Chapter 2

Sustainability of Growth: Theoretical Issues
In the previous chapter, we have proposed our research question – ‘the conditions under which the growth of Indian software industry will sustain in future and consequently global supremacy will be achieved’. In this chapter, an attempt is made to find out growth sustainability conditions from the available literature. In the subsequent chapters we shall examine the Indian software industry in the light of the conditions of sustainability derived in this chapter.

In economic literature, long run sustainability of an industry did not receive any special attention. The question of sustainability has been addressed in macro level. The growth of an economy has been the concern of classical economists – a la Malthus and Ricardo. The question also enters in the Marxian scheme as a political process. At the level of industry, the question can be approached in two ways. One relates to the study of firms’ competitiveness in an industry (Schumpeterian idea) and other relates to the catching up theory where quality of economic activity (parallel to industrial activity) has been seen as engine of sustainable growth. From both approaches, we would determine long run sustainability conditions of the industry.

This chapter is divided into three sections. In the next section, the literature of growth theory (within Classical, Marxian, Neo-classical and New Growth Theory framework) is reviewed to find out long run growth sustainability conditions. Literature review reveals that the conditions of growth sustainability of an economy can only be derived from New Growth Theory. However, our objective is to find out the conditions of sustainability at industry level. The second section of this chapter attempts to elaborate Schumpeterian idea of firms’ competitiveness and catching up theory (which is the pillar of New Growth Theory) to determine industry level sustainability conditions. This
section also illustrates how catching up process (by choosing high quality knowledge intensive activities) has assisted in achieving phenomenal sustainable growth of the knowledge intensive industry as well as the economy of Newly Industrialized Countries (NICs). The last section brings out the conditions of sustainable growth, which are deduced from the characteristics of high quality knowledge intensive activity.

2.1 Sustainability Conditions in Growth Literature

In the classical economic literature, it was not the question of sustainability, but the question of non-sustainability, which has been addressed. Production and distribution were the central theme in the classical political economy with the concept of fixed economic endowment that influenced the economic growth. Ricardo is said to be the first classical economist to deal directly with and formulate a theory of economic growth based on accumulation of capital out of production of current period and growth of population following Malthusian law with explicit consideration of resource scarcity. According to him the economic growth is constrained by limited natural resources. Land has come as a main means of production in the Ricardian scheme and ultimate destiny of an economy is dependent on the limitedness of land in nature. As the economy grows over the time period, more and more inferior land is taken into production process because of scarcity of resources, making fewer resources available for future production. Under the assumption of subsistence wage rate, cultivation of ever less fertile land will result to fall in total profit and finally all accumulation will cease. The falling rate of profit is the indicator or symptom of absolute stationary state or the concept of limit to growth in Ricardian scheme. It has been asserted in his writing that this stationary state can be overcome by using technology for better use of existing resources and discovering
of new resources for holding back the situation of falling rate of profit. But here technology is seen as an exogenous factor, not as a separate endogenous factor explaining productivity growth in the economy. At a particular point of time, it is treated as constant. Thus scarcity and resulting stationary state is the destiny in Ricardian system. The system does not describe anything about the conditions of growth sustainability in long run, but the conditions of non-sustainability and limit to growth because of exhaustibility of natural resources.

Marxian model happens to be a total break from the mercantilist tradition, i.e. notion of wealth as a notion of fixed endowment within the geographical boundary of a country. It is within the production system that Marx finds the history of progress of a society through a complex process of class conflict and class hegemony. Ever active political process of class conflict would create the condition of unimpeded unleashment of productive forces, (which is labor in Marxian scheme) and that would help the society to move on the path of progress. Clearly, technology plays a crucial role in more productive use of laborers in his production process for generating more surplus value. But how the technology is conceived in the production process is not elucidated in this model. Technological progress comes in Marxian model as similar as of Ricardian exogenous factor used into the production system.

