Interpreting East Asian Growth and Innovation: The Future of Miracles

Haider Ali Khan

Dedication

For Izumi

And my three families in two continents –

The Huttos, Khans and Otomos

who taught me that we discover our fundamental unity

only when we truly respect our rich diversities.

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Manila, Philippines

Introduction

This book is an attempt to present a somewhat novel theory of innovation systems in the concrete context of the experience of growth and crisis of the East Asian economies. The historical focus, for reasons given below, is on the last few decades prior to the financial crisis. However the impact of the crisis is also analyzed in a separate chapter which underlines the need for combining corporate and international finance with economic theories of technical change in order to explain the technological trajectories in complex financial economies more completely.The overall framework is intended to be an evolutionary one. In this sense the work belongs to the growing tradition descrbed by Dosi (2000) in the introductory essay to his collected scientific papers. There he credits pioneers such as Abramovitz, Nelson and Winter,and Freeman among others. This book also begins with and acknowledges the contributions of these authors. It builds on these seminal contributions, and tries to take the idea of technology systems which is akin to Dosi's concept of technological paradigms seriously.

Technological systems in developing economies are rather like a collection and somewhat complex coexistence of several paradigms in tension. An example of this is the idea of technological dualism whereby traditional and modern technological systems may coexist for quite a long time. I consider the questions related to the technological progress, or lack of it in the East Asian context by formulating the problem in terms of the transition from one technological system to another. In terms of evolutionary economics, this means the investigation of the emergence--- or lack of it--- of a new, modern technological system in place of the old, traditional one. If there is genuine emergence in this sense, then the economy should also show capacities for innovation. The challenge is to characterize the dynamics of the process adequately. This is why the study of concrete cases is essential. The development of theories and models in this book is immediately followed by two case studies from East Asia. The transition

of South Korea and Taiwan is examined within the concepts and models developed in the earlier chapters of the book.

Is the East Asian growth experience a myth or a miracle? The interpretation of the spectacular growth performance of these economies (called high-performing Asian economies by a World Bank study) has given rise to a fierce debate among development and international economists over the last few years. One might observe somewhat cynically that like some other debates in the social sciences there may be more heat than light in the controversy. But it is also likely that the dust has not settled yet for us to see what has really happened. However, at one point this controversy seemed to have been largely overshadowed by the Asian financial turmoil. It is as if the financial woes of the Southeast Asian economies and then of Korea that started in 1997 and then deepened – can show conclusively that the whole "miracle" was really a myth. Without minimizing the significance or seriousness of the financial problems, it can nevertheless be seen that the financial turmoil by itself can not be the incontrovertible proof of the long-run failure of these economies. To be sure finance and growth are related (Schumpeter, 1934; Levine, 1997). It is also possibly true that the effects of the financial crisis may persist and even impair long-run growth potential. However, that can hardly settle the question of the long-run growth prospects for the economies. In particular, the role of technical progress would still need to be examined carefully.

Therefore, finance is important but the really significant issue from the perspective of long-run growth is the one raised earlier. Do these economies

display productivity growth via technological change? Furthermore, if technological change has taken place, to what extent is it endogenous or likely to be so in the future? In other words, have these economies developed the capacities to innovate, or are they likely to do so in the near future?

This book attempts to offer a new perspective on this debate by going beyond the growth accounting or production function fitting approaches used by the participants. It can be seen as belonging broadly to attempts, most notably by Nelson and Pack (1996), to eschew the conceptual problems arising from the standard methodologies. It also begins from the idea that while technology is the key issue, for judging performances of entire economies we should begin with consideration of systems of technologies (James and Khan, 1997) and ask ourselves how modern systems of technology can replace more traditional systems during the process of development. We should then ask ourselves if the South Korean and Taiwanese economies have in fact made this transition. This book argues that indeed a transition has been made by these two East Asian economies in particular, and goes further in investigating how permanent this transition is likely to be. In this sense also, the approach and conclusions are consistent with what Nelson and Pack call the 'the assimilationist' interpretation of the East Asian growth.

In the view of a World Bank study and economists such as Lucas there is indeed a miracle; but this miracle can be explained largely by the ability of countries such as Korea and Taiwan to "get the basics right." Lucas also adds theoretically the important ingredient of human capital to the analytical picture.[1]

Opposed to various neoclassical attempts to explain the “miracle” are the heterodox economists. However, they, too, accept the assessment that the growth performance of these economies may indeed be a miracle. Where they differ from the neoclassical economists is in the explanation given for the seeming miracle. Writers such as Alice Amsden (1989) and Shahid Alam (1989) have emphasized the role of state intervention in creating some of the conditions for the miracle to happen.

An entirely different and dissonant view within the neoclassical camp questions the interpretation of the historical record of high growth in these economies as being a miracle at all. Paul Krugman has been the most vocal and aggressive exponent of this view. However, his work draws heavily on the empirical work done by Lau and Kim (1992a,b,c;1994a,b,c,d;1995) and Young (1995), among others. The upshot of this line of research has been to infer that the growth can be accounted for simply by accumulation of labor, capital and human capital. Again, this view is consistent with the orthodox neoclassical growth models. However, Krugman spells out clearly the pessimistic implications that have been glossed over in the general euphoria over the miracles in the neoclassical camp: “Mere increases in input, without an increase in the efficiency with which those inputs are used—investing in more machinery and infrastructure—must run into diminishing returns; input-driven growth is inherently limited” (Krugman 1996; 172).

If the factor accumulation story is true—and it seems to be within the standard production function approach as well as the meta-production function

framework—then indeed such high growth rates cannot be sustained in the long run. If the observed performance of these economies, in Krugman's words "is no more than what the most boringly conventional theory would lead us to expect" then indeed the miracle is a myth.

However, this need not be the end of all our conversations about the growth in East Asian economies. Perhaps only some particular ways of understanding the performances of these economies may end here. Future work on macroeconomic growth accounting or neoclassical model building may not offer much further insight. At the same time reentering the state vs. market debate at this point will also not address Krugman's arguments directly.

The seeming impasse can only be overcome by looking at growth in a more disaggregated manner. Krugman's provocative essay actually raises the theoretical possibility of doing this. However his almost exclusive reliance on results from aggregate growth accounting clearly suggests that he is not prepared to pursue this line of inquiry empirically for the East Asian economies.

> How, then have today's advanced nations been able to achieve sustained growth in per capita income over the last 150 years? The answer is that technological advances have led to a continual increase in total factor productivity—a continual rise in national income for each unit of input. In a famous estimate, MIT Professor Robert Solow concluded that technological progress has accounted for 80 percent of the long-term rise in U.S. per capita income, with increased investment in capital explaining only the remaining 20 percent (Krugman 1996, 172-3).

Although Krugman is still thinking within the terms of the standard Solow-type model and total factor productivity there is a recognition of the key role of technology that is missing from the earlier debates about the miracle. If we are

to ascertain the true nature of the growth process in East Asia we must ask if there has been technological progress.

In fact, the empirical work cited by Krugman answers this question in the negative. Indeed, at the macroeconomic level, given the data, there seems to be zero total factor productivity growth. One could, of course, raise various objections to the imperfections of the data but that really will not advance the debate either.

However, if technology and innovation can become the focus of the debate then another alternative approach is possible. This is both an economy-wide and disaggregated approach at the same time. In this book I use the concept of a positive feedback loop innovation system (POLIS, Khan 1998; 2001a;2001b) to examine whether countries such as Korea and Taiwan have any potential for creating self-sustaining innovation structures. The question is important in the light of Krugman's assertions and earlier findings of growth accounting. If indeed there is no self-sustaining innovation structures (nor a realistic possibility of the creation of such structures in the near future) one is logically compelled to concur with Krugman's pessimism. If, on the other hand, there is either a POLIS in existence or one in the making, there may be some room for optimism. Our starting point, therefore, is that the profound issues raised by both the earlier debate on the East Asian industrialization or the most recent debate on the implications of growth accounting cannot be settled without further conceptual clarifications of innovation systems and empirical work following such clarifications. What then is a POLIS?

A formal definition of POLIS is given in chapter 4 using a non-linear model of a production economy. The fixed point theorems proved there raise the possibilities of multiple equilibria in such economies. Here, I will offer an informal definition that recognizes the force of Krugman's criticism. An economy with a POLIS has an innovative technological structure that can lead to non-diminishing returns to capital and human capital even in the long run. Such an economy will exhibit structural transformation not just from a predominantly agricultural to an industrial setting, but will be characterized mainly by continuous transformations *within* the advanced industrial sectors. Most importantly, these continuous technological changes within the advanced sectors will lead to an overall high growth performance that can be sustained theoretically for an indefinite period. [2]

But this conceptual shift immediately raises questions regarding its applicability. Further modifications of the abstract model will be necessary for this. The organization of this book reflects these operational concerns as well.

The next two chapters essentially review closely the debate within the neoclassical camp about the nature of the miracle. These two chapters also are designed to motivate the reader to go beyond the macroeconomic models of growth that are used implicitly or explicitly by the various participants in this debate.

Chapter 4 offers an alternative methodology to the standard growth accounting. It also differs from the standard heterodox approaches in that an evolutionary, non-linear formal approach is presented. This is not intended to replace the political economy approaches, but rather to supplement them. The

intention is to push the debate on state vs. markets to a different level. In a disaggregated, yet economy-wide framework, the examination of policies as well as market forces can be best carried out by explicitly formalizing the non-linear relationships that characterize an economy with both markets and state. To this end the concept of POLIS is formalized in such a way that both markets and the government can be included. Existence of a possible POLIS is shown by characterizing multiple equilibria in a non-linear model with both increasing returns and technical progress. The existence of POLIS for economies defined on abstract function spaces is shown both for vector lattice and Banach spaces. Tarski's and Amann's fixed point theorems can be used to demonstrate formally such existence theorems.

The empirical application is really what matters ultimately. For this, an economy-wide model based on Social Accounting Matrices (SAMs) can be used. Chapter 4 shows how a successive series of SAMs can approximate the non-linear world of POLIS described earlier. Incorporation of R&D and human capital turns out to be the greatest of the empirical challenges in this context. The modeling approach is applied to both Korea and Taiwan using data from late 80's and early 90's. A modest "POLIS-effect" is found in both cases. However, the effect is somewhat stronger for Taiwan.

An institutional analysis to the extent that is possible, given the complexities of actual institutions—confirms the finding of the above "POLIS-effect" to some extent. However, serious problems may also lie ahead. The transformation of an underdeveloped economy from a largely rural-agricultural

base to a predominantly urban-industrial one is almost half a miracle, given the fact that only a handful of countries in the last two and one-half centuries have managed to do this.

However, the ability to form a POLIS seems to be rarer still. For this, favorable domestic and international circumstances are necessary, but not sufficient. A critical mass of R&D expenditures as well as skilled scientific and technical personnel must be formed. At the same time, as pointed out in chapter 4, a transformation of economic as well as social and political institutions will inevitably have to take place if innovation capabilities are to be more than a temporary phenomena. Given the complexity of the transformation processes, it is too early to characterize these countries as having erected a fully functional POLIS structurally. On the other hand, the “miracle”—while not nearly as miraculous as one might wish—does not seem to a be a complete myth. Only further historical development can determine the future trajectories of these “miracle” economies.

Endnotes

[1] The World Bank (1993), *The East Asian Miracle: Economic Growth and Public Policy*. World Bank Policy Research Report, New York: Oxford Univ. Press. Robert E. Lucas (1993), "Making of a Miracle", *Econometrica*, March, pp. 251-272. It will be clear from the argument developed in the subsequent chapters that the treatment of technology in these widely cited pieces leaves much to be desired. Innovation requires a base of physical and human capital; but it also requires an institutional set up, knowledge creation and application on a sustained basis. The concept of POLIS is meant to capture these complex processes in a systemic manner.

[2] The reader may note that the literature on the endogenous growth theory with interactions between human capital and R&D also offers prospects of sustained growth. Of course, critics in the past have pointed out that any theory that allows growth without limits ignores the second law of thermodynamics. See for example Nicholas Georgescu-Roegen (1971), Herman Daly and John B. Cobb (1989), Kenneth Boulding (1966), among others. Therefore, the energy and environmental constraints that might apply should be kept in mind. But for any such set of constraints the above conditions mentioned in the text are assumed to apply when a POLIS exists.

Chapter 2
The Miracle of East Asian Growth

When the World Bank published a book in 1993 with the dramatic title *The East Asian Miracle* it gave currency to an already widespread perception and interpretation of the growth process in that region. This particular study singled out eight economies: Japan, the "Four Tigers," and three South-east Asian countries. These economies were called the high-performing Asian economies (HPAEs). It pointed out that,

> Since 1960, the HPAEs have grown more than twice as fast as the rest of East Asia, roughly three times as fast as Latin America and South Asia, and five times faster than Sub-Saharan Africa. They also significantly outperformed the industrial economies and the oil-rich Middle East-North Africa region. Between 1960 and 1985, real income per capita increased more than four times in Japan and the Four Tigers and more than doubled in the Southeast Asian NIEs. If growth were randomly distributed, there is roughly one chance in ten thousand that success would have been so regionally concentrated.[1]

Table 2.1 Growth of real per capita GDP, 1966-2004

	1966-73	1974-90	1991-93	1993	1994	1995-2004
World	5.1	3.0	1.2	1.3	2.8	3.3
Industrial countries	4.8	2.8	1.2	1.0	2.9	2.8
Asia (general)	5.9	6.3	7.0	7.4	7.8	7.0
East Asia and Pacific	7.9	7.1	8.7	9.4	9.3	7.7
Latin America and the Caribbean	6.4	2.7	3.2	3.8	3.9	3.5
Europe and Central Asia	7.0	3.6	-9.4	-7.5	-7.5	3.4
Middle East and North Africa	8.5	0.7	3.4	1.8	0.3	3.2
Sub-Saharan Africa	4.7	2.2	0.6	0.8	2.2	3.8

Source: World Bank, *Global Economic Prospects and the Developing Countries*, Washington D.C. 1995.

The study went on to point out,

> The HPAEs have also been unusually successful at sharing the fruits of growth. The HPAEs enjoyed much higher per capita income growth at the same time that income distribution improved by as much or more than in other developing economies, with the exceptions of Korea and Taiwan, China, which began with highly equal income distributions. The HPAEs are the only economies that have high growth *and* declining inequality. Moreover, the fastest growing East Asian economies, Japan and the Four Tigers, are the most equal.
>
> As a result of rapid, shared growth, human welfare has improved dramatically. Life expectancy in the developing HPAEs increased from 56 years in 1960 to 71 years in 1990. (In other low- and middle-income economies, life expectancy also rose considerably, from 36 and 49 to 62 and 66 years, respectively.) In the HPAEs, the proportion of people living in absolute poverty, lacking such basic necessities as clean water, food, and shelter, dropped—for example, from 58 percent in 1960 to 17 percent in 1990 in Indonesia, and from 37 percent to less than 5 percent in Malaysia during the same period. Absolute poverty also declined in other developing economies, but much less steeply, from 54 to 43 percent in India and from 50 to 21 percent in Brazil form 1960 to 1990. A host of other social and economic indicators, from education to appliance ownership, have also improved rapidly in the HPAEs and now are at levels that sometimes surpass those in industrial countries.[2]

According to this view high growth in the HPAEs has been accompanied by a rapid overall improvement of economic welfare. The World Bank study is also quite clear on the causes of East Asia's success:

> In large measure the HPAEs achieved high growth by getting the basics right. Private domestic investment and rapidly growing human capital were the principal engines of growth. High levels of domestic financial savings sustained the HPAEs' high investment levels. Agriculture, while declining in relative importance, experienced rapid growth and productivity improvement. Population growth rates declined more rapidly in the HPAEs than in other parts of the developing world. And some of these economies also got a head start because they had a better-educated labor force

> and a more effective system of public administration. In this sense there is little that is "miraculous" about the HPAEs' superior record of growth; it is largely due to superior accumulation of physical and human capital.[3]

The soundness of development policy was also singled out as a causal factor.

> Fundamentally sound development policy was a major ingredient in achieving rapid growth. Macroeconomic management was unusually good and macroeconomic performance unusually stable, providing the essential framework for private investment. Policies to increase the integrity of the banking system, and to make it more accessible to nontraditional savers, raised the level of financial savings. Education policies that focused on primary and secondary schools generated rapid increases in labor force skills. Agricultural policies stressed productivity and did not tax the rural economy excessively. All the HPAEs kept price distortions within reasonable bounds and were open to foreign ideas and technology.[4]

The study went on to point out that government policies also played an important role.

> But these fundamental policies do not tell the entire story. In most of these economies, in one form or another, the government intervened—systematically and through multiple channels—to foster development, and in some cases the development of specific industries. Policy interventions took many forms: targeting and subsidizing credit to selected industries, keeping deposit rates low and maintaining ceilings on borrowing rates to increase profits and retained earnings, protecting domestic import substitutes, subsidizing declining industries, establishing and financially supporting government banks, making public investments in applied research, establishing firm- and industry-specific export targets, developing export marketing institutions, and sharing information, widely between public and private sectors. Some industries were promoted, while others were not.[5]

In interpreting the connections between government policies and success, however, the World Bank publication assumed a stance of studied caution.

> Our judgment is that in a few economies, mainly in Northeast Asia, in some instances, government interventions resulted in higher and more equal growth than otherwise would have occurred. However, the prerequisites for success were so rigorous that policy makers seeking to follow similar paths in other developing economies have often met with failure. What are these prerequisites? First, governments in Northeast Asia developed institutional mechanisms which allowed them to establish clear performance criteria for selective intervention and to monitor performance. Intervention has taken place in an unusually disciplined and performance-based manner. Second, the costs of interventions, both explicit and implicit, did not become excessive. When fiscal costs threatened the macroeconomic stability of Korea and Malaysia during their heavy and chemical industries drives, governments pulled back. In Japan the Ministry of Finance acted as a check on the ability of the Ministry of International Trade and Industry to carry out subsidy policies, and in Indonesia and Thailand balanced budget laws and legislative procedures constrained the scope for subsidies. Indeed, when selective interventions have threatened macroeconomic stability, HPAE governments have consistently come down on the side of prudent macroeconomic management. Price distortions arising form selective interventions were also less extreme than in many developing economies.[6]

The Bank document on East Asian Miracle does contain a section on coordination failures. This section offers a rather sophisticated view of a plurality of ways in which coordination can be achieved in economies. Coordination through prices may not always be possible. However, the point made by Martin Weitzman in 1974 that the price system is not widely used in allocating resources within many organizations is not recognized. Weitzman (1974, p. 478) pointed out:

> If there really were some basic intrinsic advantage to a system which employed prices as planning instruments, we would expect to observe many organizations operating with this mode of control, especially among multidivisional business firms in a competitive environment. Yet the

> allocation of resources within private companies (not to mention governmental or nonprofit organizations) is almost never controlled by setting administered transfer prices of commodities and letting self-interested profit maximization do the rest. The price system as an allocator of internal resources does not pass the market test.

Despite the attempt of the Bank's economists to offer a balanced view, it appears that ultimately the "miracle" is to be explained by "market fundamentals." Whether this was intended as a strict interpretation or not, in practice this remains the accepted interpretation among many professionals within and outside the Bank. In particular the export promotion strategy has received a disproportionate amount of attention in these debates.

The emphasis on export promotion strategy as an explanation of the "East Asian miracle," of course, predates the World Bank study. A number of contributions such as Keesing (1967), Bhagwati (1978), Little (1981), Krueger (1981), and Nishimizu and Robinson (1984), already focused on this particular aspect. Empirical studies carried out to identify and validate the causal relationship between the export growth and economic growth in Asian NIEs by Michaely (1977), Balassa (1978), Tyler (1981), Kavoussi (1984), Jung and Marshall (1985), Hsiao (1987) and Ni (1989), also predate the magisterial volume published by the Bank in 1993. However, it is this publication that gave (perhaps without fully intending to) apparently the official imprimatur to the term "The East Asian Miracle."

