Economic Growth, Catching Up, Falling Behind and Getting Ahead

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INTRODUCTION

Moving beyond firm-led racing patterns revolving in a particular industry to a clustering of racing on an industry level is putting industry in different geo-economic zones against each other as they are becoming dominant in strategic product/process technologies. Here racing patterns among industries in a relatively free trade environment could lead to competitive advantages , more wealth creating and accumulating skill dominance in key product / process technologies in one region at the expense of others. The question is whether individual races on the firm level induce alike races on the industry level and if so, what controlling effects may be rendered by regional or multilateral policies on regulatory, trade and investment matters.

Similar catch-up processes are taking place between leaders and followers within a group of industrialized countries (or even emerging economies) in pursuit of higher levels of productivity. Moses Abramovitz (1986) explains the central idea of the catch-up hypothesis as the trailing countries' adopting behaviour of a 'backlog of unexploited technology'. Supposing that the level of labour productivity were governed entirely by the level of technology embodied in capital stock, one may consider that the differentials in productivities among countries are caused by the 'technological age' of the stock used by a country relative to its 'chronological age'. The technological age of capital is an age of technology at the time of investment plus years elapsing from that time. Since a leading country may be supposed to be furnished with the capital stock embodying, in each vintage, technology which was 'at the very frontier' at the time of investment, 'the technological age of the stock is, so to speak, the same as its chronological age'. While a leader is restricted in increasing its productivity by the advance of new technology, trailing countries 'have the potential to make a larger leap as they are provided with the privilege of exploiting the backlog in addition of the newly developed technology.

Hence, followers being behind with a larger gap in technology will have a stronger potential for growth in productivity. The potential, however, will be reduced as the catch-up process goes on because the unexploited stock of technology becomes smaller and smaller. This hypothesis explains the diffusion process of best-practice technology and gives the same sort of S-curve change in productivity rise of catching-up countries among a group of industrialized countries as that of followers to the leader in an industry. Although this view can explain the tendency to convergence of productivity levels of follower countries, it fails to answer the historical puzzles why a country, the United States, has preserved the standing of the technological leader for a long time since taking over leadership from Britain in around the end of the last century and why the shifts have taken place in the ranks of follower countries in their relative levels of productivity, i.e., technological gaps between them and the leader. Abramovitz poses some extensions and qualifications on this simple catch-up hypothesis in the attempt to explain these facts. Among other factors than technological backwardness, he lays stress on a country's 'social capability', i.e., years of education as a proxy of technical competence and its political, commercial, industrial, and financial institutions. The social capability of a country may become stronger or weaker as technological gaps close and thus, he states, the actual catch-up process 'does not lend itself to simple formulation'. This view has a common understanding to what Mancur Olson (1996) expresses to be 'public policies and institutions' as his explanation of the great differences in per capita income across countries, stating that 'any poorer countries that adopt relatively good economic policies and institutions enjoy rapid catch-up

growth'. The suggestion should be taken seriously when we wish to understand the technological catching-up to American leadership by Japan, in particular, during the post-war period and explore the possibility of a shift in standing between these two countries. This consideration will directly bear on the future trend of the state of the art which exerts a crucial influence on t the development of the world economy.

Steering or guiding the process of racing through the pursuit of industrial policies aims to increase competitive advantage of respective industries, as having been practised in Japan (Gottinger,2006), in that it stimulates catch-up races but appears to be less effective in promoting frontier racing. A deeper reason lies in the phenomenon of network externalities affecting high-technology industries. That is, racing ahead of rivals in respective industries may create external economies to the effect that such economies within dominant 'increasing returns' industries tend to improve their international market position and therefore pull ahead in competitiveness vis-à-vis their (trading) partners (Krugman, 1997). The point is that racing behaviour in leading high technology industries by generating frontier positions create cluster and network externalities pipelining through other sectors of the economy and creating competitive advantages elsewhere, as supported by the 'increasing returns' debate (Arthur, 1996). In this sense we speak of positive externalities endogenizing growth of these economies and contributing to competitive advantage.

