overinvested' in capital in the sense that the very low cost of capital by international standards encouraged investment in projects with very low marginal benefits.

Thus far, we have only considered changes in aggregate capital intensity. Much of the recent literature on the impact of knowledge technology focuses on changes in capital quality (substitution of ICT capital for other forms). Estimates for the USA using growth accounting methods by Oliner and Sichel (2000), Jorgenson and Stiroh (2000) and Whelan (2000) show significant impacts in recent years of ICT capital on output growth. Oliner and Sichel suggest that, between 1996 and 1999, about 1.1 percentage points of the 4 per cent per annum rise in US real output can be accounted for by a broad measure of ICT capital, which includes computer hardware, software and communications equipment. This is in contrast to estimates for earlier time periods, when the contribution of ICT was relatively small. Very rapid investment in new technology has increased its share in total capital to the extent that it is now a significant contributor to growth. This recent surge in the contribution of ICT to output growth is consistent with the high stock market valuations of high-technology firms.

This raises the question of whether European countries will follow the US pattern of a significant impact of ICT on growth. A recent comprehensive study on measuring ICT's contribution to UK productivity (Oulton, 2001), taking account of software and communications equipment as well as computer hardware, shows that in many respects the UK appears to be following the US pattern. ICT investment in the UK has been growing significantly in recent years, and its impact on output growth is beginning to appear, although its contribution is lower than in the USA, at about 0.7 of a percentage point. Estimates of the impact of ICT on relative labour productivity levels are presented in Table 5 below.

3. Human Capital

From the end of the 1970s, the existence of better data-sets on labour force qualifications allows a detailed look at human capital stocks comparing the UK

TABLE 3

Stocks of Qualified Persons as a Percentage of Employees, by Skill Level and Relative Total Skills

	Total economy				Market sectors		
	UK	*USA*	*Germany*	*France*	*UK*	*USA*	*Germany*
1978–79							
Higher	6.8	15.8	7.0	9.4	5.0	11.1	3.8
Intermediate	21.8	11.4	58.5	40.1	20.3	11.0	59.7
Low or none	71.4	72.8	34.5	50.5	74.7	77.9	36.5
Relative skills (UK = 100)	100.0	103.3	109.1	108.0	100.0	101.9	108.5
1993							
Higher	13.5	22.1	11.4	11.0	10.6	17.1	7.6
Intermediate	30.9	17.5	60.7	50.1	30.3	16.8	62.9
Low or none	55.6	60.4	27.9	38.9	59.1	66.1	29.5
Relative skills (UK = 100)	100.0	102.3	106.5	103.9	100.0	100.9	105.0
1998							
Higher	16.6	24.1	13.5	16.4	—	—	—
Intermediate	34.6	18.1	63.8	51.2	—	—	—
Low or none	48.8	57.8	22.7	32.4	—	—	—
Relative skills (UK = 100)	100.0	100.5	105.5	105.3	—	—	—

Notes:
Higher-level skills: USA — Bachelor degrees and above; UK — first degrees and above, membership of professional institutions; Germany — Hochschulabschluss and Fachhochschulabschluss; France — 0.25 of baccalauréat + 2 ans, Diplôme superior and En cour d'études initiales.
Intermediate vocational qualifications: USA — Associates degrees and 50 per cent of those designated 'some college but no degree'; UK — BTEC HNC/HND, teaching and nursing, BTEC ONC/OND, City & Guilds, apprenticeships; Germany — Meister/Techniker gleichwertig Fachschulabschluss, Lehr-/Anlehrausbildung gleichwertig Berufsfach-schulabschluss, berufliches Praktikum; France — Cap, BEP ou autre diplôme de ce niveau, baccalauréat, brevet professional ou autre diplôme de ce niveau and 0.75 of baccalauréat + 2 ans.
Sources:
1978–79 and 1993: USA — *Survey of Current Population: Educational Attainment*, US Department of Labor; UK — *Labour Force Survey*, OPCS; Germany — *Mikrozensus*, Statistisches Bundesamt; France — *Sources d'Emploi*, INSEE.
1998 updates: Derived using information on growth in qualified employees between 1993 and 1998 from Mason (2000) for the UK, the *Statistical Abstract of the United States*, 1999 and the *Statistisches Jahrbuch*, 1999. Data for 1978–79 and 1993 refer to the former West Germany whereas 1998 data refer to unified Germany. Skill proportions for 1995, available on both bases, showed little difference between West Germany and unified Germany.
Relative skills: Derived by weighting the skill proportions by their relative remunerations — see O'Mahony (1999) for details on weights and sources.

with France, Germany and the USA.[3] The basic data are shown in Table 3, with workforce skills divided into three categories — higher-level qualifications (degree or above), intermediate qualifications (vocational qualifications above high school but below degree) and low or no skills. By the late 1970s, we see that the UK had a substantially smaller fraction of the labour force with higher-level qualifications than the USA, but there was little difference between the UK and Germany at this level, with France marginally ahead of both. The data for market sectors suggest that the UK had proportionally fewer graduates employed in non-market services than either Germany or the USA.

