The Economic Journal, **109** (*July*), 416–436. © Royal Economic Society 1999. Published by Blackwell Publishers, 108 Cowley Road, Oxford OX4 1JF, UK and 350 Main Street, Malden, MA 02148, USA.

THE ASIAN MIRACLE AND MODERN GROWTH THEORY*

Richard R. Nelson and Howard Pack

The article argues that the rapid growth in a number of Asian economies that occurred between 1960 and 1996 was accompanied by a major change in the structure of their economies including shifts in the size of firms and the sectors of specialisation. These changes were a fundamental component of the growth process. While capital accumulation was an important source of growth, its productive assimilation was a critical component of the success of these economies. Estimates of the contribution of total factor productivity to aggregate growth that neglect these phenomena may lead to erroneous estimates.

Over the past thirty-five years Korea, Taiwan, Singapore, and Hong Kong, have transformed themselves from technologically backward and poor, to relatively modern and affluent economies. Each has experienced more than a four fold increase of per capita income over the period. It took the United Kingdom, the United States, France and Germany eighty years or more, beginning in the 19th century to achieve such growth although the Japanese did it even more quickly, between 1952 and 1973. Each now has a large number of firms producing technologically complex products competing effectively against rival firms based in the United States, Japan, and Europe. The growth performance of these countries has vastly exceeded those of virtually all other economies that had comparable productivity and income levels in 1960. On these grounds alone the question of 'how they did it' obviously is of enormous scientific and policy importance.

The crisis of late 1997 and 1998 may have tarnished the 'Asian Miracle'. However, their human, organisational, and physical capital remain intact, and GNP at purchasing power parity in Korea and Taiwan is far above that of their peer countries in 1960 such as Ghana and Mexico. Despite their recent difficulties it is important not to forget that their move from poverty and economic and technological backwardness to relative affluence and economic and technological modernity over a space of less than forty years has been something of a miracle. This article argues that the absorption or assimilation of increasingly modern technology and the change in industrial structure has been the critical component of this process. The learning that underlay assimilation was instrumental in preventing a decline in the marginal product of capital despite the rapid growth in the capital-labour ratio generated by the very high investment ratios in these economies. In turn, learning reflected the

* We would like to thank M. Abramovitz, G. Akerlof, M. Gersovitz, B. Kogut, K. Pavitt, V. Ruttan, James Tybout, L. Westphal, S. Winter, and participants in seminars at the Canadian Institute for Advanced Studies, Columbia University, IASSA, the Johns Hopkins University, and Yale University for comments on earlier drafts. Christopher Bliss and two anonymous referees provided extensive and helpful comments. Pack has received research support from the University of Pennsylvania Research Foundation and the World Bank Development Research Group.

Mu-Yen Hsu provided excellent research assistance.

interaction of a favourable policy environment (in which innovation was rewarded) and the entrepreneurial efforts of firms.

Section 1 sets out the view that assimilation of technology was a critical component of the 'Asian Miracle' and presents a model that focuses on the change in industrial structure facilitated by the efficient absorption of modern technology. The model generates most of the major stylised facts of Asian development. Section 2 delineates an alternative view, namely, that physical and human capital accumulation were sufficient to account for the unprecedented growth and analyses the statistical efforts that support this interpretation. Section 3 presents cross-country evidence on the relative Asian performance. Section 4 assesses the alternative views of the newly industrialised countries' (nics) development. Section 5 presents conclusions.

1. The Technology Assimilation Interpretation of Asian Development

1.1. *The Policy Context*

After brief interludes of import substituting industrialisation, Korea, Taiwan, and Singapore switched to increasingly liberal trade policies while Hong Kong was always a free trade entrepôt. Korea and Taiwan provided substantial export incentives while gradually lowering trade barriers. When protection was granted in the home market, especially in Korea, it was tied closely to export performance. The granting of low interest loans was also contingent, especially in Korea, on firms meeting export targets. Firms were able to obtain inputs needed for producing exports at international prices as a result of a tariff rebate system. Subsidised credit was also tied to export success. Hence, individual firms had strong incentives to improve efficiency to enable them to export rather than to engage in rent seeking in the domestic market. A relatively stable macroeconomic environment characterised by limited inflation relative to many developing countries provided the overall context. Rarely did the real effective exchange rate appreciate and such episodes were quickly corrected.[1] Manufacturers were thus able to concentrate on improving productivity rather than coping with rapidly changing relative prices of inputs and outputs. Within this context, the countries in question experienced 5% or more growth in per capita income over a period of 30 to 35 years.

While this paper will focus on the determinants of supply growth, the policy environment was obviously a critical component of the success in these countries.[2]

1.2. *Assimilation Theories of Asian Growth*

Over the last dozen years a number of different views have been put forth attempting to explain the 'Asian Miracle' (Amsden, 1989; Kim and Lau, 1994;

[1] For more detailed discussion of the policy background discussed in this paragraph see Little (1982), Pack and Westphal (1986) and World Bank (1993).

[2] The political process leading to the policies is discussed by Campos and Root (1996).

Krugman, 1994; Pack and Westphal, 1986; Rodrik, 1995; Stiglitz, 1996; Westphal *et al.*, 1985; World Bank, 1993; Young, 1995). One set of views that we denote by 'assimilation' theories, stresses the entrepreneurship, innovation, and learning, all encouraged by the policy regime, that these economies had to go through before they could master the new technologies they were adopting from the more advanced industrial nations; it sees investment in human and physical capital as a necessary, but far from sufficient, part of the assimilation process. Another which emphasises physical and human capital accumulation we denote by 'accumulation' theories.

The assimilationist view notes that the technologies that the nics came progressively to master during the 1970's and 1980's were ones with which, in 1960, they had no experience at all. In addition, the product mix changed dramatically as shown in Table 1 for Taiwan. For example, in 1960 virtually no electronics goods were produced in Taiwan but by 1990 these accounted for roughly 21% of manufacturing exports. To learn to use new technologies and to function effectively in new sectors required the development of new sets of skills, new ways of organising economic activity, and becoming familiar with and competent in new markets. To do this was far from a routine matter, but involved risk taking entrepreneurship as well as good management. What makes the Asian miracle miraculous is that these countries did these things so well, while other countries were much less successful. To be sure, adopting the technologies of the advanced countries required, among other things, high rates of investment in physical and human capital, and the nics achieved these high rates. But to say that these investments were all that was required offers too limited a perspective on the magnitude of the achievement.

Table 1

Changes in Physical Production Levels
Selected Industrial Products
Taiwan 1960–90

Product	1960	1990
Man Made Fibres – millions of tons	1,762	1,785,731
Polyvinyl Chloride – millions of tons	3,418	920,954
Steel Bars – millions of tons	200,528	11,071,999
Machine Tools	0	755,597
Sewing Machines	61,817	2,514,727
Electric Fans	203,843	15,217,438
Television Sets	0	3,703,000
Motorcycles	0	1,055,297
Telephones	0	13,992,431
Radios	0	5,892,881
Tape Recorders	0	8,124,253
Electronic Calculators	0	44,843,192
Integrated Circuits (1,000)	0	2,676,865
Electronic Watches	0	5,115,695
Shipbuilding (tons)	27,051	1,211,607

Source: Taiwan Statistical Data Book, 1992, Council for Economic Planning and Development, Republic of China, Taipei, Table 5-6c.