It should, however, be pointed out that neoclassical economists had begun by the early 90s to search for rigorous foundations for explaining this growth process in a competitive framework. One example of the enthusiasm

generated among the economists about the "miracle" of Korean growth is the 1991 Fisher-Schultz lecture, given at the European meetings of the Econometric Society by the (then) future Nobel Laureate Robert E. Lucas, Jr.[7] Lucas' lecture carries the title "Making A Miracle." In the very first sentence, Lucas contrasts the growth performance of Philippines and Korea. Both the countries had about the same starting point in 1960 with GDP per capita of approximately $640 in 1975 U.S. dollars. However, Lucas points out, Korean GDP/capita from 1960 to 1988 grew at more than 3.5 times per annum than that of the Philippines. Lucas concludes categorically:

> I do not think it is in any way an exaggeration to refer to this continuing transformation of Korean society as a **miracle**, or to apply the term to the very similar transformations that are occurring in Taiwan, Hong Kong, and Singapore.[8] (emphasis added)

During the course of his lecture Lucas raises important questions such as: how did it happen and why did it happen in Korea and Taiwan and not in countries like the Philippines?

Lucas goes on to view "the growth miracles as <u>productivity</u> miracles." In other words, he chooses to focus on technology within the neoclassical paradigm. Ultimately, human capital and learning-by-doing are the fundamental determinants of the Lucasian "productivity miracle."

Lucas (1993) begins with the model of a single economy that uses physical capital and human capital to produce a single good although we are cautioned that one cannot "obtain a theory of economic miracles in a purely aggregative set-up in which every country produces the same single good." The

single country, single good framework is used merely as a convenient device for stating the problem and narrowing down the theoretical possibilities. In such a model, the long-run growth rate of both capital and labor productivity is equal to the rate of growth of human capital. The ratio of physical to human capital will also converge to a constant in the limit. Therefore, in the long run, income must be proportional to the economy's initial endowment of human capital. Thus, initial differences in human capital can lead to long-run divergences in income levels among countries.

Lucas also shows that by modifying the human capital accumulation technology according to the approach taken by Parente and Prescott (1991) one can obtain convergence. The strategy here is to allow one country's human capital growth rate to be a function of the overall level of human capital in the world. If the functional form is chosen appropriately, countries with a lower than average level of human capital can accumulate this type of capital faster, leading to a faster than average rate of overall economic growth.

Ultimately, Lucas relies on learning-by-doing effects to explain the "miracle." He recognizes that "…[a] growth miracle sustained for a period of decades…must…involve the continual introduction of new goods, not merely continued learning on a fixed set of goods." This raises the possibility of productivity levels dropping with continued learning of new processes.

Using a model of an economy that produces a variety of goods indexed by quality, Lucas is able to derive the asymptotic growth rate for such an economy. This growth rate turns out to be a product of the quality gradient parameter and

the exogenously given rate at which better goods become producible. Using this model under alternative assumptions, Lucas claims, one can explain "the East Asian miracle."

> The objective was to set down on paper a technology that is consistent with a growth miracle, which is to say, consistent with wide differences in productivity growth among similarly endowed economies. This has been done, following Stokey and Young, in a way that I think is consistent with the main features of the East Asian miracles, all of which have involved sustained movement of the workforce from less to more sophisticated products. A fast growing economy or sector under this technology is one that succeeds in concentrating its workforce on goods that are near its quality frontier, and thus in accumulating human capital rapidly through the high learning rates associated with new activities and through the spillover of this experience to the production of still newer goods. These hypotheses are consistent with commonly known facts, and have testable implications for many more.[9]

Lucas does not want to see economic miracles as a function of backwardness. As he puts it,

> A successful theory of economic miracles should, I think, offer the possibility of rapid growth episodes, but should not imply their occurrence as a simple consequence of relative backwardness. It should be as consistent with the Philippine experience as with the Korean. For the purpose of exploring these possibilities, the conventions of small, open economy trade theory are more suitable (as well as simpler to apply) than those of the theory of a closed, two-country system. If the technology available to individual agents facing world prices has constant returns, then anything is possible. Some allocations will yield high external benefits and growth in production and wages; others will not. There will be a large number of possibilities, with individual agents in equilibrium indifferent between courses of action that have very different aggregative consequences.[10]

Within the context of the human capital and learning models it is also attractive to consider the connection between rapid productivity growth and

openness of the economy. Lucas makes this point against import-substitution quite forcefully.

> Consider two small economies facing the same world prices and similarly endowed, like Korea and the Philippines in 1960. Suppose that Korea somehow shifts its workforce onto the production of goods not formerly produced there, and continues to do so, while the Philippines continues to produce its traditional goods. Then according to the spillover theory, Korean production will grow more rapidly. But in 1960, Korean and Philippine incomes were about the same, so the mix of goods their consumers demanded was about the same. For this scenario to be possible, Korea needed to open up a large difference between the mix of goods produced and the mix consumed, a difference that could widen over time. Thus a large volume of trade is essential to a learning-based growth episode.
>
> One can use the same reasoning to see why import-substitution policies fail, despite what can initially appear to be successful in stimulating growth. Consider an economy that exports, say, agricultural products and imports most manufactured goods. If this economy shifts toward autarky through tariff and other barriers, its workforce will shift to formerly imported goods and rapid learning will occur. But this is a one-time stimulus to productivity, and thereafter the mix of goods produced in this closed system can change only slowly, as the consumption mix changes. Note that this argument has to do only with the pace of change in an economy's production mix and does not involve scale, though it can obviously be reinforced by scale economies.[11]

I have spent some time on Lucas' approach to the explanation of the miracle to underline the strengths of a theoretically plausible strategy. Lucas is by no means unaware of the objections one can raise to only working in one's office with pen and paper. He ends up by strongly endorsing his approach, however.

> Can these…be viewed as a summary of things that are known about economic growth? After all, they are simply a sketch of some of the properties of mathematical models, purely fictional worlds, that certain economists have invented.

> How does one acquire knowledge about reality by working in one's office with pen and paper? There is more to it, of course: Some of the numbers I have cited are products of decades-long research projects, and all of the models I have reviewed have sharp implications that could be, and have not been, compared to observation. Even so, I think this inventive model-building process we are engaged in is an essential one, and I cannot imagine how we could possibly organize and make use of the mass of data available to us without it. If we understand the process of economic growth - or of anything else - we ought to be capable of demonstrating this knowledge by creating it in these pen and paper (and computer-equipped) laboratories of ours. If we know what an economic miracle is, we ought to be able to *make* one.[12]

Although one may be willing to agree with Lucas in principle, the question of specificity even at the theoretical level still remains. Making human capital the center piece in a theoretical model is not objectionable empirically; but it may only be a partial approach. This is an issue that will be taken up for further investigation in chapter 4.

The theoretical approaches exemplified by Lucas, Stokey and others assume that the "miracle" is a fact. They then explore ways of modeling an economy so that the fact would be consistently explained within the model. However, some recent criticisms challenge that assumption altogether. We need, therefore, to raise the question: is there, in fact, anything like a miracle in this whole episode of rapid East Asian growth? The next chapter explores the issues raised by this question.

Endnotes

[1] World Bank (1993), The East Asian Miracle: Economic Growth and Public Policy , Oxford University Press, p. 2.

[2] Ibid. p. 2-5.
[3] Ibid. p. 5.
[4] Ibid. p. 5.
[5] Ibid. p. 5-6.
[6] Ibid. p. 6-7.
[7] This lecture has subsequently been published in *Econometrica*. See R. E. Lucas Jr. (1993), "Making of a Miracle," *Econometrica*, March, 251-272.
[8] Ibid., 251.
[9] Robert E. Lucas, Making A Miracle, *Econometrica*, vol. 61, no.2 (March, 1993), p. 267.
[10] Ibid. p. 269.
[11] Ibid. p. 269-70.
[12] Ibid. p. 271.

Chapter 3
The Myth of an Asian Miracle?

We saw in the last chapter that the theoretical project outlined by Lucas takes the fact of a "miracle" as a given. Therefore, the interpretation of growth as a miracle is seen as the empirical problem that requires a theoretical explanation. We have also discussed extensively the particular explanation advanced by Lucas.

But, is the interpretation of this growth process so straightforward? Is high growth in countries such as Korea and Taiwan also accompanied by a high rate of productivity growth? If it is so, what explains the productivity growth? If it is not, then the miracle would seem to stop short of the prospects for a sustained performance. In this latter case, the explanation of the non-performance on the productivity front would seem to be just as significant as the explanation of the miraculous performance on the growth front.

In this chapter I begin with a critical analysis of some disquieting findings in the 1990s, even before the financial crises, regarding growth accounting and total factor productivity increase in the East Asian miracle economies. It should be noted that these studies did not go completely unchallenged; but it is important to understand the theoretical and empirical bases of these findings first. Having done this, next, I explore the specific question of technology and growth in these economies. In the next chapter, I offer a specific methodological approach for studying the relations between technology and

growth. It is seen there that following up on technology and learning in a serious manner also requires a close look at national innovation systems of these countries. The results discussed in this chapter cast some doubt on the merits of the easy enthusiasm that thinking in terms of “miracles’ might have generated. However, the strategy of investigation in the next chapter also calls for a look at the micro-structure of innovation at the sectoral or even at the firm level. In this sense my methodological approach is similar to that of the assimilationist school. The major difference is that along with the micro, sectoral investigation, I also integrate the various sectors in terms of their interdependence. Finally, distribution is also integrated with production structure. Therefore, the present approach takes the assimilationist argument to the economy-wide level from both the production and the distribution side in a multi-sectoral framework.

The controversy over technical progress in East Asia

In a very provocative essay Paul Krugman (1996b) challenges the wisdom of calling the growth performance of the East Asian countries a “miracle.” His essay, “The Myth of Asia’s Miracle,” starts out by offering “a cautionary tale” regarding earlier Western envy and fear with respect to the growth performance of the former Soviet bloc countries in the 1950s. Krugman then points out that contrary to the West’s fearful expectations of being overtaken in the economic race, the whole Soviet-style economic system more or less collapsed a few decades later. The failure of these economies to post

efficiency gains is identified as one of the major reasons for stagnation and subsequent collapse. Is there a close parallel between this story and the often told fables about the East Asian tigers? Krugman thinks that there are "surprising similarities":

> The newly industrializing countries of Asia, like the Soviet Union of the 1950s, have achieved rapid growth in large part through an astonishing mobilization of resources. Once one accounts for the role of rapidly growing inputs in these countries' growth, one finds little left to explain. Asian growth, like that of the Soviet Union in its high-growth era, seems to be driven by extraordinary growth in inputs like labor and capital rather than by gains in efficiency. [1]

Krugman cites the example of Singapore where the economy grew by 8.5 percent per year between 1966 and 1990. However, Krugman points out, such a phenomenal growth performance cannot be automatically associated with overall technical progress. Krugman tells us:

> The employed share of the population surged from 27 to 51 per cent…investment as a share of output rose from 11 to more than 40 per cent.
>
> Even without going through the formal exercise of growth accounting, these numbers should make it obvious that Singapore's growth has been largely on one-time changes in behavior that cannot be repeated.[2]

However, Singapore, Krugman admits, is an extreme case. For other East Asian countries the situation may indeed be different. However, it is precisely in this respect that the empirical work by scholars such as Lau, Kim and Young seems quite discouraging. Their collective efforts raise a set of pertinent and vexing questions regarding growth, technology, and ultimately the possibilities of a POLIS—in developing economies.

Sources of long-term growth in East Asia

In a number of papers (Lau 1996, Kim and Lau 1992a,b,c, 1994a,b,c,d) Lau and Kim have explored extensively the empirical features of growth accounting in the East Asian economies. Using a meta-production function approach they utilize flexible functional forms to allow for non-neutral returns to scale and technical progress. One of the most significant maintained hypotheses in this approach is that of identical production functions in terms of "efficiency-equivalent" units of output in all countries. It is found that the data cannot reject this hypothesis.[3]

In Kim and Lau (1994c) decomposition of the economic growth in a number of countries into the sources of growth is carried out. One characteristic of their approach is that it does not require the traditional assumptions of constant returns to scale, neutrality of technical progress, profit maximization and complete disembodiment. Their contrasting findings for the developed and developing nations were stark enough to raise quite a few eyebrows among the believers of the miracle.

Kim and Lau (1994a,b,d) and Boskin and Lau (1990, 1994) find that technical progress indeed is the mainspring of growth in the developed countries. However, quite surprisingly, this is not the case for the Four Tigers. With embodied technical progress attributed to the technology parameter for the Tigers as a whole there is no role left for technical progress. For these four countries as a group, in this instance, capital, labor and human capital account for 64.25, 18.25, and 17.5 percent of their growth performances respectively.

Together, these numbers are sufficient to account for all the growth. Nothing is left for technical progress to explain.

Perhaps it is wrong to put the whole burden of technical progress on the technology parameter? Perhaps it is necessary to consider capital as a source of embodied technical progress as well? This is not an unreasonable criticism of the above approach. However, calculations using this alternative assumption (which were repeated and verified for the most part) do not offer much hope.

For this scenario the results on the average are almost identical to the situation where technical progress is parametrized. For Korea, our country of particular interest, the two sets of numbers are almost identical. In this case, 60.2 percent of the growth can be attributed to capital; 29 percent to labor and 19.8 percent to human capital.

This lack of measured technical progress in the miracle economies is paradoxical. In particular the “catch-up” hypothesis suggests that these high growth economies should be exploiting technological opportunities available to them. What may have gone wrong? Lau (1991) offers a number of explanations of varying degrees of plausibility.

First in line is whether the physical depreciation has been adequately taken into account. It may seem that since the gross capital stock rather than the net capital stock is used as a factor input in the aggregate production function, allowance has apparently not been made for the physical depreciation. If

physical depreciation is significant then the measure for capital stock will be biased upwards. This will naturally bias the estimated capital augmentation rate.

> Thus, an estimated capital augmentation rate of zero may not necessarily imply a zero "true" rate of capital augmentation—it is also consistent with the interpretation that the "true' rate of capital augmentation is equal to, and hence offset by, the "true" rate of depreciation, resulting in an estimate of zero for the measured capital augmentation rate. However, since the same concept of the gross capital stock is also used for the developed countries, the above argument cannot explain the fact that the estimated rates of capital augmentation are positive and statistically significant for the developed countries but low or negative and statistically insignificant for the developing countries.[4]

This last point may indeed be valid. However, one should also consider the possibility that there may be greater errors in the measurement of capital for the less-developed countries. It is not clear, however, why the error should work in the direction of hiding technical progress.[5]

Lau goes on to make several other points:

> Second, as we have seen, there are significant measured economies of scale in all inputs taken together for the developing countries. For economies in which output and inputs are both growing, economies of scale and technical progress provide alternative explanations for the reason why doubling the inputs results in more than doubling the outputs. With data from a single country, it is difficult to distinguish between the existence of economies of scale and technical progress. However using the meta-production function approach, in which time-series data from several countries are pooled, it is possible to distinguish scale effects from technical progress, because at any given time, production at different scales is observed across countries and the same scale of productions is observed in different countries at different time. Empirically, we have found that as far as the developing countries are concerned, it is economies of scale, rather than technical progress, that have been responsible for the good economic performance.

> Third, the effects of technical progress in the Boskin-Kim-Lau studies are essentially being captured by the time trend, which is supposed to reflect the influence of omitted or unmeasured variables, such as R&D capital; land, or more generally, the natural endowment of resources; and other intangible "investments," such as software and market development. However, it is likely that such omitted or unmeasured variables are actually relatively unimportant in the developing countries, where there has been, until very recently, little investment in R&D, especially in basic research. Thus the *indigenously* generated improvements in technology must be quite scarce in these countries. By contrast, the developed countries invest a significant percentage of their GDP and R&D and even greater amounts in innovation and other productivity-enhancing activities. Thus, it should not be surprising that technical progress, or the "residual," is much larger in the developed countries than in the developing countries. It is also true that despite the very rapid capital deepening in the developing countries, their industries are by and large not knowledge- or technology-intensive, at least until recently. Moreover, the developing countries have been playing "catch-up" in technology—the capital goods installed are likely to be on-the-shelf variety, and the possibility for indigenous improvements is limited. For all these reasons, the "residual" due to omitted variables is likely to be small, or at least smaller, for the developing countries.[6]

As mentioned previously, even treating technical progress non-parametrically does not improve matters. The claim regarding increasing returns also requires careful consideration. We deal with this issue in the next chapter. Lau continues:

> Fourth, the industries in the developing countries typically employ mature technologies with limited innovation possibilities, and the capital goods for these technologies, mostly imported, have been fully priced (that is, the acquisition as well as royalty costs fully reflect the possible efficiency gains and the amortization of R&D and other developmental costs) in the international market, so there is little or no net increase in value-added, over and above the normal returns to the factor inputs. In other words, the "innovation rents" have been largely captured by the foreign inventors, manufacturers, and distributors of the new equipment or intermediate inputs, in markets that ate only very

imperfectly competitive. The "rents" can also take the form of royalties and fees paid to the foreign technology licensers by the developing countries, which, for some sectors, can constitute a rising share of the output produced, reducing correspondingly the domestic part of the real value-added. Consequently, even if a new technology were adopted. Its effect might not be reflected in the form of a higher real value-added, holding measured factor inputs constant.

Fifth, it is possible that whatever technical progress there is in the world is mostly embodied in the capital goods used in the high-technology industries; thus, the developing countries, with a much smaller high-technology sector, would not have been able to take advantage of it to the same extent as the developed countries.

Sixth, it is possible that the growth of the "software" component, broadly defined to include managerial methods and institutional environment as well as supporting infrastructure, lags behind the "hardware" component in the developing countries—and hence the capital goods have not been able to realize their full potential productivity, especially in the non-tradable sectors, which are often also the most monopolistic.

Seventh, it is also possible that positive technical progress in certain industries in the developing countries may be offset by rising inefficiency in certain other industries, especially those in the non-tradable sectors, so that the economy as a whole exhibits no measured technical progress. (This is less likely to be true for an open and competitive economy such as Hong Kong's.) Rising inefficiency can persist only in protected markets, under monopolistic or oligopolistic conditions. Thus, technical progress at the microeconomic or industrial level may be nullified by the inefficiency caused by the lack of competition in the domestic market.

Eighth, it is also possible that the efficiency of production may be negatively related to the rate of growth of the factor inputs, especially capital inputs, for given levels of the factor inputs, because of costs of adjustments and learning. Essentially, the more rapid the rates of growth of the factor inputs, especially that of capital, the further away is the economy from the steady state, and the productive potential of the new investments may not be fully realized. The rate of growth of the capital input may be taken to be a measure of the amount of disruption of necessary adjustment. If this is the case, the positive effect of any technical

> progress may be offset in the short term by the negative effect of overly rapid growth of factor inputs until their rates of growth decline to more absorbable, or "steady-state," levels. Thus, as long as a developing country continues in a phase of high input growth, the measured "residual" may be small or negligible.
>
> Finally, it is also possible that improvements in the quality of life, such as a reduction in air pollution or traffic congestion, brought about by increased inputs of both capital and labor, may not be fully reflected in measured real GDP. In other words, not all of the output resulting from the inputs, and its growth over time, is captured by measured real GDP, and hence in the efficiency and productivity measurements.[7]

Another finding of these studies is the complementary augmentation of physical capital and human capital simultaneously during technical progress. This line of reasoning accords very wll with the strategic complementarity view presented in chapter 2. Indeed, Lau (1996) offers this as an explanation of the non-existence of endogenous technical progress at the aggregated level for the East Asian economies.

> This complementarity may in fact be one reason why technical progress is not as yet an important source of economic growth in the developing countries. At the prevailing levels of physical capital and human capital, it has not yet become profitable for the developing countries to invest in R&D and other technical progress-creating activities. In time, with diminishing marginal productivity of physical capital and the increase in inputs complementary to technical progress (physical and human capital), the attractiveness of technical progress creation will increase relative to traditional investment in physical capital. In this sense too, technical progress can also be said to be endogenous at the level of the aggregate economy.[8]

Tales of Cities and Nations in East Asia: The Growth Paradox

Young (1998b,1995, 1994, 1992) has written a series of papers where the existing estimates of productivity growth for the East Asian economies are

called into question. These papers point out, as do the works discussed in the previous section, that the assumption of high productivity growth in these economies cannot be accepted. On the contrary, the remarkable rapid growth of factor accumulation seems to explain their remarkable growth record. Thus Young's work has become another source of vindicating Krugman's thesis of the myth of the Asian miracle discussed earlier.

Young (1995) uses the translog index of total factor productivity (TFP) growth and very careful estimates of factor accumulation to arrive at the final estimates of TFP. Average TFP for Hong Kong (1966-1991) is found to be 2-3 percent per year. For Singapore (1966-1990) it is only 0.2 percent. Taiwan posts a figure of 2.1 percent. For Korea TFP growth during 1966 to 1990 turns out to be about 1.7 percent.

