CHAPTER 1
Introduction and Overview

1.1. Introduction

The study of economic growth is broad and immense and its importance is indisputable. Barro and Sala-i-Martin (1995) show that small differential in growth rates, when compounded over long periods of time, resulted in dramatically different standards of living. Over the centuries, from Adam Smith (1776), David Ricardo (1817) and Thomas Malthus (1798), to the recent New Growth Theory by Grossman and Helpman (1991) and Aghion and Howitt (1992), economists seek to find answers to the questions, "what are the drivers of economic growth?", "what are the necessary factors for economic take-off?", and "what explains the differences in income levels across countries over time?"

The focus of this book is the extension of the work on development economics by Emeritus Professor Lim Chong Yah. In over 40 years as an academic researcher, Professor Lim preserves in his relentless pursuit of answers to the questions "how might poverty be alleviated?" and "how might affluence be achieved?" His decade-long efforts crystallized into the Trinity development model, encompassing the EGOIN theory, the Triple C theory and the S-Curve hypothesis (Lim, 2009). Professor Lim's Trinity development model seeks to provide utilizable solutions to poverty alleviation and economic development. It has the noble objective of providing a general formula for development that can be adopted by developing countries. Of the three theories within the Trinity development model, this book focuses on the mathematical and econometrical sophistication of the S-Curve hypothesis, although references will be made to the other two theories.

The structure of this chapter is as follows: Section 1.2 provides a review of the S-Curve hypothesis, and relates the S-Curve hypothesis to Lim's EGOIN theory and Triple C theory. The interpretations of the S-Curve are

given in Section 1.3. Section 1.4 provides empirical support for the S-Curve hypothesis using empirical data and empirical conclusions presented by other researchers. The S-Curve hypothesis offers interesting insight and policy implications for economic development, and these are elaborated in Section 1.5.

1.2. Review of the S-Curve Hypothesis

1.2.1. *Brief description of the S-Curve hypothesis*

The S-Curve hypothesis, as shown in Fig. 1.1, classifies the world economy into three broad groups: turtle (low income, slow growth), horse (middle income, rapid growth), and elephant (high income, slow growth). The S-Curve is plotted with log per capita income on the *y*-axis and time on the *x*-axis. The growth rate of the per capita income is given by the slope of the S-Curve. Thus, the steeper the slope, the higher the growth rate. According to Lim (2009), in terms of per capita income growth rate, elephant economies normally grow at less than 3–4% per annum, whereas horse economies grow at more than 4%, at times much more than 4% per annum. Turtle economies, like elephants, will grow at 3–4% per annum at best.

Turtles move slowly, hiding beneath their shells. Turtle economies are plagued by low savings and investment rates, poor infrastructure, underdeveloped human resources and low quality of government. Many

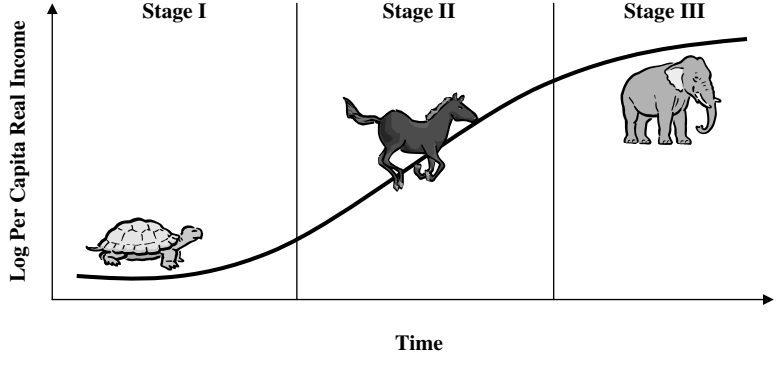

Fig. 1.1. S-Curve of economic development.

of these countries are in the low-level equilibrium trap, where high population growth often wipes out any potential per capita income growth. Developing at a crawling pace, the income levels of these turtle economies diverge further and further away from the rest of the world.