An emphasis solely on investment assumes that the state of technological knowledge at any time is largely embodied in machinery and codified in blueprints and associated documents and that for a firm to adopt a technology that is new to it, but not to the world, primarily involves getting access to equipment and blueprints. However, only a small portion of what one needs to know to employ a technology is codified in machine manuals, textbooks, and blueprints; much of it is tacit and learning is as much by doing and using as by reading and studying (Nelson and Winter, 1982; Rosenberg, 1994). Most business organisation practices and market judgments are even less codified. A large number of case studies have documented this for hundreds of firms in the Asian countries (Hobday, 1995; Kim, 1997; Goto and Odagiri, 1997). All arrive at a view that is illustrated by a quotation from Hobday (1995).

> East Asian latecomers did not leapfrog from one vintage of technology to another. On the contrary, the evidence shows that firms engaged in a painstaking and cumulative process of technological learning: a hard slog rather than a leapfrog. The route to advanced electronics and information technology was through a long difficult learning process, driven by the manufacture of goods for export. (p. 1188).[3]

Such learning and the eventually high levels of productivity with which imported equipment are operated allows the modern sector to gradually increase its share of output, capital, and labour. The sector expands and the relative size of less productive sectors contracts, yielding a growing level of national productivity. This change is a central feature of the model introduced below.

The rapidly rising education levels in the nics is a frequently noted phenomenon. Rising human capital can be viewed simply as an increase in the quality or effectiveness of labour, adding a third factor to the conventional production function. An alternative view perceives the effects of sharply rising educational attainments, in particular the creation by these countries of a growing cadre of reasonably well trained, managers, engineers and applied scientists as providing a comparative advantage in identifying new opportunities and effectively learning new things (Nelson and Phelps, 1966; Schultz, 1975). It permits an earlier identification of new product areas and new technologies and makes the transition to them more efficient. Thus education was critical to realising the change in the sectoral structure in Taiwan, illustrated in Table 1.

1.3. *A Two Sector Model*

We present here a model that we believe captures important elements of the evolution of countries such as Korea and Taiwan.[4] In this model output per worker grows over time accompanied by rising physical and human capital per worker. The model is totally devoid of any possibility of increasing output per

[3] For similar findings see Kim (1997) and Goto and Odagiri (1997).

[4] This model draws on an earlier formulation in Nelson and Winter (1982).

worker by increasing capital intensity within a given technology – we assume a Leontief fixed proportion production technology within each sector. All development takes place through the shifting of resources from one technology, which we will call craft, to another, which we will call modern. The rapid expansion of the modern at the expense of the craft sector captures the evolution in Korean and Taiwanese manufacturing, shown in Table 2, which documents the rapid change in the allocation of labour by firm size during the critical period of growth acceleration. For example, the share of employees in firms with over 100 workers increased from 33 to 74% in Korea between 1958 and 1975. An even more rapid shift must have occurred in the allocation of capital as the larger firms were more capital intensive.

Within this model a basic constraint on the rate of assimilation is the effectiveness of entrepreneurship. There are always profits to be made by expanding the modern sector. The strength of entrepreneurship in responding to profit opportunities determines the rate at which this happens. This response can be encouraged by a favourable policy climate or more directly as in the fostering of the chaebol conglomerates in South Korea and the provision of considerable technological support for the small and medium enterprises on which Taiwan's development was based. In turn, a strong entrepreneurial response may, if successful, generate still more latitude for the government to pursue additional desirable policies. We believe this interaction accurately depicts an essential ingredient of the 'Asian Miracle'.

In the model there are two different kinds of fixed proportions constant returns to scale technologies, which we denote by c for craft and m for modern. Capital per unit of output is the same in the two technologies but output per unit of labour is higher in the modern sector than in the craft. So

Table 2

Percentage Distribution of Employment by Firm Size

	Number of employees					
	4–9	10–19	20–49	50–99	100–499	500+
Taiwan						
1954	18	13	14	9	16	31
1961	18	10	14	8	17	34
1971	8	7	11	9	29	37
Index of value added per worker, 1971	NA	100	91	100	117	259
Korea						
1958	17	16	21	13	21	12
1963	15	14	16	12	21	22
1975	4	5	8	9	30	44
Index of value added per worker, 1971	NA	100	133	193	256	304

Source: Ho (1980), Tables 3.1, D2, D3.

also, then, is capital per unit of labour. If factor prices in the two sectors were the same, unit costs using modern techniques would be lower than costs using craft technology.[5] However, the modern sector requires 'educated' labour while education is not necessary or productive in craft technology.

At the start of accelerated development almost all of capital and labour is in the craft sector. We assume, however, that there is a tiny amount in the modern sector that serves, in effect, to 'seed' the development process. At any time output per unit of labour input in the economy or industry as a whole will be the weighted average of labour productivity in the two technologies, the weights being the proportion of labour employed by each of the technologies. Let a_c be output per unit of labour in craft technology and a_m be output per unit of labour in modern technology, with $a_c < a_m$. Then:

$$Q/L = a_m L_m/L + a_c L_c/L \tag{1}$$

$$Q/L = a_c + (a_m - a_c) L_m/L. \tag{2}$$

As L_m/L grows over the development process, so does Q/L. Since capital per unit of output is the same in the two sectors, an increase in L_m/L is accompanied by a rise in K/L. Indeed, within this model Q/L and K/L grow at the same rate.

Within our model a shift in the proportions of capital in the two sectors drives development. We assume that the price of the product is the same whether it is produced by modern or craft technology, and is constant over time. The latter can be rationalised by assuming that the product is sold on world markets and hence is insensitive to the quantity produced within the particular economy in question. We also assume that the cost of capital is the same in the two sectors. This means that the difference in labour cost is the only factor that affects the relative profitabilities of the two technologies. We could modify these assumptions, but making them enables us to tell a cleaner story.

Let w be the price of labour in the craft sector, and gw its price in the modern sector, with $g > 1$. Thus g (for graduation) reflects an education premium. We assume, however, that g never is so large as to completely offset the productivity advantages of modern technology.