One of the interesting features of Young's empirical work is that the numbers above are the results of a set of separately derived small effects all coming together. Furthermore, these results point out the fallacy of the premise of high productivity growth in the manufacturing sectors of the East Asian NIEs, a premise shared by both theoretical and policy-oriented research in this area. The range of productivity growth in non-agricultural sectors turns out to be from a low of 0.2 percent for Singapore to a high of 2.3 percent for Hong Kong over the relevant period.

Total Factor Productivity for Korea

Since in a future chapter (chapter 5) I will be concerned with the existence of a POLIS in Korea it seems worthwhile to pay special attention to TFP calculations in Korea. I have tried to test Young's claim regarding the "confluence of small effects" by modifying carefully some of the estimates and recalculating the overall effect. The bottom line still remains the same—no more than a 1.8 percent per annum TFP growth for 1966 to 1994. The slight increase is consistent with Young's (and others') observation that productivity growth in Korea shows an upward time-trend. The slope did increase in the 1980s and 1990s; but the overall rate is still significantly below the more optimistic pronouncements.

The 1.8 percent TFP growth that I was able to derive contrasts with the Christensen and Cummings (1981) estimate of 4.1 percent during 1960 to 1973. However, as Young has pointed out, their inclusion of land input and agricultural inventories biased the measure of capital stock.

Both my estimate and Young's are close to Pyo and Kwon's (1991) estimate of 1.6 percent for the private sector during 1960-1989. They also use the Korean Statistical Yearbook for hours of work estimates for 1960-62 and the Economically active Population survey from 1962 on. The change in methodology in 1962 may have given rise to a statistical artifact showing a very rapid increase in hours worked. This would partially account for the slightly lower estimate on their part.

Total Factor Productivity for Taiwan

Taiwan is the second country which I intend to analyze in depth later (chapter 6). Hence a preliminary look at Taiwan's productivity performance seems worthwhile. The following table 3.1 (table viii in Young (1995)) shows the total factor productivity growth estimates by Young for Taiwan.

Table 3.1 Total Factor Productivity Growth: Taiwan

Time period	Output	Aggregate capital	Weighted capital	Aggregate labor	Weighted labor	TFP	Labor share
Economy--excluding agriculture:							
66-70	0.111	0.152	0.171	0.043	0.044	0.034	0.739
70-80	0.103	0.137	0.144	0.068	0.068	0.015	0.739
80-90	0.078	0.085	0.083	0.024	0.032	0.033	0.749
66-90	0.094	0.118	0.123	0.046	0.049	0.026	0.743
Manufacturing:							
66-70	0.168	0.207	0.214	0.078	0.075	0.031	0.558
70-80	0.121	0.145	0.146	0.100	0.101	0.001	0.566
80-90	0.072	0.078	0.079	0.012	0.021	0.028	0.613
66-90	0.108	0.128	0.130	0.059	0.063	0.017	0.579
Other industry:							
66-70	0.104	0.177	0.190	0.100	0.096	-0.020	0.702
70-80	0.112	0.165	0.169	0.063	0.066	0.013	0.691
80-90	0.059	0.058	0.060	0.012	0.018	0.027	0.692
66-90	0.088	0.122	0.127	0.048	0.051	0.014	0.695
Services							
66-70	0.087	0.145	0.162	0.018	0.023	0.040	0.828
70-80	0.094	0.134	0.139	0.049	0.050	0.029	0.827
80-90	0.090	0.094	0.092	0.036	0.038	0.039	0.777
66-90	0.091	0.119	0.123	0.038	0.040	0.035	0.811

It is interesting to note that the sectoral pattern of productivity growth in Taiwan seems to be quite different from the Korean pattern. Manufacturing and other industry have average growth rates of 1.7 percent and 1.4 percent, respectively. These sectors lag behind services. For the latter, the average growth rate is more than double — 3.5 percent per year.

Young also points out that <u>within</u> the “other industry” classification there are differences between the two countries as well.

> Thus, over the 1966-1990 period total factor productivity rose 3.7 percent per annum in Taiwanese mining (as compared with a decline of -1.1 percent per annum in Korea) and fell -0.2 percent per annum in Taiwanese electricity, gas and water (as compared with rapid growth of 5.2 percent per annum in Korea). Elsewhere, the performance of the two economies was more similar, with productivity in Taiwan rising 1.5 percent per annum in construction (2.2 percent Korea), 4.7 percent per annum in transport, storage and communications (3.4 percent Korea), and

> 0.2 percent per annum in finance, insurance, real estate, and business services (-0.1 percent in Korea).[9]

There are some statistical issues with respect to the Taiwanese authorities' measurement of public sector output. According to Young:

> Whereas most national accounts authorities deflate public sector output by the wages of different types of public sector employees, leading to an approximately zero growth in output per effective worker, the Taiwanese national accounts incorporate a "quality adjustment," allowing for the growing (unmeasurable) productivity of public sector employees. According to my estimates, between 1966 and 1990 output per effective worker in the Taiwanese public sector grew 4.4 percent per annum (6.6 percent per annum if one includes military personnel in the denominator.[10]

After adjusting for the above treatment of public sector output the results change somewhat. The following table 3.2 captures the changes.

Table 3.2 Modified Factor Productivity Growth

Time period	Output	Aggregate capital	Weighted capital	Aggregate labor	Weighted labor	TFP	Labor share
Economy-excluding agriculture and with adjustment of public sector output:							
66-70	0.092	0.152	0.171	0.043	0.044	0.015	0.739
70-80	0.103	0.137	0.144	0.068	0.068	0.015	0.739
80-90	0.073	0.085	0.083	0.024	0.032	0.028	0.749
66-90	0.089	0.118	0.123	0.046	0.049	0.021	0.743
Services-with adjustment of public sector output:							
66-70	0.050	0.145	0.162	0.018	0.023	0.003	0.828
70-80	0.094	0.134	0.139	0.049	0.050	0.029	0.827
80-90	0.082	0.094	0.092	0.036	0.038	0.031	0.777
66-90	0.082	0.119	0.123	0.038	0.040	0.026	0.811
Economy-excluding agriculture and official public sector:							
66-70	0.120	0.173	0.187	0.069	0.073	0.012	0.699
70-80	0.112	0.141	0.145	0.072	0.073	0.017	0.693
80-90	0.080	0.083	0.081	0.024	0.033	0.033	0.715
66-90	0.100	0.122	0.125	0.052	0.056	0.023	0.702

Young points out:

> As the reader can see, this adjustment has a large impact on the aggregate nonagricultural economy, where productivity growth falls to an average of 2.1 percent, and an even stronger impact on services, where productivity growth now appears to have averaged 2.6 percent (which nevertheless remains higher than manufacturing and other industry). Table [3.2] also presents estimates for the nonpublic sector nonagricultural Taiwanese economy, which sidesteps these measurement issues by excluding the public sector from consideration. I find that total factor productivity growth in the nonagricultural private sector Taiwanese economy averages 2.3 percent per annum between 1966 and 1990. Interestingly, the two sets of estimates for the aggregate economy, both with and without the public sector, show a substantial improvement in productivity growth during the 1980s, which is reminiscent of the results for Korea.[11]

The last sentence offers some hope for productivity change through technology in the 1980s. However, the conclusions Young reaches at the end of his essay would seem to dismiss this possibility. First of all, he reiterates that productivity growth cannot be thought of as extraordinarily high.

> Underlying the pervasive influence of the East Asian NIEs on both theoretical and policy-oriented research in the economics profession lies a common premise: that productivity growth in these economies, particularly in their manufacturing sectors, has been extraordinarily high. The results of this paper, as summarized in Table [3.1], suggest that this premise is largely incorrect. Over the past two and a half decades, productivity growth in the aggregate nonagricultural economy of the NIEs ranges from a low of 0.2 percent in Singapore to a high of 2.3 percent in Hong Kong, whereas in manufacturing productivity growth ranges from a low of -01.0 percent in Singapore to a high of 3.0 percent in South Korea. For the purposes of comparison, Table [3.2] reproduces the results of two detailed cross-country studies of productivity growth, with methodologies similar to that used in this paper. As the reader can se, it is not particularly difficult to find either developed or less developed economies whose productivity performance, despite considerable slower growth of output per capita, has approximated or matched that of the NIEs. While, with the exception of Singapore, productivity growth in the NIEs is not particularly low, it is also, by postwar standards, not extraordinarily high.[12]

He then goes on to state without conscious irony,

> The results of this paper should be heartening to economists and policy-makers alike. If the remarkable postwar rise in East Asian living standards is primarily the result of one-shot increases in output brought about by the rise in participation rates, investment to GDP ratios, and educational standards and the intersectoral transfer of labor from agriculture to other sectors (e.g., manufacturing) with higher value added per worker, then economic theory is admirably well equipped to explain the East Asian experience. Neoclassical growth theory, with its emphasis on level changes in income and its well-articulated quantitative framework, can explain most of the differences between the performance of the NIEs and that of other postwar economies.[13]

If the Lau-Kim findings or Young's findings on East Asia that are corroborated by my own econometric reestimation are right then one faces a problem similar to the one faced by Sherlock Holmes in The Hound of Baskervilles. In this story Holmes is puzzled by the fact that the dog did not

bark at night. In an analogous way we should be puzzled by the absence of technical progress in rapidly growing countries such as Korea and Taiwan.

One possible route to take at this point is to investigate the state of the development of technology itself. Indeed, this will have been the most direct route; but there are numerous roadblocks which make straightforward econometric calculations a difficult if not impossible task. Still there are insights to be gained if we pursue the existing descriptive evidence with perseverance. A careful analysis should be rewarding in any event. But what is also required at this point is a framework of analysis that can enable us to look at technology and growth both at the macro and at the sectoral and micro level. It will be seen that increasing returns, R&D and creation of a skilled scientific and technical work force lie at the heart of the debate regarding the East Asian economic performance. For this reason, we need to develop a rigorous theoretical framework that can be operationalized for carrying out the necessary empirical work. This is the task of the next chapter.

Endnotes

[1] Paul Krugman, Pop Internationalism, 174-5.

[2] Ibid., 175.

[3] Indeed after repeating the exercise for a cross-section of Asian economies separately, I could not reject this hypothesis either.

[4] Unless one were to assume, in addition, that the 'true' depreciation rate is higher in the developing countries than in the developed countries, because of various factors such as the mix of outputs. However, we may also note that Japan, which is supposed to have a high 'depreciation' rate, also has a high estimated rate of capital augmentation. In any case, given the magnitudes of the estimated capital augmentation rates of the developed countries, the implied "true" depreciation rates would have to be implausibly high.

[5] Lawrence J. Lau (1996), "The Sources of Long-Term Economic Growth: Observations from the Experience of Developed and Developing Countries," in Ralph Landeu, Timothy Taylor and Gavin Wright (eds.) The Mosaic of Economic Growth, Stanford, CA: Stanford University Press, p. 81.

[6] Ibid., p. 82.

[7] Another way in which there may be little or no net increase in value added even with the adoption of new equipment and technology is if critical components that are needed as intermediate inputs can be imported only at high monopolistic prices. Thus, the benefits of the new technology are appropriated by the foreign manufacturers and suppliers of the critical components. Examples of such critical components include microprocessors, liquid crystal displays, and MS-DOS and Microsoft Windows softwares for notebook computers; plastic lenses for cameras; and recording heads for video-camera recorders.

[8] Lau, op. cit., pp. 83-84.

[9] Alwyn Young, "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," *The Quarterly Journal of Economics*, August 1995: p. 662.

[10] Ibid.

[11] Ibid. p. 663.

[12] Ibid. p. 671.

[13] Ibid. p. 673-5.

A Methodological Critique of the Growth Accounting Approach

Here I consider some long-dormant criticisms of the neoclassical aggregate production function approach[1]. These criticisms, if they are to be taken seriously, would seem to invalidate the neoclassical growth theory altogether. Furthermore, the empirical growth accounting and factor-shares fitting would also turn out to be tautological at best and meaningless at worst. In this appendix I will summarize the basic criticisms in a loosely structured historical fashion.

It may be recalled that the critics of the East Asian miracle called 'accumulationists' by Nelson and Pack (1996) start from the aggregate neoclassical production functions and derive the following conclusions:

1. Growth is (almost) entirely due to the growth of factor inputs.
2. Total factor productivity growth is very slow.
3. There must be inevitable slowdown of this type of growth because of diminishing returns to capital.
4. According to Lau and Kim there is little evidence of catching up with the advanced countries.

If the above facts are indeed true then it follows that these economies will not become economic powers threatening the advanced economies. At least this will not happen in the immediate future.

[1] See also, Felipe(1997)

Opposing the accumulationists are ‘assimilationists’ like Richard Nelson, Howard Pack and John Page. They express their dismay and disbelief quite dramatically:

> Totally autarchic and corrupt Burma exceeds the TFP growth of South Korea!... These results strain credulity and severely undermine the claim based on Young’s work that the HPAE were simply run-of -the mill countries in the period from 1970 to 1985. (Pack and Page, 1994b, p. 253)

Although Nelson and Pack go to great lengths in distinguishing their position from that of the accumulationists they raise no qualms about methodology. Only the substantive empirical claims of the accumulationists are questioned. However, starting with Wicksell as early as 1919, questions have been raised about the validity of the aggregate production function approach to growth and distribution. In 1953 Joan Robinson ignited the capital theory controversy with her *Review of Economic Studies* article: “The Production Function and the Theory of Capital.” The subsequent flurry of articles from the two Cambridges resulted in a clarification of the meaning of capital and the conditions under which an aggregate production function itself is a meaningful entity. Essentially, the critique of the marginal productivity theory carries over into a critique of the aggregate production function. Partly as a result of this devastating theoretical critique neoclassical growth theory went into a recession in the 1970s.

The more recent critique of growth accounting revives another line of criticism of growth theory first stated with great clarity in an article by Phelps-

Brown in 1957. There he points out that cross-sectional Cobb-Douglas production functions are not a hybrid; they are, in fact, indistinguishable from the cost identity.

This line of criticism was pursued in the 60's by Simon and Levy (1963) and in the 70's by Shaikh (1974). Felipe (1997),and others try to elucidate these issues further for Cobb-Douglas production functions as well as other production and cost functions. Their basic conclusion can be summed up as that of a circularity. The statistical findings do not provide an independent test of, say, the elasticity of substitution as a technological parameter. Likewise the growth accounting estimations of TFP , by themselves do not justify the methodology of this approach.

Chapter 4
Making a Miracle:
A New Approach

As the discussion in the last two chapters shows, a large part of the problem of resolving the debate between the miracle-mongers and miracle-breakers has to do with the characteristics of the growth process itself. In this chapter a systematic attempt will be made to arrive at a methodology for identifying the nature of the growth process in the East Asian economies. The key issue, from this perspective is whether these countries have been able to create a positive feedback loop innovation system (POLIS).

Can the New Growth Theory Help?

By the 1970s formal neoclassical growth theory must have run into rapidly diminishing returns from further research efforts. Romer (1991) has suggested that many theorists must have understood the necessity for making technical change endogenous. However, the theoretical and technical innovations that would be necessary in order to make such a theoretical venture feasible were not forthcoming until the late 1970s. In particular the paper by Dixit and Stiglitz in 1977 on imperfect competition provided theorists in both the new growth theory and the new trade theory with the formal apparatus to make the necessary intellectual progress.

Theoretical advances in several areas of economics have led to the identification of technology and innovation as the prime movers in the process of growth and wealth creation. Both the new growth theories and new theories of international trade figure prominently among these advances.[1]

Solow (1994, p. 48) states that 'no one could ever have intended to deny that technological progress is at least partially endogenous to the economy.... The question is whether one has anything useful to say about the process, in a form that can be made part of an aggregative growth model'. In retrospect, it is clear that the new growth theorists have tried to answer precisely this challenge.[2]

The way the new growth theory rises to this challenge is by simply abandoning the idea of diminishing returns to capital. At the microeconomic level, the formal apparatus of a representative agent model with infinite-horizon intertemporal optimization to determine investment and the introduction of monopolistic competition provide the analytical foundations of this approach.

Romer (1994) points to a number of stylized facts to motivate new growth theory. According to him, the basic challenge for the growth theories has been to incorporate the following propositions or, as Romer seems to treat them — stylized facts:

1. There are many firms in a market economy.

2. Discoveries differ from other inputs because many people can use them at the same time.

3. Physical activities are amenable to replication.

4. The source of technological advance must be the activities of people.

5. Discoveries enable many individuals and firms to earn economic rents.

The neoclassical model captures facts 1, 2, and 3 but not the others. Technology, in fact, is treated as a pure public good in this model. Endogenous growth theories also treat knowledge as a public good with spill-over effects. At the same time these models

try to accommodate fact 4 as well. Romer credits Arrow (1962) and Shell (1967) as early precursors in this formal venture.

Early models of endogenous growth (e.g. Romer (1986) or Lucas (1988)) still did not capture fact 5. Romer (1986) assumes that aggregate output can be written in the following form:

$$y = A(R)\, F(R_j, K_j, L_j)$$

where,

y = aggregate output

R_j = stock of research results from expenditure on research and development by firm j.

K_j = capital of firm j

L_j = Labour in firm j

In order to exclude any prospects of monopoly power F (.) has to be homogeneous of degree 1 in all its arguments. For R_j this carries the implication that research is a rival good.

Once imperfect competition is admitted, however, the above sleight-of-hand is no longer necessary. The key problem now becomes the specification of the evolution of technology. Grossman and Helpman (1989) present a model which specifies an evolutionary path different from that of a neoclassical model. Coe and Helpman (1993) demonstrate that domestic and foreign ‘knowledge capital stocks’ help to explain the growth in total factor productivity in OECD countries. In an even more specific study Eaton and Kortum (1993) found that the number of national scientists and engineers is a significant determinant of a country's income level. The findings with regard to POLIS in

Korea and Taiwan presented in the next two chapters will also support this line of thought. Earlier a study by Lichtenberg (1992) had found that the level of spending on Research and Development (R&D) was also a significant variable in the determination of a nation's output.

In many plausible endogenous growth models (e.g. Grossman and Helpman (1991a)) successful innovation leads to increased productivity. The market leader earns monopoly rents until a rival firm discovers and markets a better version of the same product.

The R&D expenditure is related to the prospects for earning economic rent. Firms are taking a necessary gamble here. By deciding to spend money on R&D the firm buys a chance at developing the future product. Firms may invest in knowledge up to the point where the marginal costs of such investment equals the marginal expected gain. Both physical and human capital accumulation can be introduced in such models in a straightforward manner.

Extension of such innovation-based scenarios to open economies can provide new reasons for global integration. Rivera-Batiz and Romer (1991) show that integration may lead to greater access to a larger technical knowledge base (one could draw a mental picture showing the difference between North and South Korea in this respect) than would be available under autarky. It is also possible that exposure to international competition may reduce unnecessary industrial research. However, without ready access to the global research base this may not necessarily be the situation.

It should also be recognized that free trade may not always be the best state of affairs. A country with abundant natural resources and unskilled labor (but not enough

skilled labor) may specialize under free trade in activities that are **not** human capital intensive. In the long-run, this may thwart technical progress and lower the steady state rate of growth. Technological spillovers may also mean that a small country must spend some time in 'catching up' with the rivals in the world market. Although this is not a scenario to be pursued by all countries under all circumstances, the chapters on Korea and Taiwan will show the relevance of 'technology policies' even in a regime of export-led growth.

Increasing Returns and Positive Feedback Loops to the Rescue

The extension of the new growth theory to the problems of innovation in LDCs is not obvious. The models discussed above deal mainly with the well-developed innovation structure that is already in place in the industrialized economies. For the LDCs the problem is to create such a structure. This problem, as we will see soon, is intimately connected with the existence of multiple equilibria in complex economies. A positive feedback loop leading to a virtuous cycle of growth and technology development is necessary for this purpose. For this reason the understanding of increasing returns in this context is also crucial. In the remainder of this chapter a theoretical exploration of innovation, increasing returns and multiple equilibria will be undertaken.

According to Arrow, '...increasing returns has had a long but uneasy presence in economic analysis'. Although given much prominence by Adam Smith, concerns with increasing returns were soon replaced by constant returns and perfect competition. Apart from the asides by Marshall in his otherwise competitive framework, sporadic attempts by Sraffa (1926), Joan Robinson in the 1930s and Kaldor in the 1950s did little to dislodge the orthodoxy.