Based on industry specific studies across industrial sectors (Gottinger, 2006) we briefly recall the pattern of industrial racing and the implications of the way the firms in major high technology markets, such as telecommunications, split clearly into the two major technology races, with one set of firms clearly lagging the other technologically. The trajectories of technological evolution certainly seem to suggest that firms from one frontier cannot simply jump to another trajectory. Witness, in this regard, the gradual process necessary for the firm in the catch-up race to approach those in the frontier race. There appears to be a frontier 'lockin' in that once a firm is part of a race, the group of rivals within that same race are the ones whose actions influence the firm's strategy the most. Advancing technological capability is a cumulative process. The ability to advance to a given level of technical capability appears to be a function of existing technical capability. Given this path dependence, the question remains: why do some firms apparently choose a path of technological evolution that is less rapid than others. Two sets of possible explanations could be inferred from our case analysis, which need not be mutually exclusive. The first explanation lingers primarily on the expensive nature of R & D in ICT industries which rely on novel discovery for their advancement. Firms choosing the catch-up race will gain access to a particular technical level later than those choosing the frontier, but will do so at a lower cost. How does this process on the micro level correspond to the one on a macro level?

ECONOMIC DEVELOPMENT: BACKWARDNESS AND CATCHUP

We can view the growth literature as consisting of three distinct theoretical explanations of growth: the first is the neoclassical growth model which predicts country convergence; the second is the endogenous growth model which, in general, predicts country divergence; and the third is the correlating theory of economic development which takes a more historical perspective on the growth of countries. The neoclassical model is based on diminishing returns to factor inputs and view the long-run rate of growth as being exogenous. Endogenous (or New) growth theory considers constant or increasing returns to factor inputs and attempts to explain the forces that give rise to technological change. Development theory includes a wide variety of approaches to economic catch-up including technological change [(Gerschenkron (1962), Abramovitz (1986)), neoinstitutional economics [North (1990), Eggertsson (1990)] and theories of institutional sclerosis [Olsen (1982)]. These three theoretical explanations are not mutually exclusive categories and many papers belong to more than one category. For example, Abramovitz (1986) fits also within the neoclassical explanation, but we choose to place him in the development camp.

We study whether the neoclassical model can explain the empirical finding of relative income shifts. When finding the standard neoclassical model insufficient, we extend it using ideas from the development approach, thus adding some endogeneity to the resulting model. The research is not a direct extension of the early papers mentioned above. Since 1986, in particular, there has been a flood of papers which deal with the growth of nations, catch-up, and transfer of technology.

The importance of a nation's institutional framework [such as government regulation and laws] to growth is probably shared by most, if not all, people and economists. Surely the existence of positive and negative externalities, the legal environment, property rights, transaction costs, culture and environmental pressures will affect the growth of a nation (Gottinger, 1998) .However, the neoclassical model neglects these factors in an effort to clearly show the implications of a competitive market structure. In addition to factor accumulation and institutional soundness, technology also plays an important role in growth. Thus, part of our argument addresses technology diffusion, a concept dating back to Gerschenkron (1962) who proposed in Economic Backwardness in Historical Perspective that a backward country by the very virtue of its backwardness, will tend to develop very differently from the advanced country. He states that "industrialization always seemed the more promising the greater the backlog of technological innovations which the backward country could take over from the more advanced country." (p.6). The important idea that catch-up might occur due to a backlog of technology will not be traced back historically. Suffice it to say that it is an idea which is far from dead as exemplified by recent papers in the American Economic Review: Papers and Proceedings 1996 [Crafts (1997), Romer (1997)]. These ideas are clearly expressed in a paper by Abramovitz (1986) from which we derive much motivation for what follows. It is worth pointing out, however, that modern development economics emphasizes the importance of ideas, which are also emphasized in the endogenous growth models. The model we look at has some endogeneity in it, but it is also an extension of the neoclassical model.

Abramovitz (1986) asserts that being backward in level of productivity carries a potential for rapid growth [the catch-up hypothesis]. If the level of labour productivity were given by the level of technology embodied in the capital stock, then the "leading" country's capital stock embodies the frontier technology at the time of investment, therefore, as Abramovitz states "the technological age of the stock is ... the same as its chronological age."