At the intermediate level, however, although the UK clearly had no shortfall relative to the USA, there was a massive skills gap between the UK and Germany and a substantial shortfall relative to France. These cross-country differences continued into the 1990s. During the 1980s and into the 1990s, there has been a significant expansion of higher education in the UK, so that by 1998 the higher-level skills gap with the USA has been narrowed and the UK has pulled ahead of Germany. There has also been a significant expansion of vocational training in the UK, and the intermediate-level skills gap with Germany and France has narrowed, but Germany's lead in this respect remains substantial. Similarly, the estimates of aggregate relative skills in Table 3, derived by weighting skill proportions by their relative remunerations in each country, show the UK falling behind all three countries in 1979 but catching up with the USA by 1998 and considerably reducing its shortfall with Germany and France also by that year. The policy changes that have been implemented in the UK cannot bring instantaneous results, and it takes a long time before changes in the flow of investment in human capital feed through to significant changes in the stocks of qualified workers.

Mechanisms by which skills can affect productivity are discussed in a series of studies, carried out over a number of years at the National Institute of Economic and Social Research (NIESR), comparing matched samples of production plants in the UK against those in competitor countries. In summarising the findings for European countries, Prais (1995) concludes that production today requires firms to produce a greater range of specialised products to meet the specialised needs of customers (flexible specialisation) and to do so on specialised machinery appropriate for small batches of variants. This requires greater skills in the choice of machinery, operating it effectively and maintaining it in good working order. In comparisons between European countries and the USA, Mason and Finegold (1997) suggest that, in the USA, graduate manufacturing engineers play a key role in instigating incremental process innovations and improvements in US plants. More generally, graduate engineers represent key components of the traditional US mass production

[3]The situation in 1979 reflects a history of different strategies of capital accumulation across these countries; see Broadberry (2000).

system, with prime responsibility for planning, assisting and improving the work of semi-skilled employees.

4. R&D and Innovation

The most readily available measures of innovative activities are R&D expenditures, shown relative to output in Table 4. Using aggregate GDP as the denominator shows the UK with the lowest ratios in recent years, suggesting some UK deficit in R&D activity. But using GDP as the denominator may be misleading, as most R&D activity is carried out in manufacturing, whose importance varies across countries.[4] The R&D/output ratios for manufacturing, available only up to 1996, suggest very little difference between the three European countries in most of the period, although again the UK has fallen behind in the 1990s. Table 4 also shows relative levels of R&D stocks/output ratios for 1996. On this measure, the UK falls considerably behind the USA,

TABLE 4

R&D Expenditures as Shares of Output (average over time periods)

	UK	*USA*	*France*	*Germany*[a]	*Japan*
Total economy (%)					
1973–79	1.36	1.54	1.06	1.42	1.15
1980–84	1.45	1.83	1.19	1.75	1.51
1985–89	1.49	2.04	1.35	2.04	1.90
1990–98	1.35	1.98	1.45	1.77	2.04
Manufacturing (%)					
1973–79	4.61	6.34	3.95	3.77	3.51
1980–84	6.13	8.31	4.85	5.17	4.95
1985–89	5.73	9.28	5.73	6.16	6.44
1990–96	5.94	8.39	6.61	6.37	7.37
Relative R&D stocks/output, 1996					
Total economy	100	138	100	126	119
Manufacturing	100	142	106	109	104

[a]Former West Germany.

Note: The R&D/output ratio is very volatile and is highly influenced by the business cycle. Therefore averages over a number of years were calculated rather than presenting the data for selected years.

Sources: R&D expenditures — *Research and Development Expenditures in Industry, 1974–1998*, OECD, Paris, 2000; nominal output — *National Accounts, Volume II*, OECD, Paris, 2000. R&D stocks are estimated using the perpetual inventory formula as given in the note to Table 2. This employs an assumption, common in the literature, of a constant 15 per cent depreciation rate (Mairesse and Sassenou, 1991).

[4]Note that if there were significant externalities from R&D, then the whole-economy figure would be the more appropriate measure.

Germany and Japan in the aggregate economy, but in manufacturing, only the gap with the USA is significant.

5. Accounting for Relative Productivity: ICT, R&D and Skills

Using a combination of growth accounting and econometric estimates, it is possible to explore 'some of our ignorance' regarding the TFP residual. Thus we can estimate the extent to which the productivity gap between the UK and other nations is due to lower levels of R&D expenditures, lower levels of ICT or less use of skilled labour.[5] The results are shown in Table 5, which brings together the data underlying Tables 1–4 with econometric estimates of R&D output elasticities from O'Mahony and Vecchi (2000). The table contrasts the position in 1979 with that in the mid- and late 1990s. These results should be seen as suggestive of the likely importance of the variables considered rather than as precise estimates of their quantitative significance.

As discussed above, lower overall physical capital deepening explains a large proportion of the UK's labour productivity gap with the USA, France and Germany in the 1990s, and capital was equally an important explanatory factor in 1979. Table 5 presents a division of the capital contributions into ICT and other assets. By 1995, and especially by 1999, some part of the UK's labour productivity gap with the USA can be explained by the latter country's greater investment in ICT equipment. Nevertheless, the contribution of traditional capital remains large. ICT capital intensity in Germany is about equal to that in the UK, with France lagging both. Hence the UK's failure to invest to the same extent as competitor countries is not primarily a problem with new technology, since the UK performs no worse than other European countries in this respect. Rather, it is due to the UK's poor investment record in more traditional capital, primarily non-ICT equipment.

Using the growth accounting methodology, which weights each type of skill by its remuneration, shows that greater use of skilled labour in the USA explains some small amount of its lead over the UK in 1979 and only 2 percentage points of its lead in 1995, but that this has no explanatory power by 1999. Labour force skills have a somewhat greater impact in explaining the productivity lead of both Germany and France, but their contribution has declined over time. These calculations make no allowance for external benefits from skill acquisition. If external benefits affected all skills equally, then more of the gap with European countries could be explained by this factor input. If, on the other hand, external impacts were greater from investment in higher education, through, for example, facilitating the adoption of new technology including ICT, then skills would have a greater explanatory power in accounting for the US productivity lead.