It is to be noted that falling rate of profit and stationary state of situation is not the destiny in Marxian system. Unlike Ricardo, Marx's falling rate of profit is internal to the system. It is the very dynamics of the capitalist system that finally leads to the situation. It is only a stage in the course of the history of social progress arising because of exploitative nature of the social and economic order that makes the ruling class incapable
of further development of productive forces beyond its narrow class interest. Ever active political process of class conflict removes this impediment on eternal path of progress of society. Thus the issue of long run growth sustainability enters as a political process in Marxian scheme.

The problem of scarcity of natural resources has also received special attention in neoclassical system as a result of unlimited human needs to be fulfilled by known resource endowment. This scarcity can be removed by expanding the horizon of knowledge of resources as well as best use of known resources. In neoclassical economics, time is notional. At every point of time the problem of matching resources with unlimited greed remains. The scarcity therefore has no particular relation with time and growth of the economy over time. At the same time, there is no limit to growth in neoclassical system, in spite of the arrival of optimal allocation of resources at a particular point of time. This is possible because of the technological progress that enters into the system in every successive time period. The economy is set on a growth path as long as it is technologically progressive. In the absence of exogenous technological progress, there would not be any sustainable productivity growth in the long run. In neoclassical economics, therefore, time is synonymous with technological progress.

Although long run sustainable economic growth is critically dependent on technological progress, there is no theory of technological progress in neoclassical theory. It is only the assumption of rational individuals maximizing economic gains in making economic decisions can provide some clue to the question how technological progress takes place in a typical neoclassical system. The neoclassical equilibrium theory established by Walras was not able to deal with problems relating to the proper
explanation of the role of technological progress as the most prominent driving force of economic growth. Although the problem of technological progress was one of the main topics given consideration by classical economists but it was not an object of concern for neoclassical school. It is interesting to observe that neither Ricardian nor neoclassical system has any dynamic principles within the system that sets the economy to sustainable growth path. Therefore long run sustainability conditions can also not be derived from neoclassical theory.\textsuperscript{14}

However, development economists for the last two decades tried to search for explanations of the role of technological change and innovation in economic progress. In the 50s, Robert Solow (1957) for the first time crafted theory that added a third factor - technical knowledge - along with diminishing returns of capital and labor - that assisted economic productivity and growth. Although Solow's model pictured technology as a continuous, ever-expanding set of knowledge, this model is often referred to as an "exogenous" model of growth as technology was assumed to be determined by forces outside the economy (Cortright 2001).

By mid 70s, attempts had been made to develop new theories of long run sustainable growth in productivity. Inspired by Schumpeter and Kaldor, the terrain was taken over by mostly economic historians and economists with a more heterodox background. They tried to explain difference in growth by the existence of gaps in technology between countries. One stand of research focused on the potential for catch-up by countries behind the technology frontier and prerequisites for exploring this potential (Gomulka 1971, Cornwall 1977, Maddison 1979, Abramovitz 1979). Large

\textsuperscript{14} The discussion is based on Nath (1992)
technological difference between rich and poor countries and engaging in technology catch up (narrowing the technology gap) was perhaps the promising avenue that poor countries could follow for achieving long run sustainable growth. Others (Dixon and Thirlwall 1975, Thirlwall 1979), to a large extent inspired by Kaldor pointed out that the existence of technology gaps between countries may equally well be consistent with a diverging pattern rather than convergence. However, in the middle of the 80s, "New Growth Theories" were developed by mainstream economists based on the technological congruence and catch-up theory (Fagerberg et al. 1994, 2001). The New Growth Theory describes the conditions of sustainable growth along with knowledge intensive economic activities (which is parallel to industrial activities) that can ensure the economy to the growth path.

