Richard Nelson and Howard Pack. 1999. The Asian Miracle and modern growth theory. The Economic Journal vol. 109 (July), pp. 416-36.

TRADITIONAL GROWTH THEORIES

Capital accumulation growth theories (ex., Harrod and Domar) focus exclusively on capital formation because they assume that the state of technological knowledge at any one time is largely embodied in machinery and codified in blueprints. In this case:

$g = f(I)$, where g and I refer to growth and investment.

$g = kv$, where k=$\frac{\partial K}{K}$, and v=$\frac{dQ}{dK}$, where K and Q refer to stock of capital and output

Given that the marginal productivity of capital is technologically determined, and technology is automatically transferable and acquirable, the entire growth function is reduced to capital formation. Therefore, the rate of growth is determined by the rate of savings:

$$I \equiv S$$
$$g = f(S)$$

Neo-classical production functions do not had very much to this debate. By assuming that technology (t) is fixed and largely embodied in capital and transferable via blueprints, and that labour inputs (L) are determined by the rate of growth of the population, the neo-classical explanation of growth also collapses into the rate of capital formation determined by the rate of savings. Hence:

$y = k^{\alpha} l^{\beta} t$, where the powers refer to growth elasticities with respect to factors.

y=$\frac{\partial Y}{Y}$, $k = \frac{\partial K}{K}$, $l = \frac{\partial L}{L}$

If "t" and "l" are exogenously determined:

$y = f(k)$, where $k = I - a$, where "a" refers to amortization.

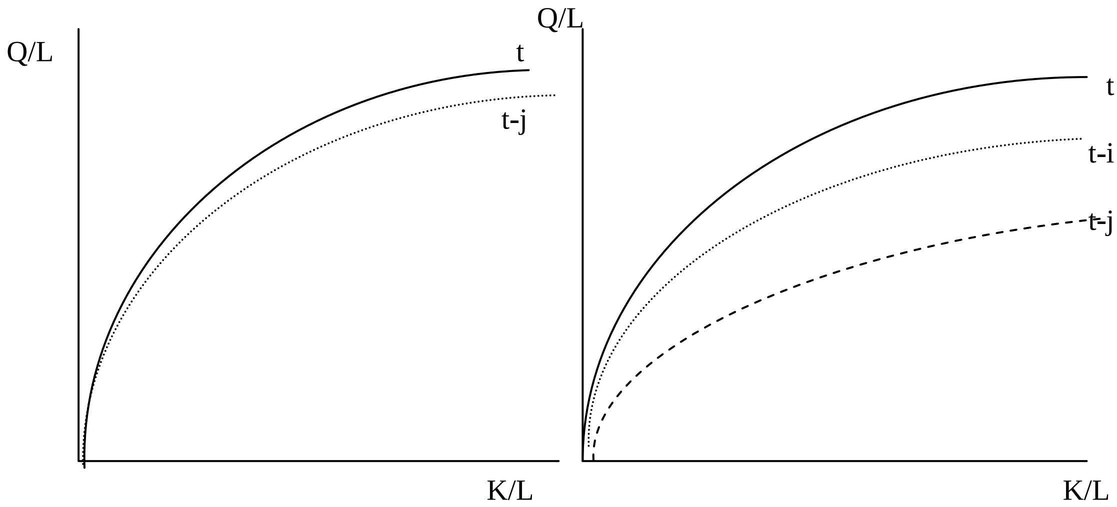
Thus, $y = f(S)$ as in the accumulation model.

In the neo-classical model, change in labour productivity (q/l) is mostly determined by changes in capital labour ratios (k/l), so that:

$$\frac{q}{l} = \frac{k}{l}$$
$$q = \frac{\partial Q}{Q}, \quad k = \frac{\partial K}{K}, \quad l = \frac{\partial L}{L}$$

where Q, K and L stand for output, stock of capital and stock of labour.

If the elasticity of substitution between capital and labour is high, productivity of labour is entirely due to capital intensity, and growth is mostly associated with growth of inputs. If the elasticity of substitution is low, a large change in capital intensity yields a small change in output. In this last case, other factors beyond capital intensity (ex, education, R&D, etc.) have to be accounted for.



(a) (b)

In graph (a), the elasticity of substitution is high. The firm knows everything about the new technology and is capable of using it at the highest level of efficiency straight away. Therefore, an increase in intensity of capital is immediately converted in higher labour productivity, with a very short learning period. In these circumstances, a combination of high returns on capital and rapid growth of capital is compatible with keeping high shares of capital. Hence, growth is determined by investment in capital formation.

In graph (b), the elasticity of substitution is low. An increase in capital intensity would only increase labour productivity by a small amount. The firm needs to learn about the new technology and to adapt it to production conditions; labour has to be trained; tacit component of knowledge is probably high. Hence, the learning period is longer and the learning curve significantly less steeper than in the graph (a). This is the case in which the productive assimilation of investment is as fundamental, if not more important, than capital formation in order to ensure growth.

