Growth Prospects for Australia

lessons from the revolution and counter-revolution in the theory of economic growth

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TOWARDS OPPORTUNITY AND PROSPERITY

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ABSTRACT

The 1980s revolution in growth theory was greeted with enthusiasm by academics and policy-makers of the interventionist ilk. Paul Romer and Robert Lucas developed economic models that placed education and research as the twin-carburettors of the engine of endogenous growth. Skilled adjustment of the input-mix would enable policy-makers to increase the cruising speed of the economy. But it was all too good to be true, according to the academic counter-revolution of the 1990s. Robert Solow and Trevor Swan were correct all along in suggesting that the cruising speed of the economy is beyond our control. The best we can do is to improve short-run acceleration.

In this paper I argue that the counter-revolutionists from Cambridge have overlooked the crucial economic insights of the Romer-Lucas analysis of the nature of human capital accumulation. Compared with machinery and buildings, human capital – in the form of skills and ideas - has fundamentally different economic attributes: complementarity, positive feedback and non-rivalry. These attributes imply that raising investment in human capital does indeed have the potential to enhance economic growth over a long time period, whilst at the same time requiring particularly careful policy analysis to establish the optimum level and mix of investment. These arguments can be extended to consider the extent to which some types of investment in physical infrastructure also involve complementarity and non-rivalry.

Another implication of this approach to analysing growth is that some of the present concerns about the ageing of the Australian population may be misplaced if the underlying decline in fertility is driven by rational decision-making, as parents choose to invest in more human capital of fewer children.

1. Re-thinking Economic Growth: the role of knowledge

Knowledge is fundamental to economic progress. Our material standard of living would be reduced to unrecognisable levels if we were to suffer collective amnesia - forgetting that a circular shape reduces friction, not remembering how to read and write, losing all knowledge of electro-dynamics. All economic activities depend on institutions that encourage the preservation, transmission and development of knowledge.

This seems blindingly obvious. Yet for several recent decades, the economic analysis of growth was dominated by an approach which sidelined the role of knowledge. Economists concentrated on the accumulation of objects rather than the accumulation of ideas.

The object-oriented approach to economic growth was formalised in 1956 by two economists operating at opposite ends of the globe: Robert Solow at the MIT in Cambridge and Trevor Swan at the ANU in Canberra. Their neo-classical growth models were formulated independently but in broadly the same way, leading to similar conclusions. Accumulation of capital – machinery, buildings, equipment, etc. - is the engine of growth in the short-run. Policies that increase the share of resources going to investment will raise the productive capacity of the economy. But as the growth of the capital stock outpaces the limited resources of land and labour, the impact of each successive unit of investment is diminished. However large the boost to the investment rate, growth will eventually revert to some fixed rate determined by exogenous technological progress.

This implication of the neo-classical growth model is illustrated in Figure 1. A boost to investment at time T_0 raises the rate of growth (the slope of the logarithmic output line) from the solid line A to the dashed line B. Ultimately, however, growth reverts to the exogenous rate, where line B becomes parallel to line A, albeit with output and incomes at a higher level than would have obtained at the lower investment rate. Tax incentives, or other policies that influence investment, affect only the level of output, not the long-run rate of growth.

The key to this conclusion is the assumption of diminishing returns to capital accumulation. Underlying this notion is the idea of capital as a collection of similar objects. A self-employed dress-maker who purchases his first sewing machine will register a large increase in annual output. Purchase of a second machine will reduce the amount of down-time when the first machine is under repair – but the consequent addition to annual output is relatively small. A third machine would probably be redundant.

This assumption about diminishing returns is typically captured in growth models by postulating an aggregate production function of Cobb-Douglas form, where output per unit of labour at time t, y_t, is related to the net capital stock per unit of labour, k_t, as:

$$y_t = A(k_t)^{\alpha} \qquad [1]$$

The elasticity of output with respect to capital, represented by the parameter α, is assumed to be less than unity. The parameter A represents the level of technology, sometimes referred to as total factor productivity.