Some, definitely not all, of these turtle economies would break away from the vicious poverty cycle and metamorphose into rapidly-developing horse economies. Horse economies are characterized by high savings rates, high private sector's investment rates (including foreign direct investment), high public sector's investment in physical and human capital, export-oriented industrializing policy, favorable investment climate, and a stable, pro-development government. The rapid growth rate enjoyed by the horse economies can be attributed to the high rate of capital accumulation undertaken by the public and private sectors. It can also be explained by the quantum-leap transfer of technology, organizational skills and production techniques from the developed nations, which were made possible by the relatively low level of development of the horse economies in addition to trade and investment openness.[1] Galloping at a superlative rate, the income levels of these horse economies converge towards those of the developed nations.

The elephant is a high consumption animal. It is big and it moves slowly. Economic success in the affluent countries has led to a decline in the marginal utility of money and an increase in the preference for leisure. People in these countries consume more, save less, and have higher marginal propensity to consume leisure. Many of these economies are also confronted with the problem of an aging population that has an adverse impact on the growth rates of these economies.[2] In addition, accumulated

[1] The basis that allows for quantum-leap improvement in productive capability is similar to that put forth by Ng and Yang (1999), although they have focused on division of labor as the determinant of organizational efficiency. According to them, a less developed country as a newcomer in the industrialization process can always "obtain free information on the efficient pattern of the division of labor". The less developed country can thus mimic the organization pattern that has been proven to be efficient in the developed economies. Hence, instead of a gradual evolution of the division of labor, it is possible for a big jump in industrialization to take place.

[2] GDP per capita can be expressed as a multiplicative relationship between average labor productivity and share of population employed: $Y/POP = Y/N \times N/POP$, where Y is total output, POP is total population, and N is number of employed workers. An aging population would thus imply a decreasing share of population employed and put downward pressure on per capita GDP growth rate of the country.

capital stock is immense after many decades of physical development, resulting in diminishing marginal returns and relatively lesser investment opportunities for both the private and public sectors. Moreover, de-industrialization commonly takes place in the elephant economies as manufacturing activities are relocated to the cheaper developing economies. All these lead to a lower rate of investment. These factors, according to the S-Curve hypothesis, slow down economic growth.

Table 1.1 gives a comparison of the characteristics of the turtle, horse and elephant economies.

1.2.2. *S-Curve and EGOIN theory*

The S-Curve hypothesis is closely associated with the EGOIN theory, another proposition by Lim (1984, 1991, 2009) that postulates the level of economic development of a country is a direct function of its EGOIN. EGOIN stands for the five domestic co-determinants of economic development: Entrepreneurship (E), Government (G), Ordinary Labor (O), Investment (I) and Natural Resources (N). EGOIN is both the source and the manifestation of growth in an economy. The higher the level of EGOIN, the higher the economy will be on the S-Curve. Economies with rapidly improving EGOIN would enjoy rapid growth, and these economies belong to the horse category. On the other hand, turtle economies are those with low and stagnant levels of EGOIN, and the EGOIN levels of elephant economies are very high but growing very slowly at the same time. The EGOIN theory distinguishes between rate and level of growth. In order to grow rapidly, economies need to improve steadily on their EGOIN. Economies that experience quantum-leap improvement in their EGOIN, for example a move from planned economies to market-oriented economies (E), or adoption of pro-development investment and trade policies (G, E, I), will enjoy a jump in their economic growth rates.

The EGOIN theory adopts a man-centred approach, where E, G and O are considered as the active agents of growth. EGO is also the social capacity of an economy to accumulate and utilize the available physical and natural resources. The theory puts human factors on center-stage and the aptitude and attitude of the government, with its accompanying bureaucracy, as the most important co-determinants of

Table 1.1. Characteristics of turtle, horse and elephant economies.

	Turtle	Horse	Elephant
Income per capita	Low and slowly growing	Medium and rapidly growing	High and slowly growing
Savings rate	Low	High	Low
Investment rate	Low	High	Low
Openness to trade and investment	Low	High	High
Demographic profile	Usually high population growth	Youthful, usually controlled population growth	Aging population
Investment climate	Poor	Conducive	Diminishing returns and rising land and labor costs
Emphasis of society	Meeting basic needs and survival	Priority on economic achievements	High marginal propensity of leisure
Entrepreneurship	Poor, profusion of market-distorting government interventions	Market-oriented and entrepreneur-enabling	Market-oriented and entrepreneur-enabling
Government	Poor in both economic and political leaderships	Good leader with emphasis on economic development	Good leadership with emphasis on social development
Human capital	Underdeveloped	Medium and rapidly improving	High
Fixed capital accumulation	Poor infrastructures and low level of private sector capital accumulation	Rapidly improving infrastructures and rapid increase in private sector capital accumulation	Infrastructures and private sector capital stock well built up
Natural resources	Not well-utilized or lacking	Well-utilized	Well-utilized