[5]Japan is not considered in this analysis due to the lack of data on ICT equipment and skills.

However, the empirical evidence has not reached anything like a consensus on the existence or quantitative significance of likely spillovers from human capital accumulation.

TABLE 5

Relative Total Factor Productivity: Total Economy

UK = 100

	USA	*France*	*Germany*[a]
1979			
Labour productivity	154	131	130
TFP after adjusting for:			
Physical capital	132	114	121
Physical capital and skills[b]	129	108	116
Above plus R&D — common returns[c]	113	106	120
Above plus R&D — varying returns[d]	122	111	111
1995			
Labour productivity	122	126	112
TFP after adjusting for:			
Physical capital — ICT	119	126	111
Physical capital — total	111	109	101
Physical capital and skills[b]	109	106	96
Above plus R&D — common returns[c]	97	107	105
Above plus R&D — varying returns[d]	104	100	99
1999			
Labour productivity	126	125	111
TFP after adjusting for:			
Physical capital — ICT	121	128	111
Physical capital — total	113	109	100
Physical capital and skills[b]	113	105	97
Above plus R&D — common returns[c]	99	108	96
Above plus R&D — varying returns[d]	107	101	100

[a]Figures for 1979 refer to the former West Germany and for 1995 and 1999 to the total unified Germany.
[b]Relative skill proportions from Table 3 were weighted by their relative remuneration and then multiplied by labour's share of value added; see O'Mahony (1999) for details.
[c]The elasticity of output with respect to R&D stocks was assumed to be 0.12 in all countries, based on econometric evidence using an international sample of company accounts reported in O'Mahony and Vecchi (2000).
[d]The elasticity of output with respect to R&D stocks was assumed to vary across countries in line with estimates in O'Mahony and Vecchi (2000). This yielded elasticities of 0.083 for the USA, 0.15 for the UK, 0.27 for France and 0.11 for Germany.
Note: In both R&D calculations, labour's and physical capital's shares were adjusted to allow for double counting, i.e. some part of payments to labour and capital are included in R&D expenditures; labour's share was reduced by 0.02 and capital's by 0.04, based on figures available for the UK in Office for National Statistics (2000).

Assuming common R&D output elasticities across countries (R&D common returns in Table 5) suggests that the addition of R&D as an explanatory factor eliminates the US TFP advantage over the UK in the mid-1990s. Differences in R&D explain much less of the UK's productivity position relative to the remaining countries. R&D was an important factor explaining the US lead over the UK (and by implication the US lead over France and Germany) also in 1979, but it accounted for proportionally less of the labour productivity gap at that time.

The nature of R&D, however, suggests that assuming constant R&D elasticities would only be appropriate if these expenditures led to innovations that raised output in each country alone without generating spillovers across countries. At the other extreme, if all innovations were costlessly transferred across countries, then the geographical location would not matter and an R&D component should not appear in the productivity gap. In between these two positions is one where technology is transferable but requires expenditure of resources (R&D) to learn about new techniques and thus approach the technology frontier, as modelled in Griffith, Redding and Van Reenen (2000). In this case, R&D elasticities would be lower in the technological leader (the USA) than in other countries. Table 5 also shows the impact of R&D incorporating elasticities that vary across countries; in this case, R&D continues to explain a significant part of the USA's productivity leadership over the UK but the unexplained proportion is now larger. These results on R&D suggest that the US lead over the UK may be significantly affected by differences in innovation rates rather than being primarily due to ICT and related new technology changes.

Thus far, the paper has only discussed ICT as affecting labour productivity through capital deepening. However, more popular perceptions of the 'information revolution' are consistent with a view that ICT also affects residual productivity — for example, through facilitating greater organisational change within the workplace. To date, the empirical evidence shows little support for significant external benefits from ICT. Probably the most widely quoted ICT scepticism is the paper by Gordon (2000) where he suggests that renewed optimism regarding the impact of the new economy may be misplaced. His calculations for the USA suggest that the acceleration in trend TFP growth in the late 1990s was largely confined to ICT-producing rather than ICT-using sectors, a result that was also found for an earlier period in Stiroh (1998). Oliner and Sichel (2000) also find an important contribution from ICT-producing sectors to TFP growth.

However, an adequate consideration of the issue of externalities requires more detailed research on sectors that use ICT equipment intensively. Recently for the USA, Stiroh (2001) presents industry-level results that indicate significant productivity acceleration in ICT-using as well as ICT-producing sectors. For the UK, Kneller and Young (2001) point to significant TFP gains in recent years in business services, a significant user of ICT. It is also important to note that TFP growth is affected by a large number of influences, some of which may be temporary, that may swamp underlying impacts from ICT. In this context, Kneller and Young (2001) suggest that the recent slowdown in manufacturing productivity growth in the UK, most likely related to cyclical movements stemming from the high value of sterling, renders it difficult to measure significant impacts from ICT at the economy-wide level. To the extent that the TFP acceleration is located in the ICT-producing sectors, its impact will be lower in European countries than in the USA. Data in O'Mahony (1999) suggest that the share of economic activity accounted for by the ICT-producing sectors is about twice as large in the USA as in the UK, where it is, in turn, over twice as large as in Germany.