If one uses a prime over a symbol to denote an inverse, then the difference between the two sectors in cost, and profit, per unit of output, and capital, can be written:

$$\Delta C = w(a_c' - g a_m'). \tag{3}$$

The higher profitability of modern technology than craft provides an incentive to shift resources from the latter to the former. Within this model the strength of the response is determined by the effectiveness of entrepreneurship, denoted by e.

$$d/dt(\log K_m/K_c) = ew(a_c' - g a_m') \tag{4}$$

[5] Ho (1980) found that both capital-labour and output-labour ratios increased with firm size in Korea and Taiwan and that roughly similar wages prevailed across firm size classes.

$$d/dt(\log K_m/K) = ew(a'_c - ga'_m)(1 - K_m/K). \tag{5}$$

If w and g are constants, the time path of K_m/K (and Q_m/Q) will trace out a logistic function. L_m/L will be increasing as these variables grow, but lagging behind them. Of course in the limit they all approach one. If w increases as development proceeds but not g, the rate of expansion of the modern sector relative to the craft will be accelerated – since modern technology saves on labour, an increased w increases its cost advantage. An increase in the education premium, g, over the development trajectory will diminish the cost advantage of modern technology. On the other hand a decline in g, say as educated labour becomes more plentiful, will enhance it.[6]

We know from (1) and (2) that, as capital and labour shift to the modern sector, K/L and Q/L will increase. If the amount of educated labour is responsive to demand, human capital also will be increasing. Economic analysts studying the aggregate data generated by this process might conclude that growth of Q/L was *caused* by the growth of physical and human capital per worker (and indeed such growth of capital was required for growth) and infer that growth was due to 'movements along the (economy-wide) production function.' This explanation would repress two things. First, the force driving growth was the progressive adoption and absorption of modern technology – the m technology became more widely used and was effectively utilised so that $a_m > a_c$, in contrast to the experience of many LDCs that purchase large amounts of equipment but utilise them very inefficiently so that a_m barely exceeds a_c. Second, while the profitability of employing modern technology was motivating the shift, the rate at which the modern sector replaces the craft was being determined by the strength of entrepreneurship. On the other hand, the traditional analysis would be right about the rate of growth of human capital being an enabling factor.

Thus consider two economies with exactly the same initial conditions, facing exactly the same opportunities to adopt modern technology, and having the same input supply elasticities. In one the response, e, to profit opportunities is high, and in the other low. The expansion of the modern sector, the growth of physical capital intensity, increases in human capital, and the advance of labour productivity, all would be faster in the former than the latter. An economist, thinking in terms of production functions, would try to explain the differences in terms of different rates of 'accumulation', but the key factor behind the scenes would be differences in the entrepreneurial response to profit opportunities and the ability to absorb modern sector technologies so that $a_m > a_c$.[7]

Behind the scenes in the model, growth of human capital is an enabling element. Other things being equal, a high e (resulting in rapid growth of the

[6] In both Korea and Taiwan, real wages increased by over 5% per annum in the period considered while skill differentials narrowed a bit due to the rapid expansion of secondary and tertiary school enrollments.

[7] A considerable literature attests to these differences among developing countries. Contrast, for example, Lall's (1987) description of the behaviour of Indian firms with those of Hobday (1995) and Kim (1997) of the efforts of Korean and Taiwanese firms. Some, but not all, of the observed differences may be attributable to differing policy environments.

modern sector) will cause a rapid increase in the demand for educated labour. If increased supply is not forthcoming at the prevailing premium for educated labour, under various ways of modelling the dynamics, g will rise. This will slow down the rate of growth of the modern sector associated with a given e. On the other hand, a rapid expansion of the educated work force, as occurred in both Korea and Taiwan, can be absorbed productively only if e is high. Indeed, in the 1950s and 1960s there was considerable emigration of highly educated Koreans and Taiwanese. Growing education in the absence of an expanding modern sector may have little beneficial effect. Within this model, a high e tends to draw forth expansion of human capital and generates high profits in the industry as a whole, and hence is a source of the savings to finance the investment in the modern sector.

In this model, development is a process driven by a disequilibrium. The disequilibrium, and the rate at which it is eliminated, shows up in the behaviour of capital's share over the development traverse. Set the constant product price as the numeraire. Then the share of capital in total income is:

$$S_k = (1 - wa'_c)Q_c/Q + (1 - gwa'_m)Q_m/Q \tag{6}$$

$$S_k = (1 - wa'_c) + w(a'_c - ga'_m)Q_m/Q. \tag{7}$$

The first term of (7) is capital's share in the craft sector. The second term is the amount by which capital's share in the modern sector exceeds its share in the craft, times the relative size of the modern sector.

If one notes (3), one can see that the expression before Q_m/Q in (7) is proportional to the rate at which capital is being shifted from the craft to the modern sector, and hence the rate at which output per worker and capital per worker are growing. Thus capital's share will be high when capital and output are growing most rapidly. A growth accounting, discussed below, would naturally assign a good share of the credit for growth of output to the growth of capital as it weighs the growth of capital stock by the share of capital in the national accounts. If the supply of educated labour just keeps pace with the growth of employment in the modern sector, human capital also will be growing most rapidly when output is growing fast.

The foregoing captures the spirit of our argument that, in the Asian Miracle, learning and technology absorption (a high a_m), large investments in physical and human capital, and forceful entrepreneurship together resulted in a growing modern sector and diminishing craft sector. These key ingredients complemented each other. Without the ability and inclination to expand human capital greatly, aggressive entrepreneurship would have been stymied. Without aggressive entrepreneurship, the returns to investment in human capital would have been low, as they were in the 1950s and 1960s. And when both of these elements were present, together they made for high and rising profits in the modern sector which provided the finance for the large investments in physical capital that were necessary for rapid assimilation.

The shift among sectors and the maintenance of a high rate of return on capital, described by (7) could also be interpreted using the Rybczynski theorem. As aggregate capital intensity increased, the labour intensive craft sector declined in absolute size while the modern sector increased and the rate of return on capital, determined by factor price equalisation, did not decrease. Our interpretation of this process is that the high value of a_m that permitted the shift to the more capital intensive sector was itself brought about by considerable technological effort in the period in question. The efficient shift of resources into the sector was not an automatic outcome of the growth of the aggregate capital-labour ratio.

Clearly our explanation places a large premium on the size of e. Without entering the quagmire of the determinants of entrepreneurial abilities, the strength of incentives must certainly have mattered. Two economic policy variables would have reinforced any culturally favourable conditions. The first is the emphasis on exports for much of the period that encouraged firms to sell in the international market. They were thus able to avoid the diminishing returns to selling in a more slowly growing domestic market, typical of import substitution regimes. Second, as part of the export orientation of these economies, the real exchange rate was kept relatively constant, thus maintaining the profitability of exporting even when domestic costs were increasing. It is also possible that, especially in Korea, the substantial implicit subsidies given to individual firms led to a perception that the government would stand behind firms that were risk taking. But in other less successful countries, made-to-measure tariffs could be viewed as having performed the same role. Thus, it is likely that export orientation and the maintenance of the real exchange rate were more important factors.

2. Accumulation Theory

As we noted, other economists propose that the massive investment in physical and human capital made by the Asian nics is a sufficient explanation of the 'miracle'. There is no need to give particular credit to entrepreneurship, innovation, and learning, except insofar as these are terms given to the shift to more capital intensive modes of production that were the almost automatic consequence of the investments.

Proponents of this view have employed both growth accounting and dynamic production function estimation. Both methods assume the existence of a single economy wide production function or one for very aggregated sectors such as manufacturing. In contrast, our view is that such functions suppress the major structural change that was occurring, the progressive replacement of smaller by larger, more efficient firms that mastered entirely new (to the country) technologies. Assume, however, that an aggregate production function existed – how can can these studies be interpreted.

2.1. *Growth Accounting*

The argument of growth accounting is that the large increase in inputs accounts for the lion's share of the increase in output, the residual being relatively small. The argument of econometric production functions is that the time trend in the fitted regression is low. We argue here that neither method can persuasively separate growth that would have occurred without technological advance from the contribution to growth made by advancing technology without some assumptions of uncertain validity. We think it is important to highlight those assumptions and to call attention to why they might not be valid, and the implications if they are not.