For a follower country the technological age of its capital stock will be high relative to its chronological age. Therefore, when a leader nation invests in new capital its technology advance is limited by the advance of knowledge. For the follower, however, investments into new capital have the potential of a larger leap as the new capital could embody frontier technology. Thus, the larger the productivity gap the stronger is the potential for growth in productivity, other things held constant. This is the catch-up hypothesis in its simple form. Note its similarity to the factor accumulation argument made earlier. The argument laid out by Abramovitz does not end here though. Technological backwardness is not usually a historical accident, societal characteristics probably account for a large portion of a country's past failure to achieve a high level of productivity. These same characteristics, or social capabilities, may remain to keep a country from making the full technological leap proposed by the simple hypothesis. This implies that the simple catch-up hypothesis needs some modification. Abramovitz argues that "a country's potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced." Thus being technologically backward is a necessary condition for catch-up, but it is not sufficient. A follower nation must also be able to adopt and adapt the technology which is potentially available to it. These intuitively appealing ideas have been missing from the empirical growth literature and we will point out how consistent they will be with this literature.

Convergence

Baumol (1986) showed that convergence could be observed in some groupings of countries [industrialized market economies and planned economies], but not in others [less developed economies]. The groups which displayed convergence were then called "convergence groups. De Long (1988) criticizes

Baumol for performing a regression that uses an ex post sample of countries which are rich and developed at the end of the period, and argues for the use of an ex ante sample. De Long then shows that such a sample does not exhibit convergence. The conclusions and results presented in the papers of Baumol and De Long may not be as relevant as their impacts on empirical growth studies. The important point for the evolution of growth theory is the fact that convergence 'clubs' as well as divergence 'clubs' had been identified. In particular, the world as a whole showed evidence of divergence. Two theoretical frameworks have been used to explain these results. One attempts to explain convergence [the neoclassical growth model], the other divergence [the endogenous, or new, growth model].

At first, the empirical convergence literature tried to find out what the steady state distribution of world per capita income and productivity would look like. This is the question which motivated Abramovitz (1986) and Baumol (1986). Since then the empirical growth literature has mostly attempted to explain the cross-country data; in particular, to explain convergence and rates of convergence and to interpret the findings in the context of neoclassical and/or endogenous growth theory. However, as mentioned by Romer (1986), cross-country comparisons of growth rates are complicated by the difficulty of controlling for political and social [institutional] variables that strongly influence the growth process. Thus one must attempt to control for these political and social variables.

There have been many studies using the neoclassical model and its steady state predictions to identify the sources of growth. First of all, if all economies have the same steady state then unconditional convergence is expected; that is, economies with low initial incomes should have higher growth rates. If economies differ in their steady states, then conditional convergence should be observed; that is, after controlling for steady state differences, initial incomes should be negatively related to growth rates. Not all convergence studies choose to consider the steady state, some take a more direct growth accounting approach. The end results are essentially the same in terms of sources of growth, but the latter approach is not able to consider the transitional dynamics.

Early catch-up literature showed much concern for technological backwardness while the endogenous growth theory highlights the importance of technology.

Endogenous growth theory emerged out of dissatisfaction for basically two things: first, some growth theorists were not happy with the exogenously driven explanations of long-run productivity growth, and secondly, the data for large samples of countries did not show convergence. This led to a construction of models where the determinants of growth are endogenous. Romer (1986) and Lucas (1988) are usually mentioned as the instigators of this movement. The Romer (1986) model contains increasing returns as a result of accumulation of knowledge which has a positive external effect on the production possibilities. Lucas (1988) is based on learning-by-doing which lead to [external] increasing returns to scale in the production process. Neither model postulates a theory of technological change. However, research and development, imperfect competition, and internal returns to scale were added to this class of models in Romer (1987, 1990), Grossman and Helpman (1991), Aghion and Howitt (1992), and Jones (1995). Technological advance is the result of R&D activity which is rewarded some ex-post monopoly power. This means that, as long as the economy does not run out of ideas, the growth rate can remain positive in the long run. Also, the long-run growth rate is now dependent on government policies.