As observed previously, in the 1980s many growth models discarded the constant returns to capital assumption. A by-product of this venture is the increasing returns to scale. More fundamentally, the work of Brian Arthur and his collaborators during the same period brought increasing returns to the forefront of mechanisms that drive modern market economies. Two sets of elegant lectures by Paul Krugman have also developed the spatial aspects of increasing returns (Krugman, 1991, 1996a).In his autobiographical introduction to *Innovation, Organization and Economic Dynamics*(Dosi, 2000), Giovanni Dosi writes of the efforts at the Santa Fe Institute to understand complexity and increasing returns by economisrs like Brian Arthur, among others.

Arthur (1994) emphasizes two fundamental aspects of increasing returns problems. The first is the commonality of economic issues captured by increasing returns. The second is the problem of determining how an equilibrium comes to be selected from among many existing equilibria. The model presented later in this chapter has multiple equilibria in technology systems. It illustrates in a substantive way both of Arthur's insights.

In a market economy, ‘success’ is often cumulative or self-reinforcing. Typically outcomes are not predictable in advance. However, once an equilibrium gets selected out of a number of long-run equilibria, there is a tendency to be locked in. Technically then, processes exhibit non-convexities -- violating the generic assumption of competitive equilibrium economics. Intellectually, the presence of self-reinforcing mechanisms sharing common features found in fields as far apart as enzyme reactions and the economics of technical change underlines the importance of such mechanisms in

governing the dynamics of processes far from equilibrium, regardless of the field in which they occur.

In Arthur (1989) the possibilities of lock-in and non-ergodicity are demonstrated rigorously in the case of competing technologies. Earlier in the classic 1985 paper 'Clio and the Economics of QWERTY' Paul David had introduced the idea of path dependence. This idea has gained rapid acceptance within the economics profession. It also has stimulated a number of subsequent studies providing these empirical approaches with the conceptual apparatus for studying the trajectories of technical change.

In collaboration with Yuri M. Ermoliev and Yuri M. Kaniovski, Arthur used the Polya urn problem in a general form to model non-linear processes. In the more general cases these models typically display multiple equilibria. These equilibria correspond to the stable fixed points of the associated 'urn function'. History seems to matter in the selection process.

One may raise the question in the light of our discussion of the new growth theory in open economies, how trade and self-reinforcing systems may be connected. How, for example, would trade liberalization affect the rate of technological change? The question is not easy to answer -- again at least partially because of the presence of multiple equilibria. In the normal dynamics, the process may be smooth for some time, but suddenly when the change becomes cumulative, one equilibrium may collapse and another one may take over. Locally stable equilibria may become unstable; but the change from stability to instability is also an opportunity for a new 'self-organization' (Krugman 1996a). Location of technologies in different parts of the globe are not predetermined; but they may depend on history. History may, in turn, be to some extent

determined by policies. Thus in a complex, non-linear world with technological uncertainties, standard economic theory is largely silent on the technological road to take for a developing open economy.[3]

Positive feedback loop innovation systems and strategic complementaries: the possibility of multiple equilibria

Throughout the preceding discussion I have been implicitly stressing the motivation for taking the possibility of multiple equilibria in our economic models with technology seriously. One might ask: why are multiple equilibria so crucial in understanding the role of technology in the growth process of developing economies? One answer to this question is that those growth models that focus on one type of equilibrium (even when there may be more than one) may be misleading in a serious way. Concentrating on a unique equilibrium leads to the kind of deterministic view of economic history that history itself cannot support. Ignoring the possibilities of stagnation or different kinds of growth leaves us quite unprepared to explain the different growth trajectories (including stagnation for certain periods for certain countries) taken by different countries.[4] In the light of recent economic history for instance, we may wish to ask why the Asian NIEs took off while the African economies stagnated.[5] One possible answer is that these countries somehow reached different kinds of equilibria. This answer, by itself, is of course not adequate and requires further elaboration. In the empirical cases of Korea and Taiwan, such a detailed elaboration will indeed be attempted later. Here, I wish to focus on the possibility of multiple equilibria theoretically when there is strategic complementarity between human capital and R&D.

Strategic complementarity is particularly relevant in the context of the new theories of growth and technological change for at least two important reasons. In the first place two important strands of new growth theory have emphasized different aspects of growth generating elements. For example, Aghion and Howitt (1992) and Romer (1990), among others have emphasized investments in R&D as growth generating elements. On the other hand works by Lucas (1988) and Stokey (1991) have stressed the role of accumulating human capital in engendering and sustaining growth. Secondly -- and of equal importance to the theoretical models -- empirical evidence already exists for the significant effect that both human capital and R&D have on growth. Among others, Coe and Helpman (1993) and Lichtenberg (1992) have found that R&D has a significant effect on growth. Khan and Thorbecke (1988) and Khan (1993) also corroborate this finding. On the human capital side, Mankiw et. al. (1992) and Barro (1991) report the significance of human capital variables in understanding growth.[6]

It is also relevant here to consider the fact that some studies have uncovered a crucial interdependence between the incentives to invest in R&D and in human capital. For example, the study by Steedman and Wagner (1989) reveals that the differences in workforce skills is a major explanation for both the greater R&D and innovativeness of German firms in clothing manufacture. It is clearly important to trace the implications of such interdependence for growth in an analytical model.

Redding (1996) presents such a model. It is not the only one possible, of course. But the combination of a model of human capital accumulation with a "quality ladder" model of R&D can address the implications of strategic complementarity in a fairly straightforward manner. All one needs to do is to investigate the relationship between

human capital and R&D investments in the context of a dynamic model of endogenous growth.

Equilibrium in a model of this type, workers' investments in human capital depend on the expected investment of capitalists in R&D. At the same time, the capitalist entrepreneurs' willingness to invest in R&D can be shown to depend on the workers' expected investment in human capital. One can follow through this approach logically and derive the Nash equilibrium under rational expectations.

The characteristics of strategic complementarity between the two types of investment and the presence of pecuniary externalities (together with indivisibilities in R&D expenditures) create the possibilities of multiple equilibria. The existence of multiple equilibria creates possibilities for technology policies.

It is interesting to note that two possible kinds of equilibria may exist under the above circumstances -- a high growth, high quality equilibrium and a low growth, low quality equilibrium. In the low growth equilibrium situation, entrepreneurs do not expect the workers to invest in human capital and hence reduce their R&D investment. In a mutually reinforcing manner, the workers at the same time do not expect the capitalists to invest in R&D. Therefore, the workers in this model also reduce their investment in human capital.

In the high growth equilibrium, the size of innovation must be ‘sufficiently large’. The productivity from education (or human capital in general) must also be ‘sufficiently large’. The steady state growth rate is determined by both the rate of human capital accumulation and investment in R&D.

In the high growth equilibrium a higher level of output is available for consumption. Redding (1996) proves the following proposition:

A small, temporary subsidy towards the cost of R&D may induce the economy to select the high-skills equilibrium and can be self-financing.

Later I address the issue of whether or not such a subsidy (and an analogous one for human capital accumulation) has indeed played a major role in Korean innovation system. It is important to only note here the difficulty in practice of determining when and by how much to subsidize such activities.

Indeed one of the trickiest issues raised by both strategic trade and strategic complementarity approaches to high technology is the question of subsidies. Careful work by Suzumura et. al. (1988) and others (e.g. the studies in Robert Baldwin, ed. Trade Policy and Empirical Analysis (Chicago, 1988) and Paul Krugman and Alasdair Smith, eds. Empirical Studies of Strategic Trade Policy (Chicago, 1994)) reveal the difficulties that lie in wait for those who seek an easy vindication of industrial policy or protectionism. Another conclusion of these studies is that the pay-off from strategic trade policy is likely to be rather modest. However, the same can not always be asserted in case of subsidizing R&D or the cost of accumulating human capital. The stakes here can be quite high if strategic complementarities and indivisibilities are intrinsic features of the economy in question. If the difference between some subsidies and no subsidies is to be a high-growth as opposed to a low-growth economy, neglect of R&D or human capital by the government may not be so benign after all.

The discussion so far suggests that technology systems underlying the growth process may be complex. The next section addresses the issues raised by complex technology systems.

Technological Systems as Complex Structures

As the debate on the "East Asian miracle" underlines, the key strategic question for a country that has made a technological transition from a traditional to a modern system concerns the prospects for long-term economic growth. Ultimately, it is the sustainable long-term rate of growth that will determine the wealth that can be distributed among personal consumption, investment, government spending on infrastructure and public services, etc. However, some kind of distributional consensus is a presupposition of the particular growth trajectory followed. Therefore, there is a strategic socio-political decision regarding distribution that must be settled.

Given the distributional characteristics of an economy, it is the creation of an innovation system that will determine the viability of a technology-based growth process. This process of building an innovation system is very much a path-dependent process. The central idea is that the provision of appropriate types of capital, labor and forms of organization for high value-added industries will lead to rapid productivity increases. However, to sustain such an increase, a domestic innovation system must be set up.

There is a further requirement that this innovation system must fulfill. This is the requirement of a positive feedback loop or a virtuous cycle of innovations. In the current period -- Mark V, in Freeman and Perez's terminology[7] -- such a system will require networks involving technologies such as mini-computers, semiconductors,

robotics, fiber optics, genetics, etc. As Kitschelt[8] has pointed out, there are two important dimensions of high technology - 'coupling' and 'complexity'. Coupling refers to spatial or temporal linkages between different production steps. If the steps must be carried out at an identical location at the same time, they are coupled tightly. On the contrary, if they can be done at any location and the temporal sequence is not important, they are loosely coupled. An example of the latter is the computer technology (sub-) system.

The complexity dimension of a technology system or sub-system **is** the feedback process referred to earlier. In a complex environment, the non-linear processes with feedbacks at work may lead to multiple equilibria. In this chapter I present a relatively simple non-linear model and show how easily multiple equilibria may exist in complex technology systems. But before presenting the formal model, I want to stress the informational and organizational implications of coupling and complexity. It is to be expected that tight coupling requires close monitoring and supervision. Loose coupling, on the other hand, permits considerable decentralization.

Complex technology systems have large information requirements. This necessitates the creation and management of an information processing system. Large communications flows can overload the capacity of centralized management structures. Therefore, complex systems are more easily managed if they have loose coupling properties. Network coordination of relatively decentralized units may be the optimal organization of such loosely coupled complex systems.

Postwar development of technology (sub-) systems involving nuclear power, aircraft, spacecraft, and large computers shows a tight coupling and complexity. This

juxtaposition may have created scale characteristics and levels of risk that could only be managed, if at all, through various forms of intervention and regulation - usually on an ad hoc basis. However, the Mark V technologies mentioned before (e.g., software, microprocessors and genetic engineering) bring forth substantial complexity in a loosely coupled setting. Network organizations may provide the most effective structures for such a situation.

At the same time, returning to the question of technical progress in LDCs, we should realize that the problems faced by the typical developing economy are twofold. In the first place, the problem of the positive feedback loop innovation system (POLIS) must be solved. After the creation of a POLIS, its transformation from Mark IV to Mark V phase must be carried through. Just as only a sinner may officially confess, only a country that has committed the technological sin of creating a POLIS can move forward to the next stage. It is in the creation of a POLIS that many of the stumbling blocks must be faced first. Technology, industrial and trade policies have been the key national policy instruments for creating a POLIS.

A 'Simple' Non-linear Model of Complexity

In order to give the reader some idea of the problem of formalizing complex technological systems, in this section, I present a 'simple' non-linear model embodying distinct technological systems. The model is presented as a Social Accounting Matrix representation of the socio-economic system that was first mentioned in an abstract form in chapter 1. The next chapter will describe an empirical SAM for Korea. The key distinction here is the explicitly non-linear nature of the functional relationships. The

key theorem shows the existence of equilibrium. It is important to underline that the equilibrium is not necessarily unique. Some further considerations (using Herbert Amann's theorems on fixed points of increasing maps) show that multiple equilibria are the natural outcomes in such models. There would seem to be some role for domestic policy in guiding the economy to a particular equilibrium among many.

As mentioned before, the virtue of an economy-wide approach to technology systems is the embodiment of various inter-sectoral linkages. In a SAM, such linkages are mappings from one set of accounts to another. If there are no production activities then there are mappings connecting each activity with as many relevant other accounts (including other production activities) as possible. In terms of technology systems, the production activities can be broken down into a production (sub-) system and a set of innovative activities. In practice, this presents considerable difficulties of classification and empirical estimation. But conceptually the distinction has been made clear.

One major component of the entire innovation system is, of course, the expenditures on R&D. In the SAM presented later, this can appear either as an aggregate expenditure along the column labeled R&D, or as a set of disaggregated expenditures.[9] In the latter case these may be specified according to productive activities (e.g., construction, electrical equipment, etc.) or by institutions (e.g., private R&D expenditures, government R&D expenditures, etc.). It should be emphasized that the dynamic effects of R&D on the economy can be captured only in a series of such SAMs over time. This approach is still at the conceptual stage, but appears to be quite appealing. One can contrast the possible policy experiments that can be undertaken within such a framework with the apparently ad hoc science and technology policies in

many developing countries. In particular, the impact over time of a POLIS can be traced by building and maintaining such SAMs. Even without a complete SAM, partial (equilibrium or disequilibrium) analysis can be carried out that can approximate the system-wide results.[10]

In the following model, the main purpose is to establish a multiplicity of equilibria when the innovation system exhibits a non-linear relationship between parts of the socio-economic system. Such a relationship may obtain simply because of the existence of increasing returns to scale in production. Other types of non-linearities may also be present. However, the non-linearities in the production relations are the most relevant ones from the perspective of POLIS. Among other things this creates the possibility of moving from a technologically stagnant equilibrium to an equilibrium that makes a POLIS possible.

Choice of new technology in a developing country is affected by research and development in at least three different ways. Such a country can attempt to develop new technology through R&D, as mentioned previously. This ultimately requires a positive feedback loop innovation system in order to be self-sustaining. Another alternative is to adapt existing technology. This too requires a production system geared towards innovation in a limited way. A third alternative is to import technology or to acquire it through attracting foreign direct investment. In practice, all these different forms may be combined.

The abstract model below may be thought of embodying all these different possibilities. However, the first option requires, among other things, a presence of multiple equilibria. In a unique equilibrium world the competitive equilibrium (under the

assumption of complete markets) will always be the most efficient one. The presence of increasing returns usually destroys such competitive conditions.

We begin with a number of productive activities reflecting the existing technological structure. We also incorporate the possibility of R&D as a separate productive activity. At the level of abstraction we are working, it is always possible to break R&D down into as many finite components as we want. In chapter 4, a detailed description of modeling technology systems via SAMs is given. In chapter 5, the empirical implementation of the ideas presented here and in chapter 4, is carried out. The key relationship in this context is that between the endogenous accounts (usually, production activities, factors and households) and the exogenous ones. It is this relationship that is posited to be non-linear and this together with some assumptions on the mathematical space can lead to the existence of multiple equilibria, as shown below. We now turn to the formal part of the analysis. The analysis is carried out in abstract function spaces. In the first part the relevant space is a vector lattice over a real field R. In the second part some results on ordered Banach space are discussed.

I. The Model on a Lattice

Define X as a vector lattice over a subring M of the real field R.

Let $x_+ = \{x \mid x \in X, x \geq 0\}$

A non-linear mapping N is defined such that $N : X_+ \to X_+, N_0 = 0$. Given a vector of exogenous variables d, the following non-linear mapping describes a simultaneous non-linear equations model of an economy, E:

$$x = Nx + d \qquad (1)$$

for a given $d \in X_+$.

This non-linear system represents a socio-economic system of the type described previously. In order to specify the model further, the following assumptions are necessary.

1. X is order complete
2. N is an isotone mapping
3. $\exists \hat{x} \in$ such that $\hat{x} \geq N\hat{x} + d$

In terms of the economics of the model, the non-linear mapping from the space of inputs to the space of the outputs allows for non-constant returns to scale and technical progress over time. The 3 assumptions are minimally necessary for the existence of an equilibrium. Assumption 3, in particular ensures that there is some level of output vector which can be produced given the technical production conditions and demand structure.

Existence of Multiple Equilibria:

Theorem: Under the assumptions 1 - 3, there exists $x^* \in X_+$ so that x^* is a solution of

$x = Nx + d$

Proof: Consider the interval $[0, x] = \{\hat{x} \mid \hat{x} \in X_+, 0 \leq \hat{x} \leq x\}$ where $\hat{x}$ is defined as in assumption 3. Take a mapping F.

$F : x \in X_+ \rightarrow Nx + d$

F is isotone and maps $[0, x]$ into itself.

Define a set $D \equiv \{x | x \in [0, x], x \geq Fx\}$.

By assumption 3, D is non-empty.

We now show $x^* \equiv \inf D$ is a solution to $x = Nx + d$. $x^* \equiv \inf D$; therefore $x^* \leq x, \forall x \in D$. F is isotone; therefore $Fx^* \leq Fx \leq x$ for each $x \in D$ implying.

$$Fx^* \leq x^*$$

From (2) we have $F\left(Fx^*\right) \leq Fx^*$. Thus $Fx^* \in D$; hence $x^* \equiv \inf D \leq Fx^*$ so, $Fx^* \leq x^* \leq Fx^*$. Therefore $x^* = Fx^*$.

This is an application of Tarski's and Birkhoff's theorem. The key feature to note here is that the equilibrium is not necessarily unique. It should also be noted that under additional assumptions on space X and the mapping N the computation of a fixed point can be done by standard methods (e.g. Ortega and Rheinboldt).

II. Multiple Equilibria on Banach Space:

In this section the results for multiple equilibria are extended to functionals on Banach Space. We can define the model again for monotone iterations, this time on a non-empty subset of an ordered Banach space X. The mapping $f : X \to X$ is called <u>compact</u> if it is continuous and if $f(x)$ is relatively compact. The map f is called <u>completely continuous</u> if f is continuous and maps bounded subsets of X into compact sets. Let X be a non-empty subset of some ordered set Y. A fixed point x of a map $N : X \to X$ is called minimal (maximal) if <u>every</u> fixed point y of N in X satisfies

$$x \leq y\left(y \leq x\right)$$

Theorem: Let (E, P) be an ordered Banach space and let D be a subset of E.

Suppose that $f : D \to E$ is an increasing map which is compact on every order interval in D. If there exist $y,\ \hat{y} \in D$ with $y \le \hat{y}$ such that $y \le f(y)$ and $f(\hat{y}) \le \hat{y}$, then f has a minimal fixed point x. Moreover, $x \le y$ and $x = \lim F^k(y)$. That is, the minimal fixed point can be computed iteratively by means of the iteration scheme

$$x_0 = y$$

$$x_{k+1} = f(x_k) \qquad k = 0,1,2,....$$

Moreover, the sequence (x_k) is increasing.

Proof: Since f is increasing, the hypotheses imply that f maps the order interval $[\bar{y}, y]$ into itself. Consequently, the sequence (x_k) is well-defined and, since it is contained in $f[\bar{y}, y]$, it is relatively compact. Hence it has at least one limit point. By induction, it is easily seen that the sequence (x_k) is increasing. This implies that it has exactly one limit point $\bar{x}$ and that the whole sequence converges to $\bar{x}$. Since f is continuous, $\bar{x}$ is a fixed point of f. If x is an arbitrary fixed point in D such that $x \ge \bar{y}$, then, by replacing y by x in the above argument, it follows that $\bar{x} \le x$. Hence $\bar{x}$ is the minimal fixed point of f in $(\bar{y} + P) \cap D$. It should be observed that we do not claim that there exists a minimal fixed point of f in D.

We can also show that if $F : x \in X_+ \to Nx + d$ is an intersecting compact map in a non-empty order interval $[x, \hat{x}]$ and $x \le Fx$ and $F\hat{x} \le \hat{x}$ then F has a minimal fixed point x^* and a maximal fixed point x^{**}. Moreover, $x^* = \lim F^k(x)$ and $x^{**} = \lim F^k(\hat{x})$. The first of the above sequences is increasing and the second is decreasing.

The above results are applications and extensions of fixed point theorems for increasing maps on abstract spaces due to Herbert Amann (1976). It is intriguing that they find such natural applications in economics with evolving technology systems and non-constant returns to scale. Although those theorems provide some structure for the equilibria in the socio-economic structure with evolving technology systems, it is not specified a priori which equilibrium will be reached. The problem of equilibrium selection thus remains open. The idea behind POLIS can now be stated more formally. It is to reach a sequence of equilibria so that the maximal fixed points that are attainable are in fact reached through a combination of market forces and policy maneuvers over time. It is also to be understood that path-dependence of technology would rule out certain equilibria in the future. Thus initial choices of technologies can matter crucially at times.