In summary, the results in Table 5, combined with those in Tables 1 and 2, lead to the tentative conclusion that, relative to the European countries, the UK's poor productivity standing can largely be explained by lower capital accumulation, both physical and human, with no impact from ICT equipment. The UK's capital deficit has been reduced over time but continues to be large. On the other hand, the US lead over the UK is probably largely accounted for by greater innovative activity, with some small contribution from ICT capital deepening. Greater impacts from ICT through its effect on underlying TFP are not, at present, evident.

IV. MICROECONOMICS OF PRODUCTIVITY PERFORMANCE

Growth accounting indicates that capital accumulation and improved technology are important proximate determinants of labour productivity. In turn, these are the result of decisions to invest or to innovate, which are, of course, the very essence of microeconomic analysis, and it is natural to suppose that agents, when making them, will be responsive to incentive structures. This aspect of productivity performance has recently been central not only to the new growth economics but also to the Treasury report on UK productivity (HM Treasury, 2000). This section explores some key impacts of economic incentives on productivity outcomes in the context of the empirical evidence of Section III. This paves the way for a review of the Treasury report in Section V.

1. Choice of Technique

Profit-maximising or cost-minimising firms will choose factor intensities of production based on relative factor prices. It follows that countries where capital is relatively cheap compared with labour will tend to use more capital-intensive techniques and thus experience higher labour productivity, *ceteris paribus*, as in Germany compared with the UK recently. However, this basic neo-classical analysis, while providing useful insights in many international comparisons, needs to be extended to take account of bargaining between firms and their workers and also of transactions costs more generally.

In the UK, work effort and staffing levels were traditionally the subject of formal negotiation between firms and their workers, productivity outcomes depended on bargaining power and industrial relations were important for UK productivity. Changes in the context of bargaining in the 1980s included rises in unemployment, which weakened workers' exit options, anti-union legislation, which strengthened firms' fallback positions, and greater competition in the product market, which reduced rents and raised the cost to the firm of accepting a lower level of effort. The evidence suggests that these changes in the bargaining environment had implications for productivity. Empirical support for this hypothesis can be found in Haskel (1991), who stresses the role of greater competition, and in Bean and Symons (1989), who highlight adverse employment shocks in labour productivity improvements. Most of the impact may have come through a temporary boost to manufacturing productivity growth as firms adjusted to a higher equilibrium productivity level (Crafts, 1991).

A further aspect of the choice of technique turns on possible exposure to opportunistic behaviour in the context of irreversible investments where, once costs have been sunk (and consequently bargaining power has changed), hold-up problems may arise from actions by agents supplying complementary factors of production, by mafia or by government. In a UK context, with an idiosyncratic history of decentralised bargaining and weak legislative control which might be highly conducive to opportunistic behaviour, this once again highlights the possible impact of industrial relations. Denny and Nickell (1992) found that the presence of trade unions in UK manufacturing reduced investment by 28 per cent gross but only 16 per cent net in competitive and 3 per cent net in monopolistic firms, after allowing for offsets from wage and productivity feedbacks.

2. Insights from Growth Economics?

The advent of the new growth economics underlined the possibility that institutions or policies that affect the appropriability of returns to investment can have effects on the growth rather than just the level of labour productivity in the long run as in the traditional Solow model. The AK model with constant returns to investment in (broad) capital, which was fashionable in the early days of endogenous growth theory, embodies this property (Barro and Sala-i-Martin, 1995). In this model, following the Ramsey Rule, the return to investment is equated to the return to consumption along the optimal growth path, and higher prospective returns to investment — for example, following a reduction in the fear of expropriation — raise the equilibrium growth rate of output per person given the rate of time preference and the elasticity of marginal utility with respect to consumption.

Sadly, the key assumption of the AK model — that of constant returns to capital accumulation — is rejected by the data. It is now generally agreed that the evidence points clearly to the validity of the traditional assumption of diminishing returns (Temple, 1999). In that case, the prediction of the Augmented-Solow model rather than the AK model would apply and the long-run effect of better appropriability of returns would be on the labour productivity level rather than its growth rate. However, the adoption of models using a broader concept of capital does imply that diminishing returns will be less severe and the transitory effects of stimulating capital accumulation last longer.

A simple extension to the basic AK model is to allow productive government expenditures to enhance the return to capital while distortionary taxes lower it. Thus an increase in transfer payments financed by income taxes is growth-reducing whereas a rise in government infrastructure spending financed by higher VAT raises the growth rate. Estimation of growth regressions in which the financing aspect of government spending is explicitly taken into account supports these hypotheses for the OECD countries. Kneller, Bleaney and Gemmell (1999) find that either increasing productive expenditures or reducing distortionary taxes by 1 per cent of GDP raised the growth rate by at least 0.1 of a percentage point per year.

This suggests that policy under the Conservatives can be expected to have had mixed effects on capital intensity and thus on labour productivity. On the one hand, there was a switch from direct to indirect taxation, and distortionary tax revenues fell from 26.2 per cent of GDP in 1980 to 23.2 per cent in 1997, which compares with 26.9 per cent in Germany and 32.0 per cent in France (OECD, 1999). On the other hand, the public sector investment/GDP ratio fell by about 4 percentage points. There is no reason to have expected a large impact on the capital/labour ratio from Conservative policies and it is perhaps not surprising that there has been little change in the relative position of the UK since 1979.

The main thrust of growth economics has shifted from the AK model to endogenous innovation theories. Since R&D involves fixed costs, imperfect competition is required to enable these to be recovered by successful innovators. Thus the usual formulation of these models allows greater market power to raise the profitability of research and the growth rate in line with a Schumpeterian view of innovation. As with the AK model, however, there are doubts about the empirical validity of the claim of endogenous growth and thus the suggestion that good policy can raise the steady-state growth rate. The issue turns on scale effects in R&D, on which the evidence is rather weak (Jones, 1999).

