Societal Growth Rates

At least up to the early 1980's the orthodox theory of economic growth was Solow's neoclassical model which involved an exogenously determined long-run rate of growth and hence predicted convergence of growth rates between countries. However, widespread convergence has clearly not occurred, something that -among other things- caused dissatisfaction with the orthodox view and led to the emergence of the New Growth Theories. These made the rate of growth endogenous and as we will see allowed for non-convergence and even for divergence of income levels and growth rates between countries so the opposite from the essay title is true.

A brief account of the neoclassical model would be useful. It assumes that only one good is produced, all savings are automatically invested, factor prices are flexible (i.e. there is no independent investment function), universal perfect competition and the aggregate production function conforms to the "Inada conditions" which among other things require that we have constant returns to scale and diminishing returns to either of the factors of production by themselves. Technology is assumed to be exogenous though it is easy to incorporate labour augmenting or Harrod neutral technical change In any case the conclusion of the model is that since (with labour and technology exogenous) investment (I) in capital (K) exhibits diminishing returns, any change in the rate of investment will have only a temporary effect in the growth rate -though it will have a permanent effect in income level- since eventually the marginal productivity of K will fall to zero. In fact, as the marginal product of I continues to fall, the savings generated by the income accruing to new K will also fall so the I rate will decline until it will only be just sufficient to replace worn-out machines and equip new workers. We, thus, have exogenous growth, determined by the also exogenous population growth and technological progress.

As far as convergence is concerned, it depends what assumptions we make about woldwide technological spillovers and K mobility. The most common assumptions attributed to the neoclassical model is that technology is universally available but we have no -or imperfect- capital mobility. In this case, growth rates will be equated, though not necessarily income per capita. This is so because poor countries with a lower K stock have higher rates of return on I. So if a country has a lower propensity to save and hence to invest, its relative income and K stock will decline until the return to I in that country increases so much its growth rate eventually equals the high I country. Actually the increased return on I will increase I so the equilibrium income differential will not be as big; though this may be counterbalanced by the low saving ratios that poor economies near the level of subsistence may have.

If we assume both technological diffusion and perfect capital mobility then convergence in both growth rates and income levels should be almost instantaneous since it means that domestic saving and I are uncorrelated : Capital would flow from the rich-high K-low returns economy to the poor-low K-high returns one until the returns are equalised, i.e. until they have the same income/K stock. In fact the optimal rate of Current Account Deficit was found to be equal to the level of I with a market rate of return. If we have perfect K mobility but imperfect technological diffusion then no convergence needs to occur -even divergence may occur- but it is difficult to have such a case within the neoclassical model since it is hard to reconcile perfect capital mobility with imperfect technological spillovers, especially given the model's view of technology.

The evidence as we have said, did not conform to the neocl. predictions as growth rates have shown significant variations both through time and between countries with little signs of convergence occurring. On the other hand, it has been argued that 3 groups of countries can be identified -rich, intermediate and poor- and that convergence exists inside these groups but not between them. This could in fact be compatible with the neocl. model if we recognise that technology moves freely between the rich countries but only imperfectly so between the rich and less developed countries. This was recognised by Solow who argued that introduction of such things like political instability could make the growth rate endogenous and explain non-convergence. Barro has also pointed out the importance of political stability but as we will see later on in a rather different context.

We could also mention here the "traverse perspective", associated with Hicks and Lowe, which by concerning itself with the transition phase from one steady growth to another, allows the neoclassical model to break away from many of their restrictive assumptions. In this approach the non-convergence could simply be a medium-term adjustment to the neocl. steady state. Nevertheless, this begs the question of how long this adjustment takes while since a dynamic economy is always in a traverse, pinpointing the equilibrium point can be problematic to such an extent that it may ultimately render irrelevant the neocl. theory. Furthermore, the problem with the neocl. model is not only it does not fit the evidence but that it is incomplete since, among other things, we "know" that technology (and pop. growth?) are not exogenous. Few would subscribe to the view that technology is solely driven by science which in turn proceeds at a pace and direction independent from economic conditions and incentives.