Less work has been done on the magnitude of international R&D spillovers; how R&D expenditures in one country affect the growth of other nations. Nadiri and Kim (1996) do provide a study of, among other things, how R&D spillovers have affected the productivity of the G7 countries. International spillovers are shown to significantly affect the growth of total factor productivity for all seven countries. The importance of own R&D to foreign R&D spillovers vary across countries, e.g. for the U.S. own R&D is much more important than spillovers, while for countries like Canada and Italy foreign R&D is more important than own R&D for their productivity growth.

AGGREGATE LEAPFROGGING

We will argue that 'leapfrogging', i.e. shifts of relative income positions, is important and a significant characteristic of cross-country growth. Given this, the question is whether the growth models discussed above are consistent with leapfrogging. The neoclassical growth model has attempted to explain the cross-country data in terms of convergence and rate of convergence. The Solow model predicts, in general, that countries converge to their own steady states; it assumes identical technologies in all countries and concludes that exogenous differences in saving and education are the cause of all observed disparity in levels of income and rates of growth. The neoclassical model's predictions with regards to leapfrogging are apparent: in a group of homogeneous countries [as defined by the similarity of steady states] no leapfrogging should be observed. The diminishing return to capital provides a vehicle for convergence, but there is no mechanism for shifts in relative positions. If, however, countries are approaching different steady states, then positions might change due to the transitional effects as shown by Jones (1995). Also, if a random disturbance is added to a model which contains a convergence force, then one would expect shifts in relative income positions. As mentioned in Easterly et al. (1993), if there is a large dispersion of distances between countries' initial incomes and their steady states then the transitional effect will dominate the effect of random shocks. New growth theory has appeared in reaction to the neo-classical model. These models consider non-convexities and economies of scale, and, in particular, focus on the incremental change in technology. In these models, investments into human and physical capital make either the same or an increasing contribution to output as economies become richer. Hence, the "predictions" of the early endogenous growth models are that technical change proceeds most rapidly in those countries with established advantages in technologically advanced sectors, the "leaders". This implies economic and technical divergence between nations and no leapfrogging should be observed. However, in general, endogenous growth models can lead to a variety of growth experiences. Different starting conditions and the fact that government policies are allowed to make a difference can lead to leapfrogging. For example, if long-run growth is a function of the amount of R&D conducted in a nation, then a follower could leapfrog by allocating funds to R&D.Lately a few endogenous growth models have in fact approached the issue of overtaking, discussing either growth miracles [Lucas (1993)] or leadership change [Brezis, Krugman, and Tsiddon (1993)]. A more general treatment can be found in Goodfriend and McDermott (1994). Parente and Prescott (1994) provide a recent attempt to simultaneously account for disparity in income levels and growth miracles. Their model is based on differences in technology adoption barriers which may lead to both income differences and, if persistently reduced, to development miracles.

Modern development economics argues that a technology gap presents an opportunity for rapid growth through technology flows, but a country's ability to absorb the new technology must also be considered. A low absorption capability makes it difficult for a country to take advantage of its opportunity. Since poor developing nations typically suffer from both a large technology gap and a low absorption capacity, the predictions about rate of growth and convergence are ambiguous. However, high indicators of absorption capacity [e.g. high level of education or "good' institutions] imply a faster rate of growth for a country which faces a given technology gap, hence the possibility of leapfrogging.

Cross Country Performance in Leapfrogging

Looking at the OECD sample it is apparent that the nations' growth paths cross. They show the countries' per capita GDP relative to the U.S. over the period 1960-90. The U.S. is the income leader for most of the years [Switzerland obtained the leader position a few times over the sample period]. Three countries in particular shifted income positions. Japan went from being one of the poorest countries in 1960 [rank 19] to become quite wealthy [rank 8] in 1990. Japan appears to be a growth miracle. The same can be said for Norway which advanced from rank 12 to 4 over the sample period. In contrast, New Zealand made a rapid descent through the relative income positions [from 3 to 17],

earning the title growth disaster. However, most of the rank movements take place among the middle countries [those ranked 3 to 16 in 1960] which are close in per capita GDP levels. For these countries leapfrogging could be due to random disturbances or heterogeneous shocks. A closer examination of the rankings reveals that it is very common for two countries to switch positions, only to immediately switch back. A few examples are: Germany and the U.K. from 1961 to 1968, Japan and Italy between 1971 and 1980 [these two countries changed positions six times only to end up at the same place in 1980], and the U.S. and Switzerland up until 1975. This shows that much of the rank dynamics are driven by short-term fluctuations. These rank movements are most likely due to country-specific fluctuations, such as lagged business cycles, and represent what this paper calls randomness. One way to remove this from the data is to consider a longer time period than one year for the analysis. Panel studies often consider 3-5 year time intervals to side-step the influence of business cycles.