The marginal product of capital is:

$$\frac{\partial y_t}{\partial k_t} = \frac{\alpha A}{k_t^{1-\alpha}} \qquad [2]$$

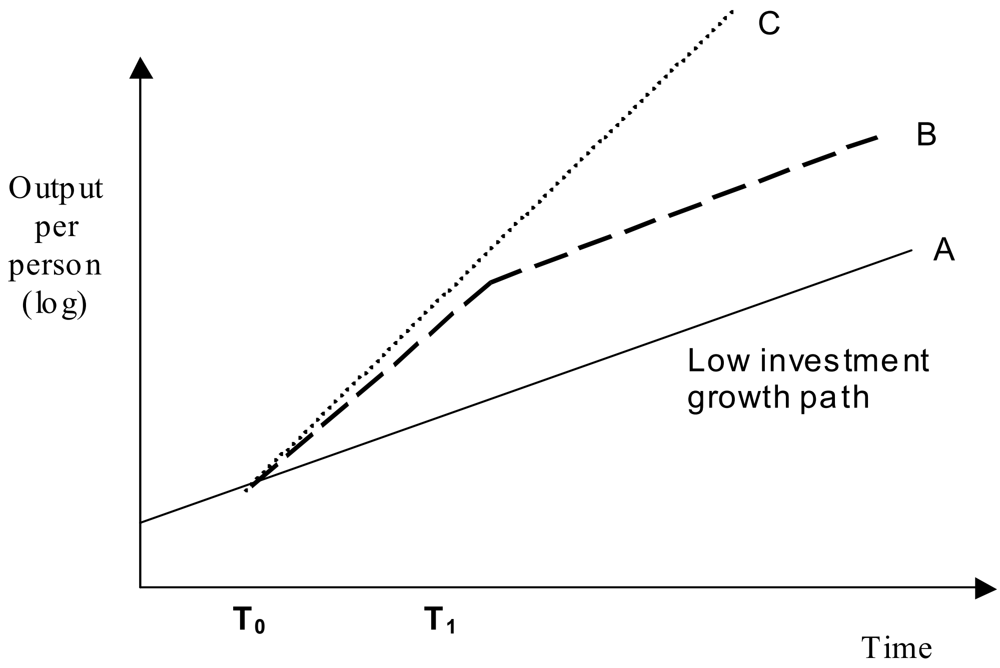
which, given $\alpha < 1$, diminishes towards zero as capital intensity increases.

This way of thinking about economic growth was challenged in a series of papers, starting with Paul Romer in 1986, heralded as 'the new growth theory' or 'endogenous growth theory'[1]. A prominent feature of this new wave of economic models, indeed their defining feature, is that policy intervention and the nature of institutions can influence the long-run growth rate of the economy.

[1] The key papers are Romer (1986), Romer (1990), Lucas (1988), Rebelo (1991) and Aghion and Howitt (1992). Paul Romer is usually identified as the progenitor of this intellectual revolution, but in Romer (1993) he acknowledges the extensive intellectual debt due to Adam Smith, Joseph Schumpeter, Arthur Lewis and others.

In terms of Figure 1, the new models suggested that policy or institutional change, instituted at time T_0, could permanently alter the slope of the growth path – as illustrated by the dotted path C.

Figure 1
The impact of increased investment in the neo-classical and endogenous growth models



There are various technical features of these models that make it feasible for the long-run growth rate to be determined endogenously, i.e. determined by economic behaviour that is analysed within the model. One possibility arises where the degree of substitutability between capital and labour is sufficiently high that returns to the accumulation of capital do not diminish to zero.[2] We can imagine that this might be the case in some manufacturing processes where human labour is readily replaced by robots, or in the delivery of some financial services such as ATM banking. But it is

[2] This possibility was originally canvassed by the Australian economist, John Pitchford (1960).

not clear that this robotic model of growth is applicable to all sectors of the economy.

More interesting, to my mind at least, are models of endogenous growth that build on the economic properties of complementarity, dynamic feedback and non-rivalry in investment. These are the properties that distinguish the accumulation of ideas and skills from the accumulation of objects. It is worthwhile considering each of them in turn.

Complementarity of investment

Economic complementarity arises when your investment increases the return (monetary and/or psychic) to my investment. This may occur when we invest in activities that exhibit network externalities. Learning to play chess, to speak Esperanto, or to read and write becomes much more rewarding for me if others invest in the same skills. Complementarity is not exclusive to investment in human capital; the benefits I get from investing in a telephone line and a fax machine are also enhanced when others do the same. But network complementarity is probably more pervasive in the accumulation of skills than in the accumulation of objects. Indeed such complementarity is an essential ingredient of the development of 'social capital'.

Network complementarity is a feature of the endogenous growth model of Lucas (1988) where the productivity of any worker is enhanced not only by their individual level of skill but also by the average skill level amongst their fellow workers. This implies that the economic analysis of external effects is relevant to growth. Although my productivity depends in part on your human capital, I cannot expect you to take that into account when you decide how much education and training to undertake – and *vice versa*. So if we make individual decisions about the time and money we spend on education and training, we are likely to under-invest in human capital.

It follows, from Lucas' analysis of network externalities, that there is an important role for government to play. Subsidising education will improve economic welfare in the sense that everyone will be better off as a result of an increase in human capital.[3]

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[3] This is not the only reason for subsidising education. Given that many parents are constrained in financing their children's education, there are both equity and efficiency reasons for public support.