The general understanding of models prior to New Theory of Growth was 'growth happens in its way'. But New Growth Theory started with the question - 'how to make growth happen'. New theory views technological progress as a product of economic activity. The rate of economic growth of a country is believed to be positively influenced by the rate of growth in the technological level of the country. Here long run sustainable growth is characterized by increasing returns to reproducible factors as a result of the accumulation of knowledge and technology. These increasing returns drive the process of growth. An economy with a continuous expansion of knowledge base may therefore experience positive long run growth instead of the neo-classical steady state growth. Thus the central notion behind New Growth Theory is increasing returns associated with new knowledge or technology - shift from a traditional resource-based (capital and labor) economy to a new knowledge-based economy.
From the above discussion, it is apparent that although long run sustainability conditions can not be derived from Classical, Marxian and Neo-classical literature, New Growth Theory narrates about sustainable growth. However, non-of the theories directly provide the conditions of long run growth sustainability at the industry level. In the next section, an attempt is made to derive industry level sustainability conditions from the literature of New Growth Theory.

2.2 Growth Sustainability at Industry Level

Previously we have argued that the industry level sustainability question can be approached in two ways. One relates to the study of firms' competitiveness in an industry based on Schumpeterian thought and other relates to catching up theory. Both are being discussed in details in this section.

2.21 Competitiveness of Firms in an Industry

A subsequent class of models is developed explicitly based on the Schumpeterian idea that innovation by firms is the force that drives the growth process. These models articulate the conditions of micro level growth sustainability, which assists us to derive sustainability conditions of industry. Here profits are viewed as the motivation of innovative activity and the vehicle by which successful innovators grow relative to other firms. Competition (monopolistic) is represented as an active ‘out-of-equilibrium’ dynamic process. Businesses compete with one another, not based on the price of

Joseph Schumpeter is considered as the central contributor to ‘out-of-equilibrium dynamics’ literature. Many economic historians, for example, Alexander Gerschenkron, Moses Abromovitz and Nathan Rosenberg are also developed their theories in the same line. What these authors have in common is that they focus on evolution as a process of qualitative change that take place in historical time, driven by firms, governments and other organizations (rather than individuals) with a diverse set of motivations, decisions rules and capabilities (rather than optimizing behavior and perfect information) (Fagerberg et al 2001).
similar products, but based on their monopoly position with a particular differentiated product and service. In these models, technology is seen as a separate, endogenous factor explaining productivity growth in the economy (Romar 1990, Grossman and Helpman 1991). Users of new technologies seem to pay a price to cover the cost of new technology. In return they receive an exclusive monopoly right to its use. Thus, technological progress is at least partly appropriable, and this introduces an element of imperfect competition into these models. At the same time, new technologies also add to the existing pool of knowledge and in the process facilitate new technological developments. Thus the incentive to innovate due to the appropriability of technological progress and the positive externality from this process are the two elements, combination of which allows growth to go on (Cortright 2001). In these models growth therefore depends positively on the amount of resources available (i.e. human capital and R&D) for development of new technologies. Along with traditional factors of production namely capital and labor, human capital or knowledge therefore appears to be the main factor in the production process. Accompanying with knowledge, innovation, imperfect competition and technological progress are the conditions derived for the long run sustainable industrial growth.

2.22 Catching Up Process

Can developing countries catch-up with the developed countries? This and similar question(s) have been central to the literature of New Growth Theory. Abramovitz (1979) pointed out a set of conditions that governed the relative potential of different countries to raise their productivity. He also elaborated a group of factors that influenced their ability to realize their potential. According to him, countries’ potentials for rapid productivity
growth by catch-up are not solely determined by the gaps in levels of technology. The laggard countries may face varying degrees of difficulty in adapting and adopting the current practice of leaders. The resource availability, factor supplies, technological capabilities, market scales and consumer demands in laggard countries may not conform well to those required by the technologies that have emerged in the leading countries. Thus 'technological congruence' depends on the characteristics of leader country. To implement leader country technologies, backward countries need to emulate some of these characteristics. At the same time development of 'social capability' is required that covers countries' level of general education, technical competence, development of commercial, industrial and financial institutions to exploit the opportunities afforded by existing technological best practice. In a nutshell, along with the productivity gaps in levels of technology among countries, technological congruence and social capability are the important determinants of catch-up potential.