The New Growth theories are a fairly heterogeneous collection of models but they all have in common the endogenous determination of the long-run growth rate by abandoning the assumption of constant returns with respect to the use of (physical) K and labour together and assuming instead increasing returns to a broad measure of K which includes things like knowledge or public infrastructure. Increasing returns are of course incompatible with perfect competition but the viability of perfect competition is preserved by making knowledge a social factor of production so each individual firm faces const. returns. This means that knowledge is under- provided so we have an externality which justifies government intervention to correct it, in particular given that now govt. policies can permanently affect the long-run rate of growth. The role of the govt. in helping growth is a huge and controversial issue I don't want to get into here, but it should be noted that most New Growth theorists are relatively reluctant to advocate widespread govt. intervention, partly because of fear of govt. failure and partly because New growth theory could even be interpreted as a demand for less rather than more govt. intervention in the sense of low tax rates and no crowding out of private I.

The New Growth theories are often distinguished in two main types depending on the way they incorporate knowledge: The first type is akin to Arrow's (1962) "learning by doing" models who was one of the first to attempt to render technical progress endogenous. Arrow recognised that learning by doing may enhance productivity and argued that it is related with cumulative gross I because I changes the environment and provides stimulate for learning. The effect of learning by doing on productivity is external to an individual firm, thus allowing perfect competition. The long-run rate of growth, however, remained exogenous because Arrow considered learning by doing to have rapidly diminishing returns. A similar model was made by Mankiw et al. (1991) with the extension that the accumulation of human capital (HK) is intentional with saving being allocated partly to physical and partly to human K.

Romer (1986,and 1989?) extended and modified Arrow's insight. He saw knowledge as HC although it has been argued that in fact it functions more like a stock of technical knowledge. For example, HK is assumed not to perish when people die which is often presented as an assumption of infinitely lived households though, as Lucas argued, the stock of HK can be transferred from older generations to younger ones. Romer departed from Arrow by arguing that knowledge displays increasing marginal productivity. Again to make it compatible with perfect competition, Romer argues that we have increasing returns at an aggregate level but const. returns at a firm level because of the lack of an effective patent market. This means that an increase of investment in HK can permanently raise the long-term growth rate. Romer (1986) had also assumed for simplicity that the labour supply and the physical capital are fixed while he also ignored pure, time-dependent technological growth. Thus, the technology of a firm is represented by a production function F(hk,HK,x) where x stands for physical K, raw labour and all other imputs held const. and hk and HK are the level of HK of the firm and of the whole economy respectively.

The assumption of increasing returns, however, would mean that growth rates would continuously accelerate any given % level of I will result to a greater growth rate the bigger the existing stock of HK. Thus, Romer argued that there are also increasing costs in the production of HK which cancel out the increasing returns . Nevertheless, the Romer solution is a corner one and there is always the 'danger' of either degenerating to the Arrow case or leading to explosive situations. In any case, Romer accepted Hicks' idea that there exists a ceiling to the rate of growth. [?] It can be noted though, that explosive properties with ceilings and floors lead to situations with limit cycles akin to Kondratief waves -unlike Romer's view that a steady state growth exists. The question here is how rational agents do not learn to anticipate these endogenously generated cycles but it can be argued that non-linearities may lead to chaotic quasi-cycles which though deterministic can be unpredictable.

Romer also makes three assumptions, that the growth rate of HK cannot be greater than a const. a and that -given HK=s*hk if we have s homogeneous firms- F(hk,HK,x) behaves more or less like (hk)b for large hk, where b>1. Finally a*b>r where r is the discount rate. These assumptions are required to ensure that postponing consumption forever cannot be the winning strategy [??] but the restriction they impose may not be trivial since b>1 means we must have r>a (i.e. the discount rate must be larger than the maximum rate of growth of knowledge) and there is no reason for this to be true.

