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POLICY INFLUENCES ON ECONOMIC GROWTH IN OECD COUNTRIES: AN EVALUATION OF THE EVIDENCE

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by
Sanghoon Ahn and Philip Hemmings

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ABSTRACT/RÉSUMÉ

This paper examines the recent literature on economic growth with a focus on policy issues and evidence relevant to OECD countries. The review begins with an overview of developments in the theory of economic growth and also comments generally on the nature of evidence exploring the influences on growth. This is followed by an examination of issues relating to the link between growth and factors of production (physical and human capital). The third section of the paper assesses the evidence linking a number of other factors (or 'framework conditions') to growth, namely: macroeconomic policy; finance; trade and competition policy; 'social capital'; and, population and health issues.

*JEL classification:*O40, F43.
Keywords: Economic growth, productivity, OECD.

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Ce document examine la littérature récente sur la croissance économique en particulier sur les aspects empiriques et de politiques économique concernant les pays de l'OCDE. L'étude commence par une vue d'ensemble des développements de la théorie de la croissance économique et présente également des observations générales sur la nature des recherches sur les déterminants de la croissance. Suit un examen des implications relatives aux liens entre la croissance et les facteurs de production (capital humain et physique). La troisième section du document évalue les implications des liens entre un certain nombre d'autres facteurs ('conditions cadres') à la croissance, à savoir : la politique macro-économique ; la finance ; la politique du commerce et de la concurrence ; le 'capital sociétal' ; et les aspects liés à la population et la santé.

Classification JEL : O40, F43.
Mots-Clés : croissance économique, productivité, OCDE.

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POLICY INFLUENCES ON ECONOMIC GROWTH IN OECD COUNTRIES: AN EVALUATION OF THE EVIDENCE

Sanghoon Ahn and Philip Hemmings[1]

INTRODUCTION

1. This paper provides a review of recent literature on economic growth, with a focus on the theory and evidence relevant to OECD countries. The review begins with an overview of developments in the theory of economic growth and some general comments about the nature of evidence exploring the factors driving economic growth (Part 1). This is followed by an examination of issues relating to the link between factors of production, namely physical and human capital and growth (Part 2). Part 3 provides an assessment of the evidence linking a number of other factors to growth, namely: macroeconomic policy; finance; trade and competition policy; 'social capital'; and, population and health issues. These influences can be seen as 'framework conditions', influences on growth that are typically less obvious and direct in their effects compared with human and physical capital but nevertheless potentially important.

1. OECD. The authors wish to thank their colleagues at the OECD, especially: Andrea Bassanini, Sylvain Côté, Jørgen Elmeskov, Mike Feiner, Tom Healy, Pierre Moise, Dirk Pilat, Kotaro Tsuru, Stefano Scarpetta and Nick Vanston for their additional input and comment. Many thanks are also due to Sandra Raymond for secretarial and administrative assistance.

PART 1. THE NATURE OF EVIDENCE ON LINKS WITH ECONOMIC GROWTH

2. This section examines key developments in the theory of economic growth and a range of general empirical issues in growth research. The main points to emerge are as follows:

- Although the Solow model remains a basic research and pedagogic tool, it has proved to be difficult to square the model with certain stylised facts when comparing growth across countries. One response to this has been to remain within the neoclassical framework of the Solow model but to take a broader view of capital, either by hypothesising that there may be spillover effects in capital or by introducing human capital as an additional factor of production. In addition, there has been substantial development of endogenous growth models introducing more plausible mechanisms for technological change compared with standard neoclassical theory.

- There are a number of measurement issues. Measurement of physical capital is sensitive to estimates of the of length of service lives of capital and the deflators used to account for price and quality changes. In cross-country analysis, indicators of human capital are often forced to be fairly basic due to data limitations whilst more sophisticated measures have been developed in country-specific analysis. Finally, the widespread use of indicators to represent hard-to-measure concepts in cross-country regressions poses additional problems of measurement error and interpretation.

- Analysis of the role of physical and human capital inputs via growth accounting methods has become more sophisticated and the 'residual' growth once factors of production are taken into account has been reduced significantly compared with early research.

- Cross-country growth regressions have been an extremely popular means of testing ideas about the causes of growth. However, this research program has been questioned by some because many of the variables claimed to be significant have not stood up to tests for statistical robustness. This being said, the techniques used to test robustness are not universally accepted and this area remains controversial.

- The greatest problem underlying the use of cross-country growth regressions is the lack of accepted formal theoretical models that can accommodate the wide range of variables that are often included as explanatory variables. Despite advances in the theory of economic growth, there still remains a large gap between the formal models and the informal but often complex mechanisms that are tested in empirical work. A related issue is that insofar as causal links between aggregate economic variables and growth are bi-directional then most estimates are likely to suffer from endogeneity problems. Another problem that some researchers emphasise is that outlying observations may overly influence the results of cross-country regressions and prevent the establishment of reasonable results. Finally, there are good reasons for thinking the evidence and conclusions from many of the cross-country studies are difficult to apply in the context of OECD countries as the regressions are based on trying to explain growth differences across countries at widely different stages of development.

1.1 Key developments in the theory of economic growth

3. This section sketches out the main developments in the formal modelling of economic growth in recent years, following the approach taken by Mankiw (1995). The section begins by explaining the Solow model and reasons why in certain respects it has proved to be at odds with some of the stylised facts of economic growth. This is followed by a brief description of extensions to the Solow model and the development of endogenous growth models.

1.1.1 The Solow growth model

4. The Solow growth model is set within a neoclassical framework, and emphasises the role of capital accumulation. It is assumed that population growth, depreciation, and most notably technological progress are exogenous to the growth process with the result that it is only the accumulation of capital that is determined endogenously.

5. To get a feel for the dynamics of the Solow approach it is useful to consider a simplified version with zero population growth and no technological progress. When the economy is in a 'transitional' state, there is growth (or decline) in the capital stock according to whether the investment generated from savings is greater than (or less than) the investment required to cover the amount of depreciation. Dynamic equilibrium, where the capital stock is constant, is achieved by assuming a diminishing marginal product of capital. For example, with a growing capital stock the diminishing marginal product implies diminishing marginal saving as the same saving rate is applied to smaller increases in output. Gradually, the economy moves to a point where savings provide investment only sufficient to cover depreciation. In this example, the dynamic equilibrium involves no further growth in output. In the standard version of the model the steady-state rate of output growth is the sum of the exogenously determined rates of population growth and technological progress.[2]

6. One point sometimes emphasised about the Solow model and which is true of most neoclassical growth models is that the 'long-run' rate of growth is unaffected by the rate of savings (or investment). However, it should be stressed that this refers to the concept of dynamic equilibrium and does not necessarily equate with what policymakers might typically think of as being a 'long-run' rate of growth. For example, a transitional period of increased growth resulting from an increase in the savings rate could be prolonged. Arguably, the Solow model in fact stresses the significance of transitional states, demonstrating the potential for (say) increases in savings rates to generate periods of increased growth in addition to whatever growth may be generated by demographic or technological processes.

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2. The Solow model centres on a production function $Y = F(K, AL)$ where *Y* is output, *K* is capital and *AL* is the labour force measured in efficiency units, which incorporates both the amount of labour and the productivity of labour as determined by the available technology. It is assumed that there are constant returns to scale in production that allows the function to be expressed more simply as $y = f(k)$ where *y* and *k* are both expressed per efficiency unit of labour. Using this production function in a dynamic setting and introducing an exogenous rates of saving (*s*), population growth (*n*), technological change (*g*) and depreciation (δ) shows that $\dot{k} = sf(k) - (n + g + \delta)k$. Hence, in the steady state where capital is constant over time, $sf(k^*) = (n + g + \delta)k^*$ where the * serves to distinguish from non-steady states. See Mankiw (1995) and Barro and Sala-i-Martin (1995) for further details.

7. Another aspect of the Solow model, and one applying to most models of growth is that it describes the dynamics of output (or output per worker) based on the assumption that the resources of the economy are efficiently utilised. Whilst this is a useful simplifying assumption, allowing focus on other issues of interest, it clearly does not always reflect real-world realities or policy considerations. For example, in quite a number of OECD countries, high levels of structural unemployment and low labour force participation imply these economies could experience higher growth rates for some time merely by engaging on macroeconomic and structural policies that allow greater utilisation of labour resources.

8. Several features of the Solow model are reflected in real-world data, something that has contributed to its long-standing appeal. For example, according to the model countries with higher savings rates should have higher levels of income per capita and the capital-to-income ratio should be constant, both of which are borne out reasonably well in the data (see Mankiw 1995 for further discussion). However, the Solow model does not tie up with the stylised facts in other areas, notably:

- The model does not plausibly account for the magnitude of income differences observed between rich and poor countries. Applying reasonable estimates of the differences in savings rates between countries and differences in population growth only goes a small way to account for output differences.

- Calibration of the Solow model using reasonable estimates of the share of capital and other parameters implies rates of convergence to the steady state that are much faster than those found in empirical studies.

- The model suggests differences between rates of return to capital across countries are much greater than those actually observed. Calibration of the Solow model based on a Cobb-Douglas production function implies that the rates of return to capital in poor countries should be very large multiples of those in rich countries, something that is not borne out in the data.[3]

9. New growth theories have endeavoured to be at least potentially more congruent with these aspects of growth. One approach has been to remain largely within the neoclassical framework but re-interpret the nature and role of capital, the other has been to abandon key aspects of the neoclassical approach and to develop models which endogenise the rate of technological progress.

1.1.2 Re-interpretation of capital

10. In the Solow model it can be shown that all three of the inconsistencies described above can be ascribed to too-low a value of the share of capital in income. In broad terms, a larger share of capital in income increases the impact of the rate of saving on output because investment and capital is more important . It also extends the length of time required to converge to steady state since the larger the capital share the less rapidly the average product declines. And finally, a larger share of capital in income reduces the differences implied by the model in the returns to capital by diluting the marginal gains of capital.[4]

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3. The range of possibility under this calibration exercise is, however, fairly broad because the result is highly sensitive to what is assumed about the elasticity of substitution and it is possible to claim that the predictions of the Solow model are not that far removed from reality (Mankiw, 1995).

4. Manipulation of the Solow model (see previous footnote) shows the importance of the factor shares in determining outcomes with regard to output, the speed of convergence and the rate of return to capital (see, for example, Mankiw (1995) for further details). Thus:

11. Furthermore it seems plausible that the role of the capital share is indeed understated, largely because the standard interpretation of capital is limited to tangible assets whose returns accrue solely to their owners. Thus, it has been proposed that that there are positive externalities to capital, *i.e.* that the returns to capital do not only accrue to the owners of the capital. For example, if new ideas arise as new capital is created and if these ideas enter the general pool of knowledge this implies an added importance for capital in production. Such ideas were pioneered by Arrow (1962) and re-formalised by Romer (1986) who developed a model in which each firm's production was based on their own capital and the average level of capital across all firms.[5]

12. The second argument for a greater importance of capital is that it should not only include physical plant and machinery but also account for the acquisition of skills by the workforce, *i.e.* human capital. If part of labour income is seen as human capital this boosts the share of total capital in output and also therefore helps bring the Solow model closer to reality. Indeed, the role of human capital has been widely acknowledged and confirmed by empirical evidence (see for example Mankiw *et al.*, 1992).

1.1.3 Theories of endogenous growth

13. An important step in the theory of economic growth has been the development of models that endogenise the process of technological progress. These models not only have the potential for accommodating the stylised facts of growth but also provide more realistic mechanisms for technological progress. The basic modelling framework used to develop endogenous growth theories is to assume that output varies proportionally with the amount of capital, thus giving rise to constant, rather than diminishing marginal returns to capital in production (this is often referred to as the "AK" model).[6] This provides an environment where, as long as investment is positive, net of depreciation, then income grows forever as

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– total differentiation of the model in the steady state show that changes in output relate to the exogenous variables via the ratio of the share of capital (α) to the share of labour in output (1-α): $dy^*/y^* = (\alpha/(1-\alpha))(ds/s - d(n+g+\delta)/(n+g+\delta))$;

– the rate of convergence (λ) is determined by the product of the labour share and exogenous variables, $\lambda = (1-\alpha)(n+g+\delta)$;

– the rate of return to output (dR/R) can be shown to relate to the level of output via the factor shares and the elasticity of substitution (σ) in the following way: $dR/R = -((1-\alpha)/\alpha\sigma)dy/y$.

5. Following Mankiw (1995), Romer (1986) has been cited with regard to extensions of neoclassical growth models. However, it should be stressed that the work by Romer was very much a catalyst for much of the endogenous growth theory as it suggested a mechanism to counteract diminishing returns to capital. Clearly if assumed to be sufficiently large, Romer's externalities could completely offset the normal process of diminishing return and therefore there could be constant returns to scale--as set out in the basic endogenous growth model (see Romer, 1987, 1990, 1993*a*, 1994).

6. The textbook production function used in explaining endogenous growth theory is Y=AK where Y is output, K is capital and A is a constant. Following the notation used in previous footnotes, suppose capital accumulates according to $\dot{K} = sY - \delta K$, then the rate of growth of output simply becomes $\dot{Y}/Y = \dot{K}/K = sA - \delta$. As Mankiw (1995) points out, the endogenous growth model can be seen as a limiting case of the neoclassical model with the capital share tending to unity and the rate of convergence tending to zero.

there is no diminishing marginal product of capital to bring transitional equilibrium to the point where investment only covers depreciation.

14. The advantage of the "AK" framework is that it frees the theory of the exogenously determined steady state and allows models to introduce endogenous mechanisms of technological progress. Clearly the "K" in this approach is not the same as that in traditional models. What is typically hypothesised is that capital should not only incorporate physical and human capital but also the accumulation of knowledge, which is assumed to be the basis of technological progress. Some models are based on adding a knowledge-producing sector (such as research universities) to the economy whose production of knowledge can be used by the other sectors of the economy.[7] One problem with this approach is that the mechanisms generating knowledge are fairly rudimentary, in particular often failing to reflect that much research is performed for profit motives. This issue has been tackled by using dynamic models of oligopolistic firm behaviour which incorporate incentives for research and development. Some of them echo many of the ideas developed about linking technological change with market power developed by Schumpeter (and are consequently often referred to as Schumpterian models).[8]

1.2. Empirical techniques

15. The main techniques used to examine aggregate economic growth are *growth accounting exercises* and *cross-country growth regressions*. Growth accounting exercises have a long tradition, seminal calculations were made as early as in the 1950s (*e.g.* Solow, 1957). Cross-country growth regressions are a more recent avenue of research, boosted significantly by the development of databases by Summers and Heston (see Summers and Heston,1991).[9] Prior to examining these techniques however, a reminder of some of the measurement issues in this area is required.

1.2.1 Measurement issues

Physical capital

16. Stocks of physical capital in OECD countries are usually estimated based on the perpetual inventory model. Two aspects of this approach are particularly important in determining the accuracy of capital-stock data:

- *Service lives*. The perpetual inventory model requires information about how long capital stock will last or how fast the capital stock depreciates. This is usually based on information about the average service life of capital goods and assumptions about the distribution of service lives around that average. The problem is that accurate information about service lives is difficult to acquire and so there can be a wide range of plausible values. The aggregate service life of capital equipment can change because of compositional shifts in the stock of capital and also because average service life of specific items are periodically altered to reflect changing characteristics. In the case of computers, for example, there has been a

7. An early example of this type of model was by Uzawa (1965), later models of this type are by Lucas (1988), Romer (1990), Grossman and Helpman (1991), Aghion and Howitt (1998).

8. The text by Aghion and Howitt (1998) provides a comprehensive account of the Schumpeterian approach.

9. In addition to these techniques, some argue (for example, McGratten and Schmitz, 1998) that simulation exercises may provide a useful avenue for further empirical research into growth issues.

tendency to introduce shorter service lives, reflecting the shift from the use of mainframe computers to personal computers.

– *Deflators*. The way in which deflators are constructed can effectively mean that part of technical progress is hidden in the capital stock. For example, some countries have made moves to account for the increased 'quality' of computer hardware by including hedonic price deflators in calculations of investment and the capital stock (see OECD 2000*a*). These changes increase the volume of investment--effectively absorbing part of the Solow residual in growth accounting exercises (see below).

Measurement of human capital

17. In cross-country growth regressions human capital is often based on indicators of formal education. Given the wide range of countries that researchers typically include in their data, these indicators are often unsophisticated. For example it is common to use primary, or secondary school enrolment rates. Life expectancy is also sometimes included as an indicator of human capital. More advanced measures, such as the average number of years schooling in the working-age population can be developed if data are available.[10]

18. In contrast, growth accounting exercises often use relatively more sophisticated measures of human capital. Typically, data on relative wages at different levels of education are combined to generate an indicator of human capital.[11] This approach, however, relies on the assumption that the returns to human capital are reflected in relative wages. This only holds if wages reflect marginal products in competitive labour markets, something holding only partially true and also with varying degrees across countries. For example, the fact that wage distributions vary quite significantly across countries with fairly similar educational attainment would seem to indicate that there are certainly differences across countries in the relationship between wages and educational attainment and brings into question this approach.

19. A major problem with most existing measures of human capital is a failure to account for differences in the quality of education. Attempts to take this into account have been based on using proxies for school input and output quality; for example, Barro and Lee (1997) use teacher-pupil ratios, per pupil spending and percentages of students repeating their grade as inputs to a measure of human capital. Others have opted for direct indicators of human capital, for example Hanushek and Kim (1995) construct an indicator of human capital based on international tests for cognitive ability in mathematics and science.

Issues relating to indicators

20. Many of the factors potentially influencing growth are not directly measurable (*e.g.* trade openness, financial development). Thus, cross-country growth regressions frequently make use of indicators, which proxy specific variables of interest. This may lead to two potential problems. First, it is

10. In terms of recent evidence, de la Fuente and Domenech (2000) construct human capital indicators for OECD countries and test them in a simple growth model.

11. Relative wages at different levels of education are usually calculated with reference to some low level of earnings, such as the minimum wage. An average of these relative wages is then calculated using the relative size of the population at each level of education to generate the indicator of human capital. The Bureau of Labour Statistics in the United States uses a more detailed approach where not only education but also experience are combined with wage data to generate an indicator of human capital (see OECD 2000*a* for more detail).

not always convincing that the variable accurately reflects the underlying concept being tested. Second, there is often a degree of ambiguity; it is frequently possible to imagine an indicator could represent some other plausible growth-related variable. This is particularly the case in proxies for difficult-to-define concepts such as political instability, social capital and so on.

1.2.2 Growth accounting

21. Growth accounting attempts to establish how much growth can be attributed to the accumulation of factors of production and the importance of remaining, or 'unexplained' growth once this is taken into account. The 'unexplained' component is often referred to as Solow's residual or multifactor productivity.

22. The most straightforward approach is to apply time-series data for labour and capital to a Cobb-Douglas production function with constant returns to scale, and the difference between growth of output implied by this calculation and actual growth is the unexplained component. The Cobb-Douglas production function is convenient because the required parameters, the partial output elasticities of capital and labour (assuming perfect competition), are easily calculated by taking average income shares over the time period in question. A variant of this approach is to assume that the shares in output change over time, based on observation of long-term trends. A more sophisticated approach is to regress output against a production function, typically with the addition of a time-trend. The estimated time-trend, plus the residual from the regression then represent the Solow residual (see OECD, 2000*a*).

23. The size of Solow's residual depends partly on the extent to which volume and quality changes in the stocks of labour and capital are reflected in the data. Interest in growth accounting initially arouse partly because the residual in early calculations turned out to be positive and relatively large (*e.g.* Solow, 1957), implying that factors (such as technological progress) other than increased inputs are important in driving growth in output. However, more careful measurement of capital and labour, taking greater account of quantity and quality changes significantly increases the role of the factors of production, reducing the size of the "Solow residual".[12] Thus, it appears early estimates of the residual included a good proportion of measurement error and embodied technical change and that more recent estimates are arguably closer to reflecting purely disembodied technological change.

1.2.3 Cross-country growth regressions

24. Cross-country growth regressions have been widely used in studies of economic growth. The regressions typically use average growth in per capita GDP over a period of at least 20 years as the dependent variable, and the majority of studies attempt to explain growth differences across a broad range of countries, ranging from those with the lowest as well to the highest GDP per capita. Cross-country data are particularly amenable to investigation of what drives growth differences over long time periods and enable the role of institutional, political and social factors to be explored. An alternative approach based on time-series regressions for single countries is also sometimes used, especially in the investigation of interactions between short-run and long-run performance. In addition, some studies have used panel data, notably Englander and Gurney (1994) develop a panel data set for OECD countries.

25. Much work on cross-country growth regressions uses the 'Summers-Heston' database (for a review of these data see Summers and Heston, 1991), developed in the late 1980s and subsequently refined

12. Quality improvements have been taken into greater account by disaggregating labour and capital inputs into many different classes in the growth accounting exercise.

and augmented.[13] The Summers-Heston database aims to provide a range of growth related variables for a large number of countries at diverse stages of economic development. For this reason the data are suited to very broad assessment of economic development since a 'successful' regression must explain differences in the growth of GDP per capita between the most under-developed countries of the world and the very richest.

26. Some cross-country regression studies have been used in evaluating the Solow model and endogenous growth theories of growth. In a widely-referenced paper Mankiw *et al*. (1992) use cross-country regressions to support the view that an augmented Solow formulation (*i.e.* including human capital indicators) fits the data well and that there is less support for constant-returns type formulations (see Table 1.1). This result has been confirmed in later analysis by, for example, Vasudeva Murthy and Chien (1997) who provide further supporting evidence based on a sample of OECD countries as do Hamilton and Monteagudo (1998) using a wide sample of countries.

27. The majority of studies using cross-country regressions are aimed at trying to establish links with economic growth, beyond the more 'direct' influence of physical and human capital. Some of the initial results showed promising signs that a specific set of influences on growth could be found. One of the earliest papers to be widely recognised was by Kormendi and Maguire (1985) whose explanatory variables focussed on macroeconomic influences on growth. The paper also established the possible role that political factors might play in growth, finding an indicator of political stability significant in regressions. Possibly more influential has been the paper by Barro (1991) which provided further supporting evidence that indicators of the size of government, political stability and market efficiency are important for growth (see Table 1.1).

28. One issue faced by researchers is whether to include a variable representing additions to the capital stock (typically the average share of investment in GDP over the period concerned) as an explanatory variable. On the one hand, the 'direct' role that additions to the stock of physical capital have on output in the context (say) of neoclassical models make it an obvious candidate for inclusion in regressions. On the other hand one can argue that investment is merely a transmission mechanism for other (possibly more interesting) influences and that including investment reduces cross-country growth regressions to a form of growth accounting. For example, any role that financial development has to play in growth may operate largely by encouraging investment. Thus, the omission of investment can be justified on the basis of the researchers' wish to reflect the full influence that financial variables may have on growth. However, leaving investment out of regressions requires some faith in *a priori* reasoning as well as confidence that the proxies used (say, for financial development) are not themselves driven by investment. The result is that sometimes investment is included in the basic 'conditioning sets' used by researchers, and sometimes it is not. However, it does appear that where it is not included there is often a partial investigation of the role that investment might be playing by reporting additional regressions that include investment, and sometimes by presenting results of regressions to explain cross-country differences in investment shares.[14]

29. Attempts at finding links with growth have been called into question by a number of studies that test for the robustness of statistical links by running regressions with different combinations of variables. Levine and Renelt (1992) carry out an 'extreme-bounds' analysis to investigate the robustness of variables that other research had purported to be linked to growth and found that few of them passed their statistical criteria. A related approach by Sala-i-Martin (1997) proposes results based on a ranking of variables, rather than a division into 'robust' and 'fragile' results. Also, a study by Ley and Steele (1999) using a Bayesian-

13. Notably, Barro and Lee (1994) have developed a set of human capital indicators.

14. The seminal paper by Barro (1991), for example, takes this approach.

Model-Averaging technique also produces a ranking of variables but finds results quite different from those of Sala-i-Martin.[15] (see Table 1.1).