Dynamic feedback

These education externalities are not, however, sufficient in themselves to drive long-run growth. In Lucas' model, the rate of output growth is still limited by diminishing returns to the accumulation of both physical and human capital. He endogenises growth by appealing to another feature of education: dynamic feedback. As we learn more, it becomes easier to acquire further knowledge and skills. An obvious example is reading. Once we have learnt this skill, the acquisition of further information and skills is facilitated through book learning.

This view of dynamic feedback can be represented by a function expressing the change in the level of human capital in some representative household as a function of the amount of adult labour time, L_h, that is devoted to education (of self or of children) and the current level of human capital per person, h_t.

$$\frac{dh_t}{dt} = \phi . L_h . h_t^{\gamma} \qquad [3]$$

The extent of dynamic feedback is captured by the value of the exponential parameter γ. A value of zero implies that there is no feedback.

Aggregate output per person, y, now depends on both physical and human capital per person:

$$y_t = A\left(k_t\right)^{\alpha}\left(h_t\right)^{\beta} \qquad [4]$$

where we maintain the assumption of diminishing returns by restricting α, $\beta < 1$.

Endogenous growth is made feasible by the existence of positive feedback in the second sector of this economy, the education sector. To demonstrate this, take logarithms of equation [4], differentiate with respect to time and substitute in equation [3] to derive the growth rate of output per worker:

$$\frac{d\,y_t}{dt}\frac{1}{y_t} = \alpha\frac{d\,k_t}{dt}\frac{1}{k_t} + \beta\frac{d\,h_t}{dt}\frac{1}{h_t} = \alpha\frac{d\,k_t}{dt}\frac{1}{k_t} + \beta\frac{\phi\,L_h}{h_t^{1-\gamma}} \qquad [5]$$

Whether or not the accumulation of human capital can drive long-run growth is determined by the final term in this equation. With no positive feedback, i.e. if γ=0, this term diminishes to zero as the level of human capital, h_t, increases over time.

(This is exactly what happens to the physical capital term, as a given investment rate leads to slower and slower proportional growth in the stock.) But if there is sufficiently high feedback in human capital accumulation, i.e. if γ=1, the final term in [5] is a positive constant. That is to say, the long-run growth rate is positive. Moreover, it is increasing in the amount of labour time that is devoted to education.

Given sufficient dynamic feedback, public subsidy of education and training can increase long-run growth. In the presence of network externalities, or other sources of market failure, such policy will also increase economic welfare.

Embodied or disembodied human capital

Is it reasonable, however, to suppose that the feedback effect is sufficiently strong to make education the engine of long-run growth? Note that even if the feedback parameter is close to unity, say γ=0.9, the long-run rate of growth in [5] will diminish to zero as the level of human capital increases. Stable long-run growth requires a parameter value of unity.[4] It also requires that there be no limit to the accumulation of human capital. Human capacities to think, organise and remember are, however, usually presumed to be finite. Moreover, our skills and abilities die with us.[5]

In addressing the problem of limits to human capabilities, Paul Romer (1990) emphasises the distinction between the skills and abilities that are embodied in individual humans, and disembodied knowledge. He focuses on the properties of the latter category, the world of ideas and research, supposing that there is sufficient dynamic feedback in the research sector to generate endogenous growth and that the scope for developing new ideas is limitless.

[4] Empirical studies, comparing growth rates of countries over the past few decades, do tend to find that higher levels of education promote faster growth, suggesting that feedback is indeed high. (For a discussion of this evidence, see the companion conference paper to this one.) Nevertheless, it is not self evident that this will always be the case.

[5] Lucas (1988) asserts that his model of endogenous growth can be sustained across generations if a child's initial endowment of human capital is proportional to the level already attained by the adults – but, unless Lysenko was correct, the genetic transmission of acquired human capital is unlikely.

In Romer's model, it is the number of people engaged in research and development that drives long-run growth. His mathematical representation of the generation of new ideas (or blueprints for new products) is similar to that of Lucas' educational sector:

$$\frac{dA_t}{dt} = \phi L_A A_t \qquad [6]$$

where A_t represents the number of ideas that have been realised at time t in history and the differential, dA/dt, is the current output of new ideas from the research sector. L_A represents the amount of human capital, or the number of researchers, devoted to innovation.

Crucially, Romer assumes that the rate of innovation is directly proportional to the extant stock of knowledge. This is the 'standing on shoulders' hypothesis of knowledge accumulation, so labelled by Charles Jones (1998), in reference to Isaac Newton's disclaimer:

> *If I have seen farther than others, it is because I was standing on the shoulders of giants.*

In the accumulation of disembodied ideas, rather than embodied skills, it is indeed plausible to suppose that the level of current output might be directly proportional to the size of the stock. The more ideas and theorems that we have to draw on, the easier it is to generate new ones. Moreover, ideas do not necessarily disappear when their developer dies – they can typically be recorded and transmitted at virtually zero cost.