Romer's innovation is very important because it allows cumulative causation and the possibility of a virtuous circle in which I spurs knowledge and knowledge spur I. Thus it can explain histerisis effects since any shock such as a temporary increase of I in HK may not wash out but may even magnify itself. This means that identical countries with different initial conditions which are otherwise identical (in terms of time preferences etc.) may never converge in either income level or growth rate. In this model perfect capital mobility would not help much since there is no reason for the returns in poor countries to be lower than in rich ones. This means that even if we introduce a common -exogenous or not- technology (distinguished from HK), convergence need not occur because of the lack of HK in the poor countries. Furthermore, large countries have an advantage over small ones because of the increasing returns to I in knowledge [???]. This is so because given that knowledge is a non-rival good, its returns are greater the larger the labour and capital stock which uses this technology so the firms/agents in large economies have greater incentives to I in technology, provided they can secure at least part of the benefits of their innovations (which must be the case for people to invest at all in research. It should be noted here, though, that in effect Romer's model obtains non-convergence results by the same way that the neocl. one could, i.e. making part of knowledge non transferable beyond national boundaries (or outside the rich countries). On the other hand, we can argue that HK can be much more difficult to transfer than pure technical knowledge which often can be acquired by simply buying the machine; of course there exists a contradiction of making HK almost a public good within one country and non-accessible outside but it can be argued that, for example, through universal education it can be quite easy in a rich country to incorporate a change in knowledge by simply changing the curriculum, while poor countries which may not have formal education at all it is much more difficult to do so. Nevertheless, things like labour mobility can reduce such problems; of course, labour mobility is quite limited -and often of the 'wrong' way- but very little of it may be required to transfer a large part of 'knowledge': a single worker sent to learn a new technique abroad may suffice to transfer back a large portion of the relevant expertise.

The second type of models date back to Uzawa (1965) and more recently Romer (1990) and Lucas (1988). The essential difference of these models is that they identify a sector specializing in the production of ideas; this sector is monopolisticaly competitive, unlike those involved in the production of both (physical) K and cons. goods. Knowledge enhances productivity and is available to other sectors at virtually zero marginal cost i.e. technology is a non-rival imput which implies that we a production function with increasing returns to scale. Furthermore, in those models the supply of raw labour is allowed to grow at a const. rate and I in physical K is taken explicitly into account.

Romer (1990) maintains his assumption of increasing returns to HK while he also argues that physical K has const. returns. Furthermore, he has knowledge entering the production function in 2 distinct ways: a new design allows the production of a new intermediate good but also increases the total stock of increases the productivity of HK in the research sector. The owner of a new idea has certain property rights over its use in the production of (K) goods but not over its use in research. This model by allowing firms to capture at least part of the benefits of their innovations, allows research to be explained - in Schumpetarian fashion- in terms of profit-maximising behaviour, so the influence of such variables as interest and tax rates is even clearer. The results as far as convergence is concerned are as before: countries with higher stocks of HK enjoy higher growth rates.

Lucas differs in his view on the accumulation of HK which he makes more like the acquisition of skills and less like research in that for example he sees HK as a rival good, although here too it is assumed that HK does not dissipate with the death of an individual person. HK here is non-excludable which obviously begs the question of how and why is knowledge produced at all. The rate of growth of HK is proportional to the time spent in training, i.e. we have const. costs of producing HK while he also assumed (at least) constant returns to HK.** This means that an economy beginning with low levels of physical or human K will again permanently remain below an otherwise identical but initially better endowed economy but they will not diverge, i.e. they will -ceteris paribus- have the same growth rates. On the other hand, Lucas maintains the assumption that there are no diminishing returns* in the production of physical K so that again an increase in the (physical) I rate will permanently increase the rate of growth, even with a static level of HK.

Azariadis and Drazen have also formulated an interesting model which breaks away from the steady state solutions found by both Lucas and Romer. They work in a 2 year period overlapping generations model instead with an immortal agent model but their major innovation is that they have the returns of HK abruptly increasing at a series of thresholds with normal concavity holding between them. This means that we have multiple equilibrium paths differing in either the level of output or in the rate of growth, depending on the initial HK stock History (and policy) clearly matter greatly in such a model.

Another interesting model is that of Barro who makes public infrastructure rather than HK as the driving force of growth. Thus, the prod. function is extended to include govt. services which increase the productivity of private capital, so that we have const. (or increasing) returns to scale with respect to public goods and aggregate physical K. Barro points out, however, that we must also take into account that the increased provision of public goods will be financed by distortionary taxes, i.e. we have a trade-off. This public infrastructure framework can be extended to incorporate a large part of the HK thesis (e.g. publicly provided schooling) as well as such things as political instability which can be seen as inadequate protection of property rights.