Therefore the necessary condition of the laggard countries to be able to take advantage of the available technology, is the well-developed capacity to adopt the superior technology. The capacity to adopt and implement advanced technologies is determined by policy variables that are conducive to technology adoption. The catching up theory states that technological catching up is strongest in countries that are not only technologically backward but also has policy determinants conducive to technology adoption.

Growth of technological capability and knowledge are therefore highly cumulative and path-dependent. For a lagging country to be able to absorb knowledge from leader countries, it must accumulate sufficient prior knowledge; the initial
knowledge gap should not be too wide. Sufficient absorption capability implies having qualified researchers who are able to understand external knowledge spillover and recognize their value in operation. In other words, a lagging country needs a strong human capital base with well-developed scientific, engineering and technical skills.

Let us discuss how catching up process has assisted in achieving phenomenal long run sustainable growth of newly industrialized countries. This will guide us to make out how knowledge intensive industrial growth becomes central force in sustainable economic growth and development.

2.23 Recent Growth of NICs by Catching up Process

For more than three decades, the export-oriented East Asian NICs or the so-called NICs 4, i.e., Korea, Taiwan, Hongkong and Singapore, grew by nearly 10 percent per annum on average. Japan also grew at a similar rate. The new NICs, i.e., Thailand, Malaysia, Indonesia and China have recently begun to reveal similar high growth performances.

However, one common strategy can be observed among these East Asian NICs. They have, in one way or another, tried to approach learning, productivity change and technology issues, through an active role by the state, in encouraging knowledge intensive industrial growth and therefore economic development. For example, in less than 20 years, Taiwan and Korea have not only dramatically increased their production capacities and market share in the semiconductor industry, but also more impressively improved their R&D capabilities in the same sector, which directed their economy to grow enormously. This demonstrates the importance of long-term perspective of

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16 For detailed study, see Song (2000)
knowledge intensive industrial growth and the necessary accumulation of technological capabilities to that end. Porter (1990) also provides similar message. He advised to concentrate on few 'star'/ 'good' industries for economic development. Knowledge intensive industry specific growth of nation is therefore believed to be the core of the economic growth in New Growth Theory.

Be it the result of extraordinary resource mobilization / technological catch-up / industry specific growth, the very natural questions are, out of more than 150 underdeveloped countries, how the industry specific technology catching-up process had commenced in these handful number of countries and how the growth dynamism could have been maintained in these economies over such a long period of time.

To provide answer to the above questions, Nath (et al 2002) has elaborated the case of Kuwait and Korea. Although it has been observed that the GDP per capita of Kuwait is higher than that of Korea, Kuwait’s economy is said to be non-sustainable in future. Kuwait’s source of growth is its export of primary commodity (fossil fuel, a natural resource) which is exhaustible. On the other hand, Korea’s per capita GDP is dependent on technological and manufacturing capability and export of manufactured commodity. The strength of Korea is in its knowledge intensive production activity as opposed to natural resource intensive economic activity of Kuwait. Korean economy is likely to be more sustainable because by generation and application of knowledge, it would be able to offer new products and efficient production process. Therefore, two

However, Krugman (1996) criticizes Porter arguing that the competitive metaphor that works well in the context of the performance of firms within an industry is far less effective in efforts to understand the forces that drive the prosperity of an economy. His principal argument is that a country’s success is determined by the productivity of its people operating across all as opposed to a few sectors. And that should be the policy focus.
important insights developed from the example of Kuwait and Korea are (a) The value of the economic activities resides in the knowledge component attached to it (b) Enhancing value of any economic activity of an economy needs strategic choice of economic activity of high knowledge intensity.