Implicit in Romer's formulation of research output is the idea that there is an evenly distributed and infinite universe of potential ideas waiting to be discovered. So a given amount of research effort will produce a predictable number of new ideas. A more realistic approach, allowing the discovery rate to fluctuate, is summarised by Aghion and Howitt (1998) in their discussion of General Purpose Technologies stemming from innovations such as the steam engine, the electric dynamo and the computer.

Non-rivalry of ideas

As well as hypothesising dynamic feedback in the generation of new ideas, Romer emphasises that ideas have another significant economic property, *non-rivalry*, in respect of their application to economic activity. Objects are usually rival, meaning that if you are using something, I cannot use it at the same time. But this is not true of ideas. Once the binomial theorem has been published, your use of it does not in any way interfere with my use of it.

Of course, people can try to stop us making use of ideas. The idea of the printing press has, at times, been bitterly opposed by church and state. Bill Gates employs lawyers who might try to prevent an entrepreneur from selling the new computer operating system ‘Box2002’ which relies on opening and closing ‘boxes’ on the computer screen by pointing and clicking with a moulded plastic ‘cat’. But these examples refer to the *excludability* of ideas, which depends on the actions of people supported by institutions of laws and property rights, rather than *non-rivalry,* which is an inherent features of ideas.

Romer makes use of this distinction by assuming that ideas are fully excludable in the application of ideas or blueprints to the production of goods. For example, a researcher can acquire full patent protection for the design of a new drug; it can only be manufactured if royalties are paid. On the other hand, she has no protection against other researchers who can reverse engineer her ideas and come up with their own different but improved drug design. Indeed, when the original researcher files her patent, she has to describe her idea, thereby providing her rivals with a free input into their subsequent research.

Romer’s hypothesis that ideas are non-rival and non-excludable in the research process has important implications for public policy. Researchers may reap the benefits from the direct application of their ideas, but they do not receive monetary reward from others who ‘stand on their shoulders’. Left to the market, there will be an under-supply of research effort. Public intervention is required to subsidise research, hence stimulate growth, up to the socially optimum level.

Other aspects of knowledge accumulation are analysed by Aghion and Howitt (1992) and Aghion and Howitt (1998) who emphasise the Schumpeterian notion of ‘creative destruction’. Patent rights may bestow monopoly power on the producer of a particular generation of an innovative good; but they cannot prevent the development by a rival of the next generation of goods which are superior in quality and/or price. The creation of the improved version destroys the flow of profits to the previous monopolist. Unbridled competition in such a market can lead to too much research being carried out, where the research is concerned with marginal quality improvements rather than new products and processes. Nevertheless, such research is still capable of driving long-run economic growth.

2. *The Cambridge Counter-Revolution*

The intellectual euphoria of endogenous growth theory was soon challenged by a group of economists, all connected with or based in Cambridge, Massachusetts, who chose to stand behind (as well as on the shoulders of) Nobel laureate Robert Solow of MIT.

Solow (1994) himself was critical of the knife-edge assumption required to generate stable long-run growth in the models of Romer and Lucas. His point is that these models require the dynamic feedback parameter in the education / research sector to be exactly equal to unity. If we look back to Lucas' model, where the growth rate of the economy is determined by equation [5], we can see that a value of 0.9 for the parameter, γ, will, eventually, reduce growth to zero: the final term of that equation has $h_t^{1-\gamma}$ in the denominator, which drives the term to zero as human capital, h_t, rises if γ is less than one. Stable long-run growth requires that the parameter be exactly one.

Romer (1994) has argued that this knife-edge property can be overcome in a more complex model. More damaging to the endogenous growth cause, however, has been the empirical work of another Cambridge (Harvard)-based economist, Greg Mankiw. In a much-cited paper, Mankiw, Romer and Weil (1992), he and his co-authors do not tackle the endogenous growth modelers head-on. Rather, they steal the ball of human capital from the endogenous growth scrum and use it to reconstruct the 1956 Solow model.

Their “augmented Solow model” [6] includes human capital as a third factor in the aggregate production function, alongside capital and unskilled labour. They investigate the relationship between steady-state levels of output and the three factors, using secondary school enrolment rates as a proxy for the rate of investment in human capital. They conclude that the factors are of approximately equal importance – i.e. that the elasticity of output with respect to each factor is approximately one third – and that together they account for eighty percent of the observed variation in 1985 income levels across some 98 nations.