Nevertheless, empirical evidence does strongly support the proposition that innovative effort responds to expected profitability (Jaffe, 1988). Imperfections of competition matter for innovation, as witness the role of patenting in pharmaceuticals. In general, however, the most important imperfections relate to lead times and learning advantages over rivals with high imitation costs (Levin et al., 1987). However, a quite general finding in recent work is that greater (though less than perfect) competition promotes innovation (Blundell, Griffith and Van Reenen, 1999). Geroski (1990) finds, using data from the Science Policy Research Unit database on UK innovations, that, while the profitability impact of market power is per se positive, this is far outweighed by the implications of the absence of competition on managerial innovative effort. This suggests both that the simple Schumpeterian message of conventional endogenous innovation models is misleading and that the lack of interest of the Conservatives in strengthening competition policy may have been a mistake.

3. Agency Costs

Principal–agent problems arise in situations of asymmetric information and result from the non-alignment of the agent's interests with those of the principal where effort is costly. Relationships between the owners of a firm and its managers and between employers and workers are possible examples that can impair productivity performance. The standard way of mitigating agency problems is through the use of incentivised contracts, although risk aversion on the part of agents typically implies that the optimal contract from the principal's point of view has a reward rate of less than 100 per cent.

The empirical evidence suggests that the impact of switching to incentivised contracts on worker productivity can be very substantial. Two well-designed studies illustrate this point very well. McMillan, Whalley and Zhu (1989) find that the switch from collective to individual responsibility in Chinese agriculture, whereby individual households were able to retain and sell production in excess of their quotas, increased effort by 56 per cent and total factor productivity by 32 per cent between 1978 and 1984. Lazear (1996) studies a US autoglass company that switched to piece-rates and finds that labour productivity rose by 36 per cent, a little over half of which came from higher output by the existing workforce and the rest from attracting more-able workers to join the firm.

The role of agency problems in reducing UK productivity growth has been highlighted in the analysis of the impact of competition on corporate performance. Nickell (1996) notes that the theoretical argument for a positive relationship between competition and productivity outcomes is weak and ambiguous, but he suggests that reduction of the opportunities for low managerial effort in reducing costs is the most likely channel for such an effect. Greater opportunities to compare performance and greater sensitivity of profits to managers' actions under competition permit the design of schemes with sharper incentives. However, a dominant external shareholder with a high degree of control and who is able to internalise much of the gain from close monitoring of managers may be able to perform a similar function. This is exactly what the

TABLE 6

Policy Impact on the Rate of Technology Adoption

	Profit-maximising firm	*Conservative firm*
Competition policy	Negative	Positive
Industrial policy	Positive	Negative

empirical evidence suggests — reducing supernormal profits from 15 to 5 per cent of value added raises TFP growth in a sample of UK firms by 1 percentage point per year in the absence of, but has no effect in the presence of, a dominant external shareholder (Nickell, Nicolitsas and Dryden, 1997).

The apparently favourable effect of competition on innovation is also probably best explained by costly managerial effort and imperfect monitoring by shareholders with asymmetric information. Aghion, Dewatripont and Rey (1997) provide the following tableau of the implications of agency costs for policy impacts on the adoption of new technology (see Table 6).

For profit-maximising firms, industrial policy, which can be thought of in this context as government subsidies to innovation, speeds up technology adoption by raising its profitability, and a strong competition policy tends to reduce innovation by making it harder to appropriate returns to cover fixed costs. But if firms are ‘conservative’, with a separation of ownership from control where the private benefits of control to managers are sufficiently large and they are sufficiently impatient, then Aghion et al. (1997) show that managers will always seek to delay cost-reducing initiatives, subject to keeping the firm afloat. For this conservative firm, industrial policy cushions managers and subsidies reduce managerial innovative effort, whereas competition policy has the opposite effect. In an economy where most firms are conservative, putting substantial effort into competition policy rather than industrial policy will be indicated.

The case for subsidising industrial investment is indeed undermined by evidence that it may reduce productivity growth, as would be the case if the economy comprised mainly ‘conservative’ firms. Nickell et al. (1997) find, in their sample of UK firms in the period 1985–94, that financial pressure raised productivity growth especially where competition was weak. Thus, when rents are 25 (5) per cent of value added, a rise in interest payments from 10 to 30 per cent of cash flow raises productivity growth by 1.7 (0.8) percentage points per year. This implies that subsidies can be expected to weaken seriously the impetus for cost-reducing effort by managers of firms because they reduce financial pressure.

4. Privatisation and Productivity

Privatisation was one of the Conservatives’ flagship policies and has had generally favourable productivity implications. An unweighted average of 12 former nationalised industries experienced annual growth rates of real output per worker of 1.3 per cent in 1972–80, rising to 5.6 per cent in 1980–88 and to 6.8 per cent in 1988–97, compared with whole-economy labour productivity growth of 1.7 per cent, 2.3 per cent and 1.5 per cent per year in the same periods. Since privatisation, the unweighted average annual rate of decrease in real operating expenditure for all privatised activities has been 4.6 per cent per year (Europe Economics, 1998).