30. Although the majority of studies have used wide samples of countries, a reasonable amount of evidence has also accumulated that is based on samples of OECD countries (See Tables 1.2 and 1.3). Many of these studies will be referred to in later sections; however there are a couple of points worth noting about them at this stage. First, to-date 'data mining' exercises, such as those by Levine and Renelt (1992), have not been carried out for the subset of OECD countries, and this possibly represents an opportunity for further work. Second, the focus of work using OECD country samples partially reflects data availability. For example, the seemingly heavy emphasis on fiscal issues probably reflects availability of comparable and detailed government accounts for OECD countries.

31. This brief summary highlights model uncertainty as a significant issue in this area of research. A closely related problem is that of endogeneity of variables. Additional issues arise from the potential for excessive influence from outlying observations; and, given the typically worldwide nature of cross-country regressions, there is a question as to how relevant the data and analysis of much research is for OECD countries.

Model uncertainty

32. At the heart of many of the problems encountered with cross-country growth regressions is that there is no strongly established theoretical model on which to derive estimating equations. This is especially so when researchers are trying to investigate the role of more 'remote' causes of economic growth, outside of the accumulation of physical and human capital.[16]

33. Endogenous growth theory has given rise to a whole range of new ideas about the possible underlying forces and mechanisms driving economic growth and in this sense has been a positive development. However, at the same time, the breadth of the range of models provides empirical researchers with a *carte blanche* when it comes to choosing variables in regression analysis. Furthermore, even when research focuses on a specific model, the precise variables that should be used to test it in regressions are not clear.

34. The lack of broadly agreed theoretical bases for empirical work has motivated some researchers to largely abandon any *a priori* reasoning and let the data show what is most consistently correlated with economic growth. This is partly what motivates the 'data mining' approaches discussed earlier. However, there is controversy over these techniques, reflecting a long-standing methodological debate in econometrics. As Temple (1999*a*) points out, the main objection is that the techniques do not discriminate between the quality of regressions being run, such that the distributions of coefficient estimates on specific variables could contain a lot of weak regressions and therefore be of little value. This sceptical view tends to favour the more traditional econometric approach of narrowing down to a preferred specification based on discretionary judgement combined with comprehensive testing of the properties of the models.

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15. The development of this type of analysis has been facilitated by increased computer power. The paper by Sala-i-Martin (1997) presents the results of 2 million regressions, although interestingly the author, even then, is forced to restrict the number of combinations of variables tested , the total number of which would be 3.9 billion.

16. Temple (1999*b*) argues that in addition to model uncertainty, an important and often overlooked aspect of mis-specification is parameter heterogeneity. For example cross-country growth regressions are implicitly assuming that the same parameter values apply to each country when it is entirely possible they are quite different.

35. Another issue related to data mining is that it obviously does not remove all discretion. First, studies usually include variables that *a priori*, researchers think should be in the regression (see Table 1.1) and also limit the number of additional variables used. Second, the data used in the analysis is a choice in itself and there are both advantages and disadvantages in exercising discretion in this regard. On the one hand choice of a wide set of variables can produce results that are difficult to interpret. On the other hand, excessive restrictions on the variables, to some extent defeats the purpose of the exercise.

Endogeneity

36. Almost all factors posited as important to economic growth are *a priori* likely to have some degree of endogeneity, *i.e.* the statistical relationship between the explanatory variables and the independent variables belies a more complex causal structure. This is clearly related to the problem of model uncertainty for if there were a reasonably established set of models to work with then regressions could be based on reduced forms that had been purged of that part of endogeneity implied by the models.

37. To illustrate the problem of endogeneity, consider the link between human capital and growth. Although indicators of the stock of human capital are almost invariably found to correlate with economic growth this is likely the result of a two-way process: human capital causing economic growth and economic growth causing increased human capital (one justification for the latter could be an increased taste for education as a consumption good as living standards rise).[17] Statistical techniques controlling for endogeneity, such as instrumental variable regressions are available but they are also not entirely reliable or easily performed.

38. From the point of view of practical policymaking the problem of endogeneity is a potentially serious matter. For example, suppose that a 10 per cent increase in the average number of years schooling has been shown to be associated with an increased rate of growth 0.5 per cent; providing policymakers with a rule of thumb about the likely impact of education policy on growth (albeit a combined effect of endogenous and exogenous processes). The problem is that failure to recognise endogeneity may result in disappointing policy outcomes. In this example, suppose that growth is also driven by capital accumulation and that the correlation between education and growth is partly governed by the accumulation of capital (capital accumulation generating growth and, hence, say, an increase in the demand for schooling). A policy to increase schooling (with no change in policy towards capital accumulation) is then likely to have a smaller effect than that implied by straightforward statistical association.

Outliers

39. Some claim that one of the major problems facing cross-country growth regression is the existence of 'outliers' (*e.g.* Temple, 1999*b*). What to do about outliers is, however, a question of debate. On the one hand providing special treatment for outliers, either by excluding them from regressions or by diluting their influence, leads to a temptation to make results to conform *a priori* reasoning. On the other hand, accounting for outliers in some way can be justified if it is considered that parameter heterogeneity is a significant problem. There are indeed certain grounds for thinking that 'outliers' in cross-country regression really can be seen as cases where the forces explaining growth are significantly different in character compared with the main body of countries. The fact that most cross-country growth regressions are attempting to explain growth across countries that differ widely in social, political and institutional characteristics suggests intuitively that outliers are likely. This is supported by some of the evidence. For

17. Some researchers have claimed there is strong evidence of two-way causality between growth and human capital, this is discussed in later sections.

example Durlauf and Johnson (1995) show that distinct country groupings can be found, across which parameters differ widely.

Applicability of the existing cross-country evidence to OECD Member countries

40. Much of the evidence is based on cross-country analysis covering a wide range of countries and it is not clear that the same conclusions would be drawn if the analysis were restricted to OECD countries. There is indeed evidence that even regressions with fairly straightforward human and physical capital variables can produce quite different results when applied only to the subset of OECD countries. For example Englander and Gurney (1994) replicate the work of Barro (1991) and Levine and Renelt (1992) for OECD countries and find most of the variables insignificant. There are a number of reasons for this, including:

- *a priori* one might expect the actual processes driving growth within the developed world to be different from those driving growth in developing countries. Hence, what appears to explain growth differences across a broad range of countries probably fails to pin down the more subtle processes distinguishing growth between OECD countries.

- many of the variables found to be significant across a broad range of countries are either completely irrelevant or likely to be so. For example, cross-country growth regressions often find certain geographic indicators to be statistically significant explanatory variables but they are frequently irrelevant for the OECD area.

- indicators developed for world-wide analysis are possibly poor indicators for OECD countries. One example is the Sachs-Warner indicator of openness (see discussion in Rodrigez and Rodrik, 1999), a binary variable which for OECD countries almost always indicates openness. Another example is Barro's (1991) proxy for political stability using observations on revolutions, coups and political assassinations; one would expect a milder indicator, such as number of changes in government to be more appropriate for the OECD area.

PART 2. THE ROLE OF PHYSICAL, INTANGIBLE AND HUMAN CAPITAL IN GROWTH

2.1 Physical capital and growth

41. The accumulation of physical capital is one of the main sources of economic growth. Growth accounting exercises show that major factors driving growth in OECD countries are the growth in capital and labour inputs, with the unexplained multi-factor productivity (MFP) residual accounting for a relatively modest portion. For example, Jorgenson (1990) finds 3.3 per cent average annual growth of private output in the United States during 1947-85 is decomposed into 1.5 per cent growth contribution from capital services, 1.1 per cent growth contribution from labour services, and the remaining 0.7 per cent from MFP growth. In other words, the contribution of capital explains more than 40 per cent of growth; and this result roughly applies to other OECD countries (Kendrick, 1993).

42. The following conclusions can be drawn from the empirical literature on the link between physical capital and growth:

- It is becoming increasingly evident that certain forms of investment matter much more for growth compared with others. In particular, equipment investment has a significantly positive and robust association with growth, while the results for non-equipment investment tend to be weaker. One reason why investment in equipment is important for growth appears to be due to embodiment of technological innovation in capital; implying high social returns to equipment investment reflect technology transfer mediated through capital goods.

- However, the growth enhancing effect of equipment investment is somewhat smaller for developed countries than for developing countries. Also, the often complimentary nature of equipment and non-equipment investment potentially make this a complex issue. There has also been empirical investigation of the role of public infrastructure investment, although the evidence to-date has been somewhat inconclusive.

- One of the more concrete conclusions reached in the debate about the effect of information and communication technology (ICT) on growth is that productivity gains in the ICT-producing sector have been sufficiently large to positively affect the economy-wide average. Whether ICT is also producing significant spillover effects and a boost to long-term growth of total factor productivity remains more uncertain.

2.1.1 Theoretical links between capital accumulation and growth

43. As discussed in Part 1, the neoclassical growth model is characterised by a steady-state rate of growth, determined by exogenous population growth and technological progress. Thus, other influences (*e.g.* capital accumulation) only have temporary effects on growth rates. In endogenous growth models the mechanisms driving permanent effects on growth are sometimes based on assuming non-decreasing returns through processes relating to physical capital. For example, Arrow (1962) and Romer (1986) introduce externalities to capital with a consequent divergence between private and social returns. In this setting,

private returns to scale may be diminishing, but social returns – reflecting spillovers of knowledge or other externalities relating to physical capital – can be constant or increasing.

44. More informally, following Wolff (1991) a number of interactions between capital accumulation and technological advance can be considered:

- capital accumulation may be necessary to put new inventions into practice. This association is often referred to as the "technology embodiment effect" implying that some technological innovation is embodied in capital.

- embodiment effect is also consistent with the "vintage effect", which states that new capital is more productive than old capital per unit of expenditure. If the capital stock data do not correct for vintage effects, then a positive correlation should be observed between the productivity gain and the change in the growth rate of capital.

- the introduction of new capital may lead to better organisation, management, and the like even if no new technology is incorporated in the capital equipment.

- a firm that increases its physical capital could learn how to produce more efficiently, as a side product of investment. This positive effect of experience on productivity is called learning-by-doing or, in this case, learning-by-investing (Arrow 1962).

- Potential technological advance may stimulate capital formation, for the opportunity to modernise equipment would promise a higher return to investment.

2.1.2 Empirical evidence

Equipment investment and growth

45. Discussions of economic growth in development economics and in new growth theory, which stress "linkages" or externalities as cause of growth, have motivated some researchers to focus on equipment investment (*i.e.* investment on machinery and equipment). A seminal paper by De Long and Summers (1991) finds that equipment investment has a significantly positive and robust association with growth while non-equipment investment (*i.e.* investment on structures) does not. A similar conclusion was reached in separate samples of developed countries (De Long and Summers, 1992) and in developing countries (De Long and Summers, 1993). Independently, Jones (1994) finds very similar results from examining the relationship between the relative price of capital and the rate of economic growth. Further evidence is seen in the results of cross-country growth regressions that consistently show a strong negative relationship between growth and the price of machinery while the price of non-machinery capital enters the regression equation insignificantly.

46. Interpreting the evidence as indicating a strong causal impact of equipment investment on growth, leads De Long and Summers (1992) to suggest number of policy implications.[18] First, in general

18. De Long and Summers (1992) argue for a causal flow from equipment investment to growth in the following way: If growth caused investment one would expect to see similar associations between both equipment and structures investment and growth. Yet it is equipment investment, not total investment or structures investment, that is associated with rapid growth in the sample. They also argue that the hypothesis that equipment investment and growth are both driven by some third variable contradicts their findings as follows: 1) Fast growth goes with high quantities and low prices of equipment investment.

terms economic growth is likely to be increased by policies to promote investment that conform to the market. Second, more specifically, governments must avoid 'anti-equipment' incentives in policy. For example, if equipment investment is important for growth, this further underlines the importance of property rights, stable macro policy, issues relating to savings, as well as competition and efficiency in product and factor markets.

47. However, some researchers have raised doubts about De Long and Summers' claim. The results of causality tests by Blomström *et al*. (1996), for example, imply growth induces subsequent capital formation more than capital formation induces subsequent growth. Auerbach *et al*. (1994) question De Long and Summers' assertion of large external benefits from equipment investment even in rich countries. De Long and Summers (1994) reply that they had already pointed out the possibility that the effect of equipment investment in growth is smaller for rich than for poor countries. In support of the De Long and Summers result, a more recent study by Temple (1998*a*) shows that the high estimated returns to equipment investment are not driven by simultaneity bias.

48. As a final note, although equipment investment appears to out-perform non-equipment investment in growth equations, the latter should not necessarily be discounted as irrelevant for growth. For example, to some extent the two forms of investment are compliments, non-equipment investment includes buildings and to some extent these are used to house equipment.

Embodiment effects and vintage capital

49. A number of studies have attempted to measure embodiment and vintage capital effects. De Long and Summers (1991) address the possibility that a high social product of equipment investment reflects technology transfer mediated through capital goods even though their data are not reliable enough to offer conclusive evidence. Using cross-country data over 1960-85, Lee (1995) finds that the ratio of imported to domestic capital goods in investment has a significant positive effect on the per capita income growth across countries, in particular, in developing countries. It implies that imported capital goods have a higher productivity than domestically-produced capital goods in developing countries, providing an indirect support to the embodiment effect hypothesis.

50. Combining Bureau of Labor Statistics (BLS) data on output and inputs in US manufacturing industries with estimates of quality change derived from Gordon (1990), Hulten (1992) estimates that, in terms of capital equipment, best-practice technology may be as much as 23 per cent above the average level of efficiency. He also estimates that approximately 20 per cent of the total factor productivity growth could be attributed to technological change embodied in capital.[19] Greenwood *et al*. (1997) go one step further and try to disentangle the effects of investment-specific technological change from the more traditional Hicks-neutral form of technological progress. The calibration results based on a general-equilibrium growth model show that approximately 60 per cent of post-war productivity growth could be attributed to investment-specific technological change.

51. If capital formation is highly influential on growth patterns, it is possible that changes in investment could explain the post-1973 slow-down in productivity. Evidence on this issue is mixed. On the

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2) OLS estimates of the relation between equipment investment and growth are not significantly different from IV (instrument variable) estimates. (De Long and Summers, 1991: pp.469-479).

19. On the other hand, however, the increase in the average rate of embodied technical change due to an increase in the rate of capital formation is found to be quite small. As a result, Hulten (1992) finds very little difference in the contribution of embodied technical change to total technical change between the periods 1949-73 and 1974-83, the slowdown period.

one hand, Hulten (1992) proposes that very little of the productivity slowdown of the 1970s could be explained by reduced contribution of capital-embodied technical change due to the slowdown in the capital formation. On the other hand, Wolff (1996) points to the negative vintage effect from the ageing of capital stock following the deceleration in capital formation as a very strong determinant of the post-1973 productivity slowdown among OECD countries. Attempting to reconcile these findings (derived from total capital stock in the total economy) with those of Hulten (based on machinery and equipment in manufacturing), Wolff suggests that the slowdown in public infrastructure after 1973 may have played an important role in the post-1973 productivity slowdown.

Debates on public capital

52. The hypothesis that reduced public infrastructure investment may have accounted for the post-1973 slowdown in productivity has been the subject of considerable debate, triggered by the work of Aschauer (1989*a*, 1989*b*).[20] Aschauers' argument is essentially based on two observations. First, the fall-off in productivity growth occurred at the same time as (or was slightly preceded by) a precipitous decline in additions to the net stock of public non-military structures and equipment (Aschauer, 1989*a*). Second, the impact of aggregate public capital on private sector output and productivity appears to be very large (for example, Aschuer, 1989*a*; Munnel, 1990). These findings have been challenged on several fronts. First, common trends in output and public infrastructure data may have led to a spurious correlation. Second, the direction of causation may run from high levels of output to greater public capital investment, rather than the other way round. Third, the implied impact of public infrastructure investment on private sector output emerging from the aggregate time series is sometimes too large to be credible (Munnel, 1992). Ford and Poret (1991), for example, examine data for 12 OECD countries including the United States and find that support for Aschauer's hypothesis is not strong.

53. There has also been broader investigation of the role of public infrastructure investment in growth. For example, using cross-country panel data, Easterly and Rebelo (1993) run growth regressions including data on public investment in six sectors (agriculture; education; health; housing and urban infrastructure; transport and communication; industry and mining). The results show that public infrastructure investment on transport and communication is consistently positively correlated with growth. However, the study had difficulty in controlling for endogeneity, as results from instrumental variable estimation proved to be somewhat implausible. In reviewing the evidence on the role of public infrastructure investment and growth, Sturm *et al*. (1996) conclude that public capital probably enhances economic growth, but the magnitude of the effect is highly uncertain. This leads to the suggestion that, decisions on public capital spending should be based on cost-benefit analysis for each individual project, rather than based on alleged growth enhancing effects of public investment.

ICT capital and productivity

54. Since the 1980s, investment in information and communication technology (ICT) has been growing rapidly in some OECD countries. For example, according to growth-accounting calculations made recent study by OECD (1999*b*), the contribution of ICT capital as a share of output growth rose in the G-7 countries during the 1980s and the first half of the 1990s. In Canada, the United Kingdom and the United States investment in ICT equipment accounts for at least half of the entire growth contribution of fixed capital (see Oliner and Sichel, 2000; Whelan, 2000).

20. For a brief survey of the vast literature on this issue, see Munnel (1992), Gramlich (1994), and Sturm *et al.* (1996).

55. The growing importance of ICT has stimulated a wider debate as to whether it represents a basic technological shift with widespread implications across sectors and long-lasting effects on productivity growth (the so-called 'new economy' debate).[21] One of the more firm conclusions so far is that productivity gains in the ICT-producing sector have been sufficiently large to positively affect the economy-wide average. This has been partly driven by estimates indicating a drop in the quality-adjusted prices of ICT equipment, which acts as a spur to capital investment and thereby labour productivity. This development could continue for some time to come. Whether ICT is also producing significant spillover effects and a boost to long-term growth of total factor productivity in other sectors of the economy remains more uncertain, partly reflecting measurement uncertainty.[22]

2.2 Intangible capital: R&D policy and productivity

56. Research and development clearly plays an important role in the process of technological change and the translation of new technologies into new products and services.[23] Furthermore, governments are actively engaged in the promotion of R&D through, for example: direct government funding of private R&D; tax incentives for private R&D; public-sector R&D; and, provisions for the diffusion of research.[24] Hence, evidence on strength and nature of the links between R&D and growth is of particular policy relevance as it brings into perspective the potential role that policy can play in this area.

57. The following sections examine the theoretical and empirical links between R&D and growth. The main conclusions emerging from the evidence can be summarised as follows:

- Evidence based on firm and industry level data points to a positive and strong relationship between R&D and productivity. Furthermore, evidence indicates the magnitude of R&D spillovers may be quite large, implying that social returns to R&D are much higher than private returns.

- Evidence also suggests that the benefits of R&D are widely diffused across industries and across countries. However, evidence suggests that the speed of diffusion is uneven; for example, international knowledge spillovers tend to be less than domestic spillovers.

- The relationship between public and private R&D is a complex one and evidence to-date has given conflicting answers as to what extent and in what dimensions public R&D acts as a complement or substitute to business-sector R&D.

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21. An assessment of the debate about ICT and the 'new economy' is made in OECD (2000*c*). For recent evidence on the effects of ICT on the U.S. economy, see for example Oliner and Sichel (2000), Whelan (2000) and Council of Economic Advisers (2000).

22. Hedonic price indices for ICT imply a boost to estimates of the capital stock. Less rapid declines in ICT prices would lower estimates of growth in ICT-producing industries but would also lower the growth of the capital stock in other industries and thereby raise recorded total factor productivity in these sectors.

23. However, R&D expenditures, that tend to consist of expenditures on research in the sciences, do not reflect all forms of experiment and innovation by firms. Innovation surveys have demonstrated that expenditure on R&D is only one element of firms' expenditure on innovation (see OECD, 1999*b*).

24. The share of government in the funding of R&D in 1998, for example, was 30 per cent in the OECD, 31 per cent in the US, 36 per cent in Europe and 19 per cent in Japan (OECD, 1999*c*). Of course, R&D policy may also be aimed at producing public-sector goods, notably defence-related products.

2.2.1 Theoretical links between R&D and productivity growth

58. In growth theory, technological progress is typically conceived either as a "free good", as a by-product (externality) of other economic activities, or as the outcome of intentional R&D activities pursuing profit (Fagerberg, 1987). While technological progress is treated as exogenous in neo-classical growth models, endogenous growth models have emphasised the importance of R&D in the production of knowledge for understanding technological progress and long-run growth (see discussion in Part 1).

59. The idea that R&D plays a central role in the production of knowledge is exemplified in Romer (1990). Here it is stressed that technology is essentially a non-rival, partially excludable good.[25] As a non-rival good, technology can be accumulated without bound on a per capita basis, making it possible to envisage technology spillovers. At the same time, the legal system of patent law or copyright makes technology at least partially excludable. Indeed, it is arguable that the main economic rationale for government support of R&D is the correction of market failures in production of scientific and technological knowledge, arising from the gap between private and social returns to R&D due to the partial excludability of technology spillovers.[26]

60. There have been various attempts to identify different types of spillover related to R&D activity. Griliches (1980) identifies two positive forms of spillover. First, *rent spillovers*: the quality of a new intermediate good cannot be fully captured as monopoly rent to the innovator (unless they can exercise perfect price discrimination), thus providing a spillover effect from innovator to users of intermediate goods. Second, *knowledge spillovers*: knowledge is sometimes freely borrowed from others. This type of spillover increases with the technical relatedness and geographical closeness of firms.

61. In contrast, Jones and Williams (1998) outline several forms of negative spillover. First, *intertemporal knowledge spillovers;* existing inventories of ideas affect the productivity of new research. Such effect can be not only positive (namely, "standing on shoulders effect") but also negative ("fishing out effect", if the best ideas are discovered first). Second, *congestion externalities*; duplication of effort in the research process (*e.g*. invention of telephone) is a classic example of congestion externalities ("stepping on toes effect"). Finally, *creative destruction;* new ideas may make old production processes and products obsolete. The introduction of a superior technology typically makes existing technologies less attractive, and hence, harms the owners of those technologies ("business-stealing effect"). In this case, social returns to R&D can be lower than private returns.

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25. 'Non-rival' means the good (or service) can be used by an additional consumer with no extra cost. 'Non-excludable' means that it is impossible to exclude others from consuming the good (or service).

26. However, the possibility of knowledge spillovers does not necessarily undermine incentives to innovate (Geroski, 1995). Geroski's point is that firms must typically invest in research themselves in order to benefit from external knowledge pools. In this case, spillovers may actually stimulate R&D. A negative effect due to imperfect appropriability still exists, but it is counteracted by an 'absorption' incentive, and consequently the net effect of spillovers on R&D investments is ambiguous. It needs to be also asked whether policymakers have sufficient information to correctly identify sectors with potentially high social returns to R&D and to improve on the market solution (Klette *et al*., 1999). After all, as succinctly put by Stiglitz (1999), "the objective of the government is not to pick winners, but to identify externality-generating innovations."