CONCLUSIONS

This paper has addressed several important issues related to the growth and performance of nations. We discussed and provided some tools to analyze some patterns of catching up, falling behind and getting ahead that we identify with aggregate technological racing among nations or regional economic entities.

In a Solow type model adoption of technology becomes one possible mechanism through which the effective capital stock may increase. The impact of social institutions arises by allowing the potential technology gap to be modified by them.

In identifying technological racing among countries, model predictions and empirical observations indicate that follower countries, in striving for catching up, significantly benefit from the technology gap to the leader and that adoption rates vary between them. This variance could be mostly contributed to the 'social capabilities' of those countries that demonstrate various 'efficiency levels' of adoption promoted by bureaucratic efficiency (including a low level of corruption) and democratic rights (Economist, 2005) – though it is naturally difficult and needs further research to pinpoint the specific types of institutions that act 'as driving forces behind countries' inefficiencies and some of the institutional factors may show some trade-off pattern between them, thus limiting the net impact of each of them. A good in case in point is Latin America which carries relatively high adoption rates but overall the region fails to take advantage of its potential because of poor political and social institutions. Other interesting cases relate to Japan, Korea and the emergence of economic rivalry between China and India (Economist, 2005), (North, 2005). A similar case pointing to institutional inertia relate to divergences in EU Europe (Baily and Kirkegaard, 2004) and elsewhere (Uzawa, 2005).

Unlike tracing technological rivalry among corporations and industrial entities with clearly defined market conditions the results one obtains from the aggregated data can only point toward 'more aggregate' explanations for the factors behind cross-country growth processes. Yet, a few key factors could be singled out. First of all, we can conclude that technology diffusion is an important source of growth of follower nations. Furthermore, countries seem to differ significantly in their ability to take advantage of newer and better technology. Thus, in general, any policy that allows follower nations to better adopt foreign technology should increase their growth rate, at least in the short-run. Since the difference in technology adoption appears to be related to a nation's institutional efficiency, research suggests that governments are well-advised to pursue policies that increase the efficiency of markets. That is, improved technology adoption is an added motivation for the pursuit of efficient institutions. For example, consider two follower nations that face identical initial technology gaps. Their growth paths will be very different according to their ability to close this technology gap. If a nation does not incorporate foreign technology into their production it will have to rely solely on accumulation of factor inputs as a source of growth. If, on the other hand, the economy adopts better technology, then rapid growth is expected until the technology gap is removed, at which time the

nation is left with factor accumulation or the coming up with new ideas as the sources of growth. However, the latter nation will be richer [more productive] at all points in time. To conclude this argument, higher income can be achieved not only from increases in the savings rate [the neoclassical prediction] but also from institutional change.

REFERENCES

Abramovitz, Moses, (1986) "Catching Up, Forging Ahead, and Falling Behind, "Journal of Economic History, Vol. 46, no.2, pp. 385-406.

Aghion, Phillipe and Peter Howitt, (1992) "A Model of Growth through Creative Destruction," Econometrica, 60: 323-351.

Bailey, Martin and Jacob Kirkegaard (2004), "The Landlocked Continent", The WSJ, December 6

Barro, Robert J., (1994) "Democracy and Growth," NBER Working Papers # 4909.

Barro, Robert J. (1997) Determinants of Economic Growth: A Cross-Country Empirical Study, Cambridge, MA: The MIT Press.

Barro, Robert J. & Xavier Sala-i-Martin (1992) "Convergence," Journal of Political Economy 100(2), pp. 223-251.

Barro, Robert J. and Xavier Sala-i-Martin, (1995), Economic Growth, New York, McGrawHill.

Baumol, William J., (1986) "Productivity Growth, Convergence and Welfare: What the Long-Term Data Show," American Economic Review, 76, pp. 1072-1085.