development. Two key features differentiate the EGOIN theory from many other development theories. Firstly, the EGOIN theory is multi-faceted. Secondly, it emphasizes on the human determinants of development, in particular the quality of government and its bureaucracy. The multi-causality of the EGOIN and its focus on government provide a higher degree of realism to the theory.

1.2.3. *S-Curve and Triple C theory*

The Triple C theory, also by Lim (1996, 2009), postulates that economic growth is propelled by three engines: the domestic, the regional and the global. The domestic engine is powered by the EGOIN of the economy, while the regional and global engines are lubricated by trade and investment openness. Trade and investment are necessary for an economy to benefit from the inventions and technological advancement of other economies. Trade and investment also help to enlarge market size and enhance competitiveness. Thus, a (horse) economy that embraces open trade and investment policies stands to grow at a much higher rate than a (turtle) economy that adopts close trade and investment policies.

The Triple C theory argues that in order to drive the other two engines, it is necessary to have a domestic engine that functions well (Lim, 2009). If the domestic engine malfunctions, in particular "G", the regional and global engines will fail to work too. The importance of government and its bureaucracy in harnessing the benefits of globalization has also been put forth by other researchers. As Kirkpatrick (1994) and Cook and Kirkpatrick (1997) point out, "deriving the potential benefits of globalization requires effective economic management and policy formulation on the part of national policy-makers. Where administrative, institutional and organizational structures are weak, the capacity to 'manage' the globalization process is undermined".

1.3. Interpretations of the S-Curve

1.3.1. *S-Curve as the development path of an economy*

The S-Curve can be used to portray the development path of an individual economy. In this case, the variable on the *y*-axis will be the level of

economic development with (log) per capita income commonly used as a proxy. The *x*-axis variable is time. The slope of the S-Curve gives the rate of growth of the per capita income ($d \ln Y(t)/dt = \dot{Y}(t)/Y(t)$).

It is noted that each country has its own unique S-Curve. The S-Curve only depicts the general pattern of development. It does not explicate the duration a country would remain as a turtle/horse economy. It also does not spell out the per capita income level of a matured elephant economy. Figure 1.2 gives an illustration of the differing development paths of three countries. Using Economy 1 as a baseline case and supposing all three economies experience take-off at about the same period, Economy 2 grows at a faster pace and is thus transformed into an elephant economy over a much shorter period of time. On the other hand, Economy 3 only manages to achieve a much lower level of per capita income as compared to Economy 1, when both economies are in their third stage of economic development. According to the EGOIN Theory, the growth rate of an economy is determined by the rate of improvement of its EGOIN, while the income level of an economy is determined by its level of EGOIN. In the case of Economy 2, the rapid improvement in its E, G, O, I and N explains its rapid transformation. In the case of Economy 3, constraints such as geographical location, political state of affairs, lack of natural resources and even culture and social norms — factors which are often not within the control of the leaders and the people of the country, could cap the potential income level of an economy.

It is also noted that the not all time plots of per capita income of economies would show an S-Curve. For instance, the time plots of

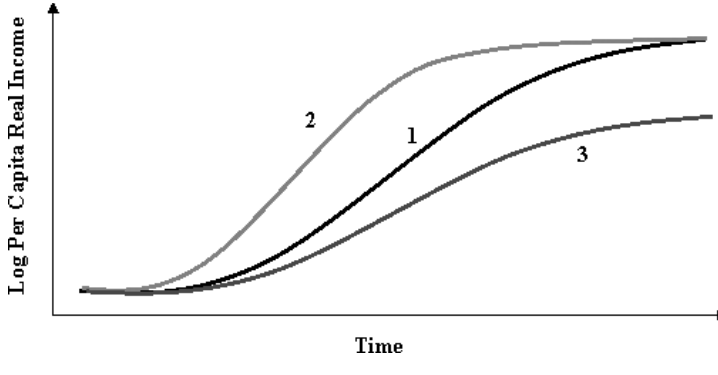

Fig. 1.2. Different S-Curves for different economies.

per capita income of turtle economies would not show an S-Curve, as these economies have not experienced economic take-off. In addition, the data series needs to be sufficiently long so as to trace the development of an economy. This will allow the time plot to show an S-Curve. Thus, limitation in the availability of data could result in the inability to sketch the S-Curve of the economic development of a country.