The logic behind growth accounting is that by weighting the proportional growth of inputs that occur over a period of time by estimates of their partial output elasticities over that period, one can calculate how much output growth was attributable to factor accumulation in the absence of a shift in the production function. The contribution of technological advance is calculated as a residual. In the studies in question, observed factor shares in the national accounts are used to estimate partial output elasticities. Since the period being analysed is lengthy, a quarter century or more, calculations are made on a year to year basis, using the Tornqvist index,

$$T = \sum_{i}[(1/2)(S_{i,t} + S_{i,t-1})(\ln x_{i,t} - \ln x_{i,t-1})] \tag{8}$$

where $S_{i,t}$ is the observed share of factor x_i in period t. This is subtracted from the log difference in output to obtain the residual, often broken down by subperiods.

In the case of the Asian Miracle the share of capital, the most rapidly growing factor of production, was quite high at the beginning of the development traverse and remained so. Thus capital growth accounts for a very large part of the successful growth experience under the logic being employed. However, under the standard assumptions of neoclassical production theory (which is the basis of growth accounting), the time path of factor shares is a function of technological advances that occurred over the time period as well as changes in factor proportions. As noted earlier, capital's share remained high over the entire period, despite that substantial increase in capital intensity. This fact is essential to the finding that high levels of investment are the bulk of the story because if capital's share had fallen significantly and become low, the growth of capital would have accounted for a much smaller share of the increase in output. Indeed, if capital's share and the rate of return on capital had fallen greatly, it seems unlikely that the high rates of investment would have been sustained.[8]

One explanation for the failure of the capital share to decline is that the elasticity of substitution, σ, was close to unity. Another is that σ was low and had firms been locked into technology they already knew, growing capital-labour ratios, k, would have run into sharply diminishing returns. The high productivity of investment was sustained only because firms rapidly and

[8] The maintenance of a high rate of return could be interpreted as the result of the maintenance of factor price equalisation as capital intensive production and exports increased as the result of the Rybczynski effect. As noted above, our interpretation is that a high value of a_m that allowed successful capital intensive exports was realised only with a considerable effort at learning.

effectively sought out and learned to master technologies that were completely new to them, i.e., a high value of a_m in our model in section 1.3 was achieved. Technological assimilation and the rapid shift of capital and labour to the more modern, capital intensive technologies was driving growth. However, a growth accounting would attribute the major share of growth simply to the growth of capital.

The question of what lies behind and sustained the high rates of return on capital, and prevented its share from falling is thus a key issue. In our model it is the shift among sectors. However, continuing in the spirit of a one sector model, assume a neoclassical production function $Q = f(K, m_L)$ in which m represents Harrod-neutral, (strictly labour augmenting) technological advance. Then the rate of change of factor shares $S_{i,t}$ is a function of the elasticity of substitution, σ, and m, or

$$S_K^* = [S_L^0(1-\sigma)/\sigma](m - k^*) \tag{9}$$

$$S_L^* = [1 - S_L^0(1-\sigma)/\sigma](k^* - m). \tag{10}$$

Equations (9) and (10) show that the factor shares utilised in calculating the Tornqvist index are affected by both technical change, in this case labour augmenting, and changes in capital-intensity. If σ is high, close to unity, a high k^* will not drive down the share of capital. If σ is low, a high value of m could prevent a fall in S_k. In growth accounting exercises the $S_{i,t}$ are assumed to provide information about the elasticity of output with respect to factor inputs. But the $S_{i,t}$ are 'uncontaminated' measures only if the *assumed* underlying translog production function exhibits constant returns to scale and Hicks-neutral technical change. If technical change was, in fact, labour-augmenting as in (9) and (10), $S_{k,t}$ used in (8) would have been lower without technical change, hence the calculated value of T would have been smaller (as k^* was > 0, and the calculated TFP growth would have been greater.

Table 3 sets out alternative calculations of the evolution of factor shares to indicate the problem. For example, if S_K^0 were 0.4, $\sigma = 0.2$, $k^* = 0.05$ and $m = 0$, the annual rate of decrease in S_K would have been -0.12 (line 1). This decline is reduced to -0.024 with $m = 0.04$ and is reduced to 0 when $m = 0.05$ (line 4). As can be seen in lines 5–8, when $\sigma = 0.9$, the value of S_K^0 is close to zero with any combination of parameters. These calculations suggest that many combinations of parameters can generate the observed constancy of S_K including ones that result from a high rate of labour augmenting technological progress. Given that rapid rate of growth of capital weighted by S_K is critical in the calculations attempting to demonstrate the absence of high productivity growth, the precise assumptions about the nature of technical change are critical. Unless there is a strong basis for assuming the existence of Hicks-neutral technical change, calculations of TFP growth using Tornqvist indices provide estimates that are subject to unknown errors.

Table 3

Effects on Factor Shares of Alternative Combinations of Capital Deepening and Technical Change

Initial share of capital	Initial share of labour	Elasticity of substitution	Rate of change of K/L	Rate of labour augmenting technical change	Annual rate of change of capital share	Annual rate of change of labour share
S_K^0	S_L^0	σ	k^*	m	S_K^*	S_L^*
0.4	0.6	0.2	0.05	0	−0.120	0.08
			0.05	0.01	−0.096	0.064
			0.05	0.04	−0.024	0.016
			0.05	0.05	0	0
0.4	0.6	0.9	0.05	0	−0.0033	0.0022
			0.05	0.01	−0.0027	0.0018
			0.05	0.04	−0.0007	0.0004
			0.05	0.05	0	0

Source: See text for discussion.

2.2. *Production Function Estimation*

One might think that fitting a dynamic production function employing time series could avoid this limitation of growth accounting. However, there are also problems here. To see this, consider estimating the bias of technical change and the elasticity of substitution. Consider the two 'explanations', shown in Fig. 1, for a large increase in output per worker depicted by points 1 and 2 associated with a large increase in capital per worker. In the explanation on the left hand side, in which the elasticity of substitution is assumed large, much of experienced growth in labour productivity would have occurred even had the economy stayed on its production function of period one (the dotted curve). The way the production function is drawn depicts only weak diminishing returns to increasing capital intensity. The firm or economy in question is presumed to know, at time one, how to operate effectively at much higher capital intensities than were employed then, but chooses not to do so because

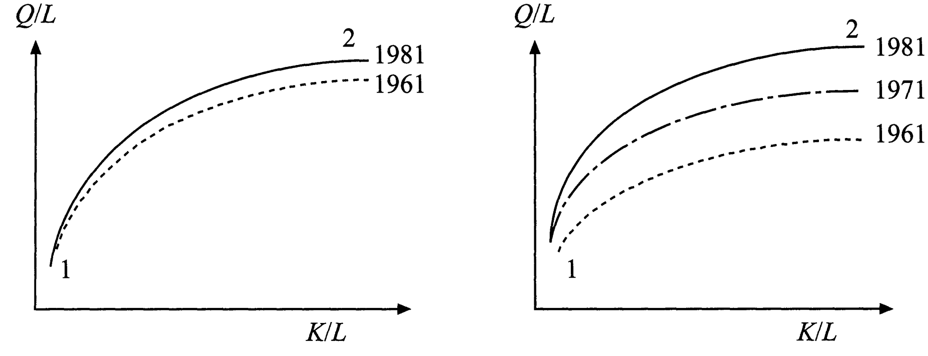

Fig. 1. *Alternate Interpretations of Growth*

prevailing factor prices made it more profitable to operate at low capital intensity. Between time one and time two, factor supplies changed.