Translating the Non-linear Model

The models in the previous section, interpreted with due caution, demonstrate the theoretical possibility for a positive feedback loop innovation system. However, it is far from transparent from the abstract model how such a system can be represented in actuality. In this chapter, an attempt will be made to first define precisely what technological systems are from an empirical standpoint. Based on this, an operational way of capturing such systems empirically will be presented. The vehicle chosen for such a representation is the Social Accounting Matrix or SAM. SAMs are elaborate quantitative constructions based on social and economic data that can show the economy at a point in time with the necessary detail. How do we depict different technology systems in a SAM? How can we show the evolution of a technology system in such a

construction? How do we incorporate R&D and other factors of significance in understanding innovation in a SAM? These are some of the questions we need to raise in the present chapter. At the end, I hope to convince the reader that through a series of approximations the non-linearities and complexities of an innovation system can be approached meaningfully by using empirical SAMs for particular countries. In the next two chapters the applicability of these ideas is demonstrated under some hypothetical conditions by using SAMs constructed from historical data for the Korean economy and the Taiwanese economies.

Technology Systems and POLIS

As stated right at the outset, one of the main conceptual features of this book in exploring the effect of innovation on growth is the idea of a technology system. Conceiving of techniques not in isolation from one another but as a system with forward and backward linkages allows a system-wide way of looking at technologies. The main methodological way of translating the conceptual approach into operational categories will be the incorporation of two (or more) technology systems within a Social Accounting Matrix. Empirically, this approach allows one to investigate the role of technology systems in the entire economy.

Production techniques can be said to embody a range of different characteristics, such as the type and nature of the product, the organization of production, raw material and labour inputs and the scale and location of production (Stewart, 1977). In orthodox economic theory, there is nothing that would suggest any systematic association between

these various characteristics. Rather, one would expect a more or less random association of characteristics across techniques of varying labour-intensity.

The alternative view adopted here however, is that different technologies form part of distinct technological systems and that within each such system predictable relationships emerge between the variables just mentioned.[11] In this view the emphasis is on the 'systemic' aspects of societies and especially the interrelations between technology, property rights and preferences in each type of society.

One way to exemplify this procedure is to approach historically the evolution of technology systems in a given society.

If a historical perspective thus helps to make a connection between the way production is organized, the type of technology and the scale of production, it also helps to provide associations between other characteristics of a production technology that were mentioned at the beginning of this section, thus further contributing to the idea that technology should be viewed in terms of a system rather than as a vector of isolated characteristics. Stewart (1977), for example, has shown how, at any point in time, techniques tend to be

> developed against a background of a particular technology package.... Any single technical innovation has to fit in with the rest of the system both in terms of the requirements it imposes for inputs and in terms of the demand for the goods. A new technique must use inputs that are available, or can be made available, and must provide output which will fit into further production if it is an intermediate good, or into consumption patterns if it is a consumer good.... There are technological linkages between different parts of the system which mean that much of technology comes as a package, which cannot be separated and introduced bit-by-bit, but which goes together.[12]

In most developing countries, however, there is no one technological system; rather a range of systems can be identified with features that may often be highly

disparate, reflecting the historical conditions at a particular point of time. At the one extreme, for example, are technology systems which represent the period of 'pre-capitalist' economic formations. In these societies, the technological relationships within the system have a strong geographical component. Production and consumption activities, that is to say, tend to be closely related in a particular geographical location: 'the greater part of the products are produced for the satisfaction of the immediate needs of the community not as commodities'.[13] This (typically rather isolated) locality would usually exhibit a heavy degree of reliance on unskilled labour and self-employment (or family labour) as the mode of production, and it would usually exhibit minimal links with external technology systems (put otherwise, there would be highly limited leakages out of the system, as occur, for example, when imports from other systems take place). Such a technology system, furthermore, tends to make intensive use of local labour and other inputs per unit of output (as one would expect in a system lacking modern technologies and advanced technological capabilities). In a model with multiple equilibria, getting stuck with such a technology system in equilibrium is not out of the question.

At the other extreme, the modern sector of most developing countries closely resembles the technology system that is found in developed countries. This means, among other things, production techniques that are associated with the following characteristics: high-income sophisticated products; high levels of investment per head; educated and skilled labour inputs; high levels of labour productivity; close links, via backward and forward linkages to the modern technological system (frequently via a heavy dependence on imported inputs from developed countries).

Table 4.1 juxtaposes these contrasting aspects of traditional and modern technology systems and it also shows the mechanisms through which these differences are likely to bear on the distribution of income. In some cases, for example, the differences bear on the direct and indirect employment effects that can be expected from traditional as opposed to modern technologies, while in other cases the differences bear on backward linkage effects or the dispersion of incomes across production units of varying sizes. Table 4.2 combines the information contained in each row of Table 4.1 into a set of 8 propositions about the differential effects of traditional and modern technologies on the distribution of income.

Table 4.1: Alternative technology systems: modes of influence on income distribution

Traditional technology system	Modern technology system	Mode of influence on income distribution
a) Labour-intensive methods of production	Capital-intensive methods of production	Direct employment effect
b) Non-capitalist mode of production	Capitalist mode of production	Share of income accruing to factors of production
c) Dispersed small-scale production units	Production concentrated in small number of large-scale units	Dispersion of incomes across production units
d) Relatively high labour-output ratio throughout production chain	Relatively low labour-output ratio throughout production chain	Indirect employment effect
e) Relatively high non-labour (input) to output ratio throughout production chain	Relatively low non-labour (input) to output ratio throughout production chain	Backward linkages
f) Uses mainly inputs from own system	Uses mainly inputs from own system	Backward linkages
g) Relatively low (savings and import) leakages from the system	Relatively high (savings and import) leakages from the system	Linkages
h) Consumes a relatively high proportion of its own products	Consumes a relatively high proportion of its own products	Consumption linkages

Source: James and Khan (1997a).

Table 4.2: Alternative technology systems: implications for the distribution of income

Traditional technology system	Modern technology system
a) Generates high amount of direct employment	Generates low amount of direct employment
b) Relatively high percentage of value added accrues to rural self-employed, household family members	Relatively high percentage of value added accrues to (local and foreign) companies as profits
c) Wide geographical dispersion of income among small-scale units	Concentrated income generation among large-scale units
d) Generates high amount of indirect employment through backward linkage	Generates low amount of indirect employment through backward linkages
e) Generates relatively large backward linkage effects	Generates relatively small backward linkage effects
f) Linkages generated mainly within the traditional system	Linkages generated mainly within the modern system
g) Linkages within the system relatively unaffected by leakages	Linkages within the system subject to relatively substantial leakages
h) Consumption linkage to (traditional) products within the system	Consumption linkage to (modern) products within the system

Source: James and Khan (1997a).

It is important to note that the concern of the present book is the further evolution of the modern technology system. By way of contrast, in Khan (1997a, forthcoming) and James and Khan (1993, 1997a, b,1998) the emphasis is on the distinction between the traditional and modern systems. Here it is assumed that either through 'inexorable laws of history' or by accident (for my purpose it does not really matter which is the case) the modern system has replaced the traditional one. It is also assumed that this state of affairs is irreversible. The focus of the inquiry then shifts to the characterization of the

modern system. Does it have an autonomous character or is it dependent on borrowings from abroad? If the former is the case, then what are the interconnections among the parts of this system? In particular, do these connections exhibit features that form a POLIS? I attempt to answer such questions (and others) within the framework of a SAM with embodied technologies.

Theoretically, the approach to the innovative modern high technology system development adopted here is also consistent with the neo-Schumpeterian approach. The focus of analysis at the microlevel is on interactive learning described in chapter 2. The macroeconomic structure is built on this microfoundation. Technology itself is not just a collection of blueprints or machines but also tacit knowledge not easily transferred. Therefore, development and accumulation of human capital will be necessary before the takeoff into a POLIS can be realized. The innovation process also requires a synergy of producer and user. Thus the existence of markets for end-use or the creation of such markets over time is also a requirement of successful innovation. The resulting trajectory of technical progress is continuous under a normal regime of innovation. But discontinuities occur when new opportunities arise and a new set of innovations swarm on the economic horizon creating opportunities for a big jump in productivity.

The Social Accounting Matrix and Technology Systems

In this section, the Social Accounting Matrix is presented as a data gathering framework as well as an analytical tool for studying technology systems. The origins of social accounting can be traced as far back as Gregory King's efforts in 1681, but more recent work stems from the attempts by Richard Stone, Graham Pyatt, Erik Thorbecke

and others.[14] A useful summary of the recent state of the art can be found in Khan (1997a).

In the methodological framework of this study, the SAM is used for mapping production and distribution at the economy wide level. In this and the next section, first a general SAM is described. Then it is shown how one rather straightforward method for studying the impact of different technology systems within this framework follows logically from such a structure. The model presented here is a simple version of a class of SAM-based general equilibrium models.[15] It summarizes succinctly the interdependence between productive activities, factor shares, household income distribution, balance of payments, capital accounts etc. for the economy as a whole at a point in time. Given the technical conditions of production the value added is distributed to the factors in a determinate fashion. The value added accrued by the factors is further received by households according to their ownership of assets and the prevailing wage structure. In the matrix form, the SAM consists of rows and columns representing receipts and expenditures, respectively. As an accounting constraint receipts must equal expenditures.

It is through a further classification of technologies within a subset of productive activities that different technology systems can be operationalized via the structure of a modified SAM. Such a SAM, constructed for Indonesia has been called a SAM-TECH by Khan and Thorbecke (1988). The term is accepted here as a short hand way of referring to SAMs which embody a number of different technology systems. The theoretical justification for this is the persistence of structural disequilibrium during the evolution of an economic system. Alternatively, technological evolution could also be viewed as a process of 'punctuated equilibria' with long periods of slow evolution and then the

relatively rapid emergence of a modern technological system which all but replaces the older one.

In the case of Korea the earlier work in Khan (1997a) captured the coexistence of traditional and modern technology systems just before the emergence of the latter as the dominant system. The present work pushes it several steps further by looking at the further evolution of the modern system for Korea and Taiwan in chapters 5 and 6, respectively. The conceptual and empirical issues regarding the identification of dual technology systems and, the related transitional dynamics are discussed in Khan (1997a). Here the focus is on the modern technology system in the context of the East Asian growth debate. In other words, the key to the resolution of this debate is seen to be the presence or absence of a self-sustaining innovation structure in the modern technology system. As alluded to previously, the empirical features will be investigated for Korea and Taiwan later in the book. For the moment the following brief discussion of simple fixed price models is intended to underline the difficulties of implementing the non-linear models on abstract topological spaces presented earlier in this chapter. However, I can promise that the reader will not have to wait in suspense for too long. At the end of this chapter a reasonable compromise for investigating non-linearities within a linear modeling approach based on a SAM is advanced. This approach is based on a strategy of successive approximations. In chapter 5 some preliminary empirical results are offered for the modern technology system in Korea to partially justify, in an empirical context, the approach developed in this chapter. Chapter 6 presents the case of Taiwan to further illustrate the use of SAM-based modelling strategy for identifying a POLIS in a real world economy.

As is elaborated further in Khan and Thorbecke (1988), the SAM framework can be used to depict a set of linear relationships in a fixed coefficient model. For deciding the question of determination, the accounts need to be divided into exogenous and endogenous ones. For instance, in the Korean SAM, there are three aggregate endogenous accounts. These are the factors, households and production activities, leaving the government, capital and the rest of the world accounts as exogenous.[16]

Table 4.3: Simplified Schematic Social Accounting Matrix

				Expenditures				
				Endogenous Account			Exogenous	Total
				1	2	3	4	5
RECEIPTS	Endogenous Accounts	Factors	*l*	0	0	$T_{1.3}$	x_1	y_1
		Households	2	$T_{2.1}$	$T_{2.2}$	0	x_2	y_2
		Production Activities	3	0	$T_{3.2}$	$T_{3.3}$	x_3	y_3
	Exogenous	Sum. Of other accounts	4	ℓ_1'	ℓ_2'	ℓ_3'	t	y_x
		Total	5	y_1'	y_2'	y_3'	y_4'	

Looking at Table 4.3, which represents a SAM, we can see immediately that

$y = n + x$ (1)

$y = l + t$ (2)

Now if we divide the entries in the matrix Tnn by the corresponding total income (i.e. Yn), we can define a corresponding matrix of average expenditure propensities. Let us call this matrix A. We now have:

$$y = n + x = Ay + x \qquad (3)$$

$$y = (I - A)^{-1} x = Mx \qquad (4)$$

M has been called the matrix of accounting multipliers by Thorbecke, for these multipliers, when computed, can account for the results (e.g. income, consumption, etc.) obtained in the SAM without explaining the process that led to them. Let us now partition the matrix A in the following way.[17]

$$A = \begin{bmatrix} 0 & 0 & A_{1.3} \\ A_{2.1} & A_{2.2} & 0 \\ 0 & A_{3.2} & A_{3.3} \end{bmatrix}$$

Table 4.4: Schematic Representation of Endogenous and Exogenous Accounts in a SAM

		Expenditures				
		Endogenous	Sum	Exogenous	Sum	Totals
Receipts	Endogenous	T_{nn}	n	Injections T_{nx}	x	y_n
	Exogenous	Leakages T_{xn}	ℓ	Residual Balances T_{xx}	t	y_x
Totals		y_n'		y_x'		

Source: H.A. Khan and E. Thorbecke, Choice and Diffusion of Technology in a Macroeconomic (SAM) Framework.

Given the accounts factors, household and the production activities, we see that the income levels of these accounts (call them y_1, y_2, y_3 respectively) are determined as functions of the exogenous demand of all other accounts. In this respect, what we have is a reduced-form model which can be consistent with a number of structural forms. This is quite satisfactory as far as tracing the effects of a certain injection in the economy is concerned or for prediction purposes when the structural coefficients are more or less unchanged.

One limitation of the accounting multiplier matrix M as derived in equation (4) is that it implies unitary expenditure elasticities (the prevailing average expenditure propensities in A are assumed to apply to any incremental injection). A more realistic alternative is to specify a matrix of marginal expenditure propensities (C_n below)

corresponding to the observed income and expenditure elasticities of the different agents, under the assumption that prices remain fixed. Expressing the changes in income (dy) resulting from changes in injections (dx), one obtains,

$$dy_n = C_n dy_n + dx$$

$$= (I - C_n)^{-1} d_x = M_c dx$$

M_c has been christened a fixed price multiplier matrix and its advantage is that it allows any nonnegative income and expenditure elasticities to be reflected in its structure. In particular, in exploring the macroeconomic effects of exogenous changes in the output of different product-cum-technologies on other macroeconomic variables, it would be very unrealistic to assume that consumers react to any given proportional change in their incomes by increasing expenditures on the different commodities by exactly that same proportion (i.e. assuming that the income elasticities of demand of the various socioeconomic household groups for the various commodities were all unitary). Since the expenditure (income) elasticity is equal to the ratio of the marginal expenditure propensity (MEP_i) to the average expenditure propensity (AEP_i) of any given good i, it follows that the marginal expenditure propensity can be readily obtained once the expenditure elasticity and the average expenditure propensities are known, i.e.,

$$e_{y_i} = \frac{MEP_i}{AEP_i} \qquad \text{where } e_{y_i} = \text{income elasticity of demand}$$

$$MEP_i = e_{y_i} \bullet AEP_i$$

$$\text{and } \sum_i MEP_i = 1$$

Thus, given the matrix A_{32} of average expenditure propensities, and the corresponding expenditure elasticities of demand, Y_i the corresponding marginal expenditure propensities matrix C_{32} could easily be derived.[18]

Further analysis of the modern technology system within a SAM

The key to incorporating the evolution of modern sector is to understand the role of R&D within this sector in the SAM framework. Conceptually, R&D as an activity is a stream of expenditures by companies as well as the government. The major problem would seem to be the contradiction between the static nature of the SAM framework and the dynamic effects of R&D on the economy. First we need to see if this problem can be resolved.

Choice of new technology in a developing country is affected by R&D in at least two different ways. A developing country can attempt to develop new 'appropriate' technology through R&D, or it can adapt the existing technology to its needs. In the latter case research expenditures with the goal of modifying the existing technology may be necessary. This includes the adaptation of imported technology to suit local conditions as well as the upgrading of traditional technologies. In a positive feedback loop innovation system, the evolution of modern system may or may not be consistent with such adaptation or upgrading. For the moment we can simplify the discussion by ignoring this issue. However, this does not mean that adaptation or upgrading are not important. In fact, even for high technology, some firm-specific adaptive activities may be necessary, as chapter 5 shows.

In the literature on R&D in developed countries a distinction is made between research (sometimes between 'basic' and 'applied' research) and 'development'.

Whereas the end result of research is 'pure' or applicable knowledge, development attempts to reduce research findings into practice. Thus, for new technologies, products or processes to be realized, research is a necessary but not sufficient condition. In practice, however, it is often very difficult, if not impossible, to identify research and development as two separate categories because the same branch and in some cases the same personnel may be involved in both activities. Furthermore, the linkages between research and development are difficult to quantify. How much research is necessary before development can begin? Once development begins, is there no need for further research? There are no context-free, unambiguous answers to these questions. Therefore, in what follows I treat R&D as a symbiotic whole when looking at their impact on the evolution of the modern technological system and the economy at large.

How then are we to link R&D with the evolution of a technology system? As suggested initially the introduction of R&D as a separate activity may be something of a starting point. In analogy with the technological link now we can think of an 'R&D link' in the evolution of technologies. Since a given SAM is static, a series of SAMs can try to capture serially the effects of R&D on the technology system.

In a given SAM for a definite period we simply now have one more row and column, i.e. R&D, giving us an (n + 1) x (n + 1) SAM. In the accounting sense, this is all transparent in the form of transactions between the new R&D account and the rest of the economy. The current flows from and to the R&D account are captured by the entries in R&D column and row respectively. Incidentally, it is thus also possible to capture the financing of R&D by domestic or foreign and by public or private sources.

The public financing of R&D is captured by the flow of funds from the government account to the R&D and to a lesser extent by the R&D entries of publicly owned corporations. For this latter information to be shown, however, the productive activities need to be identified according to the types of ownership. If carried through in this manner, such a classification and mapping will also identify the foreign financing of R&D as the expenditure flows from foreign owned firms. The residual will be domestic private financing of R&D. In the next chapter the information on financing of R&D in Korea is presented and analyzed.

A more comprehensive and direct way to display R&D according to its mode of financing for each and every sector is to further break down the R&D column according to the different ways of financing the R&D expenditures. In this formulation, there should be one column for foreign private R&D, one for domestic private R&D, and so on. However, this will require an even more detailed breakdown of R&D data than in the previous case.

The above proposal can serve as an accounting device but runs into serious difficulties as a basis for economy wide modeling of technology. The major problem, as alluded to before, is that the effects of R&D on technology are essentially dynamic whereas the framework presented so far is completely static.

Typically, several years of lead time will be necessary for a new technology to be developed. Therefore, the fixed price multipliers derived from a SAM cannot reveal the dynamic effects of R&D on the technology system. This of course does not imply that econometric or CGE models incorporating R&D cannot be at least partially based on such SAMs, or that the SAM entries cannot be used as a base year solution for a relevant CGE model.

However, further modification of the SAM framework is possible. One strategy for capturing the dynamic effects discussed previously is through the introduction of lags in the R&D accounts, treating R&D as an intermediate input of production. This strategy requires one to make the assumption that the expenditure on R&D in a sector in the past caused the present increase in its productivity. By analogy, current R&D expenditures in a particular sector will lead to increases of productivity in the future. Thus, if $R_{j,to}$ is the expenditure of the jth sector on R&D at period t_0, the output effect on this sector may be observed after a period t_1 ($> t_0$) in the future. The effect may continue for a number of years up to another future period t_2 ($> t_1$). The value of t_1 and t_2 will depend upon the industry characteristics and the type of R&D undertaken. The impact of R&D on the productivity of technology systems can be reflected more accurately if the marginal effect of R&D on input-output coefficients can be computed for an increase in R&D. Symbolically,

a_{ij} (t) = input of activity i into activity j in period t

R_j (t) = R&D input into activity j in time t

Then

$$a_{ij}(t_1) = f(R_j(t_0), A_k)$$

Here, i, j = 1, 2,..., n

k = 1, 2,..., m

$t_1 > t_0$

A_k are other factors which shift productivity.