1.3.2. *S-Curve as a snapshot of the world economy*

The S-Curve can be used to depict a snapshot of the economic landscape of the world economy. In this case, the *y*-axis variable is the level of economic development while the *x*-axis represents the development stages, i.e. turtle, horse and elephant. Countries under study would be placed in ascending order according to their stages of development. The slope of the S-Curve represents the growth rates of the economies. Although it is not possible to plot the S-Curve in this context using empirical data, it is insightful to view the ranking of the economies against the framework of the S-Curve. Figure 1.3

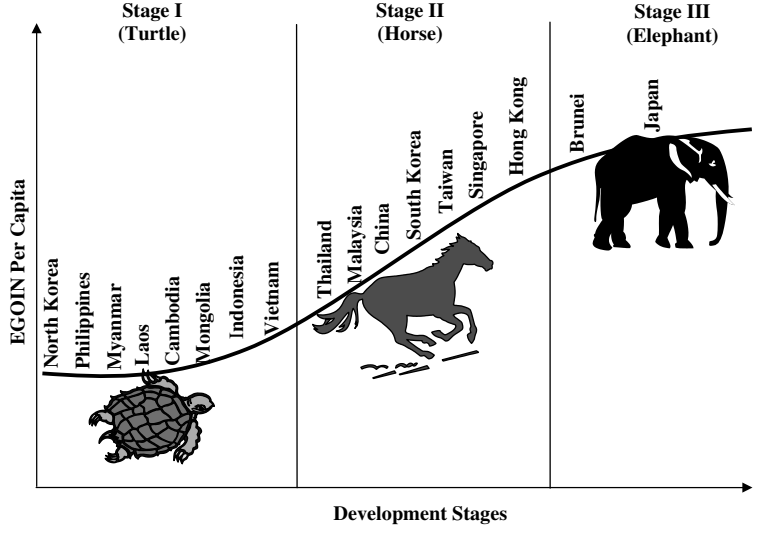

Fig. 1.3. S-Curve for the 17 East Asian economies.

Source: Lim (2005).

shows the ranking of the 17 East Asian economies according to their EGOIN per capita by Lim (2005).[3,4]

1.4. Empirical Support of the S-Curve Hypothesis

The S-Curve hypothesis is well-supported by empirical data. This section presents three separate bodies of evidence of validity of the S-Curve hypothesis.

1.4.1. *Evidence 1: Relationship between long-term growth rate and per capita income level*

If the S-Curve hypothesis is correct, a graphical plot of long-run GDP per capita growth rate against GDP per capita would present itself as an inverted U-shaped curve — low growth rates at the two ends of the income spectrum, and high growth rates for the middle-income countries.

Figure 1.4 plots the average annual growth rates of GDP per capita of 115 countries over a period of 40 years from 1961–2000 against their respective GDP per capita in 1990. The data are obtained from the Penn World Table 6.1 (Heston, Summers *et al*., 2002).[5] The GDP per capita figures are both PPP-adjusted and inflation-adjusted. The data series is fitted with a second order polynomial function with GDP per capita growth rates (*GYPC*) as the dependent variable and GDP per capita (*YPC*) as the explanatory variable. The result of the

[3] Some researchers may question the wisdom of placing Brunei as an Elephant economy. However, it is noted that the S-Curve in Fig. 1.3 is plotted against EGOIN per capita. Thus, what Brunei lacks in the quality of other aspects of EGOI is sufficiently made up through its abundance in oil and natural gas (N).

[4] GDP per capita has often been used as a proxy for EGOIN per capita. However, an important difference between the two measures is that while GDP is the output of a country, EGOIN measures the output potential of the country.