2.2.2 Empirical evidence

Measuring returns to R&D

62. Two measures of the effectiveness of R&D are commonly used: the output elasticity of the R&D stock; and, the rate of return to R&D investment.[27] Both measures are usually based on a Cobb-Douglas production function that includes the R&D capital stock as a separable factor of production. The results clearly imply a positive and strong relationship between R&D and output or productivity growth.[28] The relation is pervasive, even though the magnitudes of the contribution of R&D vary among firms, industries and countries. As summarised by Nadiri (1993), the output elasticities of R&D at the firm level tend to be around 0.1 to 0.3 and the rates of return around 20 per cent to 30 per cent. At the industry level, the elasticities range have roughly the same range, while the rates of return range between 20 per cent to 40 per cent (see Table 2.1). Evidence also suggests that basic research has higher returns than applied R&D (Griliches, 1986) and that process R&D has higher returns than product R&D (Griliches and Lichtenberg, 1984*a*).

63. However, there are problems in this simple approach (Cameron, 1998). In theory, it is not clear whether R&D capital is separable in the production function. In practice, both total factor productivity and R&D capital calculations are quite susceptible to measurement errors. Jones and Williams (1998) point out that the simple capital-based approach ignores many of the distortions associated with innovative activities, such as monopoly pricing, intertemporal knowledge spillovers, congestion externalities, and creative destruction. They derive the social return to R&D from a more general production function incorporating the production of ideas as well as consumption goods. Applying this more general approach in a calibration exercise, it is found that typical estimates in the productivity literature represent *lower* bounds on the social rate of return to R&D. According to data for the US economy, for example, optimal R&D investment is at least two to four times larger than actual R&D investment.

R&D spillovers

64. The measurement of R&D spillovers has proved to be quite difficult.[29] Evidence based on case studies tries to estimate the social return to particular research projects by tracing the effects through to the economy. One problem with this approach is that the results cannot be generalised, since they calculate social rates of returns or spillovers only for successful inventions or fields. In the case of regression-based studies, most have relied on constructing indicators representing outside knowledge combined with measures of commonality in production and research objectives. The latter are based, for example on input-output data, patent and innovation data, and proximity analysis.

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27. The output elasticity is obtained from the coefficient of R&D capital stock in a regression of the level of total factor productivity. The rate of return is obtained from the regression coefficient of R&D intensity (R&D expenditure relative to output) in a regression of the rate of total factor productivity growth. R&D capital stock is usually constructed from R&D expenditure series using a "perpetual inventory method" typically with the assumption of zero depreciation. Assumptions for deriving those two measures also include: constant returns to scale with respect to the conventional inputs; perfect competition in product and factor markets (see Nadiri, 1993).

28. See Mohnen (1990), Griliches (1992), Nadiri (1993), and Cameron (1998) for recent surveys of the evidence.

29. See Grilliches (1992) and Klette *et al*. (1999) for reviews of this evidence.

65. In spite of all these difficulties, Grilliches (1992) concludes that there have been a significant number of quality studies suggesting that R&D spillovers are not only present, but their magnitude may also be quite large, and social rates of return remain significantly above private rates. This conclusion is supported by Nadiri (1993), whose summary of the existing evidence points to the social rates of return to R&D varying from 20 per cent to over 100 per cent, with an average somewhere close to 50 per cent (see Table 2.2).

66. Some have attempted to measure to what extent knowledge spillovers may subject to international barriers. Some evidence suggests that technology diffusion is considerably faster within than between countries, implying that international barriers to knowledge spillovers may be quite large (see, for example; Eaton and Kortum ,1994; Branstetter 1996; and Narin *et al*.,1997). Others have stressed that international R&D spillovers may nevertheless be important. Based a sample of OECD countries (plus Israel), Coe and Helpman (1995) find that both domestic and foreign R&D capital stocks have important effects on total factor productivity. Based on estimates of international spillovers from previous studies, Bayoumi *et al*. (1999) run simulations of a model of the world economy which consists of the G-7 countries plus five industrial and developing country regions. The results imply that a country can raise its productivity not only by investing in R&D and but also by trading with other countries that have large 'stocks of knowledge' accumulated from R&D activities.

67. By combining business enterprise R&D expenditures data with input-output and investment flows data, Papaconstantinou *et al*. (1998) examine the intersectoral and international patterns of product-embodied technology diffusion in ten OECD countries. The approach allows the separation of the product-embodied R&D by a particular industry into that which is generated by the industry itself and that which is acquired through purchases of intermediate inputs and investment goods. They find that while R&D expenditures are mainly concentrated in a few R&D intensive manufacturing industries, the main acquirers of technology, sophisticated machinery and equipment are a different cluster of service sectors. They also find that the share of technology acquired through imports has increased in all countries except Japan.

Public R&D vs. private R&D

68. A potentially important consideration for policy is the relationship between public and private R&D. For example, is public R&D spending complementary and thus "additional" to private R&D spending, or does it substitute for and tend to "crowd-out" private R&D? According to a survey by David *et al*. (1999), available econometric evidence gives conflicting answers to this question. On the one hand quite a number of econometric studies at both the micro- and macro-levels tend to favour complementarity between public and private R&D (see Table 2.3). On the other hand, many studies cite instances where publicly funded R&D is found to displace private investment. For example, Lichtenberg (1984) finds that changes in company R&D had consistently and significantly negative correlation with changes in public R&D in the US using the National Science Foundation (NSF) panel data. Lichtenberg (1988) also finds that non-competitive R&D procurement tended to crowd out private R&D investment while competitive procurement stimulates private R&D investment.[30]

69. A recent study by the OECD (1999*b*) examines the relationship between public R&D and business R&D through regressions explaining cross-country differences in business R&D, extending the analysis of Guellec and La Potterie (1997). Variables included in the regressions include: government-funded R&D, fiscal generosity for R&D, government intramural R&D, and higher education R&D. The

30. This latter finding by Lichtenberg (1988) is based on estimating regressions of company sponsored (private) R&D expenditure on the value of competitive and non-competitive government contracts, with annual firm-level panel data for the years 1979-84 for a sample of 169 companies in the United States.

study summarises the results as follows: i) direct government funding of business R&D and tax relief have a positive impact on business R&D spending; ii) these two policy instruments are more effective when stable over time, and appear to be close substitutes; iii) the impact of government funding appears to be non-linear; funding too much or too little appears to be less effective than being somewhere in the middle; iv) public research and university intramural research exert a negative impact on business funded R&D, at least in the short run; v) however, the negative effect of university research is mitigated when government funding is increased (targeted government programs probably help firms to digest the knowledge generated by universities); and vi) defence-oriented public funding seems to be the main factor underlying the crowding-out effect of government intramural R&D outlays.

2.3 Human capital: education, training and economic growth

70. In most OECD countries between 5 and 7 per cent of GDP is spent by government on formal education.[31] Not only is government spending on education and training relatively large, it is typically the provider of the majority of formal education and training services in the economy. In most countries, basic and secondary education is largely provided by the state and government also has a key role in the provision or subsidy of higher education. Furthermore, governments usually have a significant say in the standards set by private education services, especially at primary and secondary levels. In short, government is very much in the driving seat when it comes to determining the amount and type of formal education and training that individuals receive in an economy. Hence, if the link between education and growth is strong, this is potentially an area in which policy can make a great deal of difference to future growth prospects.

71. By way of caveat, it is worth stressing that the economics literature has essentially continued to study education largely from the narrow perspective of it being an investment that adds to human capital and increases future earnings potential. Whilst this approach has merit it does not always provide a sufficiently broad perspective from the point of view of education policy, where viewing education as an means of imparting work-orientated skills is often only one of a number of (sometimes competing) goals.

72. The following sections examine the theoretical links between human capital and growth, the recent empirical evidence linking education and growth and the policy issues that are raised by this work. The main points to emerge from this are:

- Microeconomic evidence based on Mincerian regression equations points to a rate of return of between 5 and 15 per cent.[32] Generally speaking, whether education is acting largely as a proxy for other variables has been somewhat allayed, even though to some extent education may act as a signalling/credential device in the labour market. However, there are a number of reasons why the rates of return at the individual level should not accord with the social rate of return which cautions against assuming this result applies at the aggregate level.

- Cross-country regressions show a positive link between growth and the initial level of education but have been less successful at finding a link with changes in education. The estimates linking initial levels of education with growth imply very high rates of return,

31. These figures are based on OECD (1999*d*), Table A3.1 and represent total public expenditure on educational institutions, excluding public subsidies for student living costs.

32. The Mincerian wage equation is: $\ln W_i = \mathrm{B}_0 + \mathrm{B}_1 S_i + \mathrm{B}_2 X_i + \mathrm{B}_3 X_i^2 + \varepsilon_i$ where *W*, *S*, and *X* represent earnings, number of years of schooling and number of years employment experience of individual *i* respectively and ε is a random disturbance term.

which remains something of a puzzle and some suggest that education is acting as a proxy for other variables. A further puzzle in this area has been a weakness of results linking changes in education and growth, despite strong theoretical priors. Recent studies have blamed this on the grounds of mis-specification, measurement error and outlier problems.

- Investigation of the rate of return to different levels of education indicates, though not very strongly, that there is a diminishing return to education. Although such a finding is potentially important for policymaking in terms of the appropriate focus of education resources important caveats must be take into account.

- Empirical studies have also shown that a number of other influences, outside of formal education may be important for educational outcomes. In particular, some find the income and education of parents to be of particular importance and others stress evidence pointing to the importance of non-formal education, especially at an early age. These findings appear to accord to some extent with assessments of general policy priorities in education. For OECD countries these tend to stress pre-primary schooling, a need to reduce poor performance and school drop-out during compulsory education, and a need for provisions to help a smooth transition from school to work. Although policy has turned attention towards adult education in recent years, there has been little analysis of its overall significance in terms of overall levels of human capital or growth.

73. In sum, the evidence outlined above seems to have, more or less, left intact the 'received wisdom' that formal education has direct causal links with economic growth. Microeconomic evidence does not generally support the view that education is largely a signal for other qualities and of relatively little value in itself. Macroeconomic evidence, via cross-country regressions, on the link between human capital and growth has been questioned by some but recent research has cast doubt on foundations of the negative results.

2.3.1 Theoretical links between human capital and growth

74. As discussed in Part 1, within neoclassical growth theory, acknowledgement of the importance of human capital has been one of the main vehicles for bringing the model into line with the stylised facts. For example, Mankiw *et al.*(1992) find strong empirical support for a Solow model augmented by a variable indicating the percentage of the working-age population having passed through secondary school as a proxy for the stock of human capital. If indeed the neoclassical model holds, the implication is that as in the case of physical capital, the effects of an increased investment in human capital is conceptually only temporary as the dynamic equilibrium is driven by the exogenous influences of population and technology. However, as stressed in Part 1, theory is mute as to the length and importance of departures from the long-run rate of growth and therefore whether effects are 'permanent' may be of little significance in practical terms.

75. One of the main mechanisms used to motivate many endogenous theories of growth is to treat 'knowledge' as a form of capital. In a general sense this would seem to be a form of human capital and indeed the terms are often used interchangeably. However, if 'knowledge' is to be recognised as distinct, a more precise concept is needed. Mankiw (1995) defines knowledge as understanding about how the world works whilst human capital refers to the resources expended in transmitting this understanding to the workforce. The case often made in endogenous growth theory is that the non-rival and relatively non-excludable character of knowledge make it less likely to encounter diminishing returns, thus providing a mechanism for the type of permanent effects that distinguishes endogenous growth theory from neoclassical theory [see Romer (1990, 1993*a*, 1993*b*)].

2.3.2 Evidence on the link between schooling and growth

76. Many empirical studies have examined the link between the number of years of formal schooling and economic growth. There are essentially two types of evidence. First an implicit link between schooling and growth can be drawn via microeconomic studies examining the statistical relationship between individual earnings and schooling. Second, a more direct link is tested in cross-country regressions where average number of years of schooling (or similar variables) are entered as explanatory variables.

Evidence from microeconomic data

77. Microeconomic data sets, such as labour-force surveys, census data and longitudinal data have been used extensively to examine the "return" to individuals investing in human capital. If the private returns to schooling at the individual level equal the social rate of return then the microeconomic results give an impression of the impact of schooling on the growth of labour income and in the economy as a whole. If one then accounts for the share of labour income in output then the return to schooling can be translated directly into an effect on output.

78. Evidence on the rate of return education stems from microeconomic regressions based on the Mincerian wage equation. In this equation earnings relate to the number of years of schooling and, in a non-linear fashion to the number of years of experience in employment. In practice, researchers often include many other variables in their regressions, either to test specific phenomena (such as sex-discrimination) or as a result of efforts to maximise the overall ability of their regressions to explain earnings differences between individuals. The Mincerian equation has been estimated using a vast number of data sets for many countries of the world and invariably shows that an additional year of schooling is associated with between 5 and 15 per cent higher earnings (Kruger and Lindahl, 1999).

79. In addition to microeconomic regressions, rates of return to education are sometimes based on a simpler method that takes cross-tabulations of average earnings at different levels of education and imputes a rate of return from this. This method obviously has an advantage over the more sophisticated approach in that less information is required and it can thus be more easily applied across a range of countries.[33]

80. However, there has been some debate about what the statistical link between schooling and earnings means. One issue is whether the link really reflects the benefits of schooling, or whether schooling is in reality acting largely as a proxy for other factors. Education may simply correlate strongly with that which really matters to employers when hiring, acting as a (possibly inefficient) signalling/screening/credential[34] device in the labour market. Indeed, it is perhaps the case that OECD countries are potentially more susceptible to this possibility, since their education policies have typically moved far beyond the provision of basic literacy and numerical skills and aim to provide a wide range of subjects and skills - but for which links with future earnings are sometimes less clear.

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33. The OECD often uses this approach in calculating rates of return to education, see for example OECD (1999*d*).

34. The *screening hypothesis* is that education primarily acts as a filter, or screening device to identify pre-existing talents, intelligence, motivation *etc*. that employers find attractive. *Credentialism* is notion that employers may use hiring standards that appear too severe for the skill requirements of the job at hand. Hence, the observed link between individual earnings and education may be 'false' in that the skills acquired through education may not actually be used in the workplace, though they may be required to obtain the job in question.

81. Despite these concerns, there is a reasonably broad consensus that the effect of education on earnings is largely independent from other individual attributes. This is supported by research attempting to control for the influence of unobserved ability.[35] First, evidence from 'natural experiments', such as changes in school-start years or compulsory schooling laws implies a genuine effect of schooling on earnings.[36] Second, studies using data on twins also points to an independent effect of schooling on earnings.[37] More informally it has been pointed out that if education acts largely as an (inefficient) screening device one would expect cheaper methods to be found. For example, we might observe employers conducting tests on school leavers rather than waiting until they have completed degrees. However, this argument is obviously strongest in situations of full employment when employers do not have a large pool of well-educated workers to choose from. There is some evidence that the recent tightness of the US labour market may have benefited in particular those with weak educational credentials which is consistent with at least some degree of credentialism in conditions of labour market slack.

82. Although there seem to be strong reasons for a strong causal connection between individual levels of education and earnings, the translation of this into returns to education at the aggregate level must be qualified by the possibility that the social rate of return may differ from the private rate of return. On the one hand, there may be positive externalities, for example through education serving to increase technological progress, reduce crime and welfare participation. On the other hand, screening/credentialism, to the extent it exists, would act as a negative externality pushing social rates of return towards being lower than private rates of return. Clearly this issue is more easily resolved by looking at the returns to education at the aggregate level.

Evidence from cross-country growth regressions

83. More direct evidence of the link between aggregate levels of schooling and growth can be found in cross-country growth regressions.[38] Although, *prima facie* the evidence points to a positive association between human capital and growth, there are reasons for thinking the relationship may be somewhat complex.

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35. As Temple (2000) points out, however, strictly speaking it is possible to maintain a hypothesis of signalling despite this evidence.

36. One example of evidence based on natural experiments is by Angrist and Krueger (1991) who examine the differences in earnings outcomes between those who start school at different ages due to rules about the year in which children should start formal education. Harmon and Walker (1995) examine the effects of changes to the compulsory schooling age in the United Kingdom. Interestingly, evidence from natural experiments tend to find somewhat higher rates of return to schooling compared with those generated by the standard Mincerian approach. Krueger and Lindahl (1999) suggest that this may be because increases in compulsory schooling disproportionately increase education amongst 'disadvantaged' individuals which pushes up the average rate of return to education.

37. See, for an example Ashenfelter and Rouse (1998) for a study on identical twins. Ashenfelter *et al*. (2000) analyse the results of a number of studies using natural experiments and twins data and suggest that once control for reporting bias is taken into account, there are much narrower differences between estimated returns to education.

38. The use of indicators of formal schooling used in cross-country growth regressions is typically interpreted as a proxy for human capital in general. In principle it would be desirable to include indicators of human capital embodied in experience as well. However, in practical terms this is problematic. First, sufficient data for calculating the relationship between experience and earnings do not exist for a large number of countries. Second, the relationships between earnings and experience, even with controls for other factors, would seems to differ considerably across countries reflecting a number of factors unrelated to the accumulation of human capital, such as the prevalence of using seniority wages as a bonding device.

84. First, the majority of studies find a positive association between initial levels of human capital and economic growth across countries. But, as in the case of microeconomic studies, precisely what this means in terms of growth mechanisms is not entirely clear, not least because the implied rates of return to education seem implausibly large.[39] Estimates of the impact of *initial* education levels in countries on subsequent growth often imply a rate of return much greater than that implied by the 5 to 15 per cent rate of return to individual education in microeconomic studies. Topel (1999) illustrates this by calculating that if, based on private returns, a year of additional schooling raises the steady-state income by 13 per cent and the rate of convergence is 0.03 per year then the effect of additional human capital on growth should be about 0.39 percentage points per year. He then indicates that estimates from cross-country regression, such as those provided by Barro and Sala-i-Martin (1995) show effects of more than 0.01 per year, which at a rate of convergence of 0.03 implies rates of return to education of about 33 per cent. Topel (1999) proposes that the apparently large return to schooling probably reflects a mixture of reverse causality, the effects of omitted variables and nation-wide externalities from increases in education.

85. Second, some research has found that, despite theoretical underpinning, the coefficients of variables representing *changes* in human capital over the period of growth in growth regressions have been surprisingly weak (Benhabib and Spiegel, 1994; Pritchett, 1997; and Bils and Klenow, 1998). However, more recent evidence has cast doubts on the robustness of this result. Topel (1999) argues that the equations used are mis-specified, Kruger and Lindhal (1999) think that the problem lies in measurement errors in first-differenced education data and Temple (1999*c*) blames these results on unrepresentative outlying observations.

2.3.3 Other evidence on the role of education

86. Micro and macroeconomic evidence linking simple aggregate indicators of schooling with individual earnings or economic growth often gives little indication about the appropriate direction that formal education should take, apart from that 'more' of it is probably beneficial. The development of education and training policy clearly requires a deep understanding about the nature of institutional structures, their weaknesses and the feasible avenues for policy action. In this regard, there is a wealth of analysis both at country level and internationally. This section picks up on some of the issues being discussed in the economics literature, focusing on evidence for a diminishing return to education, debate about class size and the importance of other factors.

87. First, studies have identified a tendency for diminishing return to education. Where micro and macro economic studies distinguish between different stages of education ('primary', 'secondary' and 'higher'), the highest returns to education are found in primary education compared with secondary or higher education (Winkler, 1990; Psacharopoulos, 1994, 1995; Judson, 1998). This implies an importance of effective primary education, something some observers (such as Heckman, 1999) reckon to be a potentially weak link in education systems. The relationship between returns to secondary and higher education is less clear, for example Psachorapoulos (1984; 1985) finds contrasting results. Hence, one should be somewhat cautious in assuming diminishing returns to education throughout the education

39. Krueger and Lindahl (1999) list no less than six possible ways of interpreting the coefficient on the initial level of schooling in cross-country growth regressions: i) Schooling may be a proxy for steady-state income; ii) schooling could change the steady-state growth rate by enabling the workforce to develop, implement and adopt new technologies; iii) countries with low initial stocks of human capital could have greater opportunities to grow by implementing technology developed abroad; iv) a positive (or negative) coefficient to schooling may simply reflect an exogenous worldwide increase (or decrease) in the return to schooling; *v*) anticipated increase in future economic growth could cause schooling to rise; iv) schooling may pick up the effect of the change in schooling which is omitted from the equation.

system. Furthermore, even if it can be assumed that there are diminishing average rates of return to education, certain qualifications need to be born in mind:

- Strictly speaking it is marginal, not average rates of return that drive individual behaviour. For example, at the margin, investing in a few good scientists might be a better investment than generating many more primary students of average ability. Furthermore, it has to be recalled that the evidence on rates of return is based on historical enrolment rates. Hence, educational policies which, say, bring large numbers of additional students into higher education may change the relative rates of return dramatically - not least because the additional enrolments are likely to have different characteristics and abilities which are important for future earnings compared to the traditional stock of students.

- Examination of rates of return to different levels of education ignores important complementarities within the education system, such that one cannot expect the rates of return to be independent of each other. Thus, for example, weighting funds towards high-return areas of education needs to account for the interaction between this level of education with lower levels of education.

- The rates of return approach, especially when derived from microeconomic data linking schooling with earnings, ignores the externalities of education, some of which may be important contributors to economic growth (not to say other goals). Such externalities may include the secondary educational impacts on the parents of children attending school.

88. Second, statistical research is revealing more about the relationship between class-size and educational standards. Interestingly, evidence does not always show that reduced class size improves educational outcomes, sometimes even suggesting the opposite. Lazear (1999) proposes that 'perverse' findings may be due to failure to control for other important factors. For example, one problem in looking at this issue is that to some extent, education systems find large classes are optimal for students who are less 'disruptive' and smaller classes are optimal with 'disruptive' students. Hence, unless studies can control for this dimension, the potentially beneficial effects of smaller class-size are counter-acted by large classes tending to have higher 'quality' students.

89. Finally, there is growing recognition that other influences, outside of formal education, may be important for educational outcomes. For example, Barro and Lee (1997) find that family inputs (income and education of parents) as well as school resources are closely related to school outcomes, as measured by internationally comparable test scores, repetition rates and drop-out rates. Heckman (1999) challenges current methods of assessment and consequent policies in education, suggesting that much of effective human capital formation derives from influences outside of formal schooling, especially at an early age of development. A related area of research examines the relationship between the skills of the adult population and educational attainment. For example, the *International Adult Literacy Survey* conducted by Statistics Canada and the OECD (see OECD, 1999*d*) collected data on work-orientated literacy and numerical skills, providing an opportunity to compare formal education and other variables with actual skills in the workforce.

90. The broad policy implications of education research are summarised in Martin (1998) as part of a review of education and economic performance in OECD countries as follows:

- Pre-primary schooling; as some of the evidence cited above suggests, learning at the early stage of life appears to have particular significance. The diversity of approaches taken to pre-primary schooling across the OECD indeed implies there may be room for adjustment of policies towards what appears to be best practice.

- Initial education. Relatively large numbers of primary and secondary students fail to achieve reasonable standards of education and contribute to problems of school drop-out in OECD countries, as well as adding to social problems such as low employability in some sections of society.