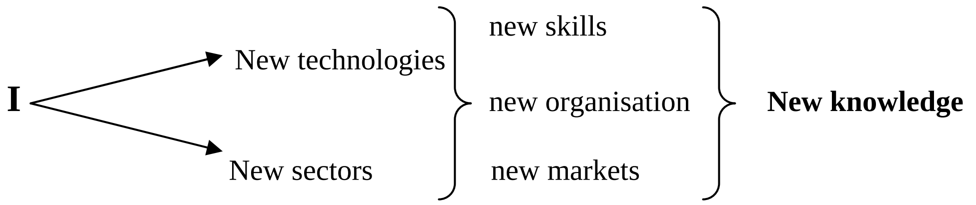
An examination of neo-classical production functions that attempt to prove the conditions of graph (a) shows that:

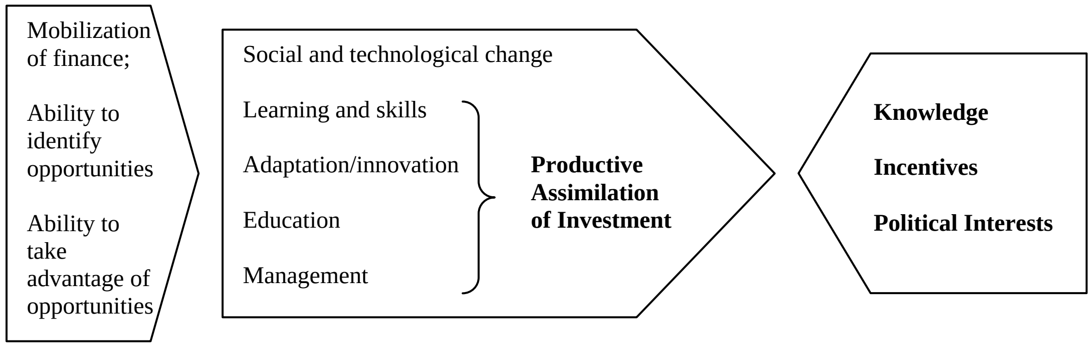
- all regressions are based on arbitrary sets of assumptions and limits (mostly about the nature of technological progress) which makes it possible to choose between them. Relaxing such assumptions or introducing others changes the results; and similar results can be obtained with different combinations of parameters;
- while the acquisition of capital equipment is enabled by I and provides the potential to improve productivity, labour productivity growth can only be attained if firms successfully engage in technological and organizational efforts to absorb, adapt and use efficiently each new technology. Otherwise, the technology may be available but productivity may not increase (period t-j in graph b) because the firm is unable to master the technology;
- most of this technological effort by firms, though benefiting from formal education, training and R&D, is not attributable to measurable formal R&D and education (ex, expenditure on R&D and education), but to continuous efforts by firms to learn about new technologies and opportunities, improve organization and management, train

workers, and undertake minor but cumulatively significant changes in the production process.

MODERN GROWTH THEORIES

For modern growth theories, economic growth requires capital investment; capital investment and economic growth generate new technologies and sectors of activity; which in turn require new skills, organization and management capacities. Thus, economic growth is a process of generating and mastering new knowledge, or, in other others, of guaranteeing the productive assimilation of investment. This means that investment in capital formation is far from enough to ensuring economic growth, because new technological and managerial challenges brought about economic growth and diversification and new investment are not easily transferable and acquirable. Specific effort has to be made for the economic agents to assimilate productively the new capacities that are potentially created by new investment, or to transform new capacities into higher labour productivity.





Economic growth can, thus, be seen as the process of increasing the productivity of labour or shifting labour from craft (low productivity) to modern (high productivity) sectors. Assuming that:

$$q_l^m > q_l^c$$

$$\beta w > w, \text{ as } \beta > 1$$

where q_l^m and q_l^c refer to labour productivity in the modern and craft sectors; w is the wage in the carft sector, and β is a premium on skilled labour wages.

The incentive to shift labour to the modern (higher productivity) sector is given by:

$$(q_l^m - q_l^c) > (\beta w - w)$$

This is, the economy faces an incentive to increase labour productivity (or shift labour from a lower to a higher productivity sectors) if the productivity gains exceed the premium on wages of skilled labour.

This model is obviously a simplification, because it assumes that capital costs per unit of output and output prices facing both sectors are the same, and that initial capital costs (fixed or sunk costs) are not significantly different. Therefore, the difference between productivity gains and skilled labour premium is all that matters. If these simplifying assumptions are relaxed, one has to consider that differences in fixed costs (which are linked with higher capital/labour ratios and economies of scale); capital/output ratios (which depend on the scale of operation and technology, as well as on X efficiency); output prices (associated with quality and diversity) are also crucial to determine whether a shifting of resources towards a higher productivity sector will ever occur.

In any case (in the simplified and in the complex scenarios), resource shift is also constrained by the ability to absorb and adopt new technologies and practices, and by the strength of the entrepreneurs that determine the rate of the shift. These two factors are the central elements for the assimilation theory, which states that growth depends on the ability to productively assimilate the new capacities created by new investment.