Various other models have extended the analysis to take into account of the endogenous determination of fertility and population growth in general. Their results vary from model to model but they typically find multiple equilibria, usually a high fertility low growth Malthusian trap and a growth equilibrium driven by HK accumulation.

A rather more radical model is that M. Scott who abandons rather than modifies the neocl. prod. function on the grounds that the measure of K that appears there is fundamentally incorrect. The aggr. Prod. function is concerned with gross I less depreciation implying that depreciation is a physical process that reduces the productivity of K. However, machines that are properly maintained can run at their designed capacity long after the prod. function regards them as having been scrapped so many economists prefer to use gross I less scraping. Scott disagrees with that as well because machines are generally scrapped when they become profitless although they may be still be making things. In other words, depreciation for Scott is a relative price effect: machines become economically obsolete because of rising real wages. Thus, since they are not adding to net output, no productive K is lost when they are scrapped so the best measure of the change in K stock is gross I without depreciation. Of course, the sum of all past gross I does not provide a good measure of K stock since we do not know how much each piece of old K is contributing to output. This means that we should discard the idea of a prod. function that links the level of output to K and use instead the change in K to explain changes in output.

The second main innovation of Scott is that he treats I and technical progress as one and the same thing, i.e. he does not distinguishes between I in physical K and I in R&D. Scott supported this by arguing that it is very hard to distinguish between I in physical K and I in new technology since innovations are not only largely diffused through physical I but also are motivated and caused by the same factors which cause I - namely expected profitability. This reminds us of Arrow's similar views about learning by doing and I but the difference here is that Scott allows for intentional investment in research.

Another element of Scott's analysis is that he argues that on top of the 'standard' I externality we have a "long-run Demand externality" as well. This arises because if all firms increase I, the economy would grow faster and all firms would find their D-curves shifting faster to the right. [Having said all that, the conclusions (no convergence, histerisis, govt. intervention) of Scott are the same with Romer/Lucas? i.e. their difference is only econometric (how do we measure the K stock)?] Scott indeed showed that the 'Solow residual' of growth accounting which was attributed to (exogenous) Total Factor Productivity growth, disappears if we use gross I to explain econ. growth. Romer, however, has insisted that it is worthwhile to separate knowledge from I which, he argues, can explain why decades of heavy I in India have yielded so little in India and so much in S. Korea and Taiwan: in India I happened behind trade and foreign I barriers that kept out knowledge of new techniques and products, unlike the Asia dragons which were constantly open to a supply of new ideas.

Scott's insights have been pursued by King and Robson who specified a non-linear 'technical progress function' relating the rate of productivity growth to the I rate. He argued that initially it exhibits increasing returns but later decreasing returns because there is a limit to the rate at which ideas can be assimilated and do not survive to be used later. This means we have multiple equilibria, 2 of them are stable and that otherwise identical economies can be on a high or low growth paths entirely due to past history.

This model has the advantage of being able to explain how catching up can become overtaking as well as the existence of 'growth clubs'.

Another important issue in New Growth models is the role of international trade. As soon as we introduce increasing returns, int. trade becomes doubly important since anything that enlarges the market can increase growth while the allocation of competitive advantage becomes endogenous and can be an important determinant of growth. Lucas tried to illustrate the endogenous evolution of comparative advantage by focusing in the 'learning by doing' case. Commodities differ in the ease with which the acquisition of experience leads to lower costs. Lucas identified goods which are HK intensive as high technology goods and the allocation of comparative adv. depends on the initial distribution of HK. Countries specialising in high-tech goods will grow faster and, thus, reinforce their comparative advantage. This can help explaining divergence between poor and rich countries. [does this mean that free trade is against the interests of developing countries which could do better by also specialising in high-tech, HK-intensive sectors ?]

Kohn and Marion pose the question if it is unambiguously a good thing for a small economy to integrate its capital market with the rest of the world. This country will of course benefit from the standard gains-from-trade but if the world interest rate is higher than the domestic one, I will fall, lowering growth. Grossman and Helpman argue that potentially it is the less advanced economy which stands to gain the most from freeing of international trade since it can draw upon the stock of world knowledge but they recognise that technology transfers are by no means automatic. In the international product cycle, according to which inventions of new goods occur in advanced countries and later by imitation or technology transfers are produced in low wage less advanced economies, is favourable to both advanced and developing countries: in the former the migration of 'traditional' goods frees resources and in the later we have faster growth because of the technology transfers. On the other hand, the lags in the transfers of knowledge mean that convergence may not occur if the advanced countries develop new knowledge faster than the less advanced ones can copy the old one, depending on the resources spend in each country for innovation and learning/imitation respectively.