This was a neat side-step, rather than a direct hit on endogenous growth theory. There was no attempt to directly confront the two models with a discriminating statistical test, but the 1956 model was effectively rehabilitated. And this was only half time in the come-back match.

In an equally influential second-half, the Mankiw, Romer et al. (1992) paper provided a clever re-interpretation of an empirical regularity. Empirical studies of post-war economic growth had typically reported a conditional convergence effect. These studies ran regression models of the form:

$$\left(\ln y_{iT} - \ln y_{io}\right) \;=\; \alpha_0 \;+\; \beta \ln y_{io} \;+\; \boldsymbol{\gamma}\mathbf{X}_\iota \;+\; \varepsilon_i \qquad [7]$$

where the dependent variable is the growth rate of y, output *per capita* (or per worker), over a period of T years. $\mathbf{X}_i$ represents a vector of additional explanatory variables. ‘Conditional convergence’ is said to exist if the regression parameter, β, is negative –a lower starting value for y is associated with a higher subsequent rate of growth, conditional on the **X** variables that explain differences in rates of growth.

Previous authors[7] had interpreted conditional convergence as evidence that technological spillovers from the most advanced economies enabled less advanced economies to imitate and thus enjoy relatively fast productivity growth. The Mankiw-Romer-Weil re-interpretation of such evidence, echoed by their Harvard colleagues

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[6] This phrase brings to mind a massive statue of the Nobel laureate. Is this Cambridge’s attempt to outdo Goulbourn’s Giant Merino? Should Canberra retaliate with the Super Swan?

[7] For example, Abramovitz (1986) and Dowrick and Nguyen (1989).

Robert Barro and Jeffrey Sachs,[8] involves treating the **X** variables as determinants of the neo-classical steady state. They then interpret the initial income variable ($\ln y_0$) as a measure of distance from steady state and the β-coefficient as a measure of the speed of convergence to steady state.

This re-interpretation of the evidence in favour of the neo-classical model has been complemented by the more direct approach of MIT graduate, Charles Jones.[9] He highlights the fact that endogenous growth models based on the accumulation of knowledge, such as Romer's model, typically suggest that the rate of growth should be an increasing function of the resources devoted to R&D. He cites evidence from the US that contradicts this prediction:

> *"Since 1950, the fraction of the labour force engaged in formal R&D has increased by almost a factor of three. Despite these changes, average growth rates ... are no higher today than they were from 1870 to 1929..".* Jones (1998)

Jones also criticises some of the key assumptions underpinning the knowledge-based models of endogenous growth. In particular, he suggests that knowledge creation may become more difficult over time as the easy ideas are discovered first, leaving subsequent researchers with a pool that has been 'fished out'. He also suggests that researchers may often duplicate each others efforts: 'stepping on toes' rather than 'standing on shoulders'.

These critiques of endogenous growth theory seem to imply that policies aimed at increasing investment in education and/or research will not be successful in raising the rate of economic growth for a sustained length of time. I will argue in the next section of the paper that this is not necessarily the case.

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[8] See Barro and Lee (1994) and Sachs and Warner (1997).

[9] See Jones (1995a) and Jones (1995b).

3. Reconciling conflicting theories of growth

A crucial difference between the neo-classical and new growth theories concerns the question of whether the long-run rate of growth of the economy is some exogenous constant or whether it can be influenced by economic policies. Put another way, the question is whether policies and institutions that influence the rate of accumulation of physical and/or human capital have long-run effects on the *level* of economic activity or on its *rate of growth*. For purposes of practical policy-making, however, this distinction may be relatively unimportant - if the 'long-run' never arrives. Looking back to Figure 1, if economies are subject to shocks of sufficient magnitude and frequency, it may be difficult, if not impossible, to tell whether the long-run growth path really looks like path B or path C. In the 'short-run' – between time T_0 when the first major shock occurs and some time T_1 when another such event occurs – the paths may be virtually indistinguishable.

The evidence of the neo-classical revivalists can be interpreted to support this view. Mankiw, Romer et al. (1992), Barro and Sala-i-Martin (1995) and Sachs and Warner (1997) all report growth regression evidence suggesting that the rate of convergence towards steady state is of the order of two percentage points per year, implying that it will take more than thirty years for a country to halve the gap between its current income and the steady state level. Within a half-life of several decades, we must surely expect that there will be changes in investment rates and changes in technology such that the neo-classical economy is rarely able to get close to steady state.

A useful way to think of this problem is to consider the specification of the Error Correction Model. The ECM is commonly used to decompose macroeconomic time-series into cyclical and long-run components and to test for long-run cointegrating relationships.