- The transition from school to work is an important issue in many OECD countries. High rates of youth unemployment appear, in part, for some countries to reflect a failure to provide appropriate mechanisms facilitating a smooth transition from school to work. In this regard the apprenticeship-based, Austro-Germano-Swiss model is often seen as possessing a number of advantages. However, as Martin (1998) points out, it is not always clear that apparently successful systems can be easily adopted in other countries due to differences in historical, cultural and institutional context. Furthermore, structural change, such as the shift towards service-sector jobs has created challenges and uncertainties for some historically successful school-to-work systems, making the identification of what is 'best practice' for the future more difficult. Also, changes in career patterns towards multi-job working lives have placed pressures for change in specialised, firm-specific training systems.

91. It should also be noted that policy in a number of countries has turned increasingly towards improving the skills of the adult population, often focussing on the lower end of the skill distribution, for example, through providing incentives for in-work training and public education services for adults. Although, in principle, such policies could be beneficial for overall economic growth, direct evidence would be difficult to gather. It is extremely difficult, for example, to develop indicators for adult learning, education or training for use in cross-country growth regressions. And, it has also to be recognised that the goal of many programs is often more social than economic. However, there is some fragmentary and indirect evidence based on evaluations of labour market training and employment programs which have often shown there are positive effects of programs on either wages or employment outcomes for individuals involved in schemes (see OECD, 1999*e*). However, this falls a long way short of robust demonstration that such programs are capable of producing a non-negligible boost to economic growth in aggregate terms. At the same time, evaluations of specific government programs fail to reflect the full range of influences on training. In particular, the regulatory and fiscal incentives for private-sector training, which potentially affect a much wider section of the working-age population, may be important in adding to human capital and hence growth.

PART 3. FRAMEWORK CONDITIONS FOR ECONOMIC GROWTH

3.1 Macroeconomic policy and growth

92. In recent years most OECD countries have made significant steps towards stability-oriented macroeconomic policy. Such a policy setting arguably provides an environment more conducive to economic growth in the longer-run due to reductions in overall levels of uncertainty and other benefits from low inflation, fiscal prudence and low volatility.

93. The main conclusions drawn from the literature on macroeconomic policy and growth are as follows:

- The evidence on the damaging effects of hyper-inflation is well-established and it is also reasonably well established that net positive benefits continue to accrue when economies achieve low levels of inflation, including evidence from cross-country growth regressions. More recent debate has focused on the issue of whether there would be further gains from shifting the focus of inflation policy from low inflation to price stability. This latter issue is more controversial and no clear consensus has emerged.

- Arguments in favour of fiscal prudence range from crowding-out effects (in conjunction with previous comments concerning the role of capital) to the need for prudent fiscal policy as an adjunct to credible monetary policy. Evidence based on cross-country growth regressions of relations between total expenditure revenue and growth is mixed. Studies using separate components of revenue and expenditure in growth regressions seem to imply that this could be because the effect of fiscal policy on growth depends importantly on what expenditures are devoted to, and how they are funded.

- Finally, a general case is often made that stable macroeconomic conditions benefit growth through reduced uncertainty, although some point out that there may be mechanisms operating in the other direction. Evidence based on using indicators of macroeconomic volatility in cross-country growth regressions has proved somewhat mixed. This may reflect that volatility will have different impacts across countries depending on whether self-correcting mechanisms are strong, or hysteresis-type phenomena are an issue. Also it seems likely that the relationship between volatility and growth may depend on the principal source of volatility. *A priori*, macroeconomic policy aimed at smoothing output fluctuations would likely help economic growth. However, at the same time there may be gains from volatility generated by agents engaging on high-risk, high-expected return activities.

3.1.1 Inflation

94. Many mechanisms have been hypothesised as to why inflation may be detrimental to economic efficiency. One of the main arguments is that it is not inflation, *per se*, that generates uncertainty but that higher inflation is highly correlated with higher *variation* in inflation and it is this that places a drag on the

economy. Other arguments (not always connected with uncertainty) for a negative impact of inflation include:[40]

- *Relative price distortion*. Some argue that inflation increases the amount of 'noise' in price signals, reflected in an increased amount of relative price variability. However, empirical investigation has revealed mixed results. A survey by Driffill *et al*. (1990) concludes that there is no empirical evidence for higher aggregate inflation causing greater relative price variability. However, more recent evidence (*e.g.* Tommasi, 1993) finds that price differences within markets, rather than between them, do increase with inflation.[41] In addition, some authors have found a direct negative connection between relative price instability and investment (*e.g.* Beaudry *et al.*, 1996).

- *Reduced credibility*. Low inflation increases "credibility" in monetary policy, and thus helps create expectations about continued low inflation.

- *Tax distortions.* A reduction in inflation may reduce distortions created by non-indexed features of the tax system. For example, decreased inflation may increase the real rate of return on interest-bearing assets if taxation of interest-income is based on nominal values.[42] For firms the non-indexing of depreciation allowances means that reductions in inflation decrease the user cost of capital, thus increasing investment. Although inevitably a complex issue, some have attempted to calculate the potential benefits of reducing inflation in the presence of tax distortions, for example Feldstein (1996) does so in estimating the benefits of a shift to price stability in the United States (see below).

- *Other distortions*. A wide number of other distortions have been discussed. Beyond the effect on investment, some have stressed the potential for inflation to generate inefficient economic behaviour in other areas. Temple (1998*b*) surveys a number of these mechanisms, including the diversion of human capital into financial management and more sophisticated monetary arguments such as: the effective shortening of contracts and difficulties in obtaining trade credit; and, difficulties in company valuation and the evaluation of alternative investment projects.

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40. Other mechanisms relating inflation to output, not listed here, include the "Tobin effect". Tobin (1965) argued a *positive* influence of inflation on output due to the fact that inflation increases the opportunity cost of holding money, thus increasing the incentive to invest. However, as Temple (1998*b*) points out the potential for such an effect is limited since money balances are only a small fraction of the capital stock and, thus the effect could at best be marginal. In addition, others have argued that monetary effects might operate in the other direction. For example, Stockman (1981) suggests that if cash has to be held for the purchase of capital goods then inflation may reduce incentives to invest.

41. The study by Tommasi (1993) is based on evidence for Argentina and the result may only apply to high levels of inflation.

42. For example, imagine an investment of $1000 earning a nominal annual rate of interest of 10 per cent and subject to a tax of 20 per cent on the interest earned. If there is no inflation then the post-tax real value of the asset is $1080. Suppose that inflation is 5 per cent, and this is matched by an increase in the nominal rate of interest. The nominal value of the investment is $1150, tax brings it down to $1120 but this is equivalent to only $1064 in real terms. Needless to say, such arguments ignore the possibility of secondary effects (for example, inflation may not be matched by an equivalent increase in interest rates), thus altering the relationship between post-tax real rates of return and inflation.

95. Both historical experiences of hyper-inflation as well as statistical evidence examining periods of very high inflation point to substantial negative economic effects.[43] For instance, the experience of hyper-inflation in Germany in the 1920s as well as similar experiences in many developing countries continue to serve as reminders of the difficulties apparently created by very high levels of inflation. Furthermore, statistical evidence on the effects of hyper-inflation is now fairly substantial. Bruno and Easterly (1998), for example, demonstrate that growth falls sharply during periods of high inflation (which they define as being 40 per cent or above).

96. The concept of a negative association between growth and more moderate levels of inflation finds some support but also some reservations.[44] Cross-country growth analyses based on OECD countries which generally have low to moderate levels of inflation often find inflation to be a significant explanatory variable (see Table 1.3). However, some have expressed reservations on the robustness of the relationship between inflation and growth. For example, Clark (1997) finds results are very sensitive to the time period chosen. More generally, Temple (1998*b*) stresses a number of problems in the evidence linking growth with inflation. Notably, he stresses that many of the cross-country analyses are effectively attempting to find a relationship between *productivity* and inflation because they include control for physical capital. Thus, any impact of inflation on growth via investment is not reflected in the estimated coefficients on the inflation variable.

97. Some researchers have investigated the relationship between long-run growth and inflation by using time-series data for individual countries. The basic problem in these studies is the separation of a long-term relationship between inflation and growth from the interactions between output growth and inflation over business cycles. One solution to this problem is to base the analysis on estimates of potential output (*e.g.* Smyth, 1992; Rudebusch and Wilcox, 1994).

98. Finally, there is some evidence that the variation in inflation matters. Kormendi and Meguire (1985) find the variability of monetary shocks is highly significant in their growth regression. This variable captures the spirit of variation in inflation in that it is hypothesised as adding noise to the process of extracting the relative price signals needed for efficient resource allocation.

3.1.2 The price stability debate

99. With many OECD countries having shifted to a low-inflation environment a debate has emerged as to whether there may be benefits from monetary policy that aims to reduce the permanent level of inflation even further - perhaps to the point of price stability (*i.e.* zero inflation, or, in the extreme price level targetting). Some proponents of price stability propose there may even be additional benefits, over and above those usually cited as arising from reductions in inflation (such as those listed above). For example, Feldstein (1996) suggests additional efficiency gains from price stability because nominal values equate with real values in financial decision-making.

100. One counter-argument to price stability is that such a goal can only be achieved at a high cost in terms of output and unemployment. The main mechanism cited for this is the existence of nominal wage rigidities in the labour market. Zero price inflation means that labour markets, in principle, will come under

43. The emergence of hyper-inflation, however, should not always be seen as a case of serious mis-management of the economy. Episodes of hyper-inflation are often associated with some sort of severe economic or political crisis such that the structure of causality is rather more blurred and the resort to hyper-inflation may have been the least-worst policy option.

44. Bruno (1995) provides a useful summary of the debate in a policy-making context.

more pressure to adjust by making reductions in nominal wages.[45] If employees resist nominal wage cuts then the economy can enter a permanently lower state of resource utilisation, manifested by a permanent rise in the rate of unemployment. Akerlof *et al*. (1996) demonstrate that the potential for a significant trade-off between inflation and unemployment under downward nominal wage inflexibility, especially when inflation is pushed towards zero. In their simulations for the US economy, inflation of around 2-3 per cent is associated with an unemployment rate of about 6 per cent. If inflation is zero then unemployment rises to a little over 7 per cent.

101. Proponents of price stability sometimes counter claims of the potential effects of nominal wage rigidity by pointing to studies that show wage cuts are common (for example, Card and Hyslop, 1996). However, this evidence is based on panel data with self-reported wages. Akerlof *et al*. (1996) point out that the reporting error in this type of data is often large; demonstrating how adding a response error to otherwise accurate data sources produces very similar distributions of wage changes to those found in panel data. Another point made by proponents of price stability is that even if nominal wage cuts may meet with strong resistance, other avenues often exist for reducing the real value of total remuneration to employees, for example through cuts in fringe benefits (Lebow *et al*., 1999), or offering lower wages to newly hired employees.

102. Another argument used in favour of positive, but low inflation is that it allows scope for monetary policy to create negative real interest rates, should circumstances, such as severe economic downturn, suggest that this is appropriate for demand-management policy (Edey, 1994). The potential difficulty of providing a suitable monetary response in conditions of zero (or even negative) inflation was exemplified during the most recent downturn in Japan; the monetary authorities were effectively caught in a "zero interest rate trap", being unable to lower interest rates further in order to generate additional consumption and investment incentives via real interest rates.

103. Finally, it should be noted that much of the discussion about nominal wage rigidities is based on US evidence, and it is not so clear what the consequences of price stability would be for other countries, especially where wage-setting is more centralised. In one of the few international comparisons, Andersen and Wascher (1999) analyse 19 OECD countries and find that sacrifice ratios have typically increased alongside falling inflation, thus supporting the notion of a non-linear trade-off between inflation and output/unemployment. It is suggested, tentatively, that the smallest increases in the sacrifice ratio appear to be in countries that have adopted measures to deregulate labour and product markets and in those where the central bank has adopted explicit inflation targets.

3.1.3 Fiscal policy

104. Debate about the merits of fiscal prudence has been somewhat more limited than that about low inflation. A traditional argument for prudent fiscal policy is to reduce the crowding out effects on the private sector. A more general point can be made about the desirability for greater 'accountability' of government funding through preventing excessive postponement in the payment for current government expenditure. Finally, it can be argued that fiscal discipline is a necessary adjunct to credible monetary policy; this is certainly one of the motivations for the fiscal conditions spelled out in the "Growth and

45. When market conditions are putting downward pressure on real wages, the required adjustment can at least be partially achieved under positive inflation by freezes on nominal wage increases without having to cut nominal wages. Under zero inflation, this avenue is no longer an option. Even in conditions where economy-wide conditions suggest that average productivity gains justify increase in average nominal wage, there are likely to be sectors of the economy at the low-end of the distribution of productivity growth where low inflation may intensify pressures to cut nominal wages.

Stability Pact" of the EMU (Buti *et al*., 1998). If monetary policy is conducted independently, excessive discretionary control of budget surplus and debt can potentially create tensions between monetary and fiscal goals.

105. Cross-country analysis points to some relation between the size of government deficits and/or debt to GDP ratios. For example, Barro (1991), Fischer (1993) as well as Easterly and Rebelo (1993) report the central government surplus to be a robust variable in cross-country regressions. However, as Easterly and Rebelo point out, it is not clear how this might be interpreted; it could be simply that the variable reflects the effect of automatic stabilisers where high deficits are associated with periods of low growth. Alternatively, the variable may be a proxy for high public debt, which, in turn, may signal higher taxes and lower public expenditure in the future; or, as in Fischer (1993) the fiscal surplus may serve as a general signal of macroeconomic stability.

106. Another issue in this area is the more general, but largely unresolved, issue of the relationship between the 'size' of government and economic growth. In a comprehensive review of the evidence, Slemrod (1995) cites a number of reasons why finding any robust relation between broad aggregates representing government involvement in the economy and growth has proved difficult. One problem is that it is difficult to get a meaningful measure of "government" or "taxes" from aggregate studies. For example, tax revenues provide a measure of average taxes, but marginal taxes (which are very difficult to measure) would probably be more closely related to the incentives created by tax systems.

107. A number of studies have used samples of OECD countries, often in the form of panel data to examine the 'size of government' issue. The lack of consensus about the effects of the overall size of government and growth is reflected in an exchange of views between Agell *et al*. (1997, 1998), who argue there is insufficient evidence to claim a negative relation between the shares of revenue and expenditure in GDP, and Fölster and Henrekson (1998) who claim to find evidence of a robust negative relationship. Other research has reasoned that the relationship between the fiscal regime and growth might also depend significantly on how revenue is raised and how it is spent. In this regard, Miller and Russek (1997) find that for developed countries, debt-financed increases in expenditure do not appear to affect growth, whilst tax-financing lowers growth.[46] On the expenditure side, one result to emerge is that debt-financed increases in education expenditure appear to increase growth. In a similar study Kneller *et al*. (1998) classify tax revenue as 'distortionary' or 'non-distortionary' and expenditures as 'productive' and 'non-productive'. The results show that this classification more-or-less works. For example, the results imply that an increase in productive expenditure, if financed by a combination of increased non-distortionary tax and reduced non-productive expenditure has a positive effect on growth. Mendoza *et al*. (1997) take a slightly different approach by using tax rates on consumption, labour, capital and personal taxes as explanatory variables in growth regressions, and find that they are not statistically significant.[47]

3.1.4 Uncertainty and volatility

108. The broadest economic argument for the benefits of stable macroeconomic policy is that it reduces uncertainty in the economy. Policy-induced uncertainty can reduce the efficiency of the price mechanism (Lucas, 1973). In addition, for example, if investment or the choice of technology is

46. Leibfritz *et al*. (1997) provide a comprehensive assessment of the relationship between taxation and economic performance.

47. Kneller *et al*. (1998) express some caution about the results of this type of panel data analysis due to sensitivity in the results to the time period chosen. Mendoza *et al*. (1997) claim their results support Harbergers' 'superneutrality conjecture' which states that in practice policy is an ineffective instrument to influence growth.

irreversible, then increased volatility can lead to lower investment (*e.g.* Bernanke, 1983; Pindyck, 1991; and Ramey and Ramey, 1991). Or, there may be a trade-off between stabilisation policies and output due to the distortions generated by the collection of taxes to fund stabilisation measures. However, not all links between output volatility and growth may be negative. Some have argued that in general there may be a choice between high-variance, high-expected-returns technologies and low-variance, low-expected-returns technologies (*e.g.* Black, 1987).

109. The more recent evidence linking volatility and growth points to a negative association. Kormendi and Meguire (1985) find that higher standard deviations in output growth are associated with higher mean growth rates whilst Ramey and Ramey (1994) find a negative link. More recently, Lensink *et al*. (1999) use a sophisticated method of generating indicators of uncertainty based on residuals from a time-series regressions. Four out of six types of uncertainty tested in a Levine-Renelt style cross-country growth analysis are found to be robust and imply that monetary uncertainty may be less damaging to economic growth compared with fiscal policy.

110. The above discussion perhaps suggests that the relationship between volatility and growth is clouded by the fact that it depends on the source of volatility. *A priori,* macroeconomic policy aimed at smoothing output fluctuations in response to exogenous shocks would likely help economic growth. However, at the same time there may be gains from structural policies to increase the incentives for agents to engage on more high-variance, high-expected return technologies, thus creating a 'positive' volatility in the economy.

111. Given that volatility in output growth over time partially reflects the impact of shocks and subsequent periods of recovery raises another issue. To some extent, long-run growth differences between countries may be partly explained by their record of shocks and macroeconomic management of them. Historical estimates of long-term economic growth include not only the initial impact of negative macroeconomic shocks but also the degree of success economies had at reverting towards potential output levels. This might not be a factor if there were a large number of shocks and countries more or less had the same ability to "get it right" in terms of policy responses. However, the post-war period over which most cross-country comparisons have been made has had few major shocks and it is quite possible that (with hindsight) some countries may have been luckier (or more adept at dealing with them) than others. Oulton (1995) in a comparative analysis of output growth across OECD countries finds that the UK, for example, suffered from much longer post-shock recessions compared to most other OECD countries--contributing negatively to long-term output growth. Easterly *et al*. (1993) stress the instability (or 'low persistence') of growth rates over time and the importance of random shocks in explaining this, implying that one should be cautious about attributing high growth rates to good policy, it could be the result of 'luck'.

3.1.5 Accountability and macroeconomic stabilisation

112. Finally, an argument is sometimes made that one of the underlying motivations for stable macroeconomic policy is to generate greater government accountability and to reduce 'political business cycle' effects. With regard to accountability, one mechanism is that low inflation may reduce the avenues open to government to exercise policy through changes to indexing of taxation and transfers which tend to be less transparent to the general public compared with alternative approaches.[48] Both greater accountability and independent monetary policy may contribute to reducing political business cycle effects on the economy. There is some evidence in this regard. For example, Hadri *et al.* (1998) following on the work of Alesina *et al*. (1993) find that that indicators of the type of political party and dummy variables

48. A simple example would be reductions in real future pension outlays by altering the basis of indexed increases in pensions.

indicating an election period to have some explanatory power in time-series regressions of inflation. They also show that the impact of these political indicators on inflation correlates negatively with indicators of central bank independence (although few of the correlation coefficients are statistically significant).

3.2 Links between finance and growth[49]

113. Financial systems and their associated regulatory and fiscal regimes potentially have strong links with growth, affecting the efficiency with which savings are translated into investment and also the efficiency and focus of investment across different activities.

114. Examination of the links between finance and growth can be broadly classified into two groups. First, research that examines the extent to which general indicators of financial development relate to economic growth. Second, a literature discussing the efficiency and suitability of different forms of financing. This includes analysis of the relative merits of various forms of corporate financing as well as more general discussions of different styles of financing at the aggregate level, such as comparison between "relationship-based" and "arms'-length" financing. This second topic evidently borders on the relationship between corporate governance and growth.

115. The main conclusions drawn from this review are as follows:

- Links between financial development and growth can arise on three fronts: effects on the efficiency in the transformation of savings; effects on the rate of savings; and, effects on the efficiency of capital allocation. Most of the theoretical mechanisms point to a positive link between financial development and growth, relatively few propose negative influences on growth from financial development.

- Evidence from cross-country regressions as well as firm-level, industry-level, or state-level evidence have often suggested positive correlation between financial development and economic growth. However, measurement issues, causality issues and model uncertainty are probably serious considerations in this area.

- Some areas of research on corporate finance provide insights into financial constraint and the relative merits of different forms of financing for firm performance. Detecting financial constraints appears to be difficult due to problems in finding good proxy variables. Debate about the relative merits of cash-flow and debt financing appears to be largely inconclusive at this stage, as does the more general debate about arms' length and relationship-based financial systems. However, the relevance of the latter debate is to some extent being reduced as many OECD countries are, on balance, tending to converge in this respect.

3.2.1 Financial development and economic growth

Theoretical Considerations

116. Diverging views on the link between finance and growth have existed among economists for a long time. While some economists such as Goldsmith (1969), McKinnon (1973), and Shaw (1973) viewed financial markets as playing a key role in economic development, Robinson (1952) among many others

49. This section is largely based on a comprehensive review by Tsuru (2000).

expressed scepticism on such an active role of finance in economic development stating that "where enterprise leads finance follows".

117. The links between the financial system and economic growth can be thought of as potentially operating through three different channels: the efficiency of the transformation of savings; effects on savings rates; and, a more efficient allocation of capital. As with other improvements in market efficiency, neoclassical models of growth imply only a transitional effect (see Part 1). Some new growth models imply increased efficiency in financial markets could have permanent effects, for example via spillover effects that eliminate decreasing returns to capital or by increasing the rate of innovation by providing better opportunity for high-risk, innovative investment projects.

The efficiency of transformation of saving

118. Financial intermediaries or securities markets channel household saving to investment but absorb some fraction of resources since their activities are costly in the presence of information and transaction costs. These costs absorbed by financial institutions include the spreads between deposit and lending rates, commissions and transaction fees. Clearly, these may be set at inefficiently high levels due to monopoly power, inappropriate regulations or other reasons.

Effects on savings rates

119. In theory, the effect of financial systems on saving rates is ambiguous. On the one hand, reduction in idiosyncratic risks (*e.g.* endowment and liquidity risks) by more well-developed insurance and finance markets might lower precautionary saving by households (Leland, 1968; Sandmo, 1970; Kimball, 1990; Caballero, 1990; Devreux and Smith, 1994; Levine and Zervos, 1998). On the other hand, a well-developed financial market could increase the returns to saving and therefore the opportunity costs of current consumption; if its substitution effect exceeds its income effect then the increased 'price' of current relative to future consumption will act to increase saving.

Efficiency in the allocation of capital

120. Aside from influencing saving and providing an efficient link between saving and investment, financial systems also allocate capital. The efficiency with which they do this, and the risk profile of the investments made can have implications for economic growth. Some new growth theories make a connection between finance and long-run growth through hypotheses that are based on a Schumpeterian view of innovation: a well-functioning financial system spurs technological innovation and hence economic growth by identifying and funding entrepreneurs with the best chances of success. For example, King and Levine (1993) suggest the financial system may encourage innovation through:

- mobilising resources to finance promising innovative projects;
- evaluating prospective entrepreneurs and choosing the most promising projects;
- allowing investors to diversify the risk associated with uncertain innovative activities;
- revealing the potential rewards to engage in innovation, relative to continuing to make existing products with available techniques.

121. In formal models, these ideas have been expressed by showing how information acquisition and risk-pooling by the financial system can encourage investment in high-risk projects. For example, Greenwood and Jovanovic (1990) focus on the role of financial intermediaries. They present a model with two production technologies, one that is safe with low return and the other risky with high return. The risky technology has two disturbances: an aggregate and a project-specific shock. The model shows how financial intermediaries can eliminate project-specific shocks by managing their portfolios and can detect the existence of an aggregate shock by noting simultaneous disturbances involving more than one project. Hence financial intermediaries can allocate resources to the place where they earn the highest return. Bencivenga and Smith (1991) also show that financial intermediaries, by allocating funds to more illiquid and productive assets and reducing the premature liquidation of profitable investments, could also enhance growth.