[5] Data on 168 countries are available from the PWT 6.1. However, only 115 countries have GDP per capita data spanning across more than 30 years. These 115 countries are used in the following analysis.

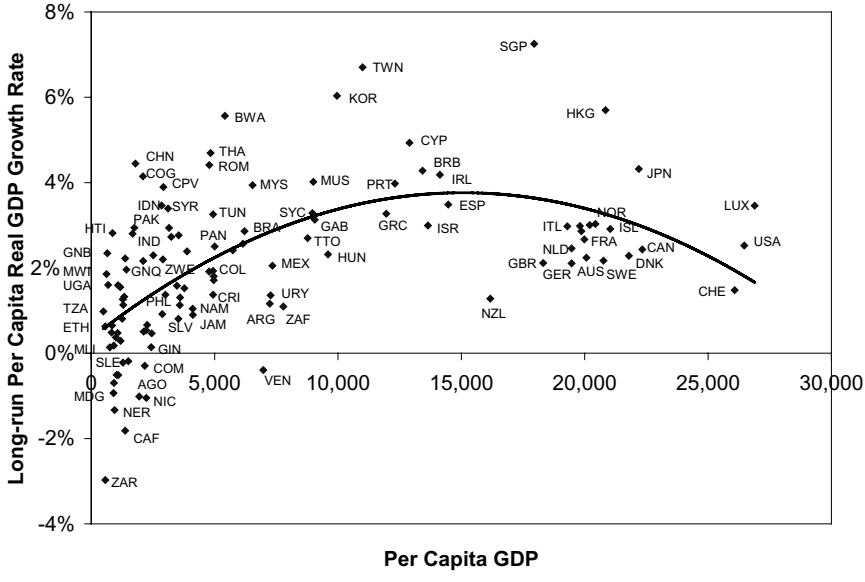

Fig. 1.4. Average annual GDP per capita growth rate from 1961–2000 versus GDP per capita in 1990 (international $ in 1996 prices).

Source: Computed through data from PWT 6.1 (Heston, Summers *et al*., 2002).

regression and the corresponding *t*-statistics (in parentheses) are given as follows:

$$GYPC = 0.00356 + (4.523 \cdot 10^{-6}) \cdot YPC - (1.501 \cdot 10^{-10}) \cdot (YPC)^2$$
$$\qquad\quad (1.404) \qquad\quad (6.426) \qquad\quad (-5.036)$$
$$R^2 \quad = 0.3588$$

The coefficients for *YPC* and YPC^2 are significant and are correctly signed. The predicted values show an inverted U-shape in Fig. 1.4.

The U-shaped relationship between the GDP per capita growth rate and the GDP per capita can also be tested using the correlation coefficient: correlation between the two variables should be positive for low to medium per capita income level, and negative for high per capita income level. Using International $15,000 as a cut-off point, we tested for the correlation between

the GDP per capita growth rate and the GDP per capita. For countries with per capita income below International $15,000, which would include the turtle and the horse economies, the Pearson product moment correlation coefficient is 0.59. On the other hand, for countries with per capita income above International $15,000, the Pearson product moment correlation coefficient is –0.09. Thus, the results support the S-Curve hypothesis again.

1.4.2. *Evidence 2: Growth patterns of country groups by income levels*

Phillips and Sul (2005) use per capita real income data from the Penn World Table from 1960 to 1996 to illustrate the growth patterns of 88 economies by income groups. The authors first divide the 88 countries into five sub-groupings based on their initial income: poorest, poor, middle, rich and richest. The authors then plot the time paths of the sub-group averages over five successive panels in the same graph, from the poorest to the richest. Each panel spans the 37-year period between 1960 and 1996. The resultant graphical plot, as given in Fig. 1.5, is an interesting and new way of looking at the evidence of convergence and growth. Equally interesting is that the graphical plot resembles Lim's S-Curve of