A typical ECM regression is of the form:

$$\left(\ln y_t - \ln y_{t-1}\right) = \alpha\left\{\mathbf{X}_t - \mathbf{X}_{t-1}\right\} + \lambda\left[\ln y_{t-1} - \beta\mathbf{Z}_{t-1}\right] + \varepsilon_t \qquad [8]$$

where y represents real output and the dependent variable is the growth rate of output. The explanatory variables are segregated. The **X** variables, which influence short-run movements, are entered in first differences. The **Z** factors are entered as lagged variables, along with the lagged value of output, y_{t-1}. For analysis of the long-run path, the first differences are set to zero, yielding the long run path for output as a function of the **Z** variables:

$$\ln y_{T*} \;=\; \boldsymbol{\beta}\, \mathbf{Z}_{T*} \qquad [9]$$

This very general empirical specification is consistent with both neo-classical and endogenous growth models. If the **Z** vector contains a time trend, T, the regression coefficient on T is an estimate of the exogenous rate of technological progress – as in the neo-classical model. However, the **Z** vector may equally well contain a variable measuring the level of human capital, H, that is multiplied by the time trend, HT. If so, the coefficient on this term captures the impact of human capital on the long-run growth rate of the economy – as in endogenous growth models.

The sign of the regression coefficient λ indicates whether output converges to the long-run path. The square brackets in [8] capture last period's deviation from the long-run path. The negative value of λ indicates the proportion of last period's 'error' that is 'corrected' in the current period.

A typical time-series study that is trying to identify breaks in trend growth, using thirty to forty annual observations, might find a half-life for the business cycle of two to three years.[10] In this context, the 'trend' growth is approximated by the average growth rate over one or two decades, averaging out fluctuations over three or four business cycles. But if convergence to the neo-classical steady state growth path has a half-life of thirty years, this time-scale is clearly insufficient to capture the underlying long-run growth. Rather, we are identifying changes in the slope of the transitional growth path.

This supposition is confirmed by the recent study of Jones (2001). He adopts a modified growth accounting approach to analyse the last fifty years of US growth. He finds that only one fifth of the actual growth rate of labour productivity (averaging 2.0

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[10] A pooled time-series cross-section study by Lee, Pesaran and Smith (1997) has estimated the rate of convergence in the Solow-Swan model with a half-life of 2.5 years. I interpret this as a failure to distinguish the speed of transition to steady state from the fluctuations of the business cycle.

percent per year) has been attributable to exogenous technical change. The remaining four-fifths of growth (1.6 percent per year) is attributable to continued growth in education and research intensity. In his terms, (p. 23): "Transition dynamics associated with educational attainment and the growth in research intensity account for 80 percent of growth".

Jones' conclusion is couched in the language of the neo-classical approach. Sustained growth above steady state levels can only be transitional and is driven by sustained (but ultimately bounded) growth in the share of GDP going to investment in human capital. An alternative interpretation of the same evidence might claim that increased investment in human capital has raised the long-run endogenous rate of growth.

Evidence that reconciles the two approaches to understanding growth comes from Benhabib and Spiegel (1994) who carry out econometric estimation on various models to explain variation in 20-year growth rates (1965-85) on a cross-section of 78 countries. In their preferred model, technological progress is the sum of two components: an exogenous component, as in the neo-classical model; and a semi-endogenous component, related to the rate of absorption of technology from the technological leading country, captured by an interactive term between the productivity gap and the level of human capital.

They report that the interactive term is statistically significant, supporting the idea that there is an endogenous component to technological progress. At the same time, they estimate an output elasticity close to 0.5 for physical capital, suggesting diminishing returns to investment and a slow rate of convergence towards the steady state capital stock.

Broadly similar results are reported by Dowrick and Rogers (2002). Our study differs from that of Benhabib and Spiegel (1994) in that we carry out the analysis on a panel of growth data. This enables us to test for country-specific effects. We also use an instrumental variable estimator to control for reverse causation between growth and the explanatory variables. Country-specific effects, which we interpret as endogenous components of technical progress, are found to be important. We confirm the finding that the level of human capital facilitates technological catch-up.

These models combine features of the neo-classical theory with the new growth theory. Changes in the rate of physical investment have, ultimately, only level effects; but within a time frame of one or two decades this is indistinguishable from a growth effect. At the same time, countries have different rates of technological progress with an endogenous component, dependent on the stock of human capital and the allocation of resources to research, and a semi-endogenous component, dependent on the rate of technological progress at the frontier and on the country's ability to absorb ideas from abroad.

4. Education, Fertility and the Ageing Population

As living standards rise, so families choose to have less children and the rate of population growth tends to fall. This is evident in the historical development of many countries[11] as well as being a well-documented observation when comparing modern nations.