The incentive-based approach to productivity helps to explain why a change of ownership, especially where deregulation and competition are also introduced, can be expected to raise productivity in the context of firm–worker bargaining over productivity and of agency costs. In terms of effort bargaining, privatisation changes the firm's pay-off function to one in which profit displaces 'social welfare', resulting in an equilibrium bargain with fewer restrictive work practices (Haskel and Sanchis, 1995). Empirical evidence from the 1990 Workplace Industrial Relations Survey confirms this prediction and shows that 91 per cent of privatised workplaces experienced increased flexibility of workforce use, compared with 40 per cent of all establishments (Sanchis, 1997).

Clearly, principal–agent problems potentially afflict both public and private sector firms. They are, however, likely to be more serious in the former. Partly, this may reflect the absence of competition (and takeover or bankruptcy threats), together with the difficulty of building adequate incentives into management remuneration, and is thus a more extreme version of the problems discussed by Nickell (1996) for private sector firms. In addition, however, when the monitoring of state enterprise brings no personal reward but some personal cost, it can be expected that monitoring intensity will be weaker for state enterprise. Empirical evidence for the UK is consistent with these predictions: whereas financial performance had no effect on the probability of top executives resigning or being fired under public ownership, after several years in the private sector there is a strong inverse relationship (Cragg and Dyck, 1999).

Principal–agent problems can also be expected to matter in areas of the public sector other than state-owned enterprises. International comparisons suggest that education is an important case in point. Scores in internationally standardised tests of mathematics and science knowledge, in which UK performance in the mid-1990s was sadly mediocre, seem to be explained much more by institutional arrangements than by expenditure per pupil. Educational systems that encourage competition rather than entrenching monopoly of provision, that embody performance tests external to the individual school and in which teachers do not control the curriculum achieve significantly better educational outcomes (Wössmann, 2000).

The international comparisons through time reported in Table 5 suggest that, relative to both the USA and Germany, TFP gaps have narrowed since 1979 in the UK when explicit account is taken of stocks of R&D and skills. On balance, that table seems to indicate that the changed emphasis after 1979 in supply-side policy away from industrial policy and protectionism towards deregulation and greater openness may have been conducive to greater efficiency in the use of factors of production. A gap remains relative to European countries related to skills, and the TFP gaps directly attributable to R&D have not been reduced.

The new growth economics argues that well-designed government policy operating through microeconomic foundations may be able to raise productivity growth. This is an important development in economic thought. However, some of the messages that are often taken from this literature seem, on further consideration, to be quite misleading. For example, subsidising physical capital may appear attractive in basic versions of the AK growth model, but it is much less appealing given the evidence on diminishing returns and absence of externalities and still less attractive when managers of firms are free of effective shareholder control. Similarly, the apparent endorsement of Schumpeterian claims that market power is good for innovation and growth in the standard endogenous innovation model deserves to be resisted on the basis of the evidence of innovative behaviour in UK industry.

V. THE POLITICAL ECONOMY OF PRODUCTIVITY POLICY

This section reviews the recent statement in HM Treasury (2000) of the government's approach to the UK productivity problem in the light of the ideas and evidence that we set out above. It also considers some political obstacles to the development and implementation of a more effective policy.

1. Productivity in the UK: The Government's Approach

The central theme of the government policy framework is to create the right environment for firms to maximise their productivity potential. This is based on two pillars — namely, providing macroeconomic stability and pursuing a microeconomic reform agenda to correct market failure (HM Treasury, 2000, p. 1). Underlying this approach is a diagnosis that inferior labour productivity has resulted from inadequate investment in physical and human capital and in R&D.

The details of the government's strategy to address this include plans to more than double public sector investment by 2003–04, a strengthening of competition policy through the Competition Act that came into force in March 2000, more generous tax treatment of R&D by small and medium-sized enterprises, together with restructuring of capital gains and corporation taxes, and, in macroeconomic policy, the delegation of monetary policy to the Monetary Policy Committee of the independent Bank of England. The document is also striking in its implicit (sometimes explicit) rejection of many of the policies that previous Labour governments used. Thus there is no return to 'picking winners' or attempts to create 'national champions', across-the-board subsidies for physical investment are not on the agenda and there is no suggestion that policy should target the reversal of deindustrialisation.

This analysis and policy framework are, in many ways, consistent with our review of the evidence. The account of the proximate sources of the UK productivity gap is right to stress that both investment and innovation have continued to lag. It is accepted that incentive structures have effects on growth performance. The strong emphasis on competition rather than industrial policy makes sense, given the evidence of weakness of shareholder control in UK firms. The move towards more favourable tax treatment of R&D rather than physical investment is in line with the literature on spillover effects. Additional spending on infrastructure and education could have a positive impact on labour productivity growth in the medium term.

Yet, earlier sections of this paper indicate that there are also some notable lacunae. These concern, in particular, the failure to discuss the overall design rather than the detail of fiscal policy, a distinct reticence in discussing agency problems in the public sector and a rather narrow view of the channels whereby macroeconomic policy can impact on productivity.

Kneller (2000) analyses the potential impact of the earlier package of increased public expenditure on education, health and infrastructure proposed in the 1998 Comprehensive Spending Review in terms of the AK model, relying on estimated coefficients of productive government expenditures and distortionary taxes to infer the possible long-run impact on growth, while explicitly taking into account the financing implications. He estimates that the combined net effect would be to raise the growth rate by 0.1 of a percentage point per year. The result assumes that 70 per cent of the extra spending is financed by distortionary taxes (corresponding to the average pattern of tax revenues in 1998), which reduces growth by 0.39 of a percentage point; the spending interventions alone would have a gross positive effect of 0.49 of a percentage point.