Up to now, much of the new work on growth has been abstract and theoretical but this is rapidly changing and the results seem encouraging. Barro, for example, found that lack of HK is what prevents poor countries from catching up. Other studies, based on the New Growth framework, have fond much higher feasible long-run growth rates for the reforming East-European economies due to their relatively high education standards while Baldwin found that the European 1992 programme would have dynamic effects as well as the standard ones found by the Cecchini report which was based on the traditional neocl. theory. On the other hand, evidence of increasing returns is ambiguous while there are problems in the empirical testing of these theories as the right data is often not available and often inadequate proxies have to be used (not all patents are of equal value nor HK is very well captured by years spent at school).

All those New Growth models, however, can be accused of having a very mechanistic and simplistic view of how technology grows and is applied by businesses.

They ignore, for example, the lumpiness and non continuous nature of technological growth, pointed out by Schumpeter who saw inventions occurring in pulses leading to I booms and 'creative gales of destruction'. Such considerations could also help incorporating short-run trade cycle theory with long-term growth, which is another issue largely ignored by New Growth theories as Solow pointed out.

Many other issues are also ignored by New Growth theories such as the importance of competition, the misallocation of resources among productive sectors which is common in many developing countries, inflation and the importance of macroeconomic policies. Olson has also argued that young societies grow more rapidly than mature ones because they have not yet been slowed down by the actions of "distributional coalitions" i.e. rent seeking pressure groups such as trade unions or farmers. However, these omissions are not really criticisms of New Growth theories but rather calls for their extension and elaboration and indeed these theories appear to provide fertile ground for such extensions such as the incorporation of endogenous population growth.

A more radical criticism against both the New Growth theories and their neocl. predecessor (and probably a large part of conventional economic theory) are the "Cambridge" attack on the aggregate production function by J. Robinson in particular. The assumption of 'malleable capital' (i.e. viewing K goods as if they were homogeneous and non-specific) is criticised as unrealistic and the use of marginal productivity theory to determine the real rate of profit is said to involve circular reasoning in a world with diverse K goods. This is so because in such a world the K stock has to be measured in money terms by weighting each good by its price and then use this K to determine the profit rate. But wages and profits enter into the prices of K so the rate of profit must be known in order to determine the size of K. [? what about simultaneous determination of profits and K prices ?] Another criticism is that the interest component in the price of a K good will vary depending on the length of time it takes to produce it so as different techniques differ in the length of time necessary to produce K, changes in interest rates may affect the costs of using these techniques in different ways. Thus, there is no need for the neocl. assumption (maintained in New Growth models) of a downward sloping I function with respect to the interest rate. However, these criticisms, though largely valid, have not been accompanied with a comprehensive alternative theory.

Concluding, the New Growth theories are very important in focusing attention to the vital role of I in generating growth which was lost in Solow's model, on demonstrating the importance of govt. policy and of past history and of course explaining the international lack of convergence of growth rates making growth theory much more realistic. Indeed there is little doubt that New Growth theory is developing into the new orthodoxy, helped no doubt by that it is seen as largely an extension of the original neocl. model. On the other hand, no claim of generality can be sustained by any model, leading to an often confusing proliferation of special and often conflicting assumptions. Furthermore, considerable work is needed yet for their policy prescriptions to escape from being over-general and largely commonplace. As far as convergence is concerned, though they do explain non-conv. and even divergence, we must not forget that this conclusion is solely based on their assumption of no knowledge transfers which range from very plausible (in the infrastructure case for example) to the really precarious (in the R&D version). We are, thus, eagerly awaiting for new developments in probably one of the most dynamic area in economics today.

[should we have mentioned the Harrow-Domar model in this essay? It has some interesting implications for convergence while in a way it is an endogenous growth theory since the actual growth rate depends on endogenous parameters. In any case, I didn't include it so as to keep the essay size within tolerable limits.]