Economic analysis suggests that the driving force that simultaneously raises income levels and reduces fertility is the accumulation of human capital. Barro (1991) reports that countries with higher human capital tend to have lower fertility rates and higher rates of physical investment.

Becker, Murphy and Tamura (1990) develop a model of endogenous fertility and human capital accumulation in order to explain the Barro finding. They hypothesise a rising rate of return on human capital – as in some of the endogenous growth models. Parents depend on their children for support in old-age. This implies that when human capital is abundant, rates of return on education are high relative to rates of return on the number of children. As a result, societies with limited human capital choose large families and invest relatively little in the education of each member.

[11] Once they have climbed out of the Malthusian trap of extreme poverty, where rising living standards are associated with rising population growth.

Societies with abundant human capital invest relatively more in the education of a smaller number of children – opting for quality rather than quantity

More recent studies suggest that gender differentials in education are of particular importance. As women catch-up on the educational attainment of men, hence on their earning power, they are motivated to have fewer children and to transfer more time to working outside the home.

It does seem likely that one of the driving forces of Australian prosperity over the past few decades has been the huge improvement in the educational attainment of young Australians, particularly young women. More than three-quarters of the current generation of young Australian women (born between 1975 and 1980) have completed Year 12 of their schooling. In their grandparents' generation, only one third of young women born between 1925 and 1939 completed their secondary education. Whilst the educational attainment of young men has also increased over the past fifty years, they started from a higher level, with fifty percent of pre-war boys completing their secondary education.[12]

This massive shift in educational aspirations and achievement has had a profound effect on fertility and population growth - both in Australia and overseas. As women have attained higher levels of education, and as discriminatory barriers, such as the public service marriage bar, have been abolished or reduced, so their potential earnings have risen. They have chosen to increase their participation in the labour force and to have fewer children.

The fertility rate of Australian women fell below two, for the first time this century, in 1978 and has since fallen to a low of 1.75. Figure 2 illustrates the time path of both fertility and female schooling over the past three decades. The baby-boom years ended abruptly in the early 1970s, with Australian families choosing to have two rather than three children on average. A massive increase in the proportion of girls staying on to Year 12 occurred a decade or two later, more than doubling from 38% in 1981 to 78% in 1991.

Meanwhile, women participated in the labour force in ever increasing numbers.

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[12] Data sources: ABS 6235.0, Feb. 1993, ABS 6227.0. Collins, Kenway and McLeod (2000).

Figure 3 charts the rise from a participation rate of 33% in 1964 to over 50% in the 1990s. Australian women, in the 1970s and 1980s, made a major break with past patterns - choosing to spend less time in domestic work and more in the labour force, whilst having less children but investing more in their education.

FIGURE 2

Female Education and Female Fertility

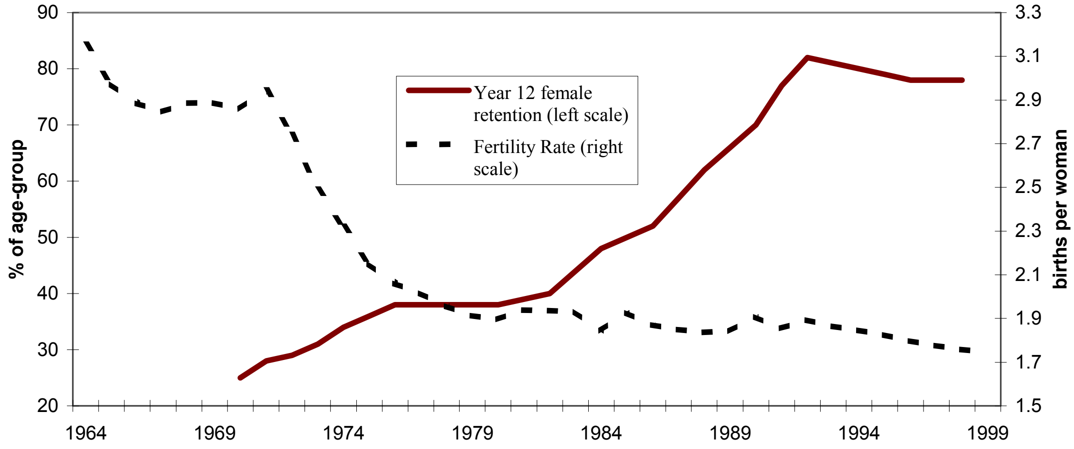
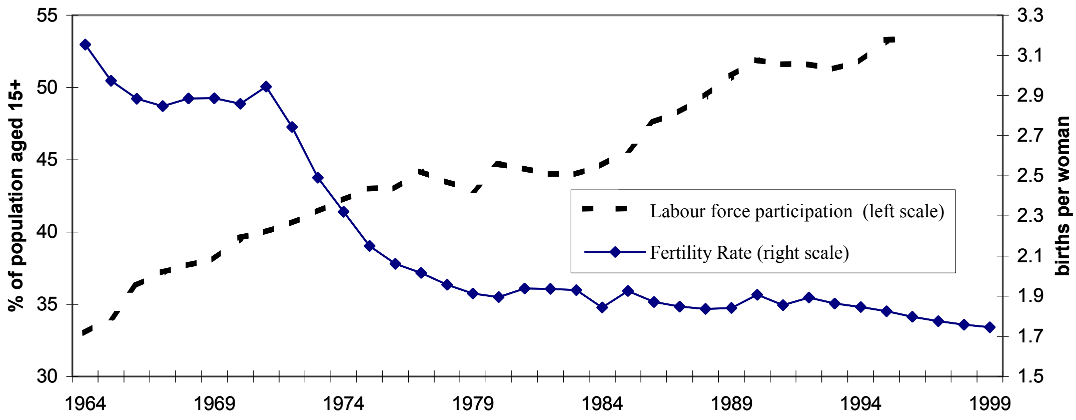