122. The role of pooling liquidity risks and rate-of-return risks is played not only by financial intermediaries but also by security markets. First, individual investors can sell shares in the stock market, for example, when they face liquidity problems. Second, they can diversify their rate-of-return risks by devising appropriate portfolios. Thus, stock markets potentially enhance the productivity of capital in similar ways as financial intermediaries (Levine, 1991). Portfolio diversification via stock markets might have an additional growth-enhancing effect, by encouraging specialisation of production by firms, as stressed in Saint-Paul (1992), since such diversification could reduce risks resulting from sectoral shocks and enable firms to specialise further. If we assume production externalities (Romer, 1986), more specialisation improves capital productivity and hence raises the long-term economic growth rate. Similarly, Devereux and Smith (1994) and Obstfeld (1994) show that greater international risk sharing through internationally integrated stock markets can induce a portfolio shift from safe, low-return investments to high-return investments, thereby accelerating productivity growth.

123. Some, however, have proposed that the development of security markets could induce behaviour that impedes growth. More liquidity in stock markets, by making it easier to sell shares, can reduce the incentives of shareholders to undertake the costly task of monitoring managers, as is shown by Shleifer and Vishny (1986) and by Bhide (1993). In this case, weaker corporate governance would impede effective resource allocation and slow productivity growth.

Evidence on the link between financial development and growth

Cross-country evidence

124. A number of researchers have found positive links between growth and various indicators of financial development. In an early empirical study, Goldsmith (1969) uses data on 35 countries covering the period 1860 to 1963. The study suggests first a rough parallel between economic growth and financial development measured by the ratio of financial intermediary assets to GDP. And second, indications that periods of more rapid economic growth have been accompanied, though not without exceptions, by an above-average rate of financial development.

125. In more recent work, King and Levine (1993) find indicators of the level of financial development to be statistically significant in cross-country growth regressions covering 80 countries. It is also found that the indicators are significant in explaining subsequent as well as current growth, providing some support for the dominant causal link running from financial development to growth.[50] Atje and

50. The indicators of financial development used by King and Levine (1993) are: i) the ratio of liquid liabilities of the financial intermediaries to GDP; ii) the importance of the role of banks (relative to the central bank)

Jovanovic (1993) find a significant correlation between growth over the period 1980-1988 and the value of stock market trading divided by GDP for 40 countries. However, they admit that there might be some upward bias in their estimated coefficients due to rising valuation of stocks when the growth rate is expected to be high. Levine and Zervos (1998) find that stock market liquidity and banking development are significantly and positively related to growth, capital accumulation, and productivity improvements in cross-section analysis based on 49 countries.[51] The results are consistent with a view that financial markets provide important services for growth, and that stock markets provide different services from banks. However it is also noted that stock market size, volatility, and international integration are not robustly linked with growth.

126. It is clear that much of this evidence is based on regressions using a broad range of countries and that detecting links between financial variables and growth may prove more difficult in regressions focussing on OECD countries; where the gaps between the 'level' of financial development are relatively narrow. Indeed, attempts to test for links between financial development and growth across OECD countries have yet to yield robust results. For example, Englander and Gurney (1994) stress the poor performance of financial deepening variables across a range of different regressions and more recent attempts underway by the OECD Secretariat to link growth with financial variables has yet to find strong results (OECD, 2000*b*).

Microeconomic evidence

127. Some researchers have used cross-country data on firm or industry performance to explore links between financial development and firm performance. For example, Demirguc-Kunt and Maksimovic (1998) find that firms in countries with better-functioning banks and equity markets grow faster than predicted by individual firm characteristics. Rajan and Zingales (1998*a*) find that industries more dependent on external finance grow faster in countries with more developed banks (measured by the ratio of credit to private business to GDP) or stock markets (measured by stock market capitalisation).

128. Natural experiments have also been used to examine the link between finance and growth. Jayaratne and Strahan (1996) examine the impact of relaxed bank branch regulation in the United States on regional growth in 50 states over 1972-1992, and find a positive effect on real per capita growth rates via improvements in the quality[52] of bank lending. They stress that states did not deregulate their banks in anticipation of future growth opportunities, and find only weak evidence that bank lending increased after banking branch reform, implying a more convincing causality from financial development to growth. They also emphasise that improvements in the quality of bank lending, not increased volume of it, appear to be responsible for faster growth.

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in allocating credit; iii) credit issued to non-financial private firms divided by total credit (excluding credit to banks); and iv) credit issued to non-financial private firms divided by GDP. The conditioning variables used in the regressions are: initial per capita income, initial secondary-school enrolment rate, the trade to GDP ratio and the government spending to GDP ratio.

51. The stock market development indicators used by Levine and Zervos (1998) include: the size (market capitalisation divided by GDP), liquidity (measures of turnover and value traded), volatility of stock returns (12-month rolling standard deviation of market returns), and international integration measures (based on international CAPM and international APT models).

52. Jayaratne and Strahan (1996) include three measures of loan quality: non-performing loans to total loans, net charge-offs (gross charge-offs minus recoveries), and loans to insiders to total loans.

3.2.2 Other issues regarding the efficiency of financial systems.

Corporate finance

129. Financial regulations and tax systems potentially play an important role in determining the level and financial efficiency and also create incentives towards different styles of financing which can affect the type of business activities carried out. Clearly, if financial constraints can be reduced and incentive structures adjusted to suit 'innovation friendly' financing then this may increase economic growth.

130. Some of the literature on corporate finance has moved part-way on these issues. First there has been research that attempts to detect the extent to which firms face financial constraints resulting from capital market imperfections. Much of this literature is based on the idea that, with suitable controls, firms facing financing constraints are those that use retained earnings (or "cash flow") as source of investment funding. Early work by Fazzari *et al*. (1988) divides firms into low, medium and high dividend paying firms, taking this as a proxy for the level of financial constraint. They then show that the lower the dividend the more likely firms are to use cash as a source of investment funding; thus lending support to the notion that there is a link between decisions to provide low dividends and to fund investment via cash flows.

131. Early research investigating financial constraints has been subject to some criticism. One problem is a need to control for the type of investment undertaken since firms using cash flow to fund investment are not necessarily financially constrained but may simply be undertaking types of investment that are more suited to cash-financing. This has been tackled by more recent research in a variety of ways; for example, Calomiris and Hubbard (1995) use natural experiments provided by changes in the tax system to test for evidence of financial constraint. In addition, some have questioned the assumption that dividend payments reflect financial constraint. For example Kaplan and Zingales (1997) examine the data used by Fazzari *et al*. (1988) and find that very few low dividend firms are unable to invest more at any given time; implying that they are not facing substantial financial constraints at all.

132. A second area of research into corporate finance that is potentially relevant to growth are debates as to the relative merits of cash flow as opposed to debt financing of investment opportunities. Some propose that excessive internal funds tend to induce inefficient over-investment (the so-called "free cash flow" theory, Jensen, 1986). A corollary of this is that debt financing may have advantages in that it imposes greater financial discipline on firms. There is some evidence to support this effect. For example, Nickell and Nicolitsas (1999) find that interest rates relative to cash flow payments have a small positive effect on capital productivity in panel data of firms. A further strand to this literature is examination of the complex systems of internal financing and cross-subsidy that exist within large, diversified conglomerates. For example, one suggestion (Scharfstein and Stein, 1998) is that conglomerates practice a kind of 'socialism' in capital budgeting; over-investing in divisions with poor investment opportunities.

The relative merits of "arms-length" and "relationship-based" financing

133. In addition to the microeconomic analysis of corporate finance, there is also discussion at a more general level about the relative merits of "arms-length" and "relationship-based" financing (Levine, 2000 provides a recent summary of the debate). [53]

53. Prominent examples of relationship-based financing are the Japanese 'main-bank' system (Aoki and Patrick, 1994) and the German 'house-bank' system (Edwards and Fischer, 1994) whilst the US financial system is arguably a prime example of an arm's length system. Although such country stereotypes are

134. "Relationship-based" financing is characterised by close, long-term links between the financial institution and the firm; the most important aspect of which is that the financial institution often has a reasonable degree of power to control the firm (see Diamond 1991, 1989; Hellman and Murdock, 1998). The general advantage of this type of system is that the long-term relationship can reduce informational asymmetries and thus agency costs. Thus it has been argued that relationship-based financing can benefit young and small firms who may struggle to establish the necessary reputation for effective market-based financing. In addition, some suggest that this form of financing is more capable of diversifying risk over long periods of time as the relationship is based more on institutions, rather than individuals who my have a somewhat shorter outlook. One potential disadvantage of relationship-based financing is that the close involvement of lending institutions can reduce financial discipline, for example because loans may be easy to renegotiate; creating problems akin to those of "free cash flow" (see previous section). Others suggest that relationship-based financing may also hold back investment plans due to caution and lack of expertise by financing institutions, especially in new industries and rapidly changing technological environments.

135. "Arm's length" financing is based on well-developed markets for a wide range of financial assets. Individual investors do not have much, or perhaps any, effective control over firms and discipline is exerted via an active market for corporate control. Arguably, the general advantage of the arm's length system is a potentially greater degree of flexibility and adaptability of finance to changing demands of firms. The pros and cons of this form of financing tend to mirror those of relationship-based financing. Thus, on the one hand, arms' length financing is arguably better at enforcing financial discipline and may be more suited to changing conditions, such as periods of rapid technological change. On the other hand, it may be unsuitable for small businesses and could suffer from an overly short-term outlook. Finally, in practical terms, arms' length financing requires highly developed legal structures, well-defined property rights and free information flow. Thus, developing countries and transition economies often tend towards relationship-based financing.

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often used, they should not be overplayed as both forms of financing are found to some degree in all countries.

3.3 Trade, competition policy and growth

136. The efficiency of markets for goods and services and the incentives for innovation created by competition policy and other regulatory frameworks potentially have an important influence on growth. The most widely investigated dimension is the relationship between international trade and growth. In addition, there has been some investigation of the relationship between domestic competition policy and growth.

3.3.1 International trade and growth

137. One of the most important points at which governments are able to affect markets for goods and services is at the level of international trade. The relative merits of removing (or imposing) various tariff or non-tariff barriers have long been debated, and the renewed interest in economic growth amongst researchers, especially in explaining cross-country differences has generated additional evidence and debate on the influence of international trade.

138. The general conclusions that can be drawn from the recent empirical literature on the link between trade and growth are as follows:

- On balance, the weight of evidence based on cross-country regressions supports the view that trade promotes growth. Early studies found positive links with growth but the results have subsequently been criticised on methodological grounds. However, when more sophisticated methods have been applied in more recent work there still appear to be grounds for upholding the link between trade and growth.

- Some evidence from case studies and cross-country regressions shows that trade assists convergence in per capita incomes. This implies that the benefits from lowering trade barriers could be even bigger for relatively less-developed countries.

- Studies based on firm-level data find support that an important mechanism whereby trade improves growth is through increases in aggregate productivity growth as a result of increased competition.

Theoretical links between trade and growth

139. Trade theories provide three broad reasons why reducing trade barriers may improve trading partners' overall welfare levels:

- *Exploitation of comparative advantage*: the classic argument for gains from trade is based on the notion that as long as there are differences in specialisation or in resource endowments between countries, there is room for mutual gain through trade.

- *Economies of scale*: more recent ideas suggest that an important motivation for trade derives from increasing returns to scale. For example, extended markets due to trade enables

producers to benefit from significant scale effects both in production as well as in distribution and marketing.[54]

– *Exposure to competition*: competition from imported goods can discipline the monopolistic or oligopolistic behaviour of domestic firms, forcing them to behave in a more competitive way.

140. Endogenous growth theory (see Part 1) has expanded on the notion of scale economies, suggesting that trade may increase the generation and diffusion of knowledge through mechanisms such as:

– *Learning-by-doing*: in the sense that increasing current production brings about higher productivity in the future, the learning-by-doing effect involves dynamic economies of scale. Larger markets integrated via trade will allow successful producers to increase their production scale and thus to have more gains from learning-by-doing. In this way, trade may contribute to productivity growth by increasing market size.

– *Invention*: in the Schumpeterian approach to endogenous technological progress, invention is a purposeful activity requiring resources and rewarded with temporary monopoly rents when successful. The more people there are around to invent things and the bigger the market for inventions, the greater the rate at which inventions will be discovered (Romer, 1990).

– *Diffusion of knowledge*: countries that are more open to the rest of the world have a greater opportunity to absorb technological advances generated in leading nations, either by exchange of ideas through communication and travel, or by spread of technology through investment and exposure to new goods.

141. However, it should be stressed that it is also possible to think of mechanisms whereby trade may have a negative influence on growth. Grossman and Helpman (1991) cite various examples: *i*) intensified competition due to trade could discourage efforts for invention by lowering expected potential profitability of a successful invention; *ii*) international competition with a technologically advanced country can bring about a slowdown of innovation and growth in a country with a disadvantage in research productivity; and, *iii*) a country with abundant unskilled labour may be led by trade to specialise in traditional low-tech manufacturing. In this vein, Young (1991) shows that a country which specialises in goods with greater potential of learning-by-doing can increase its growth rate as a result of international trade, while a country having comparative advantage in goods with less potential of learning-by-doing can have a slower growth owing to trade.

Evidence on the link between trade and growth

Evidence from cross-country regressions

142. While many empirical studies based on cross-country regressions (*e.g.* Balassa, 1985; Barro, 1991; and Dollar, 1991) report a positive link between openness and growth, more recent studies conclude

54. Models of trade in the presence of increasing returns and imperfect competition were first developed in the late 1970s. For policy implications of the new trade theory, see Helpman and Krugman (1989). Also see Grossman and Helpman (1991) for the link of the "new" trade theory and the "new" growth theory.

that caution is required when interpreting earlier results (see Table 3.1).[55] Furthermore, not all papers find a significant statistical link between trade and growth. For example, the widely-cited Levine and Renelt (1992) analysis fails to find any of a large number of trade and trade policy indicators to be robustly correlated with growth, most notably when the estimated equation includes the investment share. These results are interpreted as indicating that the relationship between trade and growth may be based on enhanced resource accumulation and not necessarily on the improved allocation of resources (*e.g*. Baldwin and Seghezza, 1996*a*, 1996*b*).[56]

143. Despite concerns about the results of early studies, more recent studies tend to show that the basic conclusion of a positive link between trade and growth is correct. In cross-country regressions, Harrison (1996) finds a trade liberalisation index, an indicator of black market premiums and a price distortion index all statistically significant out of a total of seven measures of openness. However, tests imply causality between openness and growth runs in both directions, suggesting that the independent effect of trade on growth may be rather less that that implied in straightforward regressions.

144. Also attempting to overcome some of the problems of early studies, Edwards (1998) tries to solve measurement and endogeneity problems by using nine indices of trade policy and additionally applying instrument variable regressions. The results show a positive correlation between openness and productivity growth is robust to the use of openness indicator, estimation technique, time period and functional form. However, the results related to causality are still somewhat open.

145. Frankel and Romer (1999) address the endogeneity problem by focusing on the component of trade that is due to geographic factors. Some countries trade more just because of a proximity to well-populated countries, and some trade less because they are isolated. Geographic factors are not a consequence of income or government policy, and there is no likely channel through which they affect income other than through their impact on international trade and within-country trade. Thus, countries' geographic characteristics can be used to obtain instrumental variables estimates of trade's impact on income. Interestingly, they find that ordinary least-square estimates understate the effects of trade. Their

55. For a discussion of general problems of cross-country growth regressions see Part I. Harrison (1996) suggests that in the context of the link between trade and growth, there are three reasons for being sceptical of earlier results:

- *Indicator problems*: "openness" measures based on actual trade volume are not necessarily related to policy and they are largely endogenous. For example, as Edwards (1998) also emphasises, a country can distort trade heavily and still have a high ratio of trade to GDP.

- *Endogeneity problems*: it is sometimes difficult to interpret the observed correlation between trade and growth. Policies that are not directly concerned with trade (good macroeconomic policies or education policies, for example) may have caused both superior export performance and high GDP growth. It is not easy to draw causality from simple correlation of the two variables.

- *Unobserved country-specific factors*: the use of cross-section data makes it impossible to control for unobserved country-specific differences. Moreover, long-run averages or initial values for trade policy variables ignore important changes (reducing tariff, for example) which have occurred over time for the same country.

56. The results of 'data mining' approaches have to-date produced a range of results. For example, the approach taken by Sala-i-Martin (1997) finds a measure of openness to be one of the more robust links with economic growth. See Part I for further discussion.

results imply that trade has a quantitatively large and robust, though only moderately statistically significant, positive effect on income.[57]

146. There are, however some who continue to doubt the conclusions that can be drawn from these studies. For example, Rodríguez and Rodrik (1999) question the commonly-used Sachs-Warner openness indicator.[58] Analysis of the various components of the indicator shows that its statistical power derives almost entirely from the criteria relating to the size of the black market premium and to state monopoly on exports. It is then argued that the explanatory power of these variables in growth regressions can be traced through their correlation with non-trade related issues: macroeconomic problems in the case of the black-market premium, and location in sub-Saharan Africa in the case of the state monopoly variable.

147. A few studies using samples of OECD countries have included indicators of trade and these show a mixture of statistically significant and insignificant results (see Table 1.3). Some research has even been quite negative about the role of trade in explaining growth differences across the OECD area. For example, Englander and Gurney (1994), in summing up their results, state that they found no effect of trade intensity or trade growth on labour productivity growth. One reason for this may be that attempts to measure trade-related variables, may require far more subtle indicators than are generally used. In contrast, Hoeller *et al*. (1998), using a yearly panel of 11 EU countries from 1970 to 1995, find that openness in general, rather than regional trade integration, has favoured aggregate growth in Europe.

Evidence on trade and convergence

148. Some have hypothesised that trade may influence growth via catch-up, in addition to other causal links. Thus, where studies have included a catch-up variable in regressions, they may have not captured the full effect of trade on growth.

149. The link between trade and convergence is investigated by Ben-David (1993) in an analysis of five episodes of the post-war trade liberalisation: formation of the European Economic Community (EEC); formation of the European Free Trade Area (EFTA); liberalisation between the EEC and the EFTA; expansion of the EEC to include Denmark, Ireland, and the United Kingdom; and Kennedy-round liberalisation between Canada and the United States. In all cases, he finds that per capita income dispersion among liberalising countries shrank after liberalisation started. Ben-David (1996) also finds that from 1960 to 1989, groups of relatively wealthy countries trading significantly among each other tend to display significant per capita income convergence relative to the convergence patterns of randomly grouped countries.

150. Sachs and Warner (1995) are more forthright, claiming that convergence can be achieved by all countries, even those with low initial levels of skills, as long as they are open and integrated in the world economy. This is based on regression analysis using the Sachs-Warner openness indicator (see previous). They draw four conclusions: *i*) there is a strong evidence of unconditional convergence for open countries, and no evidence of unconditional convergence for closed countries; *ii*) closed countries systematically grow more slowly than do open countries; *iii*) the role of trade policy continues after controlling for other

57. Frankel and Romer (1996) interpret their results as indicating a rise of one percentage point in the ratio of trade to GDP increases per capita income by at least one-half percent.

58. The Sachs-Warner openness indicator is a zero-one dummy that takes the value of zero (indicating a closed economy) if any one of the following criteria holds: i) average tariff rates greater than 40 per cent; ii) non-tariff barriers covered on average more than 40 per cent of imports; iii) it had a socialist economic system; iv) it had a state monopoly on major imports; or *v*) its black market premium exceeded 20 per cent during either the 1970s or the 1980s (Sachs and Warner, 1995).

growth factors; and *iv*) poor trade policies seem to affect growth directly, controlling for other factors, and for the effect of the rate of accumulation of physical capital. However, as discussed in the previous sub-section some have doubted whether the Sachs-Warner indicator reasonably represents trade openness.

151. In contrast, a study by Slaughter (1998) based on natural experiments fails to find evidence of strong links between liberalisation and convergence. The analysis compares convergence patterns in countries that have experienced a discrete move towards liberalisation, applying "difference-in-differences" methodology to compare the convergence pattern among liberalising countries pre- and post-liberalisation with the convergence pattern among randomly chosen control countries pre- and post-liberalisation. The results imply that that trade liberalisation did not cause convergence. The study is also critical of both Sachs and Warner (1995) and Ben-David (1996) for comparing the convergence of a group of already open or trading countries with a control group of closed or randomly selected countries. This single comparison, he argues, suffers the identification problem of not controlling for any differences between the two groups that may have predated the influence of openness/trade.

Evidence from micro data

152. If there are some links between trade and growth, via exposure to intensified competition or via increased incentive for creative destruction, their existence should be detected in micro data. Many micro level studies have focussed on the link between exports and productivity; and have generally shown a positive association between exports and productivity. The broad conclusion typically reached is that trade can contribute to aggregate productivity growth by enforcing natural selection through competition. Parenthetically, the relationship between productivity and imports has been relatively unexplored. According to Bernard and Jensen (1999), this is largely because micro data at the plant and firm level usually contain no information on imported inputs.[59]

153. Roberts and Tybout (1997) develop a model of exporting with sunk costs of entry and test it on a sample of Colombian firms. In the presence of such entry costs, only the relatively productive firms will choose to pay the costs and enter the foreign market. The implied relationship between exporting and productivity is positive in a cross-section of firms or industries, but the causality runs from productivity to exporting. Even if exporting does not contribute much to the productivity growth of an *individual* producer, it is still possible for trade to make an indirect contribution to the *aggregate* productivity growth. Based on firm-level panel data from the Taiwanese Census of Manufacturing, Aw *et al*. (1997) measure differences in total factor productivity among entering, exiting, and continuing firms, both in the domestic and export market. Their findings imply both the domestic and export market sort out high productivity from low productivity firms; the export market appearing to have a tougher screen for the entry of new firms compared to the domestic one.

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59. In addition to data issues, there are also methodological difficulties in detecting links between importing and productivity growth. For example, the relationship between imports and productivity often turns out to be negative in the literature, while exports and productivity are positively related in general (see Table 3.1). Harrison (1996) explains this asymmetry as due to two main factors:

- *Comparative advantage factor*: Countries tend to export goods in which they have a comparative advantage and to import goods in which they do not. It is difficult to distinguish between the expected positive effect of imports on productivity in the long run and the fact that imports are drawn to low productivity sectors where a country does not have a comparative advantage.
- *Cyclical factor*: If productivity growth moves pro-cyclically, productivity growth will be higher when output is growing and will be lower during recession. In this case, if greater import penetration is accompanied by a contraction of domestic industry, it is not surprising that productivity growth falls.

154. Using plant level data, Bernard and Jensen (1999) examine whether exporting has played any role in increasing productivity growth in the US manufacturing. They find little evidence that exporting *per se* is associated with faster productivity growth rates at individual plants. The positive correlation between exporting and productivity levels appears to be due to high productivity plants being more likely to enter foreign markets, as suggested by Roberts and Tybout (1997). While exporting does not appear to improve productivity growth rates at the plant level, it is strongly correlated with increases in plant size. Both employment and shipments growth are significantly faster amongst exporters. They conclude that trade improves welfare by fostering the growth of high productivity plants, even though not by increasing productivity growth at those plants.