Therefore, the acceleration of the rate of change in the relative size of the modern sector is given by:

$$\frac{d \log \frac{K_m}{K}}{dt} = f\left(e, T, \lambda\right) = ew\left(\frac{1}{q_l^c} - \beta\frac{1}{q_l^m}\right)\left(1 - \frac{K_m}{K}\right)$$

where log (Km/K) refers to the rate of change of the relative size of the modern sector; and "e" is the quality of the entrepreneurship, T refers to education and λ is learning.

Thus, once Km=K, the whole equation collapses to zero, unless one assumes a dynamic relationship between Km and K such that:

$$K_t = K_{t-j} + K_{t-j}^m$$

This is, the definitions of “craft” and “modern” are dynamic, dynamically related and historically determined.

One can also observe, from the equation, that the acceleration of the rate of growth of the modern sector is constrained by four fundamental variables: the quality of entrepreneurship, the labour productivity in the craft and modern sectors, and the premium on higher productivity labour. Other things being equal, a higher level for “e” or q_l^m and a lower level for q_l^c accelerate the rate of change. As the differential between the productivity in the modern and craft sectors increases, so does the acceleration of the rate of change from the craft to the modern sector.

As β falls and/or w increases, the rate of change is also accelerated. This is an interesting point, that implicitly states that if the wage rate in the craft sector is sufficiently small, other things being equal the incentive to shift to the modern sector falls. However, it is unlikely that other things stay equal, as a very small wage rate in the craft sector may be associated with very low labour productivity in the craft sector; hence the rate of sectoral shift collapses into the differential between productivity gains and the size of the skilled labour premium.

It is also interesting to note that the larger and less productive the craft sector is, the more difficult it is to shift to the modern sector. This may be so because of three reasons: the level of entrepreneurship is weak; labour skills are low and so β will be very high; and the technological differential to catch up may be very high – although this differential may provide an incentive for change, the change may be constrained by the inability to identify the opportunity and to take advantage of it.

The shift to the modern sector also depends on the level of education and training, because it depends on the supply of skilled labour. As long as $(q_l^m - q_l^c) > 0$, as "e" increases the demand for skilled labour also increases. If the supply of labour falls behind β increases such that the result $(q_l^m - q_l^c) > (\beta w - w)$ becomes undetermined as it depends on the relationship between productivity gains and the premium on skilled labour wages (which may be very high if supply of skilled labour falls short of demand).

On the other hand, if the supply of skilled labour is high but "e" is low, skilled labour will be in excess supply. Although this may reduce β and give an incentive to change, it will not ensure that shift to the modern sector will be forthcoming due to low "e". More likely, the economy may face a process of brain drain, which increases the social costs of education and may lead to policies that reduce the supply of skilled labour. If "e" remains low, such policies may only reduce even further the level of "e" and the ability to assimilate productively new opportunities that investment may bring about. Thus, high "e" and low "β" are required so that:

- the incentive $(q_l^m - q_l^c) > (\beta w - w)$ is present and $\beta \frac{1}{q_l^m}$ becomes smaller and smaller;
- the incentive $(q_l^m - q_l^c) > (\beta w - w) > 0$ is identified and taken by the economic agents; and
- given an adequate supply of skilled labour, the absorption of new technology and practices is made possible.

The entrepreneurial ability, e, can be enhanced by policies that (i) target exports, because of quality and standards, economies of scale and productivity and the learning impact of operating in exporting markets; and (ii) keep the real exchange rate constant, such that entrepreneurs can focus of learning and productivity rather than on monetary instability.

On the other hand, the labour productivity in the modern sector, q_l^m, can be enhanced by education and technological change, as well as the institutional setting under which production and learning take place.

Hence, it seems that the "accelerator" equation is an interesting starting point for analysis, but that the fundamental issue is to understand the dynamics of the relationship between the variables. Furthermore, the potential linkages between variables do not necessarily happen automatically, but require specific efforts; for example, learning requires investment in learning (time, organization and resources) in addition to technological change and education. Finally, incentives are by no means sufficient to result in sectoral shifts: they are important, but as important are the ability to identify and take advantage of the opportunities and the interest in doing so.

SUMMARY OF THE ARGUMENTS

	Accumulationists	Assimilationists
Emphasis	Capital formation ($k=I-a$)	Productive assimilation of I.
Investment	Sufficient condition ($g=f(I)$)	Requiring productive assimilation
Technology	Embodied and blueprint. All technology improvements are movements along the production function, local or international.	New technology to a firm, even if old in the world, as to be assimilated. Learning requires time, effort and practice.
Education	Investment in human capital. Added to physical capital formation to form total capital formation	Necessary condition for learning and acquisition of new technologies, as well as to ensure adequate supply of skills
Exports	Natural outcome of investment and comparative advantages.	Provides incentives to learning; imposes standards that require learning; provides contact with existent knowledge and information; helps economies of scale to develop.
Growth process	$g=kv$ (Harrod-Domar) $y=\alpha k$ (neo-classical production function)	A process of productivity increase through modernisation, that requires entrepreneurial ability, education, learning and mastering of technologies and capital formation.

OPPORTUNITIES FOR POLICY