It may seem that with technological progress one should observe that a_{ij} (t_1) is less than or equal to a_{ij} (t_0) in a particular sector. However this is too restrictive, since

technological progress may very well call for less use of one type of intermediate input and more of another. Thus one may observe a decrease in the use of cotton fibers along with an increase in the use of synthetic fibers in the textile industry. However, total factor productivity must increase.

In terms of the matrix of average propensities the approach outlined above can be rewritten in the following manner:

As before, let

$$A = \begin{bmatrix} 0 & 0 & A_{1.3} \\ A_{2.1} & A_{2.2} & 0 \\ 0 & A_{3.2} & A_{3.3} \end{bmatrix}$$

The A-matrix, of course, now includes R&D as another productive activity.

After an increase in R&D expenditures, R_j, a new average propensities matrix A* can be obtained for the future.

$$A^* = \begin{bmatrix} 0 & 0 & A^*_{1.3} \\ A_{2.1} & A_{2.2} & 0 \\ 0 & A_{3.2} & A^*_{3.3} \end{bmatrix}$$

The above approach still involves considerable simplification of reality. Among other things it abstracts to some extent from the external effects of R&D expenditures. In the real world, as the discussion of spillovers suggests, quite frequently R&D in one

activity will also lead to productivity gains in other, perhaps related activities. Thus, in agriculture the expenditure for research on rice may lead to productivity gains for other crops as well. In the industrial sector research in microprocessors will certainly affect related activities in the computer industry, but may also lead to productivity gains in other areas of information technology not directly related to the microprocessors. One possible empirical strategy for solving this problem is to obtain econometric estimates of the approximate spillover effects of R&D. However this is by itself a considerably demanding enterprise.

In addition to the above, it should also be noted that the proposed framework ignores the cumulative effects of R&D. R&D expenditures in one period may result in not just a one shot increase in productivity, but rather to a cumulative effect for several periods following a decay process until future effects monotonically approach zero. Further econometric work with distributed lag specifications may be one way of estimating such effects over the relevant time period. It needs to be realized, however, that ignoring these effects as in the next chapter, under certain circumstances is not a research handicap. If the hypothesis under investigation is the non-existence of POLIS (as the work of Krugman, Lau and others discussed previously would seem to imply in the context of innovation and growth in Asian economies) then an a fortiori argument can be constructed if the empirical result points to some positive productivity effects of R&D. In other words, the actual productivity enhancing effects of R&D may be larger than the measured impact.

The above discussion is at the same time intended to inject a necessary note of caution regarding a mechanical application of the approach to innovation outlined so far.

Keeping in mind the qualifications a properly nuanced interpretation of the empirical findings may nevertheless provide insights into the national or regional innovation processes at work.

Non-linearities and Linear Approximations

Finally we come to the issue of reconciling the linearity of the fixed price multiplier models and the non-linearities involved in increasing returns. With linearities, we seem to be back to the world of constant returns. Is this an insurmountable roadblock?

The answer is that it need not be so. However, one must be careful not to claim too much. All we can hope to achieve here is to make successive approximations. Therefore, the strategy for capturing intertemporal effects may be used in a limited way to approximate scale effects at a point in time.

Since the utilization of inputs, including R&D, must vary according to scale of production we can vary them in a manner so that the variations are consistent with the underlying production functions with increasing returns to scale. Theoretically, choosing a series of discrete points from the continuous production mappings would merely require choosing a finite subset from an infinite set of points.

In empirical work, however, it may be impractical to hope for more than a few such points. Even these few points will typically involve some measurement error. Therefore, great caution will be necessary in interpreting the results. In the next chapter only two plausible transformations are found for Korea as well as some implausible ones. However the plausibility in this instance, as the subsequent discussion in that chapter will try to show, really stems from the overall view of the structure and performance of the

Korean economy over the last two decades and not on some pristine a priori mathematical theorem. The application of this method to Taiwan in Chapter 6 shows further how adequate approximations to reality can indeed be made.

This chapter has been concerned with the conceptual and theoretical issues related to a positive feedback loop innovation system. Starting with a consideration of the role of R&D and human capital in recent models of growth we were led to consider the roles of increasing returns and strategic complementarities. These considerations led to the formulation of a POLIS structure of innovation for a successful developing country. At first an abstract non-linear model with multiple equilibria was discussed. The discussion on technology systems in a SAM shows, with some necessary qualifications, how POLIS can be made operational in the context of a growing economy.

As mentioned at the beginning, the main purpose of this chapter was to develop an alternative methodological approach to analyze East Asian growth. By now, this has been largely accomplished. I can, therefore, turn to the question of analyzing the East Asian growth in the next two chapters. The problem, as the reader must now be aware, has been reformulated in the following way: can the East Asian economies be said to have constructed positive feedback loop innovation systems? The next two chapters attempt to answer this question for Korea and Taiwan, respectively.

Endnotes

[1] It seems to me that both types of theories engage in conceptualization and the exploration of logical relations among concepts. However, appreciative theory proceeds without the help of a formal mathematical apparatus most of the time.

2. Solow (1994) is an attempt to assess the achievements and the shortcomings of the new growth theoretical models, as is discussed later in this chapter.

3. Khan (1997a) presents some preliminary thoughts and a model (in chapter 2) emphasizing this point.

4. The recent debate on convergence can also be viewed in this context as countries moving through different paths and different equilibria forming a complex of dynamic trajectories.

5. See for example H. A. Khan, African Debt and Sustainable Development, New York: Phelps-Stokes Africa Series.

6. As the subsequent discussion shows complementarities between R&D and human capital may be far more important than has been thought previously. This is a major aspect of the positive feedback loop innovation systems discussed later.

7. See Christopher Freeman and C. Perez (1988), 'Structural Crisis of Adjustment: Business Cycles and Investment Behavior', in G. Dosi, et al, Technical Change and Economic Theory, London: Francis Pinter.

8. Herbert Kitschelt, 'Industrial Governance Structures, Innovation Strategies and the Case of Japan' (Autumn 1991), International Organization 45, 453-93.

9. Both types of specifications are possible in principle. In practice, as in the case of South Korea in chapter 5, the availability of data will often determine what type of specification will be used.

10. If SAMs are available at regular intervals (Indonesia is one such country), then models with flexible prices, different closure rules, etc., can be constructed over time.

11. This does not imply that these relationships are fixed. The reasonable interpretation is that for distinct two technology systems the range of co-variations among the different variables will show distinct and regular patterns in each case. These co-variational differences will then establish the differences between the two technology systems.

12. F. Stewart (1977), p. 7.

13. See Karl Marx (1946), (first published in 1867), Capital, London: Allen and Unwin, vol. 1, p. 377.

14. For a description of SAM as a data gathering device, see G. Pyatt and E. Thorbecke (1976), Planning Techniques for a Better Future, Geneva: International Labour Organization.

15. In Walrasian general equilibrium models the flexible price vector determines the equilibrium. In a Keynesian (dis)equilibrium model in the short-run the quantities vary while the price vector remains fixed. It is, of course, possible to build more complex models of CGE variety based on both orthodox and heterodox economic theories.

16. See Khan and Thorbecke, op. cit., Ch. III. The presentations here follow the cited work closely.

17. Ibid.

18. See G. Pyatt and J.I. Round (Dec. 1979), "Accounting and Fixed Price Multipliers in Social Accounting Matrix Framework," Economic Journal 89, 861.

Appendix to Chapter 4

Some Criticisms of the New Growth Theory from the Development Economics Perspective

The new growth theory has reintroduced concerns with increasing returns and innovation into the mainstream growth theory in a formal way. The new emphasis on fixed costs and nonconvexities in this literature has opened up areas of economic analysis that were not pursued with such rigor until recently. However, contrary to the claim made on behalf of this theory some earlier models — Haavelmo (1956), Arrow (1962) and Uzawa (1965), to mention only a few — endogenized technical progress in various ways. As mentioned in this chapter, Kaldor's models dealt explicitly with technical progress. In the Kaldor-Mirrlees model (1962) investment is the vehicle of technical progress. Shell (1967) is an attempt to model innovative activity that Romer (1986) recognized later. What Romer (1986) and Lucas (1988) models mainly did was to formalize some ideas of dynamic externalities in a competitive framework. However, do these models by themselves constitute a substantial breakthrough in development economics? The answer, I believe, is that they do not.

The convergence controversy has received much attention in the discussions about new and old growth theories. The empirical work that the controversy has spawned is a rather dubious medley of cross-country regressions. The proliferation of variables on the right-hand side of the

equations has legitimately raised the question of whether this “kitchen-sink approach” really explains anything. The main conclusion reached so far seems to be that the lack of convergence of per capita income growth is inconsistent with the assumption of identical technological opportunity sets for all countries of the world. This is a result that actually confirms some of the older Lewis-Dobb-Sen type formulations of the development process. Bardhan (1994) seems to be on the mark when he remarks that:

> The main result reached on the basis of dubious cross-country regressions and even more dubious data quality, that the lack of convergence in per capita income growth rates across countries belies the standard presumption of the availability of the same technological opportunities in all countries of the world is not particularly earth-shaking from the point of view of development economics. (Bardhan, 1994, p.4)

Bardhan (1994) also points out correctly that this already voluminous literature offers very little to the reader who wants to know what factors determine the international differences in productivity growth. The argument in the main body of this chapter was partly motivated by this sort of criticisms of the new growth theory and empirics.

Of course, the new growth theory also offers formal models of endogenous technical progress. Industrial organization theorists in the late 70’s were finally able to offer some tractable models of imperfect competition. The adoption of Dixit-Stiglitz functional form in the growth and trade literature has

given rise to its own differentiated spectrum of intellectual product differentiation and innovation. But by adopting the Dixit-Stiglitz type consumer preference structures most of these models ignore the actually existing asymmetries of sectoral demand patterns between the rich and poor countries. Models of product differentiation capture in a way the innovation in product variety; but the Kaldorian concern with increasing returns is not captured.

One important omission of “quality ladder” models is the existence of different vintages of capital. By assuming away the presence of older vintages which are made obsolete immediately after the introduction of new vintage inputs the models can no longer address the issue that is at the heart of the systems approach to technology presented in chapter 4 in this book. An evolutionary approach to technology systems can not ignore the coexistence of different vintages. Furthermore, the very question of the existence of POLIS can not be raised without assuming a system of heterogeneous capital and labor.

The new growth and trade theories of product innovation do focus our attention on non-convexities arising from large fixed costs. However, the non-convexities may matter also in a fundamental way when increasing returns are modeled explicitly in a rigorous way. Tarski’s fixed point theorem in particular, helps us to follow this route of attacking the modeling issue formally. In addition to incorporating the non-convexities arising from fixed costs of innovation, non-convexities arising from the dynamics of industrial transformation can also be captured by the approach adopted in this book.

Chapter 7
Asia's Financial Blues: The End of POLIS?

The East Asian financial crisis was by all accounts the most significant event in the world economy in 1997. The topic dominated the headlines, attracted the attention of the world and generated much despairing rhetoric. The economists naturally joined the cacophony of condemnations. The dismal science had never looked so dismal since the great depression of the 30s. Without doubt, the speed and depth of the collapse of financial markets in East Asia caught all by surprise. Neither the existing surveillance mechanisms nor markets warned the euphoric investors adequately of impending calamity. The reversal of fortunes in East Asia came suddenly and surprised even the experts. The contagion spread rapidly, engulfing a number of economies in quick succession. It started as a currency crisis, then became a financial crisis. By 1998 it had become a full-blown economic crisis.

The actual trigger for the crisis was the 1996 export slowdown in Asia. The cyclical downturn in the demand for electronics, in conjunction with a rising dollar and a declining yen, slowed export growth, and led to some skepticism about future growth. The initial export downturn and growing skepticism threatened the inflow of foreign capital, now badly needed to sustain the increasing current account deficits. This in turn led to market concerns about the more or less fixed exchange rates, culminating in pressure on them and their eventual collapse. Investors suffering losses started to withdraw from these markets, and the bubble

in asset prices burst. Falling asset prices resulted in insolvency of financial intermediaries, resulting in a full-fledged financial crisis.

Although the 1996 export slowdown triggered the currency crisis, the roots of the financial crisis go much deeper. It is important to note the fact that the crisis occurred in those countries in the region that were more advanced and more integrated with global financial markets and, for that reason, were more successful in attracting large inflows of foreign private capital. In this sense, the crisis can be viewed as a new challenge facing the Asian developing countries as they move up the ladder of economic development. It is fair to say that the problems were not confined just to the affected economies and they can emerge in other developing countries when they reach a similar stage of economic development and integration globally. But this is cold comfort for the economies that were so affected, at least in the short-run.

Why were the affected countries so vulnerable? To begin with, there were weaknesses in financial and exchange rate management in these economies. For all practical purposes, these countries had all pegged their currencies to the US dollar for a decade or so. With good investment potential built up by past economic success, foreign capital inflows accelerated, especially since the capital accounts were liberalized. To keep the local currencies from appreciating and to curb inflation, much of the foreign capital inflow was sterilized. The sterilization led to an increase in the gap between domestic interest rates and international market rates, which, coupled with a fixed exchange rate system, further encouraged foreign capital to flow into the countries. Clearly, massive

capital inflows increased the level of investment. But the institutional capacities in the financial sectors of these countries were not robust enough to manage these inflows effectively. In essence, these countries lacked the capability to allocate capital resources efficiently through a mechanism that would penalize excessively risky behavior while rewarding productive use of capital. Poor corporate governance due to lack of transparency as well as inadequate accounting and auditing standards also contributed to the emergence of such overly risky behavior. Short-term external loans were often used for financing projects with long gestation periods. This led to a mismatch in maturities of financial instruments. Significant amounts of the foreign capital inflows were also invested in private real estate and other non-traded sectors which are prone to speculation. Such risky behavior in the asset markets created bubbles that had to burst eventually. Thus, in contrast to the Latin American crises, the Asian crisis was mostly a private sector phenomenon.

To make the situation worse, a self-reinforcing vicious circle occurred between currency and asset market declines and banking and corporate failures. The falling currency drastically increased the local currency equivalent of the foreign debt owed by local enterprises, which in turn exacerbated the currency decline. The fall of asset market prices decreased the capital of the banks which held the assets, and increased the level of non-performing loans to the corporate sector which used assets as collateral. The vicious circle contributed to the drastic depreciation of currencies and a large number of banking and corporate bankruptcies that are still plaguing some countries.

For all intents and purposes, the Asian financial crisis put a halt to the steady capital accumulation in Southeast Asia and South Korea. In Taiwan, too, the growth rate slowed, but unlike South Korea, the economy was not crippled. Something of value, therefore, can be learned by comparing the financial policies and systems of South Korea and Taiwan. In the rest of this chapter, this is what I plan to do. At the end, I hope to give the reader a better appreciation of the role of financial institutions in creating and maintaining a POLIS. In particular, the crucial role of an appropriate regulatory structure combined with the capacity of a developmental state to implement the appropriate regulations will be highlighted.

Financial Structures and POLIS

The chapters on South Korea and Taiwan have already alluded to the need for financing long-lived capital assets associated with building a POLIS. It is also easy to see that the financing of R & D and human capital formation is also crucial for this purpose. It can be argued that the historic evolution of the financial institutions in both these countries helped the firms to obtain financing for the construction of POLIS. However, in the 1990s the two economies evolved quite differently. A contrast between the deregulation in Korea and a much more cautious approach to dismantling the financial controls and regulations in Taiwan can be instructive in assessing the future trajectories of their POLIS-building efforts.

What should be kept in mind is that the requirements of financing arise out of the needs of building a POLIS, and not the other way around. Therefore, the

financial crunch can put a halt to the further building; but easy finance by itself can not ensure the building of a POLIS. What is remarkable in both the South Korean and the Taiwanese cases is the attention both these countries paid to the need for financing when such needs arose.

To anticipate the argument in the rest of the chapter, the recent financial and economic crisis exposes South Korea to a period of great instability and contraction. Under the current circumstances it will be foolhardy to expect an uninterrupted building of POLIS there. However, with proper recognition of the need for continuing the building of a POLIS once the crisis is over, steps can be taken to preserve knowledge, resources and institutional structures that will be crucial in the future. This line of argument will also reveal the hazards of an uncritical globalization of financial sectors.

The Taiwanese case will serve as the contrast to the Korean example in this argument. Therefore, in what follows, I first discuss the evolution of the Korean crisis. I then contrast this with the more static financial structure in Taiwan. At the end, we can draw the conclusion – at least tentatively – that for a developing economy, proper financial management is essential for building a POLIS. For this, the free financial markets globally may not always help. On the contrary, a premature liberalization of the capital account and domestic financial sector deregulation may play havoc with plans for building an endogenous innovation structure.

South Korea's Descent into Chaos:

Over a two-month period from October 1997 to December 1997 South Korea was reduced from being the 11th largest economy in the world to one that had to go beg hat in hand in order to survive. This sudden shift took even the IMF by surprise. As late as October, 1997 the IMF mission visiting Seoul had given South Korea a clean bill of economic and financial health. What went wrong?

The best approach to answering this question is historical. In order to understand the recent crisis we need to go back several years and from there trace our way towards the crisis.

Prelude to the Crisis: Financial Liberalization and Investment Growth

During the few years preceding the crisis, Korea did not experience the kind of double digit growth that it had during an earlier period, but the economic growth from 1993 to the beginning of 1997 was a respectable 7.6 percent on average per annum. It peaked in 1996 at nearly 9 percent, as shown in Table 7.1.

Table 7.1
Major Indicators of Korean Economy, 1991-97

(per cent)

	1991	1992	1993	1994	1995	1996	1997[1]
GDP	9.1	5.1	5.8	8.6	8.9	7.1	6.1
Non-agricultural	10.0	5.0	6.5	9.1	9.3	7.4	6.3
Domestic Demand[2]	10.5	3.9	5.3	8.7	8.8	7.9	2.4
Consumption	9.3	6.8	5.3	7.0	7.2	6.9	5.0
(Private)	9.5	6.6	5.7	7.6	8.3	6.9	4.8
(Public)	8.5	7.6	3.0	4.2	1.0	7.1	6.5
Fixed Investment	12.6	-.0.8	5.2	11.8	11.7	7.1	-2.1
(Construction)	13.0	-0.6	8.9	4.5	8.7	6.3	0.9
(Equipment)	12.1	-1.1	-0.1	23.6	15.8	8.2	-5.9
Commodity Exports	12.2	10.9	9.7	14.6	25.3	14.5	24.2
Commodity Imports	19.4	4.0	5.6	21.8	221.3	13.9	6.5
Increase in Stocks/GDP	0.5	0.0	-0.9	0.3	0.5	1.4	–
Compensation of employees/NI	60.2	61.0	60.4	60.0	61.2	63.3	–
Gross Savings/GDP	35.9	34.7	35.1	35.2	35.9	34.3	34.2
Gross investment/GDP	38.9	36.6	35.1	36.1	37.0	38.2	36.1
Current Account/GDP	-2.8	-1.3	0.3	-1.0	-1.8	-4.8	-1.9
Terms of Trade	0.6	0.0	4.4	1.2	-3.6	k-12.3	-10.3
Unit Export Price	0.5	-1.6	0.4	1.7	5.0	-13.4	-14.9
Unit Import Price	0.0	-1.6	-3.8	0.5	8.9	-1.2	-5.3
Consumer Price Index	9.3	6.2	4.8	6.3	4.5	4.9	4.4
Producer Price Index	4.7	2.2	1.5	2.8	4.7	2.7	3.8

Note: 1) The figures under GDP are averages from the first quarter to the third quarter.
2) Domestic demand = consumption + fixed investment
Source: The Bank of Korea, *National Income*, various issues.
The Bank of Korea, *Balance of Payments*, various issues.
The National Statistical Office, *Consumer Price Index*, various issues.

The economy was, as in the past, fueled by exports. However, growth during this period occurred with unusually high investment. As a matter of fact, investment was so high that it outstripped Korea's high savings rate, which itself was well above 30 percent. In many respects, this high investment was a positive development as the economy was coming out of a mild recession during the 1991-92 period, but it was also partly responsible for a sharp increase in the current account deficit. There were two major reasons for this high investment: the strengthening of the yen and the financial liberalization and market opening. Both these factors increased the availability of foreign credit.

Until the spring of 1995, when the yen hit the level of 79.5 to the dollar, the Japanese currency appreciated continuously. Consequently, the East Asian countries were becoming increasingly competitive vis-à-vis Japan in exports of manufactures, and increasing even further their export earnings. This resulted in a great deal of direct foreign investment and domestic capital formation throughout East Asia. Korea benefited the most of all East Asian countries from the high yen because it competed directly with Japan in many industries where Japan was the leading exporter.