3.3.2 Competition policy and growth

155. In addition to international trade, other aspects of markets for goods and services may be important for growth. In this regard, a relatively small literature has emerged that explores empirical links between competition (and competition policy) and growth. The possible links are roughly parallel to many found in the discussion about the link between international trade and growth. Thus, as in the case of international trade, it is possible to think of mechanisms that suggest not only positive mechanisms between competition and growth, but also negative ones; for example, the possibility that excessive competition between firms might discourage innovation.

156. Largely due to difficulties of measurement, the issue of product market competition/regulation and growth has only rarely been investigated using cross-country growth regressions. However, the results consistently point to a negative correlation between regulation and growth. Koedijk and Kremers (1996) and Gwartney and Lawson (1997) both find a negative correlation between measures of the strictness of national regulations and the average growth rates of GDP per capita in a cross-section of countries. Koedijk and Kremers (1996) cover eleven European countries and use an indicator that includes six dimensions of product market regulation (business establishment, competition policy, public ownership, industry-specific support, shop-opening hours and the implementation of the Single Market programme). Gwartney and Lawson (1997) build a broader indicator of "economic freedom" (including the policy environment in public finance, financial markets, product markets and foreign trade and investment) for 115 countries. Goff (1996) uses an index of regulatory intensity (constructed by means of factor analysis techniques) in a time-series investigation of the long-run relationship between regulation and GDP growth in the United States. He finds that, on average, regulation has decreased growth by almost 1 per cent over the 1950-1992 period. Dutz and Hayri (1998) relate an index of pro-competitive policy environment (resulting from a survey of managers of multinationals) to growth in a cross-section of countries. They find a positive effect of their indicator on the growth rate of GDP per capita.

157. Some studies have used simulation exercises to gauge the impact of regulatory environments on growth. The simulations usually proceed in increasing stages of aggregation. First, detailed information about regulatory reforms (or their estimated effects) at the industry level is introduced into general equilibrium or input-output models to gauge the (primary) static effects on output. Next, the (secondary) dynamic effects of such deviations of output from a baseline are simulated by means of econometric models that account for interactions between product, labour and capital markets as well as the rest of the world. For example, Emerson *et al*. (1988) estimated the effects of the implementation of the EU Single Market, and OECD (1997) examines the macro-economic effects of reforms in five industries in eight OECD countries. In addition, there have been a number of single-country studies, for example Industry Commission (1995) (Australia), Lipschitz *et al*. (1989) (Germany) and van Sinderen *et al*. (1994) (the Netherlands). Most of these simulations tend to report significant and positive effects of product market liberalisation on the levels and growth rates of GDP.

158. Evidence of firm-dynamics from micro-databases also potentially has some bearing on competition and competition policy. According to Foster *et al*. (1998), key findings established in this growing body of literature can be summarised as follows: *i*) there is large scale, ongoing reallocation of outputs and inputs across individual producers, with a pace varying secularly, cyclically, and by industry; *ii*) much of this reallocation, largely by entry and exit, reflects within rather than between sector reallocation; *iii*) there are large and persistent differences in productivity across plants in the same industry, and low productivity plants are more likely to exit; and iv) the rapid pace of output and input reallocation along with differences in productivity levels and growth rates seem to play an important role in aggregate productivity growth.[60] Clearly, deeper understanding of firm dynamics, such as the importance of entry and exit, could carry important policy messages in areas such as bankruptcy legislation, and regulation and incentives for business start-up. However, it has proved difficult to find suitable points of reference. For example, cross-country analysis of firm-dynamics are difficult to make and so comparison between different regulatory environments and different aspects of firm dynamics has rarely been attempted.

3.4 'Social capital' and growth

159. There is a growing interest amongst academics and in some policy circles in how the social, political and institutional environment, the 'social capital' of society, interacts with economic growth.[61] Research on social capital covers a wide range of issues; from discursive and largely informal analysis to formal statistical tests of hypotheses about links between social capital and economic growth. To some extent, the wide range of material reflects that this aspect of economic growth lies at a cross-roads between sociology, political science and economics; reflecting their different epistemologies. In a practical sense, 'social capital' can be seen as a useful umbrella term for many of the growth-related factors that lie outside the scope of straightforward economic linkages.[62]

160. The main conclusions drawn from the literature on social capital, in the context of the OECD area are as follows:

- No single, and clear concept of social capital has been identified in the literature. In reality the term has been used to cover a range of ideas and therefore, in many respects, striving for a unique concept of social capital is pointless. Probably the best approach to take, until clearer definitions and distinctions are drawn, is a general one which incorporates both ideas developed about the relationship between individual social interaction and growth ('civil' social capital) and, notions relating to the size and efficiency of institutions ('governmental' social capital).

60. They find a theoretical support for these empirical patterns observed in micro data from Schumpeterian "creative destruction" models such as Aghion and Howitt (1992) and Cabellero and Hammour (1996). In these models, reallocation of outputs and inputs among heterogeneous producers is crucial for growth. And this reallocation process creates winners and losers. The losers include the owners of the outmoded businesses that fail as well as the displaced workers.

61. It is noteworthy that the World Bank has a major program of work on social capital. Government reports include a report by the Canadian Policy Research Initiative, set up by the Privy Council, *Sustaining Growth, Human Development and Social Cohesion in a Global World.* Interestingly, social capital is also being discussed in the context of the private sector: Baker (1994), for example, writes about social capital within companies and suggests ways in which it might be developed by management.

62. The broad interpretation of social capital used here follows the approach taken in the review by Knack (1999). It is possible to argue that social capital might be reserved for the specific notions of trust and civic engagement developed by Putnam (see below) and that another term, such as 'social capabilities' may be more appropriate. However, the issue is clearly semantic and not yet resolved in the literature.

- Although statistical association has been found between the various indicators of social capital and economic growth, this area of research, perhaps more than most, suffers from a broad range of plausible causal links that the statistical evidence has, to date, been incapable of narrowing down. For example, some evidence suggests that there may be important interactions between the level of education and levels of social capital, suggesting that part of the link between social capital and growth may be via education.

- Even if it is accepted that at least some aspects of social capital are important determinants of economic growth, concrete policies to improve social capital are not easy to identify, especially for OECD countries. In parts of the developing world cases of poor social capital are often easily identifiable, such as: widespread and significant levels of corruption; fluctuating and unpredictable government policy; extremes of political instability; war and so on. For OECD countries, identifying weaknesses in social capital for which practical policy solutions exist is clearly more difficult.

161. The following sections discuss various definitions of social capital used in the literature and summarises some of the main ways in which social capital is thought to interact with economic activity. This is followed by a review of the empirical evidence relating to government social capital and civil social capital.

3.4.1 Concepts of 'social capital' and potential links with growth

Governmental social capital

162. Many researchers attempting to explain cross-country growth differences have found that certain indicators of government and its institutional structure are statistically associated with economic growth. The motivation for including such indicators is, broadly speaking, that they indicate the degree of efficiency of government or reflect uncertainty created by government actions or by the political environment. Not all research in this area necessarily uses the term 'social capital' in discussing this aspect of growth and it could be argued that these ideas could be labelled otherwise, such as 'quality of government' or 'governance issues'. Whatever the label used, the motivations given are fairly general. For example, Hall and Jones (1998) define *social infrastructure* as "the institutions and government policies that determine the economic environment within which individuals accumulate skills, and firms accumulate capital and produce output". They then argue "a social infrastructure favourable to high levels of output per worker provides an environment that encourages capital accumulation, skill acquisition, invention, and technology transfer. Such a social infrastructure gets the prices right so that individuals capture the social returns to their actions as private returns".

Civic social capital

163. Civic social capital relates to aspects of relationships between individuals, such as trust, common values, norms, informal networks and levels of social interaction. The basic idea is that certain aspects of society can enhance economic efficiency and technological progress either because they encourage better forms of government, or through more direct mechanisms such as reduction in transaction costs in exchange. Two inter-related concepts have been developed in the literature; the notion that social capital is generated by the various associations formed between individuals in society and, second the notion that trust is of key importance in the connection between society and growth.

164. In analysing the interaction between growth and society in Italy, Putnam (1993) stresses the importance of "horizontal associations" or "networks of civic engagement" between individuals[63]. He emphasises the potential for positive spin-offs for economic growth. Members of associations benefit from: information flows; trust with other members; and, economic co-ordination and co-operation within the group. Furthermore, Putnam argues that the membership of associations may extend outside the group; positive experiences from trusting members within a network may make individuals more trusting in general. However, not all writers have taken a positive outlook when considering social behaviour. For example, Olson (1982) is more pessimistic about the role of associations, stressing that many of them have implicit, or indeed explicit, goals of rent-seeking behaviour.

165. A key element in the discussion about the economic role of associations and networks is the concept of trust, discussed extensively by Fukuyama (1995). The basic idea is that high levels of trust reduce the cost of doing business and uncertainty. Aside from improving general levels of economic efficiency, Fukuyama hypothesised that high-trust societies might be more amenable to organisational innovations that may be important during periods of technological and structural change. However, as in the case of associations the role of trust is potentially ambiguous. For example, Knack (1999) draws attention to the idea that it is largely 'generalised' trust, *i.e.* trust in relative strangers, which might have positive implications for growth. More specialised trust, such as trust between family members, is *a priori* more ambiguous in that it might promote forms of social interaction that are rent-seeking and potentially socially destructive. A corollary to this is the idea put forward by Fukuyama that greater levels of generalised trust between individuals would be associated with economic activity concentrated into larger firms.

Other issues

166. Some writers have questioned the notion of social capital as 'capital'. For example, Grootaert (1998) wonders whether social capital should really be viewed not only as a form of capital, but also as a factor in determining the productivity of the 'standard' factors of production (*i.e.* physical and human capital).[64] If social 'capital' is to be viewed as capital in the usual economic sense this implies it should share certain common characteristics with other factors of production. The fact that it is difficult to define precisely and is intangible does not, in principle, present difficulties as the same applies to human capital, which has become a widely accepted concept. However, as Grootaert (1998) points out, the notion that there are opportunity costs to the accumulation of social capital is largely underdeveloped - something which is a fundamental consideration in the accumulation of other factors of production. Furthermore, the standard economic tools that are derived from production functions such as substitutability between factors, and notions of marginal and average product do not sound entirely convincing if applied to social capital. This being said, from the point of view of the existing empirical evidence, such debate is largely irrelevant as the statistical models being used are not derived from formal theory, as they tend to simply add indicators of social capital to standard growth regressions.

167. Some have attempted to attach more specific concepts to the role that social capital plays in economic outcomes. For example, Collier (1998) classifies social capital according to externalities relating

63. Some writers in this area (for example Coleman, 1988) have used a wider notion of associations and networks in discussing social capital, including not only concepts of horizontal association but also 'vertical' association. The latter are characterised by hierarchical relationships where there is an unequal distribution of power amongst members.

64. Technically this idea can be phrased as to whether social capital should enter production functions alongside physical or human capital or whether it should be viewed as something determining the production function itself.

to: i) *knowledge*; ii) learning about the reliability of other agents (*opportunism* externalities); and, iii) the capacity for co-ordinated action (*free-riding* externalities). One criticism of this approach is that it is not entirely clear that the sole benefits of social capital are in the form of externalities. Business associations and trades unions are forms of horizontal association whose existence is largely based on reaping various economic advantages; individuals consciously give up their time to be active members of such associations and so in this sense the benefits are not externalities. On the other hand, sports' clubs, social clubs and so on may exist entirely for non-economic reasons but may generate economic externalities.

3.4.2 Governmental social capital: empirical evidence

168. Evidence on the link between government social capital and economic growth is largely based on the finding that various indicators of the 'quality' of government and its associated institutions (such as legal structures) have been found to be significant explanatory variables in cross-country growth regressions. Some researchers have also used the results of surveys of entrepreneurs as a means of measuring property rights, contract enforceability and bureaucratic integrity and efficiency.[65]

Research using Gastil's indices of 'civil liberties' and 'political freedoms'

169. Gastil constructed two indices, one attempting to reflect 'civil liberties' and another attempting to measure 'political freedoms' covering a period from the early 1970s to 1989.[66] Each index is a single figure qualitative assessment based on a range of factors. The first use of these data in cross-country regressions was by Kormendi and Meguire (1985) who included the indicator of civil liberties in cross-country regressions explaining growth and investment. The indicator proved to be statistically significant and this result has been supported by a number of other studies. For example, Grier and Tullock (1989) found similar results using a wider range of countries and a panel data approach.[67]

170. However, it has been shown that the performance of the Gastil indicators in regressions is sensitive to specification. Barro (1996) and Helliwell (1994) found the Gastil indicators to be statistically significant only if other variables are omitted, notably education and investment rates. This suggests (at best) that the effect of civil liberties and political freedoms is indirect and (at worse) that they operate as proxies for other influences on growth.

171. Parenthetically, the problem of interpretation of indicators (mentioned in Part 1) is well illustrated in the research using Gastil's data. For example, Kormendi and Maguire (1995) see Gastil's civil liberties index as a proxy for economic rights, whilst Barro (1996) and Helliwell (1994) interpret Gastil's indices as measures of democracy. Clearly when indicators are qualitatively based and attempting to cover a general concept, the scope for interpretation is broad.

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65. An approach not covered in detail here is that used by Temple and Johnson (1998) who develop an indicator of 'social capabilities' which is then used in cross-country regressions. The indictor is a weighted average of ten variables covering a range of social and economic indicators such as the extent of urbanisation, importance of indigenous middle class, social mobility.

66. Gastil (1990) provides a summary discussion of these indices.

67. One problem with the Gastil data is that it cannot always be used to generate an index that covers the period of growth (or investment) under investigation. For example Scully (1988) uses averages for the Gastil index for 1973 to 1980 as an explanatory variable for average growth rates 1960 to 1980.

Quantitative political data

172. Some of the difficulties of qualitative indicators of government social capital can be solved by using quantitative proxies. Barro's (1991) landmark paper uses political violence frequencies (the average numbers of revolutions and, coups and political assassinations) as explanatory variables, interpreting them as reflecting "adverse influences on property rights" and finding both to be significantly negatively correlated with growth and to rates of private investment.[68]

173. Causality issues have been a little more thoroughly investigated using political violence frequencies but the evidence is mixed. Alesina *et al*. (1996) provide evidence of a two-way flow; coups lead to slow economic growth and slow growth increases the likelihood of coups. Londregan and Poole (1990, 1992) also conclude that coups are caused by low growth whilst Alesina and Perotti (1996), using instrumental variables in regressions explaining investment shares show the causality to flow from political violence to investment rates and not the other way round.

174. Perhaps not surprisingly in Englander and Gurneys' (1994) replication of Barro's cross-country analysis for a sample of OECD countries, the political violence frequencies are statistically insignificant. This exemplifies the problem of using data developed for explaining growth differences across a wide range of countries for a subset of countries where alternative indicators may be more appropriate. In the case of the OECD it would seem sensible to use more moderate indicators, such as number of changes of government.[69]

Subjective political risk rankings

175. Another source of data used to detect government social capital is from private-sector risk assessment ratings for international investors. An advantage of these data, certainly over Gastil's data, is that they are based on expert input. A disadvantage is that the risks facing international investors may differ from those faced by economic agents within the countries themselves. The most widely used database (largely because of its wide coverage of countries) is the International Country Risk Guide (ICRG) which provides a range of qualitatively-based indices under two headings: political risk indicators and financial risk indicators. Researchers have also used the Business Environment Risk Intelligence (BERI) database, where each index is based on taking the average value of ratings provided by a panel of experts world-wide. Therefore, the BERI data are slightly different in character from ICRG in that it reflects an average of 'expert' opinion, rather than a single in-depth assessment. The least used data in this area are from Business International (BI) which cover a much shorter period of time, 9 years compared to 17 for ICRG and 27 for BERI.

176. Keefer and Knack (1995) construct roughly comparable indices from the ICRG and BERI data which were viewed as of greatest relevance for the security of private property and the enforceability of contracts. They find both to have strong explanatory power in a Barro-type growth regression and also significant in explaining rates of private investment. Similar to the evidence on political violence frequencies, these indicators proved to out-perform the Gastil data. Further work by Keefer and Knack (1997) using interaction terms for initial income and their indicators implies that the rate of convergence is also dependent on the quality of governance. Using the BI data, Mauro (1995) also finds statistical links between various assessments of government and growth.

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68. Barro (1991) found that the Gastil indices failed to be significant with the inclusion of political violence frequencies.

69. *A priori* a variable such as the number of changes on government is in fact open to opposing interpretation. It could be seen as reflecting strength of democratic presence or as a sign of political stability.

177. The evidence on causality is, once again, mixed and subject to debate. Mauro (1995) tackles the issue by using ethnic fractionalisation and a set of colonial heritage dummies as instruments. However, Knack (1999) claims that the likelihood of an independent effect from the instruments is simply too great as many studies have found this to be a robust variable in growth regressions. Keefer and Knack (1995) investigate the causality issue with the use of lags between the dependent variable and their institutional variables. Chong and Calderon (1997) obtain strong evidence of two-way causality based on time-series analysis of the BERI data.

Business surveys

178. Business surveys often ask questions that can be seen as indicators of government social capital, for example, gauging expectations of the frequency of changes in government, policy surprises, protection from criminal actions, corruption, etc. Borner *et al.* (1995), for example, conducted a 41-country business survey in conjunction with the World Bank (World Bank, 1997), using the data to construct a "credibility of rules" index that proved to be highly significant in growth regressions.

179. In principle, survey data represent a direct measure of the 'output' of government social capital but inevitably suffer from the usual weaknesses involved in assessing the results of opinion surveys. An important consideration is that surveys reflect the views of the existing business community, not the potential business community. In countries with poor levels of government social capital, for example due to political instability and corruption, the business community is likely to be less risk averse than in more stable and less corrupt countries. This sample selection bias is likely to affect the type of responses given, cross-country differences in survey results reflecting not only different conditions but also differences in the basic attitudes of the business community in each country.

'Contract intensive money'

180. Some researchers have attempted to use financial data to construct an indicator reflecting the reliability of contract enforcement in business. Clague *et al.* (1995) argue that the proportion of M2 excluding currency outside banks serves to indicate the reliability of third-party contract enforcement. For example, in countries with unreliable enforcement, individuals will be less inclined to lend money as bank deposits compared with countries that have reliable banking institutions and associated government regulation. Clague *et al*. (1995) find this measure to be significant in cross-country growth regressions and also provide supporting evidence that it is neither operating as a proxy for inflation nor as an indicator of general financial development.

3.4.3 Civil social capital: empirical evidence

'Civic community' and governmental performance

181. Putnam's (1993) analysis of growth and social capital across regions of Italy suggested that social capital can influences growth via its impact on the quality of regional government as well as directly by, for example, influencing the level of efficiency in firms. More formal statistical evidence by Helliwell and Putnam (1995) supports this view, showing that indicators of the level of "civic community" (as measured by data indicating newspaper reading, the number of sports and cultural organisations, turnout in referenda and the incidence of preference voting) influence regional government performance in Italy.

182. One problem with trying to measure concepts such as civic community is that, *a priori*, one suspects that reverse causality may be important. For example, correlation between membership of sports and cultural organisations and growth may simply reflect higher demand for such formal social structures with higher incomes.

Trust

183. Formal empirical investigation of trust, building on the ideas laid out by Fukuyama, is often based on data from the World Values Survey (WVS). The first wave of World Values Surveys, covering 24 countries was conducted in 1981, the second wave in 1990-91 covered 45 countries and the latest wave covered 42 countries. The countries covered in different waves do not overlap completely, for example the most recent wave included 20 countries not previously covered. The survey focuses on memberships in various groups, attitudes towards socially co-operative behaviour, levels of trust in other people and tolerance towards alternative values and lifestyles. There are inevitable concerns about the heavy reliance on the WVS. In this regard, Keefer and Knack (1997) find some evidence that seems to corroborate with the WVS: data on the percentage of "returned lost wallets" across countries gathered by the Readers Digest is found to correlate strongly with various indicators of trust found in the WVS.[70]

184. A number of papers have found trust to be statistically associated with growth in cross-country regressions (see Helliwell, 1996*a*; Hjerppe, 1998; Granato *et al*., 1996; Keefer and Knack, 1997; Knack and Zak, 1998; La Porta *et al*., 1997). Interestingly, some of this evidence is based on cross-country regressions that consist largely of OECD countries (see, for example, Hjerppe, 1998; or Keefer and Knack, 1997), implying that, unlike some other correlates with growth, this indicator is not simply explaining variance between the very poorest or richest countries. Some have found less conclusive results. For example, Helliwell (1996*a*) finds that in regressions for 17 OECD countries the relationship is negative. Knack (1999) proposes that this could be because Helliwell's dependent variable is total factor productivity growth and that trust could operate in a positive way via factor accumulation - which Helliwell fails to capture. Some papers test for the usual problem that trust may be endogenous, for example Keefer and Knack (1997) use instrumental variables and uphold the notion that trust has an independent impact on growth.[71]

185. As in the case of analysis of the "civic community", researchers have also found a positive association between trust and indicators of governmental social capital (see, for example, La Porta *et al.*, 1997; Keefer and Knack, 1997). This suggests that Putnams' view of civic social capital as operating via the quality of government, as well as directly, is perhaps reasonable.

186. Some of the research has explored the notion of generalised versus specialised trust. La Porta *et al*. (1997) find that the revenues of the 20 largest firms as a proportion of GDP are positively associated with trust in people in general and negatively associated with trust in family, implying that there is indeed a distinction to be made between different forms of trust.

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70. Trust has also been examined in classroom experiments. For example Glaeser *et al.* (1999) report the results of a study investigating the determinants of trust based on a survey of about 250 Harvard undergraduates.

71. It should be noted that the sample of 29 countries used by Keefer and Knack (1997) includes 24 OECD countries, plus India, South Africa, Argentina, Chile and Brazil. This raises the possibility the results are largely driven by these additional countries. However, from the data shown in the paper there seems little evidence to suggest that this is the case.

Group memberships

187. Cross-country growth regressions have generally found indicators of group membership to be insignificant, implying that the link with growth is unimportant. Keefer and Knack (1997) have made some progress on this issue, finding that Olson-type associations, such as trades unions, political parties and professional associations, had little relation to growth or investment rates. Paradoxically, Putnam-type associations, such as religious or church organisations; education, arts, music or cultural activities showed no relation to growth but a significant negative relation with investment.

Social polarisation

188. A corollary to the notion of civil social capital is that economies characterised by ethnic divisions and inequality may have slower growth due to impacts on trust, social cohesion, economic policymaking and, at the extreme, violent conflict. Easterly and Levine (1997) find ethnically divided societies to grow more slowly after controlling for a range of other factors and find that their indicator of polarisation is associated with poor quality of government. Keefer and Knack (1995) find income and land inequality to be strongly associated with slower growth and claim that there might be a direct effect due to high levels of inequality impairing the development of trust. Also, Ley and Steels' (1999) search for robust links with growth in cross-country data using Bayesian techniques finds a variable indicating ethno-linguistic fractionalisation to have one of the strongest links with growth. Helliwell (1996*b*), using data for US states and Canadian Provinces, finds both regional and ethnic group differences as important in explaining social trust and memberships but much less important than education. (Interestingly though, Helliwell (1996*b*) does not find a link in these data between the level of trust and economic growth across regions.)

189. On a slightly different theme, Rodrik (1998) finds evidence to support the notion that social polarisation can impair the ability of an economy to react to negative economic shocks. This picks up on the idea that differences between long-run average growth rates across countries partly reflect relative success in their economies at dealing with shocks as well as standard 'catch-up' and technological progress variables.