Brezis, Elise S., Krugman, Paul R. and Daniel Tsiddon, (1993) "Leapfrogging in International Competition: A Theory of Cycles in National Leadership," American Economic Review, 83(5): 1211-1219.

De Long, J. Bradford, (1988) "Productivity Growth, Convergence, and Welfare: Comment," American Economic Review, 78(5), pp. 1138-1154.

Easterly, William, Kremer, Michael, Pritchett, Lant and Lawrence H. Summers, (1993) "Good Policy or Good Luck? Country Growth Performance and Temporary Shocks," National Bureau of Economic Research (NBER) Working Paper # 4474.

The Economist (2005), 'The tiger in front. A survey of India and China, March 5, pp.3-16

Eggertsson, Th., (1990) Economic Behavior and Institutions, Cambridge University Press.

Gerschenkron, A. (1962), Economic Backwardness in Historical Perspective, Cambridge, MA, Belknap Press.

Gottinger, Hans-Werner (1992),"Optimal Economic Growth when CO2 Constraints are Critical", Energy Economics 10, pp.192-199

Gottinger, Hans-Werner (1998), Global Environmental Economics, Boston: Kluwer Academic Publishers

Gottinger, Hans-Werner (2006), Innovation, Technology and Hypercompetition, London: Routledge

Grossman, Gene and Elhanan Helpman, (1991) Innovation and Growth in the Global Economy, Cambridge, MA: the MIT Press.

Hirschman, A.O. (1958), The Strategy of Economic Development, New Haven: Yale Univ.Press

Jones, Charles I., (1995) "Convergence Revisited," mimeo, Stanford University.

Jones, Charles I. (1995a) "R&D-Based Models of Economic Growth," Journal of Political Economy, 103, pp. 759-784.

Jones, Charles I. (1995b) "Time Series Tests of Endogenous Growth Models," Quarterly Journal of Economics, pp. 495-525.

Krugman, Paul (1997), "Myths and Realities of U.S. Competitiveness", Chap. 6 in P. Krugman, Pop Internationalism, Cambridge, MA: MIT Press

Lucas, Robert E. Jr., (1988) "On the Mechanics of Economic Development," Journal of Monetary Economics, 22: 3-42.

Lucas, Robert E. Jr., (1993) "Making a Miracle," Econometrica, 61(2): 251-272.

Mankiw, N. Gregory, Romer, David and David N. Weil, (1992) "A Contribution to the Empirics of Economic Growth," Quarterly Journal of Economics, 107, pp. 407-437.

Mauro, Paolo, (1995) "Corruption and Growth," Quarterly Journal of Economics, August, pp. 681-712.

Murphy, K.M., A. Shleifer, and R.W. Vishny (1989), "Industrialization and the Big Push", Journal of Political Economy 97, pp.1003-1026

North, Douglass C., (1990) Institutions, Institutional Change and Economic Performance, Cambridge: Cambridge University Press.

North, Douglas C. (2005), "The Chinese Menu (for Development)", The Wall Street Journal, April 7

Olson, Mancur, (1982) The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities, New Haven: Yale University Press.

Parente, Stephen L. and Edward C. Prescott, (1994) "Barriers to Technology Adoption and Development," Journal of Political Economy, 102(2): 298-321.
Pritchett, Lane, (1997) "Divergence, Big Time," Journal of Economic Perspectives, 11, pp. 3-17.
Romer, Paul M., (1986) "Increasing Returns and Long-Run Growth," Journal of Political Economy, 94, pp. 1002-1037.
Romer, Paul M., (1990) "Endogenous Technological Change," Journal of Political Economy, 98: S71-S 102.
Solow, Robert M., (1956) "A Contribution to the Theory of Economic Growth," Quarterly Journal of Economics, Vol. LXX, pp. 65-94.
Solow, Robert M. (1957) "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, 39, pp. 312-320.
Streeten, P., (1956), "Unbalanced Growth", Oxford Economic Papers, pp.167-190
Uzawa, H. (2005), Economic Analysis of Social Common Capital, Cambridge: Cambridge Univ. Press
Young, Alwyn, (1995) "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," Quarterly Journal of Economics, August, pp. 641-680.