The second factor which led to the investment boom was the accelerated deregulation of domestic markets and the relaxation of restrictions on capital account transactions. The market deregulation greatly reduced the scope of industrial policy, while financial market opening facilitated capital inflows. These changes were also responsible for the massive increase in investment. From the 1960's and through the 1980's, there were many restrictions on foreign capital inflows. Through its industrial policy, the government regulated the inflow of foreign capital and coordinated many of the investment decisions of the large conglomerates (chaebols), that were and still remain the backbone of the Korean economy.

By early 1990's it was thought that the national political economy had become too complex for the government to make sound investment decisions for the chaebols. Korea had also come under increasing pressure from developed countries demanding that the policymakers should liberalize Korea's financial sector. Liberalization began in earnest in 1993 immediately after the inauguration

of the administration of Kim Yon Sam and was accelerated by Korea's accession to the OECD as its 29th member. The upshot of all this was that the government lost much of its control over investment activity, and the domestic financial institutions were allowed greater freedom in borrowing from the international financial markets and in lending to domestic enterprises. Let us take a quick look at the major financial liberalization measures in the 1990s.

From 1991 to July 1997 interest rates were deregulated in four stages. In the final stage, in 1997 all lending and borrowing rates except demand deposits were liberalized.

During the same period more managerial autonomy was given to the banks. Barriers to entry to financial activities were also lowered significantly. For example, in 1994 greater freedom was given to the banks to increase capital, to establish new branches and to determine dividend payments. A series of measures (1990, 1993, 1994, 1995) ensured the continuous expansion of the securities business of deposit money banks. By 1995, banks and life insurance companies were also free to sell government and public bonds over the counter. Also, by this time securities companies were given permission to handle foreign exchange business. By 1996, limits on maximum maturities for loans and deposits of banks had been abolished.

In terms of foreign exchange market liberalization Korea had adopted the Market-Average Foreign Exchange System by 1990. By 1991, the requirements for documentation showing real non-financial source of demand for foreign exchange transactions had been eased considerably. In the same year the

Foreign Exchange Management Act was revised its result, the basis of regulation was changed from a positive system to a negative one. Foreign currency call markets were also set up. By 1993, non-residents could avail of free Won' accounts, and partial Won settlements for exporting or importing visible items. 1994 saw the introduction of a foreign Exchange Reform Plan. The plan gave a detailed schedule for the reform of foreign exchange market structure. By 1995, the so-called (Foreign Exchange Concentration System) had also seen relaxed considerably.

From 1992-1997 there was progressively wider capital market opening. By 1992, foreign investors were allowed to invest directly in Korean stock markets, albeit with ownership ceilings. By 1994, foreigners were being invited to purchase government bonds is issued at internationally competitive interest rates, and equity-linked bonds issued firms. In January 1997 non-guaranteed long-term bonds issued by small and medium sized firms were added to this list. In the same month foreigners were also allowed to buy non-guaranteed convertibles bonds issued by large enterprises. By this time the residents could already invest in overseas securities via beneficiary certificates. In 1995 the ceiling on the domestic institutional investors' overseas portfolio had also been abolished.

Foreign commercial loans were allowed without government approval in so far as they met the guideline established in May 1995. From January 1997, private companies engaged in major infrastructure projects were allowed to

borrow overseas to pay for domestic construction costs. At the same time, borrowings related to foreign direct investments were liberalized.

Since the early 1990s, policy loans and credit control have gradually been reduced. In 1993, a planned termination of all policy loans by 1997 was announced, beginning with a step-wise reduction in policy loans to specific sectors (e.g., export industries and small and medium-sized firms). Also, the controls on the share of a bank's loans to major conglomerates in its total loans were simplified and slimmed down.

The irony of the situation was that Korean financial institutions were not adequately prepared for financial market liberalization and market opening because they had not developed expertise in credit analysis, risk management, due diligence, and international finance in general. The supervisory authorities were also pressured to overhaul their regulatory system to make it more compatible with a liberalized system. In the process, many restrictions and control measures were eliminated or relaxed. At the same time the authorities did not install a new system of prudential regulation needed to safeguard the stability and soundness of financial institutions. In these developments lay the potential of a serious financial crisis.

During the 90s, all of the large chaebols also expanded their investment in Korea’s major industries in an attempt to maintain their respective relative positions. Their management system with the decision making concentrated at

the top made it difficult for the chaebols to adjust their investment and output to changes in market conditions rapidly. The chaebols were reluctant to issue equities, as doing so could lead to a loss of control by the major controlling families. Therefore the chaebols became highly leveraged. One survey has revealed that the average debt equity ratio of the 30 largest chaebols was more than 380 percent in 1996, four times as high as that of Taiwan.

Between 1993 and 1996, there was a net foreign capital inflow of $46.3 billion, more than ten times the total net inflow for the entire decade of the 1980's. For the most part, these inflows were induced by large interest rate differentials between the domestic and foreign financial markets and consisted of short-term portfolio investment as shown in Table 7.2. Most of this new capital was used to finance investment in Korea's major export-oriented industries; electronics, automobiles, iron and steel, shipbuilding, and petrochemicals, etc. Many Korean chaebols participated in a major direct investment effort in foreign countries, especially in Europe and Southeast Asia. In 1993, Korea's total foreign direct investment was about $13 billion. Only a year later it jumped to $23 billion. The mode of financing of this FDI was mainly through foreign credit.

Table 7.2
South Korea's Capital Account Balance

(bil US$)

	92	93	94	95	96	97	
						First Half	July to Nov.
Liabilities	8.8	8.4	13.4	20.0	26.4	13.8	2.5
Loans and foreign investment	5.2	8.7	7.4	9.4	13.4	8.8	5.3
Public	-0.6	-1.8	-0.3	-0.5	-0.5	-0.2	-0.1
Commercial	-0.5	-1.1	-0.3	-0.2	-0.2	0.1	0.8
Direct investment	0.6	0.5	0.8	1.2	2.0	1.1	0.8
Portfolio investment	5.8	11.0	7.3	8.9	12.1	7.7	3.8
Trade credit	0.9	-0.4	2.2	3.6	6.6	2.1	-0.1
Others2	2.7	0.1	3.8	7.0	6.4	2.9	-2.6
Assets	0.5	1.5	4.4	6.6	9.4	3.1	0.3
Direct Investment	1.0	1.1	2.1	3.1	3.9	1.8	0.4
Portfolio Investment	0	0.3	0.5	0.4	0.9	0.7	0.3
Export on credits	-1.7	-0.7	-0.1	0.9	0.6	0.1	0.5
Others	1.2	0.9	2.0	2.2	3.9	3.4	-0.9
Balance (liabilities - assets)	8.3	6.9	9.0	13.4	17.0	10.6	2.3

Note: 1) A positive balance indicates capital inflow. A positive figure under liabilities or assets means an increase.
2) Others includes the change of the liabilities of merchant bank corporations and development institutions, such as the Korea Development Bank, Korea Long-term Credit Bank, and Korea Export and Import Bank.

Source: The Bank of Korea, *Balance of Payments*, Various Issues.

Needless to say this also made Korea more vulnerable to adverse financial shocks.

The shock finally came in late 1996 when the Japanese yen began to decline. With the depreciation of the yen, Korean exporters found themselves suddenly losing competitiveness in their traditional export markets of North America and Europe. To make matters worse, terms of trade also moved against Korea. Table 7.2 shows quite clearly how inventories of exporters started

to increase and were financed by dear short-term credit from the merchant banks. The government refused to come to the aid of chaebols strapped in debt. Corporate bankruptcies began to occur and so rapidly in succession that soon there was a cascade of them. At the same time, the volume of non-performing loans at financial institutions also began to skyrocket. The twin burdens of non performing loans and corporate bankruptcies launched a full scale financial crisis.

The Crisis Unfolds

The crisis unfolded with unexpected speed. The first major victim was the Hanbo group. A large producer that specialized in iron and steel, it was Korea's 14th largest chaebol. Hanbo was unable to meet the payments of the principal and interest on its borrowings. It was supposed to be restructured through a workout program organized by its credit banks. As it turned out Hanbo was placed under court receivership because the workout program did not succeed. Thus began a series of corporate debacles in one of the most successful Asian economies.

The Hanbo collapse revealed that many loans to this group had been made under political pressure. The pervasiveness of corruption discovered in Korea was one of the major factors in foreign investors' loss of confidence in the government and the economy in general. Even in retrospect it seems amazing to hear the claim that informed participants did not know about these. It is more likely that the market participants knew – the full extent of knowledge may,

however, be debatable – but believed that the government will bail out the firms in trouble.

Most astonishing among the developments that followed and the one that caused the government to lose a great deal of its credibility was the near-bankruptcy of the Kia Group in July. At first, the Kia Group, the nation's 8th largest chaebol, was also to be covered by a workout program, but this too proved unworkable.

By the first week of September, six chaebols including Kia were placed either under a workout plan or they became insolvent. These chaebols accounted for about 10.4 percent of the total assets of the 30 largest chaebols. But the damage to credibility in asset markets was already done. By September foreign investors were already to stampede out of the Korean equities. By October foreign investors moved out of the stock market in droves, and Korean banks were increasingly unable to rollover their short-term foreign loans. In order to avoid default, they were forced to turn to the Bank of Korea for liquidity or to resort to the foreign overnight loan markets. On November 19, the government announced a reform package which included measures for disposal of non-performing loans and widening of the exchange rate fluctuation band. This, however, did little to stop the panic. It was too little, too late.

The government finally announced to the public its decision to approach the IMF to ask it for assistance. The negotiations between the Korean government and the IMF were completed in a record time of only 10 days on December 3. The IMF agreed to provide a total of $21 billion to be disbursed in

11 installments over a three-year period from its emergency financing and other facilities. It also secured financial commitments totalling $36 billion from the World Bank, the Asian Development Bank, the United States, Japan, Germany, Canada, the United Kingdom, Australia, and other international organizations and countries, which would serve as a second line of defense. The IMF conditionalities required tight monetary policy, a fiscal surplus, sweeping financial reform, further liberalization of the financial markets, and also two conditionalities which were unusual for an IMF program; greater flexibility in the labor market and restructuring of the chaebols. On closer examination one discovers that these really were standard measures, forced to fit an unprecedented situation. It is not surprising that the IMF measures did little to allay fears and stabilize the financial markets and the foreign exchange market. The won/dollar exchange rate continued to depreciate. Bankruptcies and business closures proceeded apace.

Rumors had begun to circulate among the foreign investors that Korea might have to declare a debt moratorium. The IMF and U.S. Treasury must have both realized that stronger measures would be required to shore up confidence and boost the Korean economy. Finally, on Christmas eve, the IMF and the G-7 countries came up with a $10 billion emergency financing program. It appears that this emergency finance did succeed in turning market sentiment around by demonstrating the resolve of the IMF and G-7 to rescue Korea from financial collapse. In retrospect it is now clear that the IMF served as a lender of last resort in the East Asian financial crisis. This was true especially during the Korean crisis.

The predictable effects of the IMF program were a sharp increase in the domestic interest rates and a substantial depreciation of the won/dollar exchange rate. The monetary contraction dried up the availability of bank credit, especially to small and medium-sized firms. This led to further contraction in the real economy. A genuine debt-deflation type of economic crisis humbled one of the most successful Asian economies. It is doubtful that innovators such as Samsung will have the technological advantages that were being planned earlier. A period of uncertainty and struggle awaits.

Taiwan: Playing a Different Game?

In contrast with South Korea Taiwan managed to avert both a currency crisis and a financial crisis. Not only did it survive the turbulence in 1997, its economy grew at 6.8 percent – quite a respectable showing in times of great regional economic turmoil. This was largely due to sustained growth in finance, insurance, real estate, and social services. The manufacturing sector was slowing down, but investment for POLIS still continued.

In order to understand Taiwan's somewhat different performance it will be useful to look into the structure of its financial institutions. The contrast with post-1993 Korea will be immediately apparent.

Figure 7.1 gives a snapshot of the financial system in Taiwan. The Ministry of Finance (MOF) and the Central Bank (CB) are the two major government institutions responsible for maintaining orderly markets. Within the general financial system there is a preferential subsystem that, among other

Figure 7.1

things, finances some aspects of building a POLIS. Thus, in contrast to the relative laissez faire industrial institutions, the financial system relies more on controls and directives.

The existence of a dual financial system has a historical background. The formal financial system has always been subject to strict control, and, except a few private banks established by overseas Chinese or those that were transformed for specific political reasons, banks were regulated directly by being government-owned. Bank interest rates were controlled by the Central Bank and official interest rates usually adjusted more slowly than the market-determined rate through demand and supply. These regulations were maintained for decades until 1989, when a new Banking Law was promulgated and bank privatization and interest rate liberalization were adopted. The long-regulated banking system could not meet the rising market demand for funds. One problem is that Government banks tend to operate conservatively Those firms which can afford to present collateral more easily have an edge in receiving bank loans. Usually big firms have more easy access to credit compared to small- and medium-sized businesses, which have difficulty obtaining funds from government commercial banks. Those businesses have to pursue underground capital, and an informal financial market has grown accordingly. As a result, formal and informal financial markets coexist. This is a major characteristic of Taiwan's financial market (Figure 7.2).

The formal financial system is composed of two subsystems: one is financial institutions, the other is financial markets. Financial institutions include

Figure 7.2

two groups, namely the monetary institutions which create credit money, and other financial institutions which cannot by legal restrictions do so.

The first group of financial institutions includes the Central Bank of China (CBC), commercial banks (domestic banks and local branches of foreign banks), specialized banks, and cooperatives (credit cooperative associations, credit departments of fishermen's associations). Specialized banks include the Export-Import Bank of China (trade financing activities), the Farmers Bank of China (farm financing activities), Land Bank of Finance (real estate financing activities), the Cooperative Bank of Taiwan (cooperative-related financing activities), and the Central Trust of China (dealing with government-purchase-related financing activities).

Other financial institutions cannot create money, but they can mobilize idle money to finance investments. They are the postal savings system, investment and trust companies, and insurance companies.

Financial markets include the money market and the capital market. Broadly speaking, the foreign exchange market can also be included. The money market is the short-run fund market. Financial instruments in the money market include treasury bills, commercial paper, bankers' acceptances and negotiable certificates of deposits. These instruments are usually exchanged in the three local bills finance companies. The central bank often enters this market to execute open-market operations for the purpose of controlling the money supply.

The capital market is a place for long-term bill transactions. Financial instruments in the capital market include stocks, government bonds, corporate

bonds and bank debentures. The stock market grew dramatically in the 1980s. The Taiwan Stock Exchange Corporation is the exchange center, and Fuh-Hwa Securities Finance Companies deal with finance demand for funds and securities.

The operation of foreign exchange activities is executed by the central bank and authorized foreign exchange banks. The authorized banks are where foreign exchange transactions take place, and include some major domestic banks plus local branches of foreign banks.

The informal financial markets include all the financial activities which are not approved by the Ministry of Finance. Financial installment credit companies, financial leasing companies and financial investment companies are registered companies under the Ministry of Economic Affairs. However, they operate their activities as financial institutions. Any activities of financial intermediation by a business not approved by the Ministry of Finance is illegal. Therefore, these companies are classified as informal financial markets. There are many kinds of transactions in this market. Unsecured borrowings and lendings, secured borrowings and lendings, and loans against post-dated checks are popular informal financial activities. “Deposits-with-firms” means that some businesses collect funds from their employees, even from the general public. “Mutual-loans-and-savings” is commonly used as a way to pool savings of relatives and friends.

Given the above structure of the financial system, there are four kinds of financial sources for the business sector: financial institutions, the money market, the capital market, and the curb market. Table 7.3 shows the shares of these

Table 7.3
The Financial Sources for the Business Sector

Unit: NT$ Million, %

End OF Year	Financial Institution		Money Market		Capital Market		Curb Market		Total
	Amount	%	Amount	%	Amount	%	Amount	%	Amount
1964	13, 708	47.81			7,410	25.84	7,555	26.35	28,673
1965	16,940	48.33			9,190	26.22	8,922	25.45	35,052
1966	20,889	50.40			8,180	19.74	12,377	29.86	41,446
1967	30,250	61.24			5,930	12.01	13,213	26.75	49,393
1968	37,021	61.12			7,450	12.30	16,102	26.58	60,573
1969	40,267	60.18			8,150	12.18	18,490	27.64	66,907
1970	48,886	61.04			8,930	11.15	22,267	27.80	80,083
1971	75,837	62.98			9,100	7.56	35,468	29.46	120,405
1972	95,138	67.20			10,590	7.48	35,842	25.32	141,570
1973	127,716	65.30			16,843	8.61	51,034	26.09	195,593
1974	175,311	67.83			24,964	9.66	58,188	22.51	258,463
1975	217,673	66.64			32,797	10.04	76,191	23.32	326,661
1976	252,236	64.48	2,207	0.56	48,714	12.45	88,050	22.51	391,207
1977	277,295	59.34	9,949	2.13	63,085	13.50	116,976	25.03	467,305
1978	342,513	57.40	17,373	2.91	81,166	13.60	155,707	26.09	596,759
1979	428,490	55.90	46,687	6.09	104,789	13.67	186,596	24.34	766,562
1980	573,574	53.51	65,464	6.11	131,867	12.30	301,978	28.09	1,071,983
1981	637,6221	53.67	109,769	9.24	158,080	13.31	282,576	23.78	1,188,046
1982	755,500	54.47	133,288	9.61	186,622	13.45	311,601	22.47	1,387,011
1983	821,159	54.14	159,425	10.51	201,999	13.32	334,103	22.03	1,516,686
1984	852,272	51.60	195,908	11.86	232,801	14.09	370,819	22.45	1,651,800
1985	866,343	47.81	195,423	10.79	252,536	13.94	497,613	27.46	1,811,915
1986	989,694	47.88	154,510	7.47	287,471	13.91	635,558	30.74	2,067,233
1987	1,185,375	50.60	138,066	5.89	338,976	14.47	680,352	29.04	2,342,769
1988	1,458,643	55.89	129,308	4.95	395,663	15.16	626,114	23.99	2,609,728
1989	1822,109	57.81	191,768	6.08	466,729	14.81	671,103	21.29	3,151,709
1990	2,103,235	56.89	347,112	9.39	558,025	15.09	688,663	18.63	3,697,035
1991	2,475,989	58.07	344,554	8.08	680,825	15.97	762,497	17.88	4,263,865
Ave. of 1976~1991	990,128	54.97	140,051	6.98	261,834	13.94	419,338	24.11	1,811,351

financial sources from 1964 to 1991. The money market did not appear until 1976. Table 7.3 shows that financial institutions are the most important financial source, which on average from 1976 to 1991 contributed 54.9 percent of total financial sources for businesses. The curb market is the second biggest financial source for firms, and is 24.11 percent of total financial sources. The capital market provides only 13.94 percent of financial sources for firms. The money market provided only 6.98 percent on average since it was established. In other words, the level of direct finance is rather small and the market has not been popular. The indirect finance market is comparatively larger, and has provided most of the funds.

Table 7.4 shows the relative assets of various financial institutions. Taking 1993 as an example, in terms of assets, the central bank processes about 15 percent of total financial institutions. Depository institutions have 67.99 percent. Among depository institutions, domestic banks have the largest share – 44.07 percent. Other financial institutions have lower market shares. The market shares of assets for other financial institutions in 1993 can be ranked in descending order as follows: postal savings system, life insurance companies, investment and trust companies, property and casualty insurance companies, securities finance companies, and the smallest, bill finance companies. The postal savings system grew swiftly after the 1970s because the system provided convenience due to the widespread nature of its service units.