In contrast, in the explanation on the right hand side, experienced productivity growth is almost totally the result of the establishment of a new production function (the solid curve) in that very little growth in labour productivity would have occurred had the economy remained on its old production function. Under this explanatory story, at time one the firm or economy in question knew very little about how to operate effectively at significantly higher capital intensities. The elasticity of substitution would have been very low if the firm had been limited to operating technologies it knew initially. To have increased capital per worker without learning about and learning to use new techniques would quickly have led very low marginal returns as shown in Table 3 for $\sigma = 0.2$ and $m = 0$ or 0.01. Thus the economy, in order to deal productively with the changed factor price regime of period two, had to do a lot of 'learning', or 'innovating', and in fact it did. Both explanations fit the data at time one and two. The levels and the slopes of the old production functions are the same at time one, and the levels and slopes of the new production functions are the same at time two.

When one estimates a dynamic production function through many not just two points and slopes, how does one discriminate between these two explanations? Obviously one needs to place some restrictions on the form fitted, for example, that the rate and bias of 'technical advance' be constants over the period, or that the underlying production function always have a particular shape (Diamond *et al.* 1978, Nelson, 1973).[9] Most of the econometric exercises we are concerned with here have imposed relatively loose restrictions, although sufficient to permit a best fitting equation to be calculated. However, even if an equation that looks like the left hand side explanation wins the 'maximum likelihood' contest (as in Kim and Lau, 1994), if the constraints on functional form are relatively loose it is a good bet that an equation that looks like the right hand side explanation is not very far behind. Standard regression techniques of the sort that have been employed do not permit confident acceptance of one explanation and rejection of the other.

The graphs drawn in Fig. 1 are in fact regressions estimated from the actual data for Korea's manufacturing sector for the years 1961–81. The dynamic production function fitted to the data is a standard CES, with two inputs – capital and labour – and constant returns to scale. To keep the analysis simple and transparent we constrained technological advance to be neutral and constant over the period in question. The key parameters to be estimated are r, the rate of technological progress, and, σ, the elasticity of substitution.

In the left hand figure we forced σ to be large, 0.9. Since growth of K/L then 'explains' a lot of the growth of Q/L, the estimated rate of technological change, r is low, 0.016. For regressions in which we set σ as greater than one,

[9] Efforts to estimate production functions for Korea and Taiwan arrive at mixed results about the size of the elasticity of substitution. They do not allow the inference that the elasticity is close to one. See, for example, Kim (1984).

the estimated rate of technological change was even smaller. In any case, if we also included a variable measuring the effects of rising educational attainments, there would be little room for 'technological advance' in the explanation for economic growth. In the right hand figure we constrained σ to be low, 0.2. Since under this constraint the growth of K/L cannot 'explain' much of the growth of Q/L, the estimated rate of technological progress, r, came out high, 0.045. While growing human capital will reduce this figure, it would not make the rate of estimated technological progress trivial.

Both of these regressions, and one in which all parameters were chosen by least squares, yield values of R^2 of around 0.98, leaving little to choose among the regressions on a statistical basis. The fact that the best fit of a dynamic function provides an explanation for growth in which technological advance plays a small role, and input growth accounts for the lion's share of growth, does not itself provide strong evidence against the argument that, in fact, growth would have been far less if there had not been significant technological advance. Only the imposition of particular constraints on the dynamic production function enables econometric technique to choose between the explanation on the left hand side and the right hand side of Fig. 2.[10] These constraints are basically arbitrary. And the imposition of somewhat different ones can change radically the estimated contribution of technical advance.

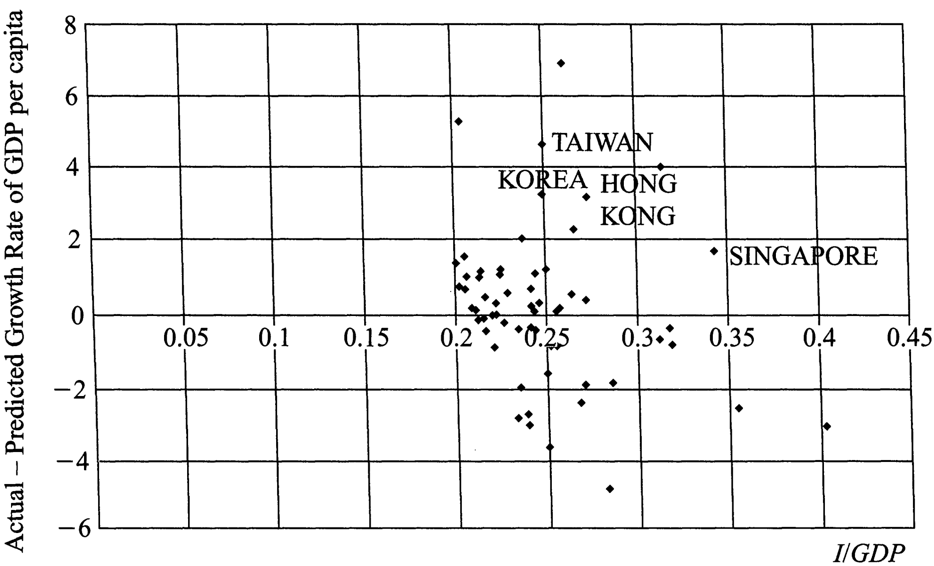

Fig. 2. *Actual Minus Predicted GDP Growth Rates and Investment Ratio*

[10] The translog *assumes* a constant rate of factor augmentation for each of the factors. If the rate of change of factor augmentation were allowed to vary, the bias could not be estimated. See Diamond *et al.* (1978). Kim and Lau (1994) pool cross section and time series for a number of countries in order to allow the identification of both the elasticity of substitution and the rate of factor bias.

3. Cross Country Evidence on Relative Asian Performance

Most of the analysis of the performance of the Asian countries has emphasised the absolute performance of the countries themselves, particularly as measured by total factor productivity growth. This section shows that in a cross country context, the Asian nics realise high productivity growth relative to other high investment countries, after standardising for a number of other country specific characteristics.

One empirical measure of performance that is eclectic rather than based on a specific production theoretic base is the estimation of cross country regressions (Barro, 1991; Mankiw *et al.*, 1992) which permits comparison of a given country's performance relative to other nations.[11] To see whether the performance of the Asian NICs, is unusual, we employ the following estimated cross country regression equation to explain differences in international rates of growth of GDP per capita,[12]

$$GDPG = -0.83 - 0.35\,RGDP60 - 0.38\,GPOP + 3.17\,SEC + 17.5\,I \qquad (11)$$

where *GDPG* is the growth rate of per capita *GDP* between 1960 and 1989, *RGDP*60 is *GDP* per capita in purchasing power parity terms in 1960, *GPOP* is the growth rate of the population from 1960–89, *SEC* is secondary school enrollment in 1960 as a percentage of the relevant age group, and *I* is the average investment/*GDP* ratio in 1960–89. The variable *I* is a proxy measure for the rate of growth of the capital stock, $K^* = \Delta K/K = I(GDP/K)$. Even if there is substantial variation in initial capital-output ratios GDP/K, differences in the value of *I* over 29 years will outweigh such dispersion and yield a good approximation to K^*.