FIGURE 3

Female Fertility and Participation in the Labour Force



Of course, falling fertility not only slows down the rate of population growth, it also changes the age composition of the population. A standard demographic projection by McDonald and Kippen (1999) suggests that over the next forty years the proportion of the population aged 65 and over will double from its current level of twelve percent. As the relatively small current cohorts replace the older cohorts in the workforce, so the working age population shrinks relative to the retired population. But these younger cohorts are, on average, much better educated than those that they are replacing. Although the workforce is becoming relatively smaller, it is also becoming relatively smarter.

5. Prospects for Australian Economic Growth

The neo-classical revival in growth theory has had the paradoxical effect of reinforcing one of the major points of the endogenous growth revolution. The driving force of economic growth is investment in human capital – skills and ideas – as well as investment in machines and buildings. The academic debate will no doubt continue over whether policies influence the long-run as well as the short-run rate of growth of the economy. But for practical purposes, if the 'short-run' involves a transition period of several decades, this debate may be strictly academic - in the pejorative sense of the word.

In a companion paper for this conference, I have reviewed the evidence on Australia's investment in education and research and on Australia's economic performance. There are good grounds on which to expect the strong economic performance of the 1990s to continue over the next several decades. The average education level of the Australian workforce will continue to increase as recent, highly educated cohorts move into the prime working age group of 25-55 year olds, replacing cohorts of lower educational attainment.

The question of whether these new technologies are developed here or overseas probably matters less than our ability to implement and adapt new ideas and techniques for domestic production, irrespective of their source - as we seem to have done very successfully with the IT technologies of the 1990s. Nevertheless, there are good reasons to support domestic research. The international evidence suggests that even small countries, like Australia, tend to earn a very high social rate of return on domestic R&D. Apart from the direct benefits of domestic innovation, perhaps it is the case that the capacity to perform effective frontier research, allied with a well educated workforce, enhances our national capacity to identify, adapt and implement foreign-developed technologies.

One of the most pressing concerns of public policy is that the ageing of the Australian population over the next fifty years will over-tax (literally and metaphorically) the working-age population. From the perspective of growth theory, however, there may not be so much to fear. The ageing of the demographic structure is being driven by the revolution in female education and workforce opportunities. For the generation born in the 1930s, only one third of girls and one half of boys completed high school. For the current generation, close to eighty percent of girls are completing Year 12. The past fifty years have also witnessed the end of legally enforced discrimination against women in the workforce – in the form of the marriage bar and legalised wage discrimination. These huge improvements in female education and workforce opportunities have been major factors in the fall in fertility, which is the driving force behind the changing age structure of the population.

The very factor that is causing the ageing of the population, the revolution in women's education, gives us reason to expect continued strong growth. The average educational attainment of the workforce will continue to rise for the next three decades as historical increases in school enrolments work their way through the adult population. These effects will be enhanced should educational enrolment continue to rise – particularly if the educational participation and achievement of Australia's young men rises to meet the levels of young women. Hence we can expect continued strong productivity growth, which will substantially – perhaps completely – offset the supposed fiscal and economic problems of an ageing population.

These positive prospects for continuing strong productivity growth will be enhanced if we can emulate the higher rates of investment in knowledge – both in education and in research and development – that we observe in the leading OECD economies.

A shrinking but increasingly well-educated workforce, operating in an economy that continues to be open to trade in goods and ideas, should be well placed to identify, introduce and manage the new technologies that will emerge over the next few decades.

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