The debate about social engagement and education

190. When researchers have run cross-country or cross-region regressions explaining different indicators of social engagement, they have usually found that education is the most important explanatory variable being positively linked with the dependent variable (other variables found to be significant include indicators of ethnic division, see for example Helliwell, 1996*b*). For Putnam (1995*a*,1995*b*) this presents something of a puzzle as, at least in the context of the United States, education levels have risen over time but social engagement, as measured across a variety of indicators has fallen. Nie *et al*. (1996) have hypothesised that the relationship is rather more complex as an individuals' level of social engagement may respond not only do their absolute levels of education but also their level of education relative to others. The authors claim to find evidence supporting the hypothesis that it is indeed the relative level of education that matters for social engagement, however some of their findings have been disputed in recent work (Helliwell and Putnam, 1999).

3.5 Population, health issues and economic growth

3.5.1 Population

191. Changes in the size and composition of the population potentially carry a number of implications for economic growth. Also, unlike other links with economic growth, the relative certainty of demographic trends for some time ahead allows for evaluation of their future impact. Most notably for OECD countries this is the prospect of low population growth and a rapid rise in the share of the elderly in populations.

192. The general conclusions that can be drawn from this literature are as follows:

- The negative correlation found between population growth and growth in GDP per capita reflects a number of mechanisms. The strongest evidence points to it being due to rapid population growth typically involving a rising dependency ratio thus damping growth in GDP per capita. For developing countries it also seems likely that capital dilution effects may play an important role.

- The continued ageing of OECD populations raises a number of issues with regard to growth. In particular, the dependency effect on growth in GDP per capita will be particularly strong unless trends in labour force participation are altered, especially that of declining participation amongst older cohorts. Also, although there are concerns about the effect of ageing populations on saving and investment, the effects remain uncertain at this stage.

Theoretical links between population and economic growth

193. The theoretical links between population and per capita income can be broadly classified into, first, links between demographic change and human capital and second, links with physical capital, via capital dilution and impacts on investment and savings behaviour.

Population and human capital

194. One potential effect of demographic change on per capita income growth is via 'dependency effects', *i.e*. the effect of changes in the ratio of the population of young and old in relation to the working-age population. Falling dependency ratios are likely to add positively to growth rates in per capita income because they boost the share of labour supply in the population. However there are at least two further considerations. First, the mixture between young and old in the dependent age groups is likely to matter as the magnitude and nature of the economic 'burden' that these groups represent is different. In this regard it may also be important to examine the issue from the perspective of average incomes per household, rather than per capita incomes to account for intra-household economies and re-distribution. Second, what matters also in this context are trends in labour force participation rates and, to some extent unemployment rates.

195. Less obvious links between demographic change and human capital may also be of importance. For example, some hypothesise that falling birth rates can have positive effect on human capital as the resources that can be devoted to the education of each child or student increase. Also, changes in the demographic structure of the workforce carry implications for the volume and character of the stock of human capital; for example ageing workforces potentially gain through increased experience but possibly become less flexible in certain dimensions. Others have argued that there may be important spillover effects. For example, Becker *et al*. (1999) discuss the idea that increasing population density may raise the

production of human capital, or at least its effectiveness, because greater density leads to a finer division of labour through scale effects in production and markets.

Population and links with capital, investment and saving

196. One of the most long-standing reasons given for a negative impact of population growth on per capita incomes is that population growth dilutes capital, resulting in lower productivity due to diminishing marginal productivity.[72] In OECD countries, the prospect of reduced growth in working-age populations - and in some cases shrinking working-age populations - implies a reverse effect with increasing labour productivity for a given capital stock. It should be stressed, however, that capital dilution argument rests heavily on assuming *ceteris paribus* conditions.

197. In addition to capital-dilution effects, changes in the demographic composition can influence investment and saving behaviour.[73] The aggregate private savings rate can be affected by a changing population age-profile through lifecycle effects and there may be further knock-on effects on investment due to changes in rates of return. For example, one concern in OECD countries is the possibility of non-negligible asset market effects resulting from the retirement of the baby-boom generation. Weighed against these concerns, capital dilution effects imply that *less* investment is required to maintain capital to labour ratios, thus reducing the need for additional saving.

198. Assessment of the savings and investment consequences of demographic change is, however, affected by at least two other factors. First, the international mobility of capital and openness of many economies means that tensions need not arise between imbalances between domestic saving and investment (see OECD, 1996*a*). Second, private saving and investment behaviour is only part of the story. For example, an important consideration in assessing the effects of demographic change in many countries is that the rapid increase in the share of the elderly in populations has prompted reforms of pension systems that in themselves may well have consequences for saving and investment.

Evidence

199. The dominant impression gained from much of the literature in development economics and from the types of policies carried out in developing countries, often with the encouragement of international agencies is that high rates of population growth inhibit economic growth. Over the past decade or so, a number of researchers have stressed that the link between population growth and per capita incomes is a reflection of a number of influences.

200. A general observation made by some (*e.g.* Becker *et al*., 1999; Kelly, 1988) is that it seems likely that capital dilution effects are most influential in relatively under-developed economies. Where there is a heavy reliance on fixed resources (typically agriculture) and only a slow diffusion of new technologies to improve productivity, additional population is much more likely to result in lower marginal productivity

72. This argument was put forward as early as the late 18th century by Malthus who also suggested that the link between population and per capita incomes could flow the other way, hypothesising that higher incomes would increase population by stimulating earlier marriages and higher birth rates and by cutting down mortality from malnutrition and other factors.

73. It seems likely that ageing populations will also lead to shifts in the pattern of consumption behaviour. Whether this could have consequences for economic growth is, however, less clear although there are some potential mechanisms. For example, shifting consumption patterns may change the focus of research and development, altering the direction of technological change and magnitude of long-run economic growth.

compared with modern urban economies with small agricultural or natural resource sectors. Kelly (1988) also points out that other factors are likely to influence the degree of capital dilution. For example, poorly defined property rights to land and natural resources can further add to inefficiencies in the use of already scare resources.

201. Evidence that the negative association between growth in population and GDP per head reflects other mechanisms is also found in cross-country growth regressions. In this regard, Brander and Dowrick (1994) find supporting evidence for a strong link between falling birth rates and growth. The most important component of this effect is found to be dependency-ratio effects; but it is also suggested that factor dilution may be a consideration. Pritchett (1996) using cross-country, time-series data concludes that there is only weak support for a negative correlation between output per person and population growth. Similar to Brander and Dowrick he also concludes that where there is an effect it is largely due to shifts in labour force participation and not due to changes in output per worker.

202. However, although population growth may be acting as a proxy for other influences and the effects may be stronger for developing countries, cross-country growth regressions for OECD countries typically find population growth to be statistically significant (see Table 1.3). However there has been little investigation of what this effect may comprise.

203. There has been some work examining the implications of future demographic trends for growth. First, OECD (1998) points out that if current trends in labour force participation continue into the future, demographic trends could pose a significant negative influence on per capita growth in the future. In recent decades many OECD countries have experienced rising employment to population ratios, largely as a result of increasing labour force participation by women. As female participation rates converge to those of males, this influence on aggregate is likely to diminish and may be insufficient to counter declining trends in both the size of the working-age population, and participation amongst older cohorts, should they continue to follow historic trends.

204. Second, with regard to the effect of ageing populations on saving and investment for the future, OECD (1996*a*) concludes that the effects of ageing populations in OECD countries on the savings/investment balance are uncertain. This is because the potential for a damped investment demand due to lower employment growth may well operate alongside reductions in savings. Also, because the international mobility of capital, to some extent, allows for flexibility in the relationship between saving and investment in individual countries.

205. There has been some work on the issue of the effects of pension reforms on growth. Schmidt-Hebbel (1997) argues that the existing body of evidence points to substantial effects on the efficiency of labour and capital of pension reform away from PAYG systems towards fully-funded systems. With regard to labour, it is argued that PAYG systems impose significant dead-weight costs in labour markets that pension reform helps reverse. In principle there are also potential gains in capital market efficiency from pension reform but as yet the effects are less well established. However, it is also pointed out that there is a good deal of uncertainty as to the size and timing of the benefits of pension reform.

3.5.2 Health issues

206. A number of health issues potentially relate to economic growth. First, the relatively large, and often increasing, share of economic activity devoted to health services means that improvements in provision may have non-negligible consequences for long-term growth by both providing healthier workforces and also through freeing up resources for other activities through efficiency gains. The growth of the health sector is also relevant to productivity growth as one concern about the expansion of service

sectors such as health is that the generally low levels of productivity growth in these type of activities can act as a drag on aggregate productivity growth. Second, amongst older cohorts in the working-age population, health status and disability-related benefits strongly affect labour market participation and hence the stock of human capital. Finally, health status is an important component in the assessment of living standards, alongside other considerations such as GDP per capita.

The provision of health care

207. For various reasons, pure market mechanisms do not work very effectively in health-care systems and this is reflected in the use of publicly funded programmes as well as regulation of health care through price and quantity controls. As a result, in various ways there are close links between government and health services. This, combined with the observation that health spending represents about 8 per cent of GDP on average across OECD countries (OECD 1999*e*), implies attention to policy-induced efficiency gains is important and could potentially make a non-negligible difference to long-run growth in GDP per capita.[74]

208. OECD (1999*e*) outlines various policy issues which countries face with regard to improving health care systems. It is stressed that important gains in the efficiency of intervention and regulation may be found through refinement of the incentive structures in individual aspects of health care, as well as global measures to control costs through global price and volume control. For example, the development of effective 'gatekeeping' mechanisms to ensure an efficient link between primary-care physicians and specialists may be important. In addition, moves towards outcome-oriented policymaking are seen as increasing the effectiveness of health-care policy as are moves to increase the awareness and responsibility amongst the public with regard to medical issues.[75]

Health and participation in work

209. As discussed in the section on population, an issue of growing importance in most OECD countries is the need to bring downward pressures on dependency ratios. One way in which this can be achieved is through increasing the share of the working-age population in employment, something that to some extent can be affected by health status. For most age-groups in the working-age population in OECD countries, low rates of mortality and of severe disability mean that further improvement in health care to reduce these could not make a substantial difference to labour supply. However, for older cohorts within the working age population, health status is one of the factors (albeit not the most important) affecting decisions to remain at work.

210. The interaction between health and labour force participation is also complicated by the provision of special benefits for those with some form of disability that influence the incentives towards participation

74. This is particularly the case in countries where health spending is considerably above the average across the OECD. Notably, in the United States, OECD data show that health spending on GDP in 1996 was 14 per cent of GDP, compared with figures below 10 per cent in European countries. A significant part of the difference is accounted for by higher price levels for medical care.

75. Health care provision is further complicated by the fact that equity is often seen as an important goal. OECD (1999*e*) outlines the various equity issues that are embedded in health-care policy in OECD countries. First, it is generally accepted that payments for health care should be positively related to a person's ability to pay. Second, for much of health care it is felt that delivery of care should be based on a need rather than a means to pay. Finally, it is generally held that there should be an equality of health status across the population.

in the labour force. The rising proportion of older persons receiving disability benefits, despite continuous improvements in the health status of the population means that the incentive structures of disability benefits may be an important influence on the size of the disabled population. Early empirical work on the relationship between labour supply and disability schemes implied that changes to disability-related benefit schemes could account for a large proportion of declining trends in labour-force participation amongst older males, hence implying a high elasticity of labour-force non-participation in relation to the level of disability-related benefits. However, more recent studies find rather more modest elasticities and Haveman and Wolfe (2000) suggest that choices made in response to benefits can only explain 10 to 20 per cent of the declining labour-force participation.[76]

211. Disability-related benefit systems have come under scrutiny in a number of countries (see OECD, 1999*e*; Blöndal and Scarpetta , 1997). One problem with traditional disability benefit schemes is that they tend to result in a permanent withdrawal from the labour force by those who are eligible for benefit. Many countries have since introduced changes that provide more avenues for at least some labour-force participation amongst the disabled. This has been achieved, for example by allowing for spells of work that do not compromise eligibility for benefit at a future date. Also, criteria for establishing eligibility for disability benefit have moved towards establishing different degrees of capacity for work, as opposed to criteria aiming at simply establishing whether individuals are capable of performing any work at all.

212. Needless to say, disability-related benefits need to be considered within the context of other aspects of the benefit system and the overall labour market situation. Of particular importance is interaction with complementary benefits that may be made available with the award of the disability benefit, such as health care and housing. Also, where disability-related benefits are partly acting as a transfer to the long-term unemployed, policy initiatives to reduce the number of benefit recipients may need to ensure that this does not create weak spots in the welfare system, or situations leading to a re-cycling of recipients to some other transfer programme.

213. Parenthetically it should be noted that some studies have investigated the link between health status and growth directly in cross-country regressions. In regressions explaining growth differences across a wide range of countries, life expectancy has sometimes been used as one indicator of human capital on the basis that especially for developing countries it is a reasonable proxy indicating physical capacity for work. For a sample of OECD countries, Rivera and Currais (1999) include growth in health expenditure as an explanatory variable in growth regressions in an attempt to establish the nature of the link between health status and growth. A strong statistical link between growth and health expenditure is found although tests based on instrumental variables indicate also strong two-way causality.

Health status and living standards

214. Arguably, evaluation of economic growth from a broad perspective should acknowledge that health status is an important component in the assessment of general living standards. The principles guiding health care, combined with the complexities of funding and provision and the uncertain links between health provision and the health status of the population, mean that a case can be made for the development of health indicators to assess living standards.[77] Furthermore, health status can potentially have positive feedback on levels of human capital.

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76. For women, the effects of disability-related benefits are less obvious as they are usually operating within the context of a general rise in female labour supply.

77. If health services could be viewed in the same light as most other goods and services, this would be a non-issue. Health status would simply be the result of consumer-driven preferences for health services and there

215. The main issue in this area is the need for the development of widely agreed methods for assessing health status. Traditionally, health indicators used for monitoring population health status have been based solely on mortality data such as life expectancy, standardised mortality rates, infant mortality and potential years of life lost.[78] With increasing proportions of OECD populations in older cohorts, there is need for more information about the consequences of non-fatal diseases for health and quality of life. In this regard, self-reporting data on general morbidity is being collected increasingly by national health surveys; examples of such data include perceived health status, physical and mental functioning, and multi-dimensional concepts of health. However, as Jee and Or (1999) point out, there is a significant lack of consensus on the appropriate concepts and methodologies for these surveys. Hence, international comparison of these data (which potentially provides a useful means of comparing relative health status) is next to impossible. With regard to data from administrative sources, such that on disease incidence and prevalence, there are also some problems with comparability and consistency of data. There has also been a growing interest in developing composite measures that integrate both mortality and morbidity in a single index.[79] Once again, there is diversity in the methodologies being applied which makes international comparison of data difficult.

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would not be a strong case for singling it out from other economic outcomes in measuring living standards which are summed-up by GDP per head figures or similar indicators.

78. Aside from measuring the health status of the population, health indicators are also developed to measure and evaluate the effectiveness of various health policies and medical care interventions. For more discussion on health indicators see Jee and Or (1999).

79. The more widely-used measures are Health Expectancies, Health-adjusted Life Expectancy and Disability-adjusted Life Years (see Jee and Or (1999) for more details).

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Table 1.1. **Key examples of studies using cross-country growth regressions**

Paper	Contribution to research	Data and technique	Comment
Kormendi and Maguire (1985)	One of the first cross-country growth regressions. Establishes the potential role that volatility and political climate may play in growth.	Data for 47 countries. The dependent variable is average growth in GDP, 1950-1977, hence the coefficient on population growth as an explanatory variable is always positive and highly significant.	Probably the first widely recognised cross-country regression analysis. Variables cover: growth in money supply, money shocks, inflation, spending by government, exports and civil liberties. Note that some tests for robustness are carried out by varying specifications and samples.
Barro (1991)	Further establishes the statistical significance of indicators of the size of government, political stability and market distortion in standard growth regressions.	Heston and Summers data, with a sample of 98 countries.	Subsequent studies often refer to specifications which augment physical and human capital with indicators of political stability *etc.* as the "Barro conditioning set" which generally implies accounting for initial income, physical capital, human capital, government activity, and indicators of political stability.
Mankiw *et al* (1992)	Shows that an augmented Solow model that includes accumulation of human capital generally fits the data well. Thus, the paper supports the notion that the neoclassical approach to growth is empirically valid.	Heston and Summers data. Results based on three samples: 1) 98 non-oil producing countries. 2) sample 1) excluding small countries (75 counties) 3) 22 OECD countries.	Poor performance of augmented Solow specification coupled with stronger evidence of convergence for the OECD sample is hypothesised to effect of World War II generating greater departures from steady states.
Levine and Renelt (1992)	Brings into question the quality of previous findings by using Leamers' (1985) extreme-bounds analysis.	Heston and Summers, World Bank/IMF. Total 119 countries. The analysis: -always includes initial income, investment share, initial secondary school enrolment and population growth. -tests for robustness of a variable by adding it to regression along with combinations of about 7 other variables.	The use of Leamer's (1985) extreme-bounds test for robustness has been criticised as being to too stringent, resulting in overly pessimistic results.
Sala-i-Martin (1997)	Uses similar approach as Levine and Renelt (1992) but avoids Leamers' robustness test by using a method ranking variable performance.	Uses Levine and Renelt data. -Always includes initial income, life expectancy in 1960 and primary school enrolment rate. -Computing and statistical constraints mean that restrictions are placed on combinations of 58 other variables run in regressions.	High-performing variables include geographic identifiers and some whose interpretation is difficult, notably variables indicating dominant religion.

Table 1.2 **Studies based on OECD countries**

Topic	Author	Data period(s) and coverage	Dependent variable (s)	Comment
a-general	Englander and Gurney (1994) (1)	19 OECD countries over 4 time periods between 1960s and 1990s.	Labour productivity growth. TFP growth.	Concludes that: -capital, schooling and labour force growth have robust links with growth. (positive); -some role played by catch-up, R&D spending and inflation; -no evidence from indicators of financial deepening or trade intensity; -regressions explaining TFP growth suggest no externalities through capital accumulation.
a-general	Englander and Gurney (1994) (2)	25 "high productivity" countries (including 16 OECD countries) over 3 time periods between 1960 and 1985	Labour productivity growth	Essentially a replication of De Long and Summers (1992) work on the role of different forms of investment. The equipment investment share produces a robust result whilst transport and investment is insignificant. However, it is pointed out that regressions explaining output per worker in the business sector show the equipment investment share to also be insignificant.
a-general	Englander and Gurney (1994) (3)	24 OECD countries	Growth rate of real per capita GDP, 1960-1985	This regression replicates the Barro (1991) regression for OECD countries. Notable in that the statistical performance is poor.
a-general	Lee (1995)	16 OECD countries, panel data.	Growth rates in GDP per capita.	Regressions suggest several important factors: private investment (positive), government consumption and debt (negative) and inflation (negative).
a-general	Mankiw, Romer and Weil (1992)	22 OECD countries	GDP per working-age person, 1985	OECD regressions are run as part of their test of the augmented Solow model. The OECD regressions perform poorly in relation to wider samples of countries but show signs of stronger convergence compared to other samples of countries. It is hypothesised that this is due to the Second World War generating greater departures from steady states.
b-public capital	Nourzad and Vrieze (1995)	7 OECD countries, panel data.	Labour productivity growth.	Finds public capital formation to have a positive influence on labour productivity growth. Conditioning variables include private-sector employment, private-sector investment and an indicator for the stock of natural resources.
c-R&D	Fagerberg (1987)	25 countries, all OECD except 2. Panel data.	Growth rate in real GDP.	A patent index equal to the growth of patent applications made in other countries proves significant, alongside a catch-up and investment.
c-R&D	Park (1995)	10 OECD countries, panel data	Growth rates in real GDP.	Main result is that private sector R &D appears more important than public sector R&D. It is suggested, however, that public-sector R&D acts to stimulate private-sector research. Conditioning variables cover catch-up, non-R&D investment and an indicator of capacity utilisation.
d-human capital	Wolff and Gittleman (1993)	19 industrial market economies.	Growth rates in real GDP per capita	Runs regressions for a number of samples of countries and time periods, investigating the differences between education as measured by enrolment rates compared with attainment rates. For OECD countries only tertiary enrolment rates are significant, whilst attainment is always more significant for primary education. It is noted that inclusion of investment strongly affects the significance of the attainment variables.

Table 1.2. **Studies based on OECD countries** (cont.)

Topic	Author	Data period(s) and coverage	Dependent variable (s)	Comment
e-inflation	Alexander (1997)	'Small' number of OECD countries, panel data.	Growth rate in real GDP.	Specification is unusual. Both levels of inflation and changes in inflation are significant.
e-inflation	Andres and Hernando (1997)	OECD countries, panel data	Growth rates in GDP per capita.	In an analysis based on several econometric approaches, consistently finds inflation to be negatively correlated with growth. Conditioning variables include catch-up, investment, human capital and population growth.
e-inflation	De Gregorio (1996)	21 OECD countries	Growth rate in real GDP per capita.	Runs regressions for a number of groups of countries and concludes a significant negative impact of inflation on growth. OECD regressions include catch-up, initial education levels and government consumption.
f-fiscal	Agell *at al*. (1998)	23 OECD countries , panel data.	Growth rate in real GDP per capita.	A critique of Folster and Henrekson (1998) with replication of results and additional analysis to support their claim of there being no evidence to support a fiscal effect on growth.
f-fiscal	Agell *et al*. (1997)	23 OECD countries	Growth rate in real GDP per capita.	Finds no support for significant influence of either the tax or expenditure share being significant in growth. Conditioning variables include catch-up and shares of young and older cohorts in the population.
f-fiscal	Folster and Henrekson (1998)	23 OECD countries, panel data	Growth rate in real GDP per capita.	In response to the conclusion of Agell *at al.* (1997), claims that their conclusion is based on poor regression results. Perform some panel regressions and find a robust link between tax or expenditure shares and growth.
f-fiscal	Kneller *et al*. (1999)	22 OECD countries, panel data.	Growth rate in real GDP per capita.	Classifies tax revenue into 'distortionary' and 'non-distortionary' and classifies expenditure into "productive" and "non-productive". Conditioning variables include catch-up, investment and labour force growth. Concludes from results that non-distortionary revenue and productive expenditure are a zero impact on growth. Furthermore suggests results imply an increase in productive expenditure, if financed from non-distortionary tax and non-productive expenditure has a positive impact on growth. Acknowledges that results are weakened by the finding that coefficients vary significantly depending on time period chosen.
f-fiscal	Medoza *at al.* (1997)	18 OECD countries, panel data.	Growth rate in GDP per capita	Introduces data on tax rates on consumption, labour, capital and personal taxation to growth regressions and finds that they are not statistically significant determinants of growth. Concludes that the evidence supports the Harberger hypothesis that in practice tax policy is an ineffective instrument to influence growth.

Table 1.2 **Studies based on OECD countries** (cont.)

Topic	Author	Data period(s) and coverage	Dependent variable (s)	Comment
f-fiscal	Miller and Russek (1997)	16 countries, panel data.	Growth rate in real GDP per capita.	Disaggregates revenue and expenditure into different components and runs regressions for both OECD and developing countries. Conditioning variables include catch-up, population growth, investment, openness and inflation. For developed countries, concludes that debt-financing increases in expenditure have no effect on growth but that tax-financed increases do. In terms of expenditure, education expenditure is positively linked with growth whilst other forms of expenditure have no significant impact.
g-social capital	Knack and Keefer (1997)	29 countries, almost all OECD	Growth rate in real GDP, 1980-1992	One set of regressions shows indicators of trust and civic engagement to be statistically significant, another shows that variables indicating co-operative and non-co-operative group membership to be insignificant. Other conditioning variables include catch-up, education and investment indicators. The non-OECD countries included in the sample (India, South Africa, Argentina, Chile and Brazil) may have strongly influenced outcomes.