Fig. 2 graphs actual minus predicted GDP growth per capita against *I* for those countries in our sample that had investment rates above 20%. Among the high investment countries, the Asian nics, Hong Kong, Korea, Singapore, and Taiwan stand out as unusual performers, even after adjusting for the other variables on the right hand side of (11) including the potential benefits of being laggards, measured by *RGDP*60. Table 4 shows the actual minus predicted growth rates of a number of countries with very high values of *I*. Compared with nations such as Greece, Jamaica, Panama, and Portugal, Korea and Taiwan have unusual performance. It is clear that high physical investment ratios and initial conditions that are thought to be conducive to growth are not sufficient to explain the Korean or Taiwanese cases nor indeed, Hong Kong and Singapore.

[11] These regressions were developed to test whether the standard Solow-Swan neoclassical model can explain cross country performance better than endogenous growth models. However, such models do not invoke strong assumptions about technical change and factor market pricing that are necessary in estimating TFP growth within a country over time. For a useful evaluation of this literature see Crafts (1996).

[12] This is the basic equation used by Levine and Renelt (1992), for sensitivity tests of cross country regressions. Variants of it lead to the same result, namely, the Asian NICs have better performance than would be predicted after adjusting for investment in physical and human capital. Equation (11) was estimated by Levine and Renelt for a cross section of 101 countries. The value of R^2 is 0.46 and all of the coefficients are significant.

Table 4

Investment Ratios and Predicted Minus Actual Growth Rates

Country	Investment/GDP 1960–89	Actual minus predicted growth rate of GDP per capita
Hong Kong	27.3	0.031
Korea	24.9	0.032
Singapore	34.3	0.017
Taiwan	25.0	0.047
Gabon	40.0	−0.030
Algeria	35.0	−0.026
Greece	24.2	0.008
Panama	24.0	0.002
Portugal	23.7	−0.002
Jamaica	25.0	−0.037
Ireland	22.2	0.011

Source: Calculations of the authors based on data underlying Levine and Renelt (1992) and *Taiwan Statistical Data Book, 1992,* Council of Economic Planning and Development, Republic of China.

There is a large literature which adds additional variables to those included in (11) including some measuring macroeconomic management, export orientation, and so on. While such variables are of interest, they do not provide information about the nature of the production performance nor of the basis of success of economies in absorbing large quantities of factor inputs while others obtained low returns. Our contention is that a critical element was the technological efforts of firms in the nics that allowed them to successfully initiate new industries and absorb new equipment. While other countries with high investment-GDP ratios could purchase machinery that gave them the potential to improve their productivity, this could only be successful when it was combined with domestic effort to absorb the new technology. Moreover, much of the successful absorption effort is not attributable to formal and measurable R&D but efforts of firms to learn about new opportunities, improve organisation and inventory management, and undertake minor but cumulatively significant changes in the production process. While proxies for such activity could be introduced in cross country estimates, their construction is tenuous and would lead to false concreteness.

4. Assessing the Alternative Theories

How is one to decide between two different explanations, each broadly compatible with the macroeconomic data, when one stresses the central importance of learning, entrepreneurship, and innovation and the other views these as more or less automatic by-products of investments in physical and human capital and attributes growth largely to moving along a well understood existing production function?

The notion of 'moving along a production function' would seem to imply changing choices within a constant and well understood choice set. The production function is usually defined, after all, as the frontier of a production choice set. Entrepreneurship and innovation, on the other hand, have the connotation of the actor doing something that is not obvious, which involves considerable uncertainty in the sense of Knight, and where success most certainly is not assured. A variety of detailed empirical studies of the introduction of totally new technology to an economy have documented these characteristics (see, e.g., Nelson and Winter (1982), Rosenberg (1994)). We believe that most economists would agree that innovation of this type cannot be treated as simply choosing a previously unchosen element from a preexisting choice set.

We have noted that accumulationists, just as assimilationists, recognise that the economies in question were progressively moving into the use of technologies they had not employed earlier. Had none ever employed them before, there might be agreement that such activities involved 'innovation' in an essential way. But of course in this case the technologies were not brand new to the world. Our argument is that these actions should not be regarded as simply a movement along an international production function. They involved Knightian uncertainty and economic risk in an essential way.

Consider, for example, Kim's description of Hyundai's efforts to produce a car after it had purchased the foreign equipment, hired expatriate consultants, and signed licensing agreements with foreign firms. Relying on detailed firm records and interviews he concludes:

> Despite the training and consulting services of experts, Hyundai engineers repeated trials and errors for fourteen months before creating the first prototype. But the engine block broke into pieces at its first test. New prototype engines appeared almost every week, only to break in testing. No one on the team could figure out why the prototypes kept breaking down, casting serious doubts even among Hyundai management, on its capability to develop a competitive engine. The team had to scrap eleven more broken prototypes before one survived the test. There were 2,888 engine design changes ... Ninety seven test engines were made before Hyundai refined its natural aspiration and turbocharger engines.... In addition, more than 200 transmissions and 150 test vehicles were created before Hyundai perfected them in 1992. (Kim, 1997, p. 122)

An emphasis on investment alone implies that if a technology is efficiently employed in advanced industrial nations, firms in poorer countries can adopt that technology at relatively low cost, and without significant uncertainties regarding the outcome of their efforts. Extensive case studies of firms such as Kim's suggest this is not the case. Even within the OECD countries, there is a considerable body of evidence indicating that many firms operate substantially below the best practice frontier achieved by the most efficient firms. (Caves *et al.*, 1992) Even the best firms in LDCs often fail to achieve the efficiency levels of firms utilising the identical technology as that of the developed countries.[13]

[13] For a discussion and references see Pack (1988).

Many high investing countries such as those of the Soviet bloc rarely learned well.[14] While this may have been due to the absence of incentives, even countries such as Chile that have had high investment rates and the right incentive regime failed, for a considerable period, to exhibit significant productivity growth.

Just as physical investment cannot by itself explain growth, an increasing level of education is not by itself decisive. Successful technology absorption and entrepreneurship in the nics certainly was facilitated by the growing supply of well trained technical people. Simultaneously, there had to be entrepreneurial firms in which to work, or the opportunity to found new ones – before the beginning of rapid growth there was a considerable brain drain from Korea and Taiwan. In a virtuous circle, aggressive entrepreneurship supported and encouraged rapidly rising educational attainment, and served to make these investments economically productive. In contrast, in many other countries initially as poor as Korea and Taiwan, the market for college graduates was almost exclusively the government bureaucracies, where their skills arguably made little contribution to economic development. Fiscal conservatism in Korea and Taiwan, quite apart from its beneficial macroeconomic effects, helped to strengthen the private sector by not absorbing well educated graduates.