Figure: 1 Stylized Catching Up

To show how countries like Japan and East Asian NICs have substantially caught up with United States, Rodrigo (1996) has drawn a highly stylized representation of the catch-up phenomenon. Figure 1 depicts the growth of GDP per capita for developed and developing countries. The gap between the two lines signifies the comparative level of economic development in both the economies. It also shows the space that has to be covered by the developing countries if they have to catch up. Catching up here means enhancing economic activities within a real time period so that the developing countries can equal the GDP per capita of the developed countries. The ‘S’ shaped curve shows the ideal trajectory of catching up within the real time period. Now it is important to determine which ingredients promote growth and which hold it back.
Like firms' competitiveness in an industry, the catching up process is also characterized by the development of most important resource of all, the skills of the people of the country. The education levels and technological competence are observed to reach high level in the countries for those who are successful in catch up process. According to Rodrigo, "The potential real income per capita of a country depends on the productivity of its labor. Potential labor productivity in turn depends on the level of accumulation of human and physical capital in that country. Human capital represents the skill levels of its entire workforce, including managers, administrators and suppliers of various other services. Human capital depends on educational levels, but even more crucially on skills acquired through actual work experience, whether in production, administration or whatever other capacity. Physical capital is, of course, a measure of the technological leverage embodied in machines and other productivity-enhancing equipment" (Rodrigo 1996, pg. 9)

In a nutshell, from the above discussion in this section, it is apparent that knowledge intensive industrial growth is the core of long term sustainable economic growth. East Asian NICs have successfully followed industry specific, knowledge intensive, technology catching up process that assisted them to maintain growth dynamism for the long period of time. On the other hand, knowledge spillover within and across industries and composition of country's industrial activity appear to be important driving force for sustainable industrial growth. A major role was played in this by exposure to the competitive pressures of the world market and its shaping of firms' incentives to invest in innovation. Technological spillovers in manufacturing and R&D, particularly the influx of technology embodied in capital goods was created comparative
advantage in a high-technology industry like semiconductor design and fabrication. Thus the technology spillover within and across industries would lead one to believe that sustained economic growth is depended on knowledge intensive industry specialization and its sustainable growth.

We can assert that economic growth is a matter of international competitiveness, which is again a matter of embracing the knowledge-base economy. The knowledge-base economy depends strongly on the growth and promotion of knowledge intensive industry (like information technology). If economic growth is to be sustainable, the increasing growth and promotion of knowledge intensive industry has to be conducive to sustainability. Hence, there is a link between the growth sustainability of the knowledge intensive industry and the economy. The link is established by strategic choice of high quality knowledge intensive activity that assists economy as well as industry to maintain its sustainable growth. In the next section, we will attempt to identify important ingredients for catching up process, which are basically the characteristics of high quality activities as well as conditions for sustainable growth.

2.3 Ingredients for Catching Up process and Conditions for Sustainable Growth

It has been observed that countries that have been successful in technology catching up are not characterized by their dependence on natural resource endowment. However, their competitiveness is based more on industrial capacity and human capital than on abundance of natural resources or physical capital. These countries have strategically chosen economic activity of high knowledge intensity. Concentrating on sustainable growth of knowledge intensive industry, they have become successful to catch up developed countries. The steepest portion of the ‘S’ curve in Figure 1 in fact
signifies the knowledge content of the economic activities that is needed to be able to climb the steep slope.

In order to establish the conditions of growth sustainability, it is important to understand the indicators of non-sustainability of growth. Theoretical insights into the growth process indicate that the remarkable lack of catch-up strategies seem to be associated with non-sustainable growth (Reinert 1994). Moreover, Michael Porter (1980), in his writings hinted at how to avoid working where there are no barrier to entry, no economies of scale and where information is reasonably perfect – to build up competitive advantage of nation. Competitiveness and creating imperfect markets in Porter’s view furnish sustainable growth in future. According to Schumpeter, creating imperfection is actually creating growth opportunity by the firms in the market through creating innovative knowledge. On the other hand, interactive learning, research & development and the resulting innovation, according to Lundvall (1992) and Nelson (1993), are crucial factors in explaining sustainable growth.