The number of units for each type of financial institution can be observed in Table 7.5. In 1991, there are 17 domestic banks, with 773 branches. Each

Table 7.4
Total Assets of Financial Institutions in Taiwan

Units: NT@ Million, %

Items (End of Year) / Institutions	Total Assets			
	1981	**1986**	**1991**	**1993**
Central Bank	523,199 (21.67)	1,749,414 (27.73)	2,253,616 (18.46)	2,651,884 (14.87)
Depository Institutions				
1. Domestic Banks	1,138,614 (47.17)	2,596,284 (41.16)	5,830,846 (42.66)	7,828,474 (44.07)
2. Local Branches of Foreign Banks	120,253 (4.98)	142,449 (2.26)	293,098 (2.14)	370,117) (2.08)
3. Medium Business Banks	78,610 (3.26)	250,337 (3.97)	847,609 (6.20)	1,196,629 (6.74)
4. Credit Cooperatives	136,619 (5.65)	336,470 (5.33)	1,030,168 (7.54)	1,556,681 (8.76)
5. Credit department of Farmers' and Fishermen's Associations	105,926 (4.39)	328,598 (5.21)	775,889 (5.68)	1,124,925 (6.33)
Subtotal	1,580,022 (65.46)	3,654,138 (57.93)	8,777,610 (64.22)	12,076,826 (67.99)
Other Financial Institutions				
1. Investment and Trust Companies	81,513 (3.38)	118,838 (1.88)	523,640 (3.83)	443,557 (2.50)
2. Postal Savings Systems	182,812 (7.57)	738,173 (11.70)	1,274,640 (9.33)	1,714,125 (9.65)
3. Life Insurance Companies	29,765 (1.23)	18,904 (0.30)	448,638 (3.28)	699,479 (3.94)
4. Property and Casualty Insurance Companies	9,221 (0.38)	16,710 (0.26)	36,643 (0.27)	56,029 (0.32)
5. Bills Finance Companies	5,110 (0.21)	7,511 (0.12)	34,702 (0.25)	44,008 (0.25)
6. Securities Finance Companies	2,350 (0.10)	4,577 (0.07)	48,843 (0.36)	86,070 (0.48)
Subtotal	310,771 (12.87)	904,713 (14.34)	2,367,106 (17.32)	3,043,268 (17.13)
Total	2,413,992 (100.0)	6,308,265 (100.0)	13,668,332 (100.0)	17,761,978 (100.0)

Source: The Central Bank of China, Financial Statistics Monthly, Various Issues.

Table 7.5
Number of Units of Financial Institutions in Taiwan

Year / Institutions	1961 December		1971 December		1981 December		1991 December		1993 October	
	Firms	Branches	Firms	Branches	Firms	Branches	Firms	Branches	Firms	Branches
Total	409	1369	431	1897	441	3060	495	4196	526	4388
Domestic Banks	10	260	14	417	15	580	17	773	34	1145
Local Branches of Foreign Banks	1	1	6	6	24	24	36	47	37	32
Credit Cooperatives	80	153	78	228	74	286	74	499	74	522
Credit Departments of Farmers' and Fishermen's Associations	291	385	294	394	284	784	311	1096	312	851
Medium Business Banks	8	84	8	118	8	195	8	298	8	402
Investment and Trust Companies	1	1	6	6	8	31	8	70	6	49
Insurance Companies	17	34	24	80	23	167	36	181	50	156
Postal Savings System	1	451	1	648	1	1023	1	1121	1	1258
Bills Finance companies	-	-	-	-	3	5	3	20	3	22
Securities Finance Companies	-	-	-	-	1	1	1	1	1	2

Source: MOF, Yearbook of Financial Statistics of the Republic of China, 1986.
Note: 1. Data do not include the Central Bank of China, and Central Deposit Insurance Corporation.
2. The number of branches includes head offices.

domestic bank is allowed to open a maximum of three branches every year. A new bank can open only five branches when established. Foreign banks were allowed to open only one branch until 1987. Credit cooperatives and credit departments of farmers' and fishermen's associations have more units and more branches, but most of them are small, so that their market share of assets is comparatively low. What deserves mention is that the number of branches in the postal savings system has been the largest. However, the number of domestic banks rose sharply to 34 banks, because banking privatization was allowed since 1989 when new Banking Law was promulgated.

The market share of loans and deposits can be seen in Table 7.8. In 1991, domestic banks had 44.45 percent of total deposits, and 63.45 percent of total loans. Obviously, domestic banks have comprised the major portion of Taiwan's financial system. If we include local branches of foreign banks and medium business banks in this classification, then the market share for banks increases. Other financial institutions, although they provide different services and have grown quickly in terms of number of branches, have less than 10 percent of the market share.

The foreign exchange market is the place where the foreign reserve exchanges take place. The central bank and the foreign exchange-authorized banks exchange foreign reserves mutually. Foreign exchange authorized banks include domestic banks and local branches of foreign banks. In 1992, there were 55 authorized foreign exchange banks, composed of 17 domestic banks (247 branches) and 38 foreign banks (48 branches).

Table 7.6
Outstanding Deposits and Loans of Financial Institutions in Taiwan

Unit: NT$ Million, %

Items (End of Year) / Institutions	Deposits				
	1961	1971	1981	1991	1993
Domestic Banks	14,120	76,288	633,456	3,725,216	5,122,308
	(75.57)	(65.21)	(53.48)	(42.90)	(44.79)
Local Branches of Foreign Banks	6	157	5,104	75,736	122,456
	(0.03)	(0.13)	(0.43)	(0.87)	(1.07)
Medium Business Banks	915	5,858	56,713	679,028	971,010
	(4.90)	(5.01)	(4.97)	(7.82)	(8.49)
Credit Cooperatives	1,892	12,983	126,301	988,339	1,493,538
	(10.13)	(11.10)	(10.66)	(11.38)	(13.06)
Credit Department of Farmers' and Fishermen's Association	1,105	6,557	89,964	726,331	1,058,591
	(5.91)	(5.60)	(7.60)	(8.36)	(9.26)
Postal Savings Systems	632	11,812	165,751	1,242,914	1,607,323
	(3.38)	(10.10)	(13.99)	(14.31)	(14.05)
Investment and Trust Companies	-	1,167	78,398	494,780	376,609
		(1.00)	(6.62)	(5.70)	(3.29)
Life Insurance Companies	15	2,167	28,838	451,983	685,669
	(0.08)	(1.85)	(2.43)	(8.66)	(5.99)
Total	18,685	116,989	1,184,525	8,684,327	11,437,504
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
Items (End of Year) / Institutions	**Loans**				
	1961	1971	1981	1991	1993
Domestic Banks	14,358	92,289	885,035	4,742,106	6,722,477
	(82.15)	(75.54)	(66.94)	(63.45)	(62.83)
Local Branches of Foreign Banks	70	4,743	107,753	235,704	279,349
	(0.40)	(3.88)	(8.15)	(3.15)	(2.61)
Medium Business Banks	659	5,506	68,750	727,231	1,044,710
	(3.77)	(4.51)	(5.20)	(9.73)	(9.76)
Credit Cooperatives	1,235	8,719	88,028	582,911	926,602
	(7.07)	(7.14)	(6.66)	(7.80)	(8.66)
Credit Department of Farmers' and Fishermen's Associations	817	4,972	66,464	395,002	702,295
	(4.67)	(4.07)	(5.03)	(5.29)	(6.56)
Postal Savings Systems	56	479	1,873	24,918	104,701
	(0.32)	(0.39)	(0.14)	(0.33)	(0.98)
Investment and Trust Companies	277	3,746	78,210	448,780	407,154
	(1.59)	(3.06)	(5.91)	(6.00)	(3.81)
Life Insurance Companies	5	1,721	26,085	317,360	512,249
	(0.03)	(1.41)	(1.97)	(4.25)	(4.79)
Total	17,478	122,184	1,322,198	7,474,012	10,699,537
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Source: Financial Statistics Monthly, Taiwan District, the Republic of China, The Central Bank of China.
Note: Outstanding loans includes loans, investments and holdings of real estates. Deposits = Deposits held by Enterprises and Individuals + Government Deposits.

Policies for Financial System Development

Since World War II, Taiwan's financing system has been strictly controlled. Although financial liberalization has been on the agenda, its speed was not accelerated until the 1980s.

The major component of the financial system is the banking system. Therefore, when we discuss the development of the financial system, we always take the development of the banking system as being representative. The regulations on the establishment of new banks, regulations on foreign banks, and the activities of bank operations have historically been significant. These restrictions have been gradually eased, but not completely erased.

1. *Interest Rate Regulation and Deregulation*

The purpose of regulation of interest rates at the beginning stage of economic development is to provide low-cost capital to entrepreneurs. After the economy grows to some extent, interest rate liberalization is pursued presumably to improve the allocational efficiency of financial market.

The government in Taiwan has controlled bank interest rates for a long time. Only in recent years has it been decontrolled. Prior to 1975, the government-prescribed interest rates for loans and deposits were all uniform. In 1975, the government required that uniform interest rates for deposits would be prescribed by the Central Bank of China, and that the ceiling and floor interest rates for bank loans would be fixed by the Interest Rate Recommendation Committee of Banks Association and subject to the approval of the central bank.

The financial institutions can be further classified into several subsystems according to their functions and activities. Besides the commercial financing system, there is the trade financing system, the small- and medium-sized business financing system, the strategic industries financing system, among others. These subsystems other than the commercial financing system can be called the financial preferential system. This is so because they can engage in preferential financing for specific industries.

Subsequently, several adjustments were made to gradually enlarge the range between the ceiling and floor interest rates for bank loans. The interest rates for banks debentures and negotiable call loans were allowed to fluctuate freely in 1980. In 1985, the ceiling limit for interest on loans was abolished, with only the floor limit retained.

Since the promulgation of the new Banking Law on July 19, 1989, both the ceiling and floor limits for interest rates on deposits and loans have been abolished, and interest rate liberalization was finally completed. The interest rate recommendation committee was dissolved at the same time. Before private commercial banks started operations, although interest rates could technically be decided by each bank, market interest rates remained quite stable for a period of time. The cost of capital for the three major commercial banks were similar so that their interest rate structures were also alike. After interest rate liberalization, they acted as the price leader for a while in a Stackelberg fashion. The interest rates of the three were identical most of the time. In effect, they collusively monopolized the market. However, since the new private banks began to prepare

for establishment in late 1991, the variances of the prime rate of different banks widened, from 0.24 percent before August of 1991 to over 0.45 percent after September of 1991. The trend continued through the rest of the 90s.

2. *Deregulation of Private Banks*

In order to completely secure the stability of financial markets and control the flow of funds, the government still prefers government-owned financial institutions to private banks. However, the efficiency of government banks is considered much lower than private banks. Yang's (1993) study on their relative efficiency supports the above assertion. However, private banks have also been known to engage in risky lending as well.

Banking privatization is one of major financial reforms in Taiwan's financial history. Deregulation of private banks was allowed by the Banking Law of 1989. In June of 1991, 15 new banks were authorized. By April of 1993, 17 banks were established and operating, creating better service attitudes and more competition in the whole banking industry. However, Taiwanese authorities have become convinced of the need for prudential and other regulatory structures for private banks in the aftermath of the Asian crisis.

3. Control and Deregulation of Ownership of Banks

Owning the banks allows the government, but also councilmen, to have the power to determine the direction of funds. From the viewpoint of public policy, the government can execute industrial policy through government banks better

than through private banks. From the viewpoints of vested groups, councilmen can influence loan decisions by manipulating their political power.

Banks in Taiwan were not allowed to be privatized until the Banking Law of 1989. Although there were four private banks, three of them were owned by overseas Chinese, the fourth was recast from the Bank of China for political considerations. Government banks have been criticized because their operations restrict efficiency, and their attitudes are much too conservative.

In order to increase its ability to self-manage, some measures were attempted. The three major commercial banks sold their share of stock from the government to the public in 1990. However, this act was not successful because the stock market was in recession and few people purchased the stocks. The proposal of selling shares was then delayed further. In addition, several drafts of "The Law on the Management of Government Banks" were proposed, written and modified, but they were not approved by the Legislative Yuan. As alluded to earlier both privatization and regulation continue to be policy objectives in Taiwan.

4. *Restrictions on Foreign Banks*

In order to attract foreign capital, local branches of foreign banks were welcomed. On the other hand, in order not to put too much pressure on local financial institutions, foreign banks are even now restricted to some extent. However, although restricted, activities of foreign banks did create some competition for local banks. Facing global the tide of financial internationalization, the regulations on foreign banks were gradually reduced.

The number of local branches for each foreign bank is clear proof of restriction. The foreign banks were allowed to open just one branch before 1986. In 1987, the legality of a second branch was first approved. In 1991, a third branch was also approved. By the end of 1989, each government bank had 55.7 branches on average, while foreign banks had just 1.2 branches.

5. *Broadening of Bank Activities*

Following the declared trend of financial liberalization and financial internationalization, approved activities for banks were broadened gradually. For example, in the past, bills transactions were allowed to be conducted only by bills finance companies. However, these activities were opened to some private banks in 1992. The Ministry of Finance seems to be planning to develop the banking industry into a universal banking system. But going slow has been the standard procedure while the declared policy is to liberalize and deregulate.

6. *Path Toward Financial Internationalization*

Several steps have been taken to move toward financial internationalization. These include the following: 1. Establishment of foreign financial institutions. 2. Establishment of foreign branches of domestic banks. 3. Interbank call market for foreign reserves. 4. Release of control on capital movement. The government-set limit on capital outflow per capita each year was $5 million, and capital inflow per capita each year was $50,000. This restriction has been adjusted to a $5 million ceiling for both capital inflow and outflow. 5.

Plan to establish Taipei as an Asian financial center as part of the APROC plan. The government of Taiwan wants to follow Singapore, Japan, and Hong Kong to become one of the Asian financial centers. Abundant savings, foreign reserves, and highly-educated human resources can be advantages. However, some other features still need to be improved: free capital movement, a preferential tax system, information systems, and internationally-accommodating financial regulations and affiliated financial services. It will take time for Taipei to reach appropriate standards and become a financial center with global credentials, if it indeed ever succeeds.

Financial Preferential Policy

In order to stimulate industrial development and fulfill specific purposes, financial preferential policies were and still are often adopted by the government. Some financial subsystems were specifically established for this function. One can think of examples such as an export financing system, the small- and medium-sized business financing system, and the strategic industries financing system. Some selective credit policies were and still are occasionally executed as well.

The special loans give some privileges to some selected customers. Such privileges include low interest rates and easier access to funds. Some special loans, such as strategic industry loans, are executed by the particular specialized banks. Some other loans are executed by domestic general banks and foreign banks. A good example would be loans for export. Others, such as small- and

medium-sized enterprises loans, are executed by a combination of both specialized banks and general banks.

The preferential financial subsystems have clearly been important in financing industrial development and more recently the building of a POLIS. A brief description and analysis can reveal the broad contours of this process.

1. *The Export Financing System*

General commercial banks extend loans for exports with preferential interest rates, and provide easier financing terms for exports. The Export-Import Bank of China also plays an important role, providing insurance, loans, and guarantees for exports.

Ever since export promotion was proposed in the 1960s as Taiwan's economic development strategy, export financing policy has been important.[1] To some extent, Taiwan's excellent economic performance during the 1960s and early 1970s can be attributed to its outward-oriented development policies which were supported by an inward looking financial system.

Export industries received high priority in credit rationing, and were granted low interest loans to provide financing for reshipment production financing and the import of raw materials. After the 1970s, as a continuous trade

[1] Other export incentives include rebates of custom duties and commodity taxes on imported raw materials, tax exemptions, retention of foreign exchange earnings for the import of raw materials and machinery, etc.

surplus led to increased foreign exchange reserves, the authorities gradually reduced the interest rate difference. This preferential policy lasted for many years until 1989.

In the Trade Financing System, the Export-Import Bank of the Republic of China still plays a significant role. The bank was established on January 11, 1979, and is a state-owned specialized bank which provides specific medium- and long-term export-import credits and guarantee services under the supervision of the Ministry of Finance. Starting on the first of April of its founding year, Eximbank also took over the responsibility for the export insurance services from the Chung Kuo Insurance Corporation.

In accordance with the “Export-Import Bank of the Republic of China Act”, the objectives of the Bank are to support government economic and trade policies and to assist local firms in expanding external trade and engage in overseas investments, with the aim of promoting national economic development and to further enhance international economic cooperation.

2. *Small- and Medium-sized Business Financing System*

Small- and medium-sized businesses are the most active sector of the entire economy in terms of number of firms, employees, value of products, and other relevant criteria. However, they still have difficulties obtaining loans from formal financial markets. In order to solve this problem, a small- and medium-business financing system was established within the formal financial system.

This system is composed of banks, i.e., commercial and special banks (medium business banks), Medium Business Credit Guarantee Funds (MBCGF) and the

Small business Integrated Assistance Center. The following functions are provided by this system.

(1) Financing

In addition to commercial banks, the medium business banks are the specialized banks which do SME financing. These specialized banks were transformed from mutual savings companies after 1975 when the Law of Banking was revised. Only one of them is government owned, the Medium Business Banks of Taiwan (MBBT). All others (regional) are private. Each bank has its own channel for its source of funds. The MBBT accepts transfer deposits from the postal savings system and the support of the government Development Fund of the Executive Yuan. Special loans in various programs are usually lent out through government banks. Furthermore, the credit cooperative associations and credit departments of farmers' and fishermen's associations are not directly connected with SMEs, but they may provide part of the funding demand of SMEs.

(2) *Guarantees*

The establishment of the SMBCGF, a non-profit organization, provides vital assistance to SMEs that usually do not have healthy financial structure or sufficient collateral. The SMBCGF not only provides credit guarantees to SMEs that are rich in development potential and lack collateral, assisting them to obtain financing funds from financial institutions for sound development, but also

simultaneously shares the financing risk with the financing institutions to enhance the institutions' confidence in SME financing.

(3) *Assistance*

In July 1982, seven provincial banks donated funds to establish the Small Business Integrated Assistance Center to provide assistance to SMEs that encounter difficulties in applying for financing through provincial banks or have unhealthy financing management. Financing diagnosis and financial management assistance are two primary service items of the Center.

The functioning mechanism of the entire SME financial system can be described as follows: SMEs apply to banks directly for financing. If the bank is skeptical about the SME's capability of repayment, the bank may apply to the SMBCGF to guarantee a certain percentage of the loan. The SME may also ask for diagnostic assistance of its operation, management, technology and marketing in order to prepare a report as a reference to encourage the bank to approve the loan.

Strategic Industry Financing System

This is perhaps the most crucial for our purpose. The building of a POLIS would have been impossible without this. Preferential policies for strategic industries were introduced in 1982 and six criteria were adopted which the selected strategic industries must meet to be so designated: high linkage effect, high market potential, high technological intensity, a high degree of value-added, a low energy coefficient, and a low level of pollution emissions. Within these strategic industries, certain products are designated to be actively promoted,

most of which are in the mechanical engineering products, and information and electronics sectors. The list of selected products has been amended several times and a few products from the biochemical and material industries were included after 1986. In the Six-Year National Development Plan, some new key industries were added mainly from sectors, such as biochemical and material industries. The recent policy affirms this trend and tries to deepen it.

Taiwan's government offers two preferential measures for the purpose of subsidizing the strategic industries. One is preferential loan, the other is technology and management guidance. Preferential loans are administered both by a pool of funds administered by the Bank of Communications, and by a pool of funds administered by the Medium Business Bank of Taiwan. Funds for both pools are supplied partially by the government's Development Fund. Yang (1993) evaluated the costs and benefits of this policy empirically and found that the amount of the ratio of financial support does not seem to play an important role in the technology improvement and management improvement activities of firms. However, reestimating Yang's relationships using more recent and detailed data shows both an absolute as well as a ratio effect. On both counts the preferential policies have successfully directed credit to strategic industries with positive effects.

In 1992, the Six-Year National Development Plan was promulgated. Originally, the plan targeted total expenditures of NT$8 trillion. This amount would require a great deal of domestic savings and foreign capital to accommodate the investment. In 1993, the size of plan was reduced to a smaller

scale. However, the need for funds is still very acute. In order to solve the funding problem, the government designed several methods for collecting funds, such as the issuance of government bonds, an increase of tax bases, and even the setting-up of a “Japanese style fiscal investment and loan program” to pool postal savings and pension funds. The appropriateness of these approaches were widely discussed domestically. In the aftermath of the financial crisis in Asia domestic investment went up further.

One may look at the lengthy description of the monetary and financial controls and simply conclude that these are inappropriate instruments for a complex economy making its transition to a POLIS. However, such a conclusion will be hasty for at least two reasons. First, Taiwan has shown itself capable of reforming the financial system slowly while creating a POLIS. Secondly, the plight of Korea shows that the hubris of fancying that one is a member of the club of privileged countries that led to deregulation is indeed a tragic flaw.

The contrasting examples of Korea and Taiwan show that building a POLIS requires a healthy financial system. The health of the financial system depends on a deft combination of market and non-market institutions. Overregulation can cripple an economy. So can a sudden and inappropriate move towards financial liberalization. The old fashioned virtues of prudence and caution seem attractive all of a sudden after the economic tragedy in South Korea.

Figure 7.1
Systemic View of the Political Economy of Taiwan's Financial Structure