Another difference in perspective shows up sharply in assessing the impact of the extraordinary export performance of the nic manufacturing firms. The accumulationists tend to see the steep rise in manufacturing exports as the expected result in economies where the stocks of physical and human capital were rising rapidly, and shifting comparative advantage towards the sectors that employed these inputs intensively. From this perspective, there is nothing noteworthy about the surge of manufacturing exports, save that it is evidence that the economic policies of these countries let comparative advantage work its ways. In contrast, the assimilationists, while not denying that the nics were building a comparative advantage in various fields of manufacturing, tend to highlight the active efforts by government to induce, almost force, firms to export, and the learning that firms had to do in order to compete effectively in world markets, even with government support (World Bank, 1993).

Economists of the assimilation school have argued that exporting stimulated and supported strong learning in two ways (Westphal *et al.*, 1985; Pack and Westphal, 1986). First, being forced to compete in world markets made the managers and engineers in the firms pay close attention to world standards. Second, much of the exporting involved contracting with American or Japanese firms who both demanded high performance and provided assistance to achieve it. The story here clearly is different than one which sees the development of these new competencies as, simply, the more or less automatic result of changing factor availabilities that called them into being.

[14] Easterly and Fischer (1995) stress the low *ex post* elasticity of substitution as an explanation of slow Soviet growth. This could also be interpreted as reflecting insufficient effort to identify and master new technology.

We think it apparent that the two broad theories differ both in their causal structures, and in the implications they contain about 'how to do it'. The emphasis of the accumulationists is on getting investment rates up and the prices right. The message of the assimilation theorists is that successful industrial development requires innovation and learning to master modern technologies; effective innovation and learning depend on investments, and a market environment that presses for efficient allocations, but it involves much more. And, indeed, to a considerable extent, the investments needed are induced by successful entrepreneurship.

5. Why is the Issue Important?

Given the preceding, policy conclusions derived from low calculated values of the contribution of learning to Asian growth are problematic. If they were robust, the lessons for other developing countries would be simple, namely, increase levels of investment and there would be little need to pay attention to entrepreneurship, innovation, or learning (Krugman, 1994). The message is that other countries could have done as well as the successful nics if they had made the same investment effort. In contrast, the assimilation account stresses learning about, risking operating, and coming to master, technologies and other practices that are new to the country, if not to the world. The 'marshalling of inputs' is part of the story, but the emphasis is on innovation and learning, rather than on marshalling. Under this view, if when one marshals but does not innovate and learn, development does not follow.

Our argument has been that it is a mistake to think that the nics did it largely by moving along production functions, and that understanding must involve 'learning' in an essential way. But is that argument really a tempest in a teapot? After all, assimilationists concede the central importance of the investments in physical and human capital that the accumulationists stress. Accumulationists are in accord with the assimilationists that the economic policy environment has to be right to stimulate firm managers to adopt more productive technologies and effective modes of organisation than have been characteristic of the old regime. There is basic agreement between the two views regarding many of the essential elements of the appropriate policy regime: fiscal, monetary, and exchange rate policies that make producing for export attractive, and which stimulate savings and investment; significant investments in human capital; competition to keep firm managers on their toes.

The argument is basically about the 'structural equations' that lie behind the reasonably well fitting 'reduced forms'. The assimilationists' argument is that simply getting the macroeconomic environment right will not assure effective economic development. Policy attention needs to be paid to assuring that potential business leaders who are both competent and willing to take risks have access to whatever is needed to run businesses. Since it is impossible to judge winners and losers in advance, entrepreneurs should be encouraged to try, success rewarded, and failure not coddled. And yet since, at the same time, learning to operate effectively in the world of modern practice takes time and effort, the policy environment needs to nurture learning. The successful Asian nics have succeeded until recently, albeit in different ways, at this juggling act. While recent events in Korea and other countries indicate clearly that it is a real danger to stress nurturing to the point of coddling, we believe it would be a mistake not to recognise that successful development does seem to demand some nurturing.

Above all, we think the differences between the two perspectives involve perceptions as to the nature of firms and about their processes of learning. To return to our earlier discussion, when a firm 'chooses' to do something that is radically new to it, and to the community in which it resides, this involves risk taking and, if successful, requires effective learning. In turn, learning proceeds at several different levels: that of individual workers and teams of them, that of establishments and firms, and at the level of an industry. The proposition that what is involved is simply 'a move along the production function' suppresses this.

Economic analysis in general, but development economics in particular, needs a better theory of firm behaviour in such situations. And it needs a realistic theory, that is consistent with what we have learned empirically, about the processes of firm, industry, and national learning, that have been behind The Asian Miracle.

Columbia University

University of Pennsylvania

Date of receipt of first submission: November 1996
Date of receipt of final typescript: November 1998

References

Amsden, Alice (1989), *Asia's Next Giant: South Korea and Late Industrialization.* New York: Oxford University Press.

Barro, Robert (1991), 'Economic growth in a cross section of countries', *Quarterly Journal of Economics,* vol. 105, no. 2, (May), pp. 407–43.

Campos, E. J. and Root, Hilton (1996), *The Key to the Asian Miracle: making shared growth credible.* Washington D.C.: The Brookings Institution.

Caves, Richard E., Bailey, Sheryl D., *et al.* (1992), *Industrial Efficiency in Six Nations.* Cambridge, Mass: MIT Press.

Chenery, H. B. and Srinivasan, T. N. (1988), *Handbook of Development Economics, II,* Amsterdam: North-Holland.

Crafts, Nicholas (1996), 'Post-neoclassical endogenous growth theory: what are its policy implications?', *Oxford Review of Economic Policy,* vol. 12, no. 2, (Summer), pp. 30–47.

Diamond, Peter, McFadden, Daniel and Rodrigues, Miguel (1978), 'Identification of the elasticity of substitution and the bias of technical change' in Fuss and McFadden (1978).

Easterly, R. and Fischer, S. (1995), 'The Soviet economic decline', *World Bank Economic Review,* vol. 9, no. 3, (September) pp. 341–71.

Fuss, Melvyn and McFadden, Daniel (eds.) (1978), *Production Economics: a dual approach to theory and applications.* Amsterdam: North Holland.

Goto, Akira, and Odagiri, Hiroyuki (1997), *Innovation in Japan.* New York: Oxford University Press.

Ho, Samuel (1980), 'Small-scale enterprises in Korea and Taiwan', World Bank Staff Working Paper No. 384, The World Bank, Washington D.C.

Hobday, Michael (1995), 'East Asian latecomer firms: learning the technology of electronics', *World Development,* vol. 23, no. 7, (July), pp. 1171–93.

Kim, Jae Won (1984), 'CES production functions in manufacturing and problems of industrialization in LDCs: evidence from Korea', *Economic Development and Cultural Change*, vol. 33, No. 1, (October), pp. 143–65.

Kim, J. I. and Lau, L. J. (1994), 'The sources of economic growth in the East Asian newly industrialized countries', *Journal of Japanese and International Economics*, vol. 8, (September), pp. 235–71.

Kim, Linsu (1997), *From Imitation to Innovation: Dynamics of Korea's Technological Learning.* Boston: Harvard Business School Press.