These results should not be given too much weight, given that there is no consensus in this area. They do, however, highlight the need for a broader consideration of the role of fiscal policy in productivity growth than is undertaken in HM Treasury (2000). They underline the importance of considering the tax implications of government spending in assessing the productivity impacts and also suggest that, if there were greater willingness to use indirect taxation — for example, by broadening the VAT base — the impact of fiscal policy on growth might be more substantial. More generally, this reminds us of a big question that is ducked in the Treasury report — namely, whether a move to a more typical European pattern of public expenditure and taxation would have adverse effects on economic growth, as would be implied by the empirical findings in Kneller, Bleaney and Gemmell (1999).

The government is placing substantial emphasis on the positive impact of additional education spending on productivity. The discussion in HM Treasury (2000, p. 35) is clearly aware that the impact of this additional funding will depend on how well it is used and suggests that it is important that extra spending is linked to the achievement of performance targets. Yet, US experience suggests that it would be unwise to believe that this is an adequate response to the principal–agent problems that characterise the sector. More attention may need to be given to increasing the role of competition among producers within the state sector, which has been shown to have a strong impact on school productivity in the USA, admittedly within a context of local rather than centralised public finance (Hoxby, 1996).

Indeed, given that the government's view that competition is good for productivity in the private sector implies a belief that principal–agent problems matter, it would seem natural to go on to explore the role that greater exposure to competitive pressures might play in enhancing public sector productivity where issues of agency costs may be more serious. The Treasury report is silent on these issues, but it is to be hoped that this omission is rectified in future.

The new macroeconomic policy regime has not so far been characterised by the severe recessions in GDP of the previous 25 years. Of itself, this may well be good for investment and productivity growth. The empirical investigation in Oulton (1995) offers some support and suggests that trend growth might be increased by up to 0.5 of a percentage point per year if macro fluctuations became more similar to those in the better-performing countries in the OECD. The macroeconomic turbulence of the 1970s and early 1980s seems to have led to weak productivity outcomes in manufacturing, which were later reversed as errors in employment and investment decisions were corrected (Darby and Wren-Lewis, 1991).

It seems quite possible that a somewhat similar problem has afflicted manufacturing in the mid- to late 1990s through a large increase in the value of the pound and uncertainty as to the future exchange rate regime. Making the Bank of England independent has not addressed this aspect of macroeconomic instability, and the lack of clarity of the government's true intentions with regard to EMU may have been an important ingredient in the stagnation of manufacturing labour productivity between 1994 and 1998. This aspect of macroeconomic management is not, however, dealt with in HM Treasury (2000).

What seems to emerge from this review is that there are important areas that should be covered in the productivity policy framework if a complete discussion were to be provided but that are politically too difficult. This is not, of course, surprising, but it does suggest that the report errs in focusing solely on market failure while ignoring government failure.

2. Government Failure

Whereas 30 years ago discussions of market failure typically assumed that government intervention would solve the problem, more recently it is usual also to consider the likelihood of government failure. If politicians are concerned with maximising votes, it is possible not only that policies that would raise economic efficiency and productivity will not be implemented but also that damaging interventions will be made. Time inconsistency is an aspect of this and, thus, credible commitment matters in microeconomic as well as macroeconomic policy.

At the micro level, a central aspect of the incentive structures facing policy-makers is that it may often be the case that there are votes to be lost by pursuing policies that promote economic efficiency and higher productivity. A classic example, well known to all who have studied international economics, is the attraction of protectionism to vote-seeking politicians, despite its generally adverse impact on productivity growth and overall economic welfare (Magee, 1994). Such policies heavily reward relatively small but well-organised and easily identified groups of producers at the expense of small losses per person for a large but disparate group of consumers for whom it is too expensive to organise a protest.

This problem is, however, much more general in the context of technological change, where productivity growth involves processes of creative destruction. New types of jobs appear, others disappear. Similarly, intensification of competition that stimulates the rationalisation of production through the elimination of inefficient activities and cost-reducing mergers leads to displaced workers who need to be redeployed through the labour market. In such cases, job losses are good news in terms of productivity but are rarely acclaimed as such by the press or by politicians.

As HM Treasury (2000) notes, restructuring has played a major role in manufacturing productivity growth in the recent past in both the UK and the USA. An analysis by Disney, Haskel and Heden (2000) finds that entry and exit of establishments directly accounted for about half of labour productivity growth in UK manufacturing during 1980–92. In so far as this also implies an intensification of competition for incumbents, this estimate tends to understate the importance of restructuring because indirect effects on surviving firms' productivity are not included. Clearly, productivity improvement will often be painful politically.

Slowing down or blocking exit of the inefficient or outmoded is therefore a perennial temptation for politicians, who can clearly identify the votes of the losers to be helped but cannot expect any reward from the promise that their pain will be good for the living standards of future citizens overall. The history of industrial and trade policy formation shows that the political economy of productivity improvement is highly prone to such influences.

The heyday of UK industrial policy, justified on the grounds of capital market failure, was in the late 1960s and 1970s, and the results were well described by Morris and Stout (1985, p. 873): 'it was losers like Rolls Royce, British Leyland and Alfred Herbert who picked Ministers.... What was described as "picking winners" appeared in practice to amount to spending huge sums shoring up ailing companies ...'. For example, government contributions to civil aircraft and engine development from 1945 to 1974 totalled £1.5 billion at 1974 prices and produced receipts of £0.14 billion (Gardner, 1976). Similarly, Greenaway and Milner (1994) conclude that the pattern of protection in the form of nominal tariffs in the UK in 1979 was primarily accounted for in terms of the adjustment costs associated with threatened contraction of industries with high import penetration and intensity of use of unskilled labour.