Table 1.3 Studies based on OECD countries, by variable.

Topic	Explanatory variable	Reference	Finding
a-Convergence/catch-up	Initial GDP	Cornwall (1976)	-*
		de Gregorio (1996)	-*
		Dowrick and Nguyen (1989)	-*
		Englander and Gurney (2) (1994)	-*
		Englander and Gurney (3) (1994)	-*
		Fagerberg (1987)	-*
		Folster and Henrekson (1998)	-*
		Helliwell and Chung (1991)	-*
		Hjerppe (1998)	-
		Knack and Keefer (1997)	-*
		Kneller et al. (1998)	-*
		Lee (1995)	-*
		Mendoza *et al* . (1997)	-*
		Skonhoft (1989)	-*
		Wolff and Gittleman (1993)	-*
	n.a.	Andres and Hernando (1997)	-*
	initial labour productivity	Englander and Gurney (1) (1994)	-
b-Physical capital	a-Share investment in GDP	Alexander (1997)	+*
		Cornwall (1976)	+*
		Dowrick and Nguyen (1989)	+*
		Englander and Gurney (3) (1994)	+
		Fagerberg (1987)	+*
		Helliwell and Chung (1991)	+*
		Hjerppe (1998)	+*
		Kneller et al. (1998)	-
		Lee (1995)	+*
		Mankiw et al. (1992)	+
		Miller and Russek (1997)	+*
		Skonhoft (1989)	+*
		Wolff and Gittleman (1993)	+*
	b-Equipment investment share	Englander and Gurney (2) (1994)	+*
	b-Structure and transport equipment share	Englander and Gurney (2) (1994)	-
	b-Capital to labour ratio	Englander and Gurney (1) (1994)	+*
	c-Growth in fixed public capital	Nourzad and Vrieze (1995)	+*
	c-Growth in private-sector capital	Nourzad and Vrieze (1995)	+*
	d-Capital per work-hour, physical	Park (1995)	+*
	d-Capital per work-hour, R&D private	Park (1995)	+*
	d-Capital per work-hour, R&D public	Park (1995)	+
	e-Relative price level of investment goods	Knack and Keefer (1997)	-*
	f-R&D-growth of patents made outside the country	Fagerberg (1987)	+*
	n.a.	Andres and Hernando (1997)	+*
c-Schooling	a-Attainment rates-primary school	Wolff and Gittleman (1993)	+*
	a-Enrolment rates-primary school	de Gregorio (1996)	+
		Englander and Gurney (3) (1994)	+
		Knack and Keefer (1997)	+*
	b-Attainment rates-secondary school	Wolff and Gittleman (1993)	+
	b-Enrolment rate-secondary school	de Gregorio (1996)	+*
		Englander and Gurney (1) (1994)	+*
		Englander and Gurney (3) (1994)	+
		Knack and Keefer (1997)	+
		Mankiw et al. (1992)	+
		Mendoza et al. (1997)	+
	c-Attainment rates-tertiary	Wolff and Gittleman (1993)	+
	c-Enrolment rates-tertiary	Hjerppe (1998)	+
		Lee (1995)	+*
	n.a.	Andres and Hernando (1997)	+
d-Population/labour force growth	a-Population growth	Andres and Hernando (1997)	-
		Dowrick and Nguyen (1989)	-*
		Helliwell and Chung (1991)	-*
		Lee (1995)	-
		Miller and Russek (1997)	-*
	b-labour force growth	Englander and Gurney (1) (1994)	-*
		Englander and Gurney (2) (1994)	-
		Kneller et al. (1998)	-
	c-Average number of hours worked	Nourzad and Vrieze (1995)	-*
	c-Employment growth/level of GDP	Alexander (1997)	+*
	c-Private sector employment growth	Nourzad and Vrieze (1995)	-*
	d-Dependency ratio	Folster and Henrekson (1998)	-*

Table 1.3 (continued) Studies based on OECD countries, by variable

Topic	Explanatory variable	Reference	Finding
e-Inflation	a-level of inflation	Alexander (1997)	-*
		Andres and Hernando (1997)	-*
		de Gregorio (1996)	-*
		Englander and Gurney (1) (1994)	-
		Lee (1995)	-*
		Miller and Russek (1997)	-
	b-changes in inflation	Alexander (1997)	-*
f-Fiscal influences	a-Exp.-Share of Govt. spending in GDP	de Gregorio (1996)	-
		Englander and Gurney (3) (1994)	-
		Folster and Henrekson (1998)	-*
		Lee (1995)	-
		Mendoza *et al* . (1997)	-
	b-Exp.-debt financed increases in education	Miller and Russek (1997)	+*
	b-Exp.-Share of Govt. spending ("productive") in GDP	Kneller et al. (1998)	+*
	c-Rev.-Share of Govt. taxation ("distortionary") in GDP	Kneller et al. (1998)	-*
	c-Rev.-Share of Govt. taxation in GDP	Folster and Henrekson (1998)	-*
	d-Rev.-financing by debt	Miller and Russek (1997)	+*
	d-Rev.-financing by tax	Miller and Russek (1997)	-*
	e-Rev.-tax rate, capital	Mendoza *et al* . (1997)	+
	e-Rev.-tax rate, consumption	Mendoza *et al* . (1997)	+
	e-Rev.-tax rate, labour	Mendoza *et al* . (1997)	-
g-Trade	Indicator of openness	Cornwall (1976)	+*
	Export share in GDP	Hjerppe (1998)	+
	Terms of trade	Mendoza et al. (1997)	+*
	Exports plus imports as share GDP	Miller and Russek (1997)	+
h-Social capital	a-Civic engagement	Knack and Keefer (1997)	+*
	a-Trust	Knack and Keefer (1997)	+*
	a-Trust	Hjerppe (1998)	+*
	b-Group membership, non-rent seeking	Knack and Keefer (1997)	-
	b-Group membership, rent seeking	Knack and Keefer (1997)	+
I-Political indicators	Assassinations	Englander and Gurney (3) (1994)	-
	Revolutions and coups	Englander and Gurney (3) (1994)	+
j-Productivity slow-down.	Dummy for pre-1973 period	Alexander (1997)	+*
		Englander and Gurney (1) (1994)	+*

Notes :

i) Under the column 'Finding', a * denotes a statistically significant result, based on assessment of the regressions run in the study. Clearly the table only provides a flavour of the findings, see Table 2 for further description of the studies. The "+" and "-" signs indicate the sign of the coefficient on the variable in question.

ii) Under the column 'explanatory variable', Rev. is government revenue and Exp. is government expenditure.

Source : Based on a table in Durlauf and Quah (1998).

Table 2.1 **Direct Rates of Return and Elasticities of R&D**

2.1a: Direct Rates of Return and Elasticities of R&D at the Firm Level

Study	Rates of Return	Study	Rates of Return
US		**Japan**	
Minasian (1969)	54%	Odagiri (1983)	26%
Griliches (1980)	27%	Odagiri-Iwata (1985)	17%-20%
Mansfield (1980)	28%	Griliches-Mairesse (1986)	20%-56%
Nadiri-Bitros (1980)	26% [e]	Sassenou (1988)	14%-16% [e]
Schankerman (1981)	24%-73%	Griliches-Mairesse (1990)	30%-56% [e]
Griliches-Mairesse (1983)	19%		
Link (1982)	n.s.-5%	**France**	
Clark-Griliches (1984)	18%-20%	Griliches-Mairesse (1983)	31%
Griliches-Mairesse (1984)	30%	Cuneo-Mairesse (1984)	55%
Griliches (1986)	33%-39%	Mairesse-Cuneo (1985)	9%-26% [e]
Griliches-Mairesse (1986)	25%-41%		
Jaffe (1986)	25%	**West Germany**	
Schankerman-Nadiri (1986)	10%-15%	Bardy (1974)	92%-97%
Bernstein-Nadiri (1989a)	9%-20%		
Bernstein-Nadiri (1989b)	7%	**Belgium**	
Griliches-Mairesse (1990)	27%-41% [e]	Fecher (1989)	n.s.
Lichtenberg-Siegel (1991)	13%		
Canada			
Longo (1984)	24%		
Bernstein (1988)	12%		

[e] : elasticity; n.s. : insignificant

Source: Nadiri (1993)

Table 2.1 **Direct Rates of Return and Elasticities of R&D** (cont.)

2.1b: Direct Rates of Return and Elasticities of R&D at the Industry Level

Study	Rates of Return	Study	Rates of Return
U.S.		**Japan**	
Terleckyj (1974)	n.s. - 29%	Odagirl (1985)	(66%)-24%
Link (1978)	19%	Mansfield (1988)	42%[e]
Griliches (1980)	n.s. - 42%	Patel-Soete (1988)[1]	37%[e]
Nadiri (1980a)[1]	06%-10%[e]	Goto-Suzuki (1989)	26%
Nadiri (1980b)	08%-19%[e]	Mohnen-Nadiri-Prucha (1986)	15%
Terleckyj (1980)	n.s.	Nadiri-Prucha (1990a)	27%[e]
Sveikauskas (1981)	7%-25%		
Scherer (1982, 1984)	29%-43%	**France**	
Griliches-Lichtenberg (1984a)	3%-5%	Patel-Soete (1988)[1]	13%[e]
Griliches-Lichtenberg (1984b)	21%-76%		
Mohnen-Nadiri-Prucha (1986)	11%	**West-Germany**	
Wolff-Nadiri (1987)	11%-19%	Mohnen-Nadiri-Prucha (1986)	13%
Bernstein-Nadiri (1988)	10%-27%	Patel-Soete (1988)1	21%[e]
Patel-Soete (1988)[1]	6%		
Nadiri-Prucha (1990a)	24%	**U.K.**	
Bernstein-Nadiri (1991)	15%-28%	Mohnen-Nadiri-Prucha (1986)	11%
		Patel-Soete (1988)[1]	7%[e]
Canada		Sterlacchini (1988)	12%-20%
Globerman (1972)	n.s.		
Postner-Wesa (1983)	n.s.		
Hanel (1988)	50%		
Mohnen-Lepine (1988)	5%-143%		
Bernstein (1989)	24%-47%		

[e] : elasticity; [1]: total economy; n.s. : insignificant

Source: Nadiri (1993)

Table 2.2 **Indirect Rates of Return and Elasticities of R&D**

2.2a: Indirect Rates of Return on R&D at the Firm Level

Study	**Rates of Return**	**Study**	**Rates of Return**
U.S.		**Japan**	
Jaffe (1986)	10% [S]	Sassenou (1988)	10% [e] of own
Bernstein-Nadiri (1989b)	9 -14% [S]		
		Belgium	
Canada		Fecher (1989)	0.50%
Bernstein (1988)	20% - 26% [S]		

2.2b: Indirect Rates of Return and Elasticities of R&D at the Industry Level

Study	**Rates of Return**	**Study**	**Rates of Return**
U.S.		**Japan**	
Terleckyj (1974)	48%-78%	Odagiri (1985)	n.s.
Terleckyj (1980)	183%	Goto-Suzuki (1989)	80%
Sveikauskas (1981)	50%		
Scherer (1982, 1984)	64%-47%		
Griliches-Lichtenberg (1984b)	11%-62%		
Wolff-Nadiri (1987)	10%-90%		
Bernstein-Nadiri (1988)	11%-111% [S]		
Bernstein-Nadiri (1991)	20%-110% [S]		
Canada			
Postner-Wesa (1983)	(26%)-18%[e]		
Hanel (1988)	100%		
Sterlacchini (1988)	15%-35%		
Mohnin-Lepine (1988)	11%-314% [S]		
Bernstein	295-94% [S]		

[e] : elasticity; [S] : social rate of return (direct + indirect rates of return); n.s.: insignificant

Source: Nadiri (1993)

Table 2.3 **Is Public R&D a Complement or Substitute for Private R&D?**

2.3*a*. Line of Business and Laboratory Studies

Author	Time Period	Data Type	Number of observations	Explained Variable (Private R&D)	Explained Variable (Public R&D)	Controls	Method	"Net"findings (elasticity)
Scott (1984)	1974	LB cross-section	3338	Log (private R&D)	Log (Gov. R&D)	size, firm or industry dummies	OLS (firm, ind.effects)	complementarity (.06-.08)
Leyden et al. (1989)	1987	Lab. Cross-section	120	$ Private Lab budget	$ Gov R&D Funding to Lab	size, lab K-sharing, D (R&D ind.)	3SLS	insignificant (.145)
Leyden and Link (1991)	1987	Lab. Cross-section	137	$ Private Lab budget	$ Gov R&D and Equipment	R/S. lab K-sharing, D(chem/bio), D(basic R)	3SLS	complementarity (.336)
Klette and Moen (1998) **(Norway)**	1982-95	Panel within ind. (Mach.,elec.,inst.)	192*3.6	$ Private R&D Log (private R&D)	$ Gov R&D subsidy Log (Gov R&D)	Sales, sales sq., cash flow, time dummies	FE OLS	neither (1 for 1) complementarity (0.06)

OLS = ordinary least squares, 3SLS = three stage least squares; FE = Fixed effects

Where the regression is in levels, the elasticity is derived using the mean levels of R&D spending for the sample

Source: David, Hall, and Toole (1999).

Table 2.3 **Is Public R&D a Complement or Substitute for Private R&D?** (cont.)

2.3*b* Firm-Level Studies - U.S. Data

Author	Time Period	Data Type	Number of observations	Explained Variable (Private R&D)	Explanatory Variable (Public R&D)	Controls	Method	"Net"Findings (elasticity)
Hamberg (1966)	1960	Firm CS within ind.	8* (-20)	Private R&D E/Total E	$ Gov contracts/Assets	Size, depre., invest., leg R&D E	Wtd OLS	mixed/complementarity
Shrieves (1978)	1965	Firm CS across ind.	411	log (private R&D E)	% Gov. Financed R&D	Size, prod mkt, tech oppty, C4	OLS	substitutability
Carmichael (1981)	1976-77	Firm CS within ind. (transportation)	46*2	$ Private R&D Expenditure	$ Gov R&D contracts	Size	pooled OLS	substitutability
Higgins and Link (1981)	1977	Firm CS across ind.	174	% Research in Private R&D	$ Gov-financed R&D	Profit/S, divers., D(hitech)	OLS	substitutability (-,13)
Link (1982)	1977	Firm CS across ind.	275	Private R&D / Sales	Gov financed R&D/sales	Profit/S, divers., C4, D(governance)	OLS	complementarity
Lichtenberg (1984)	1967, 72, 77	Firm CS across ind.	991	Change in priv. R&D/sales	Change in Gov R&D/sales	Size, ???	Fixed Effects	subsitutability
Lichtenberg (1987)	1979-84	Panel across Ind.	187*6	$ Private R&D Expenditure	$ Gov-financed R&D	Year dummies, size, sales to Gov.	pooled OLS	Insignificant
Lichtenberg (1988)	1979-84	Panel across Ind.	167*6	$ Private R&D Expenditure	$ Gov-financed R&D	Year dummies, size, sales to Gov.	FE OLS, IV	substitutability (IV) complementarity (FE)
Wallsten (1999)	1990-92	Firm CS across Ind.	81	$ Private R&D Exp. in 1992	Number of SBIR awards, Total value of SBIR awards	Age, size, patents, R&D exp. (1990), D(never apply), Ind. And geography dummies	OLS, 3SLS	substitutability
Howe and McFetridge (1976) (Canada)	1976-71	Firm panel within ind.	6*44	$ Private R&D Expenditure	$ Gov R&D grants	Size, (poly), profit, depre, HHI, D (foreign)	Wtd OLS	mixed/complementarity
Holemans and Sleuwaegen (1988) (Belgium)	1980-84	Firm CS across within ind.	5*(-47)	log (private R&D)	log (Gov R&D grants)	Size, divers, HHI (D(for.) log (royalities)	FE OLS	complementarity (.25-.48)

Table 2.3 **Is Public R&D a Complement or Substitute for Private R&D?** (cont.)

Antonell (1989) (Italy)	1983	Firm CS within ind.	5*(-47)	log (private R&D)	log (Gov R&D grants)	Size, divers, HHI (D(for.) log (royalities)	OLS	complementarity (.31-.37)
Busom (1999) (Spain)	1988	Firm CS across within ind.	147	Private R&D Expenditure R&D per employee	D(participation in subsidy loan program)	Size, patents, export share, Ind. Dummies	OLS with selection correction	complementarity (0.2) (hetergeneous)
Toivanen and Niininen (1998) (Finland)	1989, 1991, 1993	Panel across ind.	133*3	$ Private R&D Expenditure	$ Gov-financed R&D (loans and subsidies)	Investment, cash flow, interest rate, current and one lag of all variables	FD IV	subsitutability-subsidies to large firms (-10) loans and smalls firms insignificant

Definitions: E = employment. CS = Cross section. FE = Fixed effect (within or firm dummies).
FD = first differences IV = instrument variables
All studies use U.S. data unless otherwise noted

Table 2.3 **Is Public R&D a Complement or Substitute for Private R&D?** (cont.)

2.3*c* Industry-Level Studies

Author	Time Period	Data Type	Number of observations	Explained Variable (Private R&D)	Explanatory Variable (Public R&D)	Controls	Method	"Net"Findings (elasticity)
Globerman (1973) (Canada)	1965-69	Cross-section	15	R&D E/Total E	Gov R&D/sales	D(tech oppty), % Foreign, ind. Conc. Sales growth	OLS	complementarity
Bruxton (1975) (United Kingdom)	1965	Cross-section	11	Private R&D/Gross output	Gov R&D/Gross output	C4, Divers., entry barriers?	OLS	complementarity
Goldberg (1979)	1958-75	Panel	18*14	Log (private R&D/ouput)	Gov R&D/sales (sum of lag 0&1)	Ind. Dummies, price of R, lag priv. R/ouput	FE OLS	complementarity
Lichtenberg (1984)	1963-79	Panel	12*17	Change in private R&D	Change in Gov R&D	Year dummies, Ind. Dummies	FE OLS	insignificant
Levin and Reiss (1984)	1963, 67,72	Panel	20*3	Private R&D/pord. Costs	Gov R&D/shipments	Tech dummies, Basic R share, ind. Age, HHI	2SLS	complementarity

Definitions: E = employment. CS = Cross section. FE = Fixed effect (within or firm dummies).
FD = first differences IV = instrument variables
All studies use U.S. data unless otherwise noted

Source: David, Hall, and Toole (1999).

Table 2.3 **Is Public R&D a Complement or Substitute for Private R&D?** (cont.)

2.3*d* Aggregate Studies

Author	Time Period	Data Type	Number of observations	Explained Variable (Private R&D)	Explanatory Variable (Public R&D)	Controls	Method	"Net"Findings (elasticity)
Levy and Terlickyi (1983)	1949-81	Time-series	33	$ Private R&D Stock	$Gov contracts to industry (stock)	Lag output, lag taxes, unemplo., age R&D stock, $ Gov R&D., $ reimb.	GLS	Complementarity
Terleckyi (1985)	1964-84	Time-series	21	$ Private R&D Expenditure	$Gov contracts to industry	Output, gov. durables, lag R&D in Europe/Japan	GLS	Complementarity
Lichtenberg (1987)	1956-85	Time-series	28	$ Private R&D Expenditure	$Gov contracts to industry	Sales, sales to gov.	OLS	Insignificant (.045)
Levy (1990) (cross-country)	1963-84	Panel	9*21	$ Private R&D Expenditure	$Gov contracts to industry	GDP, country dummies, pred. Europe & Japan priv. R&D	pooled GLS	Complementarity
Robson (1993)	1955-88	Time-series	33	Change in private basic research	Change in federal basic research	Level & chg priv. Appt. R. Gov. appl. R. Gov. purchases, chg in non-gov goods&serv.	OLS - 1st-diff	Complementarity
Daimond (1998)	1953-93	Time-series	41	$ Private basic research	$ Federal basic research	GDP, time trend	OLS - 1st diff Box-Cox	Complementarity (1.04)
Von Tunzelmann and Martin (1988) (cross-country)	1969-95	Panel	22*27	Change in private R&D	Change in public R&D	Levels of private and public-funded R&D, country dummies	Fixed Effects	Complementarity

Definitions: E = employment. CS = Cross section. FE = Fixed effect (within or firm dummies).
FD = first differences IV = instrument variables
All studies use U.S. data unless otherwise noted

Source: David, Hall, and Toole (1999).

Table 3.1 **Summary evidence on trade and growth**

Openness measure	Countries	Period	Impact	Source
a. Measures based on trade shares				
			Coefficient on openness	
Deviation from predicted trade	45	1973-78	Significant, > 0	Balassa (1985)
Deviation from predicted trade (Leamer, 1988)		1982	Significant, > 0	Edwards (1992)
Changes in trade shares	19	1960-85	Significant, > 0	Helliwell and Chung (1991)
Trade shares	81 LDCs	1960-85	Weakly significant, > 0	Quah and Rauch (1990)
b. Price-based and administrative measures				
Bhalla and Lau (1992), using the relative price of tradeables to international prices	60	1960-87	Raises GDP growth	Bhalla and Lau (1992)
Relative domestic price of investment goods to international prices	98	1960-65	Raises GDP growth per capita	Barro (1991)
Relative price of traded goods	95	1960-85	Raises GDP growth per capita	Dollar (1991)
Effective rate of protection in manufacturing	47	1950-80	Lower protection raises GDP growth	Heitger (1986)
Trade liberalization index from Thomas et al. (1991)	35	1975-85	Export incentive positively affect GDP per capita growth, insignificant impact of import restrictiveness	Lopez (1990)
Trade liberalization index from Thomas et al. (1991)		1978-88	Trade reform positively affects GDP growth	Thomas and Nash (1992)

Source: Harrison (1996)

Table 3.1 **Summary evidence on trade and growth** (cont.)

Openness measure	Countries	Period	Impact	Source
c. Micro and productivity studies				
Deviation from predicted export share	108	1960-82	Positive	Syrquin and Chenery (1989)
Export growth	4	1955-78	Positive	Nishimizu and Robinson (1984)
Export growth	17	1950-80	Positive	Nishimizu and Page (1990)
Export growth	4	1976-88	Positive	Tybout (1992)
Import penetration		1950-73	Ambiguous	Nishimizu and Page (1990)
		1973-85	Negative	
Import substitution (IS)(1- Import penetration)	4	1955-78	IS negatively affects TFP	Nishimizu and Page (1984)
Import substitution	4	1976-88	IS positively affects TFP	Tybout (1992)
Effective rates of protection and domestic resource costs	Turkey	1963-76	Ambiguous	Krueger and Tuncer (1982)
Change in import shares	UK	1976-79	Ambiguous	Geroski (1989)
Tariffs and import penetration	Ivory Coast	1975-87	Positive	Harrison (1994)
d. Causality test				
Methodology			*Exports cause growth?*	
Granger tests	37	1950-81	For only 4 countries	Jung and Marshall (1985)
White specification test	73	1960-77	Yes	Ram (1985)
Granger, Sims tests	4 (Asian NICs)		Sometimes	Hsiao (1989)
Granger tests	Austria	1965	No, but productivity growth causes exports	Kunst and Marin (1989)

Source: Harrison (1996)

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