Krugman, Paul (1994), 'The myth of Asia's miracle', *Foreign Affairs*, December, pp. 62–78.

Lall, Sanjaya (1987), *Learning to Industrialize.* London: Macmillan.

Levine, Ross and Renelt, David (1992), 'A sensitivity analysis of cross-country growth regressions', *American Economic Review*, vol. 82, No. 3, (September), pp. 942–63.

Little, Ian M. D. (1982), *Economic Development.* New York: Basic Books.

Mankiw, G., Romer, D. and Weil, D. (1992), 'A contribution to the empirics of economic growth, *Quarterly Journal of Economics*, vol. 107, No. 2, (May), pp. 407–37.

Nelson, Richard R. (1973), 'Recent exercises in growth accounting: new understanding or dead end?' *American Economic Review*, vol. 73, No. 2, (June), pp. 462–8.

Nelson, Richard R. and Phelps, Edmund (1966), 'Investment in humans, technological diffusion, and economic growth', *American Economic Review*, vol. 56, No. 2, (May), pp. 69–75.

Nelson, Richard R. and Winter, Sidney (1982), *An Evolutionary Theory of Economic Change.* Cambridge: Harvard University Press.

Pack, Howard (1988), 'Industrialization and trade', in Chenery and Srinivasan (1988).

Pack, Howard and Westphal, Larry E. (1986), 'Industrial strategy and technological change: theory versus reality', *Journal of Development Economics*, vol. 22, no. 1, (June), pp. 87–128.

Rodrik, Dani (1995), 'Getting interventions right: how South Korea and Taiwan grew rich', *Economic Policy*, vol. 20, (April), pp. 55–107.

Rosenberg, Nathan (1994), 'Uncertainty and technological advance', Manuscript, Department of Economics, Stanford University, Stanford, California.

Rosenberg, Nathan and Frischtak, Claudio (1985), *International Technology Transfer*, New York: Praeger.

Schultz, Theodore W. (1975), 'The value of the ability to deal with disequilibria', *Journal of Economic Literature*, vol 13, no. 3, September, pp. 827–46.

Stiglitz, Joseph (1996), 'Some lessons from the East Asian miracle', *World Bank Research Observer*, vol. 11, no. 2, (August), pp. 151–78.

Westphal, Larry E., Kim, Linsu and Dahlman, Carl (1985), 'Reflections on Korea's acquisition of technological capability', in Rosenberg and Frischtak (1985).

World Bank (1993), *The East Asian Miracle: Economic Growth and Public Policy*, New York: Oxford University Press.

Young, Alwyn (1995), 'The tyranny of numbers: confronting the statistical realities of the East Asian growth experience', *Quarterly Journal of Economics*, vol. 110, No. 3, (August), pp. 641–80.

LINKED CITATIONS

You have printed the following article:

The Asian Miracle and Modern Growth Theory
Richard R. Nelson; Howard Pack
The Economic Journal, Vol. 109, No. 457. (Jul., 1999), pp. 416-436.
Stable URL:
http://links.jstor.org/sici?sici=0013-0133%28199907%29109%3A457%3C416%3ATAMAMG%3E2.0.CO%3B2-L

[Footnotes]

[9] **CES Production Functions in Manufacturing and Problems of Industrialization in LDCs: Evidence from Korea**
Jae Won Kim
Economic Development and Cultural Change, Vol. 33, No. 1. (Oct., 1984), pp. 143-165.
Stable URL:
http://links.jstor.org/sici?sici=0013-0079%28198410%2933%3A1%3C143%3ACPFIMA%3E2.0.CO%3B2-%23

[12] **A Sensitivity Analysis of Cross-Country Growth Regressions**
Ross Levine; David Renelt
The American Economic Review, Vol. 82, No. 4. (Sep., 1992), pp. 942-963.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28199209%2982%3A4%3C942%3AASAOCG%3E2.0.CO%3B2-J

References

Economic Growth in a Cross Section of Countries
Robert J. Barro
The Quarterly Journal of Economics, Vol. 106, No. 2. (May, 1991), pp. 407-443.
Stable URL:
http://links.jstor.org/sici?sici=0033-5533%28199105%29106%3A2%3C407%3AEGIACS%3E2.0.CO%3B2-C

LINKED CITATIONS

CES Production Functions in Manufacturing and Problems of Industrialization in LDCs: Evidence from Korea
Jae Won Kim
Economic Development and Cultural Change, Vol. 33, No. 1. (Oct., 1984), pp. 143-165.
Stable URL:
http://links.jstor.org/sici?sici=0013-0079%28198410%2933%3A1%3C143%3ACPFIMA%3E2.0.CO%3B2-%23

A Sensitivity Analysis of Cross-Country Growth Regressions
Ross Levine; David Renelt
The American Economic Review, Vol. 82, No. 4. (Sep., 1992), pp. 942-963.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28199209%2982%3A4%3C942%3AASAOCG%3E2.0.CO%3B2-J

A Contribution to the Empirics of Economic Growth
N. Gregory Mankiw; David Romer; David N. Weil
The Quarterly Journal of Economics, Vol. 107, No. 2. (May, 1992), pp. 407-437.
Stable URL:
http://links.jstor.org/sici?sici=0033-5533%28199205%29107%3A2%3C407%3AACTTEO%3E2.0.CO%3B2-5

Recent Exercises in Growth Accounting: New Understanding or Dead End?
Richard R. Nelson
The American Economic Review, Vol. 63, No. 3. (Jun., 1973), pp. 462-468.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28197306%2963%3A3%3C462%3AREIGAN%3E2.0.CO%3B2-H

Investment in Humans, Technological Diffusion, and Economic Growth
Richard R. Nelson; Edmund S. Phelps
The American Economic Review, Vol. 56, No. 1/2. (Mar. - May, 1966), pp. 69-75.
Stable URL:
http://links.jstor.org/sici?sici=0002-8282%28196603%2F05%2956%3A1%2F2%3C69%3AIIHTDA%3E2.0.CO%3B2-Y

Getting Interventions Right: How South Korea and Taiwan Grew Rich
Dani Rodrik; Gene Grossman; Victor Norman
Economic Policy, Vol. 10, No. 20. (Apr., 1995), pp. 53-107.
Stable URL:
http://links.jstor.org/sici?sici=0266-4658%28199504%2910%3A20%3C53%3AGIRHSK%3E2.0.CO%3B2-3

NOTE: *The reference numbering from the original has been maintained in this citation list.*

LINKED CITATIONS

The Value of the Ability to Deal with Disequilibria
Theodore W. Schultz
Journal of Economic Literature, Vol. 13, No. 3. (Sep., 1975), pp. 827-846.
Stable URL:
http://links.jstor.org/sici?sici=0022-0515%28197509%2913%3A3%3C827%3ATVOTAT%3E2.0.CO%3B2-F

The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience
Alwyn Young
The Quarterly Journal of Economics, Vol. 110, No. 3. (Aug., 1995), pp. 641-680.
Stable URL:
http://links.jstor.org/sici?sici=0033-5533%28199508%29110%3A3%3C641%3ATTONCT%3E2.0.CO%3B2-8

NOTE: *The reference numbering from the original has been maintained in this citation list.*