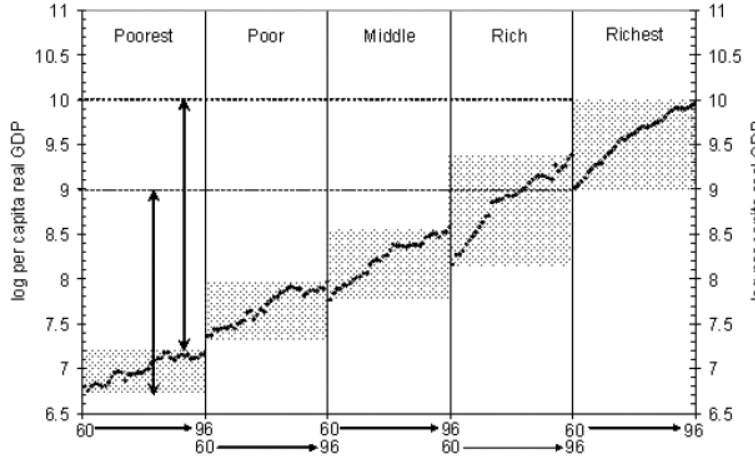

Fig. 1.5. World economic growth, 1960–1996.

Source: Phillips and Sul (2005).

economic development. Relating Figure 1.5 to Figure 1.1 of the S-Curve hypothesis, the "poorest" and "poor" country groups correspond to the "turtle economies", the "middle" and "rich" country groups correspond to the "horse economies", and the "richest" country group corresponds to the "elephant economies".

As described by Phillips and Sul (2005), "While each panel restarts the time profile from 1960 onwards, the arrangement of the panels produces an escalator effect from the poorest to the richest groups that is surprisingly connected in form. The escalator begins with a stair that has a fairly flat shape corresponding to the slow growth of the poorest nations and the stairs generally become steeper as the nation groups become richer and grow faster". The total economic growth over a 37-year time span for the average of each country group is given by the height of the shadowed area in Fig. 1.5. With the exception of the "richest" country group, the total economic growth of the first four groups correlate positively to the initial income levels of the groups. The growth of the "richest" country group is lower than that of the "rich" country group, although it is higher than the other three groups. This result concurs with the S-Curve hypothesis which states that middle-income countries grow more rapidly than low- and high-income countries.

Furthermore, it can be seen from Fig. 1.5 that the "rich" countries are catching up with the "richest" countries, signaling convergence at the upper-tier of the world economy. On the other hand, the rest of the world economies are diverging from the "rich" and "richest" countries in terms of income level.

1.4.3. *Evidence 3: Cross-country income distribution*

The S-Curve hypothesis predicts that over time, the turtle economies would diverge further and further away from the rest of the world, while the horse economies would catch up with the elephant economies. When viewed against empirical data on cross-country income distribution, one would expect the overall spread of per capita income to increase over time, while the income distribution between the upper-middle and the high-income economies to narrow over time.

Durlauf and Quah (1999) developed some stylized facts on the properties of cross-country distribution of growth characteristics. Using data from the Summers–Heston V.6 database for the period 1960–1989, the

authors show that the overall spread of per capita incomes increased over time, "the extremes appear to be diverging away from each other — with the poor becoming poorer, and the rich richer". This stylized fact is in line with the S-Curve hypothesis which postulates that the turtle economies would diverge further and further away from the rest of the world.

In addition, Durlauf and Quah (1999) also show that within clusters, there is a fall in the spread between the relatively rich countries. According to the authors, the income distance between the 85th and 95th percentiles was 0.98 times world per capita income in 1960–1964; this distance fell to 0.59 in 1985–1989. This stylized fact is again in line with the S-Curve hypothesis which postulates convergence at the upper-income level of the world economy.

1.5. Insight and Implications of the S-Curve Hypothesis

The S-Curve hypothesis offers several insight and policy implications for economic development:

1. Income levels of the horse economies would converge towards those of the elephant economies, while income levels of the turtle economies would diverge away from the rest of the world. Over time, the income differential between the world's richest countries and the world's second richest is expected to narrow, although the overall income distribution of the world economy would remain wide.
2. In the long process of world economic development, many of the horse economies would eventually graduate to become elephant economies, although the growth prospects of some of the horse economies may falter and these economies would slip back to become turtle economies. At the same time, there would be some turtle economies whose EGOIN has undergone significant improvements, and these economies would transform into horse economies.
3. The superlative growth rates of the horse economies can be explained by high investment rates and quantum leaps in technological transfer (Lim, 2005). The rapid accumulation of physical capital, from both domestic and foreign investment, would directly result in higher GDP and would generate higher output growth for the future. At the same time, the relatively low level of development of the horse economies enables the quantum-leap transfer of technology, organizational skills

and production processes from the developed nations. It is thus important for developing countries to adopt open trade and investment policies that encourage interaction and exchange with other countries.