Most of the above indicators of sustainable growth have also been reflected in Reinert’s study (1994). He emphasized that the activity specific strategies are common to all presently successful industrialized countries. He attempted to isolate the factors causing some knowledge intensive activities to be “better” than others and argued that these activities create a common platform from which growth becomes self sustainable. Characteristics of high and low quality knowledge intensive activities as shown by Reinert are listed below:
### Table: 1 The Quality Index of Economic/Industrial Activities

<table>
<thead>
<tr>
<th>Characteristics of High-quality Activities</th>
<th>Characteristics of Low-quality Activities</th>
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<tbody>
<tr>
<td>Steep learning curves</td>
<td>Flat learning curves</td>
</tr>
<tr>
<td>High growth in output</td>
<td>Low growth in output</td>
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<tr>
<td>Rapid technological progress</td>
<td>Little technological progress</td>
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<tr>
<td>High R&amp;D content</td>
<td>Low R&amp;D content</td>
</tr>
<tr>
<td>Necessitates and generates learning-by-doing</td>
<td>Little personal or institutional learning required</td>
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<tr>
<td>Imperfect information</td>
<td>Perfect information</td>
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<tr>
<td>Investment comes in large chunks</td>
<td>Divisible investment</td>
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<tr>
<td>Imperfect but dynamic competition</td>
<td>Perfect competition</td>
</tr>
<tr>
<td>High wage level</td>
<td>Low wage level</td>
</tr>
<tr>
<td>Possibilities for important economies of scale and scope</td>
<td>Little or no economies of scale / risk of diminishing returns</td>
</tr>
<tr>
<td>High industry concentration</td>
<td>Fragmented industry</td>
</tr>
<tr>
<td>High stakes: high barriers to entry and exit</td>
<td>Low stakes: low barriers to entry and exit</td>
</tr>
<tr>
<td>Branded product</td>
<td>Commodity</td>
</tr>
<tr>
<td>Standard neoclassical assumptions irrelevant</td>
<td>Neoclassical assumptions are reasonable proxy</td>
</tr>
</tbody>
</table>

Source: Complied from Erik S. Reinert (1994)

To achieve sustainable growth, Reinert has prescribed to select high quality economic activities, which are growth inducing rather than growth inhibiting. Degree of imperfect competition brings inducible growth. High risks of innovation and new technology tend to improve production process, which assists in continued growth in industry’s output. As a result, ability to pay high wages is observed and high potential profit level is achieved. High entry barrier is another characteristic of high quality activities as entry within industry brings change associated with innovation. High barriers to entry also carry with them high barriers to exit as large chunks of initial investment causes huge losses.

Bringing Schumpeter, Porter and Reinert together, we can conclude that the characteristics of high quality economic/industrial activities are the conditions of sustainable growth – the successful execution of which assists the industry to be ahead of
others. In the case of Indian software industry we shall examine some of these characteristics in subsequent chapters. Among many conditions of sustainability mentioned by Reinert, we shall stick to a few that are common between Porter and Reinert, namely, wage level, skill level, innovation level, market concentration, barrier to entry, learning curve etc. The principal argument of all the studies reviewed (within New Growth Theory) is that the selection of knowledge intensive activities for creation of competitive knowledge advantage is the crux of sustainable growth. In the next chapter, we shall investigate the knowledge advantage of Indian software industry that have located the industry in the value chain of the software development process. This is followed by a study of the structure of Indian software industry where we examine the traits of industry in terms of entry barrier, level of industry concentration, international competitiveness and technological competency. The skill issue and knowledge advantage created and utilized by the software industry is taken up in a separate chapter. Much of quality and knowledge intensiveness of activities in the software industry can be understood by the nature and behavior of the capital that is invested in the industry. We explore the nature of venture capital that is employed in the industry separately.