Recent history does not suggest that problems of government failure are only found in the distant past. For example, the Department of Trade and Industry (DTI) response to recent difficulties in contracting industries, such as cars and coal, reflects the traditional short-termist political calculations. Similarly, the Department of the Environment, Transport and the Regions (DETR)'s timidity in pursuing congestion charging on roads despite the substantial welfare gains that could be achieved (May, Coombe and Gilliam, 1996) and the lack of any obvious connection between its transport infrastructure programmes and investment decisions based on social rate of return criteria (Glaister, 1999) do not suggest that correcting market failures is uppermost in spending ministries' decision-making.

In this context, the Treasury report would have been improved by explicit consideration of government failure and strategies to contain it. For example, one type of solution to this problem may lie in reducing the discretion available to politicians by credible pre-commitment to rules that prevent interventions that inhibit creative destruction. Clearly, the international obligations of participation in the World Trade Organisation are helpful in this regard, and so too may be EU membership, especially if the rules on State Aids are tightened and the European Commission is more assiduous in the effective policing of them.

VI. CONCLUSIONS

We now return to the questions posed in the Introduction to this paper and summarise the answers suggested by the detailed discussion in Sections II to V.

1. How Should Growth Accounting Comparisons of UK Productivity Performance Be Interpreted?

Growth accounting distinguishes between labour productivity growth from capital deepening and TFP growth. It is important, however, not to see this as equivalent to attributing sources of growth in terms of investment and technical change, respectively. Thinking in terms of endogenous innovation embodied in new types of capital goods implies that the contribution of technological progress is partly reflected through capital deepening. It is particularly important to recognise this in the context of ICT, where over 20 per cent of UK labour productivity growth since 1979 has come from growth in ICT capital intensity (Oulton, 2001).

2. What Have Been the Proximate Sources of the Gap between the Productivity Performance of the UK and That of Its Peer Group?

Productivity in the UK continues to lag behind that of other countries. In 1999, purchasing-power-parity-adjusted real GDP per hour worked was about 25 per cent lower than in both France and the USA. The gap in labour productivity with unified Germany was somewhat lower, at 11 per cent. Relative to France and West Germany, the differences in labour productivity levels are very similar to those of 1979. On this measure, UK relative economic decline has ceased but not been reversed.

Analysis of the proximate determinants of relative productivity performance indicates a notable difference in the sources of the productivity gap: between the UK and the USA, innovation plays the major role; between the UK and European countries, broad capital, including both investment and skills, is more important. When explicit account is taken of stocks of R&D and skills, TFP gaps relative to both the USA and France have been reduced substantially since 1979. Together with the evidence of the impact of privatisation and continuing agency problems in UK firms, this suggests that the changed emphasis in supply-side policy away from industrial policy towards deregulation was justified but that a strengthening of competitive pressures in the UK economy would still be welcome.

The ICT revolution plays a part in explaining the Anglo-American (though not the Anglo-European) productivity gap. A comparison of the estimates in Oliner and Sichel (2000) and Oulton (2001) indicates that the ICT capital-deepening contributions to labour productivity growth were fairly similar through to the mid-1990s, but the recent US acceleration has affected relative capital/labour ratios. However, relative weakness in UK innovation is pervasive and pre-dates the ICT era.

3. How Do Incentive Structures Impact on Growth?

Growth economists are now much more aware of the potential impact on long-run growth of incentive structures that affect the expected profitability of investment and innovation. However, the policy implications of some popular endogenous growth models, which appear to justify large subsidies to physical investment and the abandonment of competition policy, are dangerous oversimplifications. It is important to recognise the role of agency costs in the design and implementation of policy. This is because they affect the response of both private and public sector managers and also inform the enthusiasm of politicians for productivity improvement in a world of creative destruction. Both market failure and government failure matter for productivity performance.

4. Is the Government's Stance on Productivity Appropriate in the Light of Recent Theory and Evidence?

The recent Treasury report on productivity (HM Treasury, 2000) embodies many of the recent developments in the academic growth literature. Its main themes stand in stark contrast to the approach of policy-makers in the 1960s and 1970s. Thus competition policy is given more emphasis than industrial policy, and government's role is characterised as addressing a number of apparent market failures and establishing a framework conducive to macroeconomic stability. Attention is paid both to proximate determinants of productivity and to incentive structures. The recognition that the UK productivity gap is substantial and not amenable to a quick fix is realistic. Fiscal policy adjustments may have been marginally favourable to faster growth in the medium term.

Nevertheless, the Treasury report also has some notable omissions. In particular, these relate to government rather than market failure and the role that incentive structures play in the public sector. There is no explicit discussion of the possibility that time inconsistency may justify reducing ministers' discretion in microeconomic as well as macroeconomic policy. The document's apparent confidence that market failures can and will be fixed by well-planned government intervention appears to owe more to a Bob the Builder mentality than to a hard-headed appraisal of the government's record in office.

If agency problems are significant in the private sector, they surely also matter in the public sector. To some extent, this has been accepted by both the present government and its predecessor. Privatisation and performance targets, including efficiency savings, have been the chief ways of addressing this issue. The very short discussion in the Treasury report is disappointing both in its brevity and in its lack of incisiveness in evaluating control and productivity problems in the public sector. There is, however, a separate report promised on these issues, and it is to be hoped that it will offer both a full evaluation of the present system and an analysis of possible alternatives.

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