4. The superlative growth rates of the horse economies would eventually slow down as their income levels approach those of the elephant economies. This is because the quantum-leap benefits enjoyed by the horse economies through technological transfer would diminish as their technological levels approach those of the elephant economies. A country such as Japan that used to be a horse economy during those decades after the Second World War has seen its growth rate slow since the late 1980s. In other words, the slow-down of the Japanese economy can be explained by the S-Curve hypothesis. Following the same line of argument, Singapore's economy will soon be slowing down to the 2–4% growth rate similar to those of the developed nations. There is very little theoretical and empirical support that suggests a very high-income economy can continue to grow at a superlative rate over a prolonged period of time.
5. The rapid-growing horse economy that is able to catch up with the developed nations in a span of a few decades is a fairly recent phenomenon. Globalization, world trade, cross-continent investment and international capital flow have provided the necessary impetus to spur the growth of poor but open economies. In other words, openness to trade and investment are two of the most critical determinants of economic development.
6. Growth determinants are multi-faceted. Apart from investment (I) and technological transfer (closely associated with I) that are emphasized by the S-Curve hypothesis, the other determinants are E, O, G and N as outlined in the EGOIN Theory. Of these, G, the attitude and aptitude of the government and its bureaucracy, is the most important determinant. G plays the role of an enabler; without G, the accumulation, development and full utilization of E, O, I and N will be hampered. However, in contrast to the stability of the other four co-determinants, G is susceptible to large and sudden fluctuations that could derail the development process of the economy.
7. The level of income of an economy is dependent on the level of its EGOIN. Likewise, the rate of growth of the economy is dependent on the rate of improvement of its EGOIN. An economy whose government is adopting pro-development policies, opening up its economy steadily to international trade and private investment (E), improving

its human capital (O) continuously, accumulating physical capital stock rapidly (I) and/or utilizing its natural resources efficiently (N) would enjoy a high rate of economic growth.

1.6. Conclusion

The S-Curve hypothesis, to a large extent, captures a snapshot of the current economic landscape accurately. Empirical analysis in Section 1.4.1 shows that the world's economies can be broadly classified into the three categories according to the S-Curve hypothesis.

The S-Curve hypothesis also describes the development experiences of economies that have rapidly developed after the Second World War adequately, such as Singapore, Japan and China. These countries have experienced an intense phase of rapid development over a 30 to 40-year period in recent decades. Two important factors were present during the rapid growth phase of these countries that greatly strengthened their growth intensity: (1) other highly developed nations that these countries could emulate; and (2) increased globalization that facilitated knowledge transfer. These two factors allowed the quantum-leap in technological level and accompanied high-income growth to take place. The S-Curve hypothesis, however, is less useful in describing the development experiences of the OECD economies.

It is important to note that the S-Curve hypothesis is not an iron law — it only depicts a tendency. For instance, the hypothesis does not imply that all horse economies will continue on the "sure path" to future economic development. Political instability, turn-about on pro-development policies, and a corrupted and inefficient bureaucracy could always derail the growth of a horse economy and even push it back to a turtle economy. The hypothesis also does not imply that an elephant economy would always remain as an elephant economy. If complacency sets in, even a developed country could regress to a developing country as well.

The S-Curve hypothesis is a useful theory that can be used to explain both convergence and divergence, and the formation of a convergence club in economic development. Lim (1996) has also succinctly described the defining characteristics of economies at the various stages of development. One of the contributions of the S-Curve hypothesis is that it highlights the drivers of growth that are needed for economic development.

The main weakness of the S-Curve hypothesis is that it lacks quantitative rigor. There is a lack of empirical proof of the S-Curve hypothesis and there is a lack of empirical analysis on the growth paths of economies at different stages of development. In addition, the completeness of the S-Curve hypothesis as a growth model is also hindered by its lack of micro-economic foundation. These weaknesses will be addressed in the following chapters.